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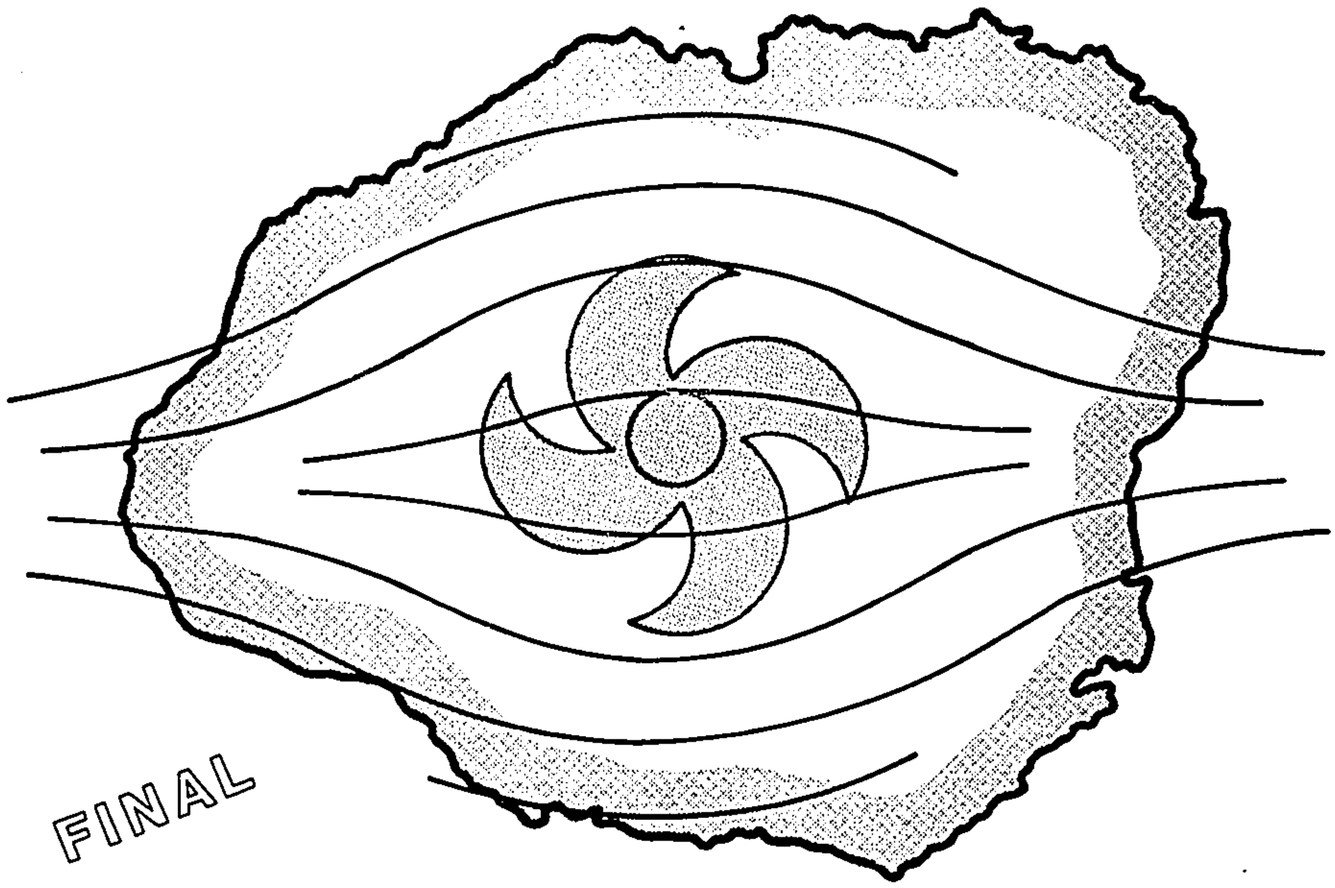
WAILUA RIVER HYDROPOWER

KAUAI, HAWAII



FINAL

INTERIM SURVEY REPORT AND ENVIRONMENTAL STATEMENT

US Army Corps of Engineers
Honolulu District

PODDE (30 Dec 82) 1st Ind
SUBJECT: Wailua River, Island of Kauai, Hawaii - Final Interim Survey Report and Environmental Statement

DA, Pacific Ocean Division, Corps of Engineers, Fort Shafter, HI 96858
30 December 1982

TO: Resident Member, Board of Engineers for Rivers and Harbors, Kingman Building, Fort Belvoir, VA 22060

I concur in the views and recommendations of the District Engineer.

R. M. BUNKER
Brigadier General, U.S. Army
Commanding

3 Incl
nc

CF:
CDR USACE (DAEN-CWP-W),
WASH DC 20314 w/incl
1. (6 cys)
2. (3 cys)
3. (1 cys)

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
FT. SHAFTER, HAWAII 96858

PODED-PJ

30 December 1982

SUBJECT: Wailua River, Island of Kauai, Hawaii - Final Interim Survey Report and Environmental Statement

Division Engineer
US Army Engineer Division, Pacific Ocean
Fort Shafter, HI 96858

In accordance with ER 1105-2-60, I am forwarding my report (Incl 1) to you for transmission to the Board of Engineers for Rivers and Harbors. Copies of the Division Commander's Public Notice (Incl 2) and mailing list (Incl 3) are also supplied.

Alfred J. Thiede

ALFRED J. THIEDE
Colonel, Corps of Engineers
Commanding

3 Incl
1. as (25 cys)
2. as (5 cys)
3. as (2 cys)

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
FT. SHAFTER, HAWAII 96858

FINAL
INTERIM SURVEY REPORT
AND
ENVIRONMENTAL STATEMENT

WAILUA RIVER HYDROPOWER
KAUAI, HAWAII

DECEMBER 1982

REV. JUN 83
REV. JUN 83 (2)

INTERIM SURVEY REPORT
FOR
WAILUA RIVER, KAUAI, HAWAII

SYLLABUS

The purpose of this report is to document the feasibility of potential hydropower improvements for the Wailua River, island of Kauai, Hawaii. The Environmental Statement which describes the impacts of the alternative plans is included. The report was prepared by the Honolulu District of the U.S. Army Corps of Engineers in conjunction with other Federal agencies and with the cooperation of the local sponsor, the State of Hawaii Department of Land and Natural Resources.

The scope of the report included identification of the energy problems, examination of various alternative plans, and evaluation of plans in terms of technical, economic, environmental, and social acceptability. The evaluation and plan selection was guided by the dual national objectives of National Economic Development (NED) and Environmental Quality (EQ) in accordance to the U.S. Water Resources Council (WRC) regulations for Federal Water and Related Land Development projects.

The energy problem on the island of Kauai is typical of many insular locations worldwide - the lack of plentiful, inexpensive fuels and economic savings resulting from large, energy efficient utility networks. As of 1981, approximately 60 percent of the utility energy generation was derived from petroleum fuels. Hence, the basic problem is to alleviate oil dependency thereby achieving energy self-sufficiency for the island. The dependency on fossil fuels may be partially remedied by tapping the abundant water resources of the island. The Wailua River basin, encompassing one of the major perennial rivers in the State, is the identified study area.

The final alternative plans were determined following consideration of a variety of energy production measures and a number of hydropower schemes. Of the three principal alternative plans, two are conduit hydropower facilities located near the Wailua Falls, South Fork Wailua River. Both of these structural plans are single-purpose, non-storage hydropower facilities formulated for an essentially undeveloped river area. The third alternative, a nonstructural plan, would provide for energy conservation including greater utilization of individual solar hot water systems.

Alternative 1A would include a concrete diversion dam sited above the falls, water conveyance and control structures, a powerplant, and transmission lines. Most of the work would center around the falls area. The location of the features is shown in the accompanying figure.

Based upon the analysis of relative benefits and costs, Alternative 1A is the recommended plan of improvement. This plan would provide the highest net National Economic Development benefits and is the designated NED plan. The benefits were derived from the potential displacement of average system energy of the existing utility company. Due to non-firm power production, no capacity benefits were claimed. The plan would provide 11.28 million kilowatt-hours of average annual energy for the people of Kauai.

The major environmental impacts of the hydropower plans would involve decreased aesthetic appeal resulting from flow diminution. However, streamflow will be maintained at the falls and in the reach affected by the power diversion. The man-made structures also would lessen the natural visual impression but would be partially mitigated by increased recreational and access opportunities for the river area. The study is substantially in compliance with WRC-designated environmental statutes.

Pertinent data are shown in the following table. Implementation of the project would be contingent upon Congressional authorization, funding, and completion of all local assurances for non-Federal responsibilities and repayment requirements. The Federal Government would design, construct and own all facilities and administer the reimbursement for Federal expenditures through marketing of energy sales. Furthermore, the Federal Government would be responsible for operation and maintenance and replacement of the project features. The financial responsibilities between Federal and non-Federal interests is subject to further determination and approval by the Administration and Congress.

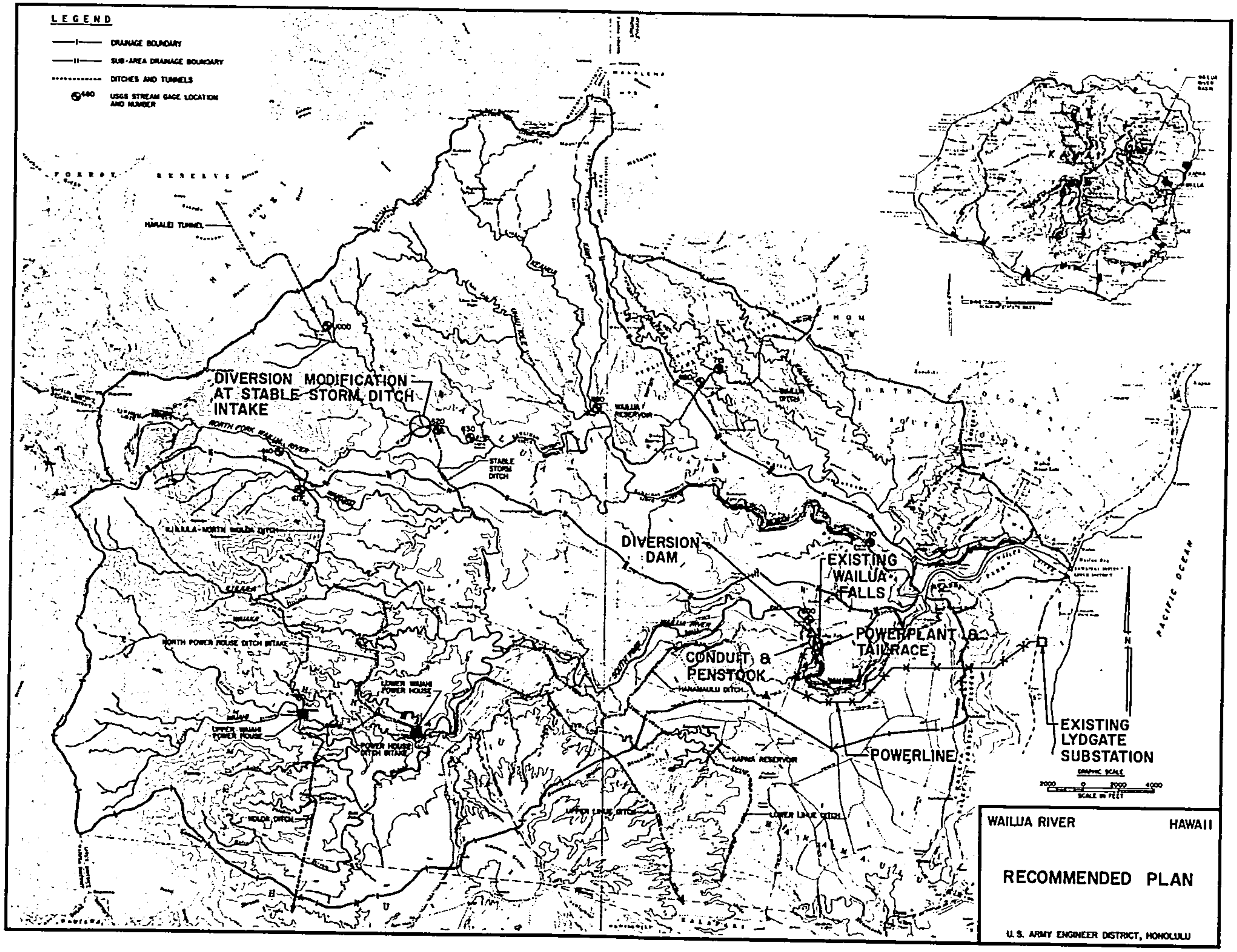
INTERIM SURVEY REPORT
FOR
WAILUA RIVER, KAUAI, HAWAII

PERTINENT DATA OF RECOMMENDED PLAN

HYDROLOGIC AND HYDRAULIC	
Drainage area at So Fork diversion, sq mi	22.4
Daily median flow (at 50%), cfs	36
Conservation discharge on So Fork, cfs	10
Ponding storage volume, acre-ft	23.5
Turbines: horizontal Francis units	
Net head, ft	178
Discharge range: Unit 1, cfs	130 to 260
Unit 2, cfs	65 to 130
Maximum diversion discharge, cfs	390
MAJOR CONSTRUCTION FEATURES	
Diversion dam, height, ft	13.5
crest length, ft	220
Conduit, 108-inch RCP, length, ft	560
Penstock, 72-inch steel, length, ft	282
Powerline, 12 kv, length, mi	3.5
Powerplant	
Capacity, Unit 1, mw	3.33
Unit 2, mw	1.67
Total, mw	5.00
Plant factor, percent	26
Average annual energy, million kwh	11.28

	Price Level and Discount Rate	
	Jan 1982 7-5/8%	Oct 1982 7-7/8%
PROJECT INVESTMENT COST, million $	8.188	8.824
Unit capacity cost, $/kw	1,640	1,760
AVERAGE ANNUAL BENEFITS & COSTS 1/		
Total average annual benefits, $000	891	914
Total average annual costs, $000	677	749
NET ECONOMIC EFFECT 1/		
Unit energy costs, mills/kwh	60	66
Average annual net NED benefits, $000	214	165
Benefit-to-cost ratio (BCR)	1.3	1.2

1/ At indicated price level and discount rate. 100-year economic life. Includes annual O, M & R. Excludes construction inflation. 1990 power-on-line date.


LEGEND
DRAINAGE BOUNDARY
SUB-AREA DRAINAGE BOUNDARY
DITCHES AND TUNNELS
USGS STREAM GAGE LOCATION AND NUMBER
HANALEI TUNNEL
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WAILUA RESERVOIR
NORTH FORK WAILUA RIVER
NORTH POWER HOUSE DITCH INTAKE
LOWER WAIAHI POWER HOUSE
UPPER WAIAHI POWER HOUSE
POWER HOUSE DITCH INTAKE
DIVERSION DAM
EXISTING WAILUA FALLS
POWERPLANT & TAILRACE
CONDUIT & PENSTOCK
HANAMAULU DITCH
KAPAIA RESERVOIR
UPPER LIHUE DITCH
LOWER LIHUE DITCH
POWERLINE
EXISTING LYDGATE SUBSTATION
PACIFIC OCEAN
N
SCALE IN FEET
WAILUA RIVER
HAWAII
RECOMMENDED PLAN
U.S. ARMY ENGINEER DISTRICT, HONOLULU

INTERIM SURVEY REPORT
WAILUA RIVER HYDROPOWER PROJECT

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1/ Separate tables of contents provided within each appendix.

INTRODUCTION

PURPOSE

The purpose of this survey study is to establish the feasibility of potential improvements in the interest of hydroelectric power development for the Wailua River basin, island of Kauai, State of Hawaii. There are no authorized nor constructed Federal hydropower facilities in the State of Hawaii.

Hydropower has had a long history of dependable service both from the perspective of U.S. Army Corps of Engineers water resource development projects and on a world-wide scale. Depending upon the specific nature of the area, hydropower improvements are suitable in a variety of locations of large topographical ground relief and water flows. Unlike many new energy developments, the technology of hydropower has been firmly established and basic research is not required to demonstrate its effectiveness. Over the past decade, hydropower as a renewable energy resource has rekindled interest for its role in alternative energy development nationally and in the State of Hawaii. The island of Kauai, similar to most insular areas, is highly dependent upon petroleum-based fuels for the electric utility system. This condition has led to relatively high costs of energy production and reliance on a potentially volatile worldwide fuel market. As a result, the basic study problem is to alleviate oil dependence in energy production which will, in turn, lead to the goal of greater energy self-sufficiency for the island of Kauai. This study was completed in compliance to the national and local interests in water resource and energy development.

STUDY AUTHORITY

This study was conducted under the authority of Section 209 of the River and Harbor and Flood Control Act of 1962 (Public Law 87-874) which states in part as follows:

> "The Secretary of the Army is hereby authorized and directed to cause surveys for flood control and allied purposes, including channel and major drainage improvements, and floods aggravated by or due to wind or tidal effects, to be made under the direction of the Chief of Engineers, in drainage areas of the United States and its territorial possessions, which include the following named localities: Provided, That after the regular or formal reports made on any survey are submitted to Congress, no supplemental or additional report or estimate shall be made unless authorized by law except that the Secretary of the Army may cause a review of any examination or survey to be made and a report thereon submitted to Congress, if such review is required by the national defense or by changed physical or economic conditions: Provided further, That the Government shall not be deemed to have entered upon any project for the improvement of any waterway or harbor mentioned in this title until the project for the proposed work shall have been adopted by law: * * * * *
>
> "Harbors and rivers in Hawaii, with a view to determining the advisability of improvements in the interest of navigation, flood control, hydroelectric power development, water supply, and other beneficial water uses, and related land resources. * * * * *"

The Honolulu District, US Army Corps of Engineers was specifically requested by the State of Hawaii to perform investigations for small-scaled hydropower development in the Wailua River basin, Kauai. This request was made by the Chairman of the Board of Land and Natural Resources by letter dated 9 April 1980 (Appendix A). This study is in response to that request.

STUDY AREA

The study area is located on the island of Kauai, Hawaiian Islands. Except for the Midway Islands in the northwest part of the Hawaiian Islands, the archipelago is under the jurisdiction of the State of Hawaii. The capital and major urban center in the State is Honolulu, island of Oahu. The Hawaiian Islands are geographically important, based on military and economic relationships to the Pacific Basin and to the Far East. The location of the islands relative to important centers is shown in Figure 1.

The island of Kauai is the fourth largest island in the chain with an area of 553 square miles and the fourth largest island in population at 39,082 persons (Census, April 1980). The County seat is located at Lihue. The major population centers are located at Kapaa (4,467 persons), Lihue (4,000), Kekaha (3,260), and Hanamaulu (3,227). The location of the Wailua River basin on Kauai is shown in Figure 2.

SCOPE OF THE STUDY

This study provided an analysis of the electrical utility energy needs and the alternatives available to meet the needs for the island of Kauai. In accordance with the study request, the investigation of hydropower resources was confined to the Wailua River basin and principally was directed to small-scale hydropower development. This report provided a definition of the problem, description of alternative solutions, evaluations of the technical, economic, and environmental characteristics, and documentation of the costs and benefits associated with the solutions.

STUDY PARTICIPANTS AND COORDINATION

The Honolulu District, U.S. Army Corps of Engineers (hereinafter referenced as the Corps) was responsible for conducting and coordinating the study and for preparing the report. The State of Hawaii Department of Land and Natural Resources (DLNR) is the local sponsoring entity for this study.

Study contributions were submitted throughout the planning process by Federal, State, and County government agencies, private organizations and individuals. Significant cooperative efforts were performed by U.S. Fish and Wildlife Service for input into the Draft Environmental Statement; the Office of the Mayor, County of Kauai for local public agency support; the Western Area Power Administration and the Federal Energy Regulatory Commission for marketing and financial analyses; AMFAC Corporation/Lihue Plantation for site data; the Division of Water and Land Development, DLNR for state-level coordination and support; and the Kauai Electric Division of Citizens Utilities Company for electrical utility information.

Informal and formal meetings with local organizations were held during the study period. An initial workshop was held on 12 February 1981 with participants of major organizations. The investigative need for the study was favorably received. A formal public meeting, following the issuance of the draft report, was held on 28 July 1982. The public response was favorable. A summary of public coordination is provided in Appendix A.

STUDY PROCESS

This investigation followed the U.S. Water Resource Council's current guidelines for federal water and related land development studies (18 CFR Parts 711, 713, 714, and 716) known as "Principles and Standards." Related Corps regulations included the Planning Guidance Notebook documents issued 30 September 1981 and ER 200-2-2 dated 15 August 1980, titled "Policy and Procedures for Implementing NEPA". In compliance with P&S, the investigations included the iterative tasks of problem identification, analysis of forecasting and information, formulation of alternative plans, evaluation of plan effects, and comparison of plans. The plan selection and recommendation will be performed following the draft Survey Report and Environmental Statement review period. This report documents the investigatory and decision processes.

The Interim Survey Report, following review by the Board of Engineers for Rivers and Harbors and the Office of the Chief of Engineers, will be submitted to Congress for project authorization. Subsequent to project authorization and contingent on appropriate federal funding, Advanced Engineering and Design work will be performed, followed by construction.

PRIOR STUDIES AND REPORTS

The Corps completed the initial report under this current study in January 1981 titled "Reconnaissance Report for Hydroelectric Power, Wailua River, Kauai, Hawaii." The purpose of this report was to identify, on an initial basis, the need for future investigation, and to develop a management plan for future studies. This and other related documents are listed below.

Belt, Collins and Associates. Waialeale Hydropower Study. Prepared for the Division of Water and Land Development, Department of Land and Natural Resources, State of Hawaii. Honolulu: Nov 1978.

Hawaii, State of, Board of Land and Natural Resources. Kokee Water Project, Island of Kauai, Hawaii. Report R22 Honolulu: 1964.

Hawaii, State of, Department of Land and Natural Resources. State Water Resources Development Plan. Honolulu: Oct 1981.

Hawaii, State of, Department of Planning and Economic Development. State Energy Plan. Honolulu: Oct 1981.

Hirai, W.A. and Associates, Inc. Hydroelectric Power in Hawaii - A Reconnaissance Survey. Prepared for the State of Hawaii Department of Planning and Economic Development. Honolulu: Feb 1981.

Lawrence Berkeley Laboratory of the University of California and State of Hawaii Department of Planning and Economic Development. Hawaii Integrated Energy Assessment. Honolulu: Jan 1981.

Tudor Engineering Company, et al. Feasibility Report on the Potential Development of the Kitano Hydroplant. Prepared for the Kekaha Sugar Company. San Francisco: July 1981.

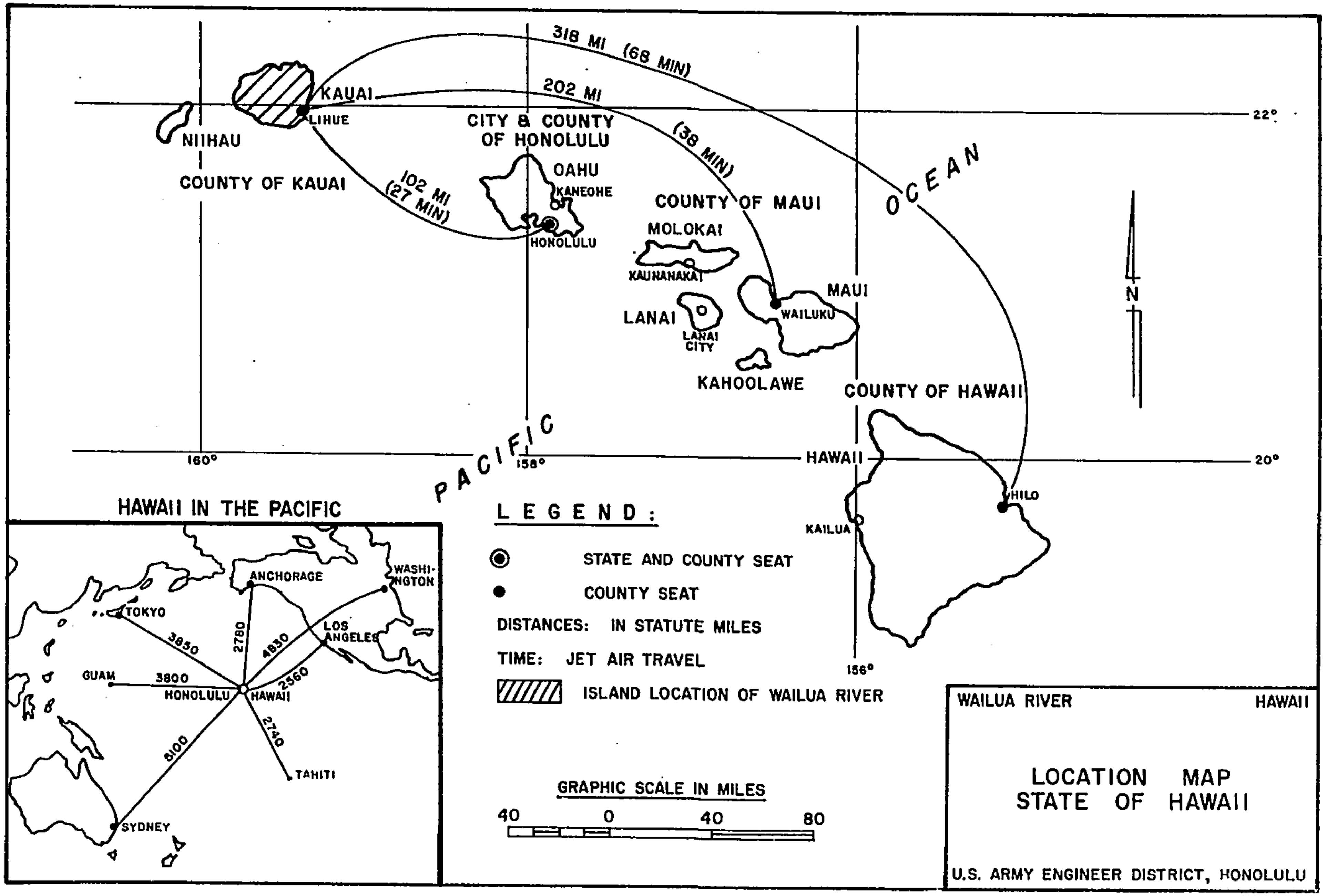


FIGURE I

FIGURE I

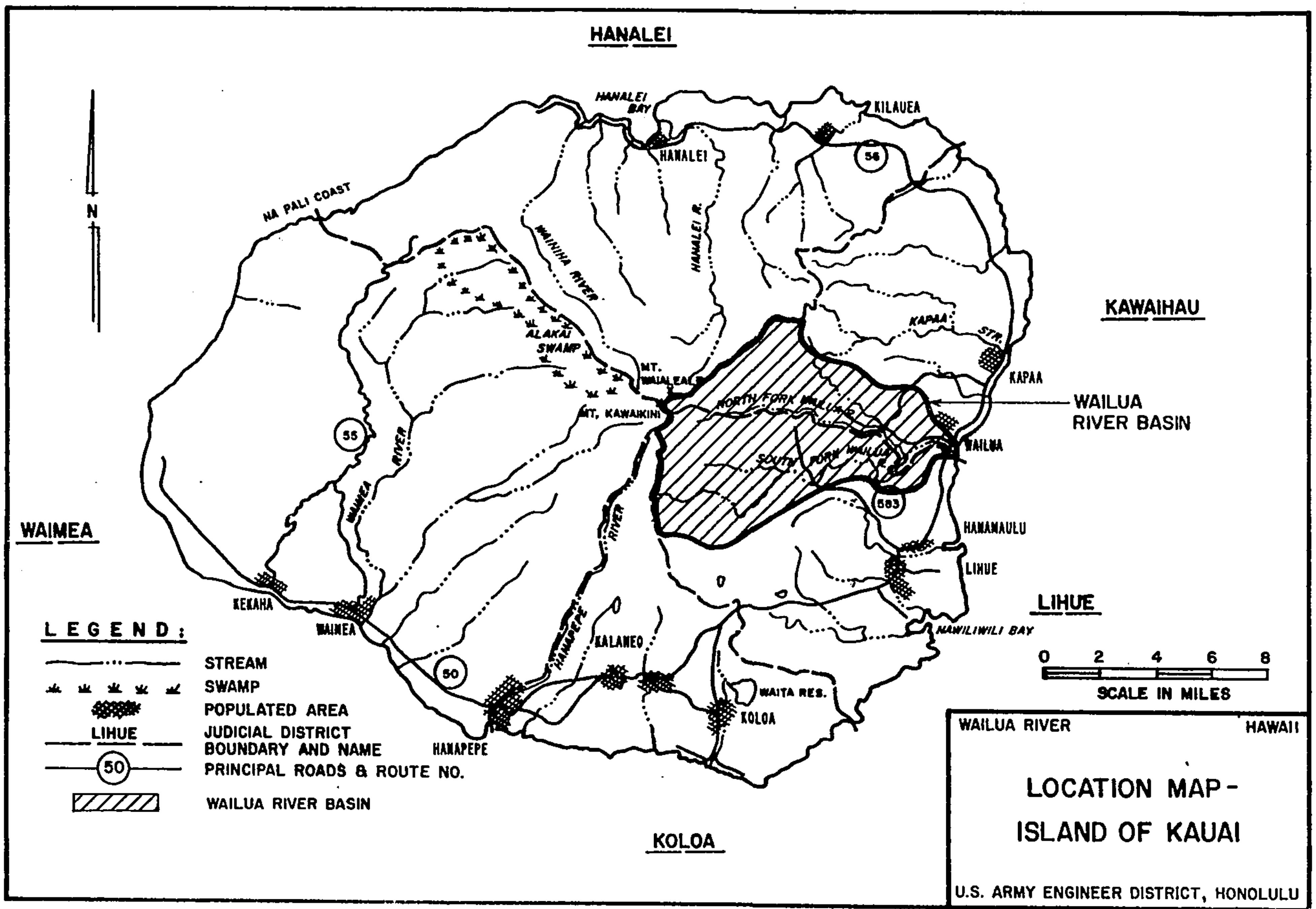


FIGURE 2

FIGURE 2

U.S. Army Corps of Engineers, North Pacific Division and Pacific Ocean Division. National Hydroelectric Power Study: Regional Assessment, Alaska and Hawaii. Prepared for the U.S. Army Corps of Engineers, Institute for Water Resources. Fort Belvoir: September 1981.

U.S. Army Engineer District, Honolulu. Plan of Study for Hydroelectric Power and Allied Purposes - State of Hawaii. Honolulu: Sep 1977.

U.S. Army Engineer District, Honolulu. Reconnaissance Report for Hydroelectric Power, Wailua River, Kauai, Hawaii. Honolulu: Jan 1981.

U.S. Army Engineer District, Honolulu. Summary Report for Hydroelectric Power - State of Hawaii. Honolulu: Oct 1978.

THE REPORT

This report consists of a Main Report, which includes the Draft Environmental Statement, and supporting appendices. The main report is a summary of the detailed and technical information contained in the appendices which should be referred to when information beyond that presented in the main report is desired. The appendices are listed and described below. Except as noted, the report and appendices were prepared by the U.S. Army Engineer District, Honolulu.

Appendix A, Public Involvement, describes the public involvement program and contains pertinent correspondence and public comments received during the study and evaluation period. The required letter of assurance from the local sponsoring and the transcript of the final public meeting are also contained in this appendix.

Appendix B, Civil Engineering and Cost Estimating Investigations, contains technical information related to the hydrology, hydraulics, structures, and cost estimates. The total project costs and average annual costs estimates are provided. The hydrology information related to power duration and turbine sizing is contained in Appendix C.

Appendix C, Hydropower Investigations, includes the power duration analysis, alternative turbo-generator and electromechanical investigations. The Appendix was prepared by the U.S. Army Engineer Division, North Pacific.

Appendix D, Geotechnical Investigations, contains the description of the geology, the subsurface conditions, and design parameters related to the foundations and materials considerations of the improvements and associated construction considerations.

Appendix E, Economics, contains the economic background, data, and analyses for determining the benefits and economic justification for the alternative plans. Federal Energy Regulatory Commission (FERC) correspondence is also provided.

Appendix F, Power Marketing Study, includes the analysis of marketing and financial conditions in accordance with provisions of Section 5 of Public Law 78-534. The Appendix was prepared by the U.S. Department of Energy, Western Area Power Administration, Sacramento Area Office.

Appendix G, Environmental Compliance Documents, contains the required documentation and evaluation reports and correspondence pursuant to the Coastal Zone Management Act, Executive Order 11988, the Clean Water Act, the Endangered Species Act, and the Fish and Wildlife Coordination Act.

Appendix H, Environmental Effects, contains supplementary background data and analyses of the ecological, cultural, and aesthetic resources of the area.

PROBLEM IDENTIFICATION

NATIONAL OBJECTIVES

The U.S. Water Resources Council's P&S require that planning for development of water and water-related land resources must be directed toward achieving two equal national objectives: National Economic Development (NED) and Environmental Quality (EQ). The NED objective is achieved by a plan with results that increase the value of the national output of goods and services and improve the national economic efficiency. The EQ objective is achieved by favorable changes in the ecological, cultural, and aesthetic attributes of natural and cultural resources.

In addition to the principal national objectives, there exists two other significant measures, the Regional Economic Development (RED) account and the Other Social Effects (OSE) account. The RED account considers changes in economic activity to an entire region's income and employment. The OSE account includes qualitative plan effects relative to urban and community impacts; life, health, and safety; displacement of people and businesses; long-term productivity; and energy requirements.

As an aid to decisionmaking and plan selection, the planning process requires that a NED plan (the plan that maximizes benefits to the economy), an EQ plan (the plan with the maximum contribution to the environment) and a primarily nonstructural plan be designated. The recommended plan must be justified on the basis that the combined beneficial NED and EQ effects outweigh the combined adverse NED and EQ effects.

EXISTING CONDITIONS

PHYSICAL RESOURCES

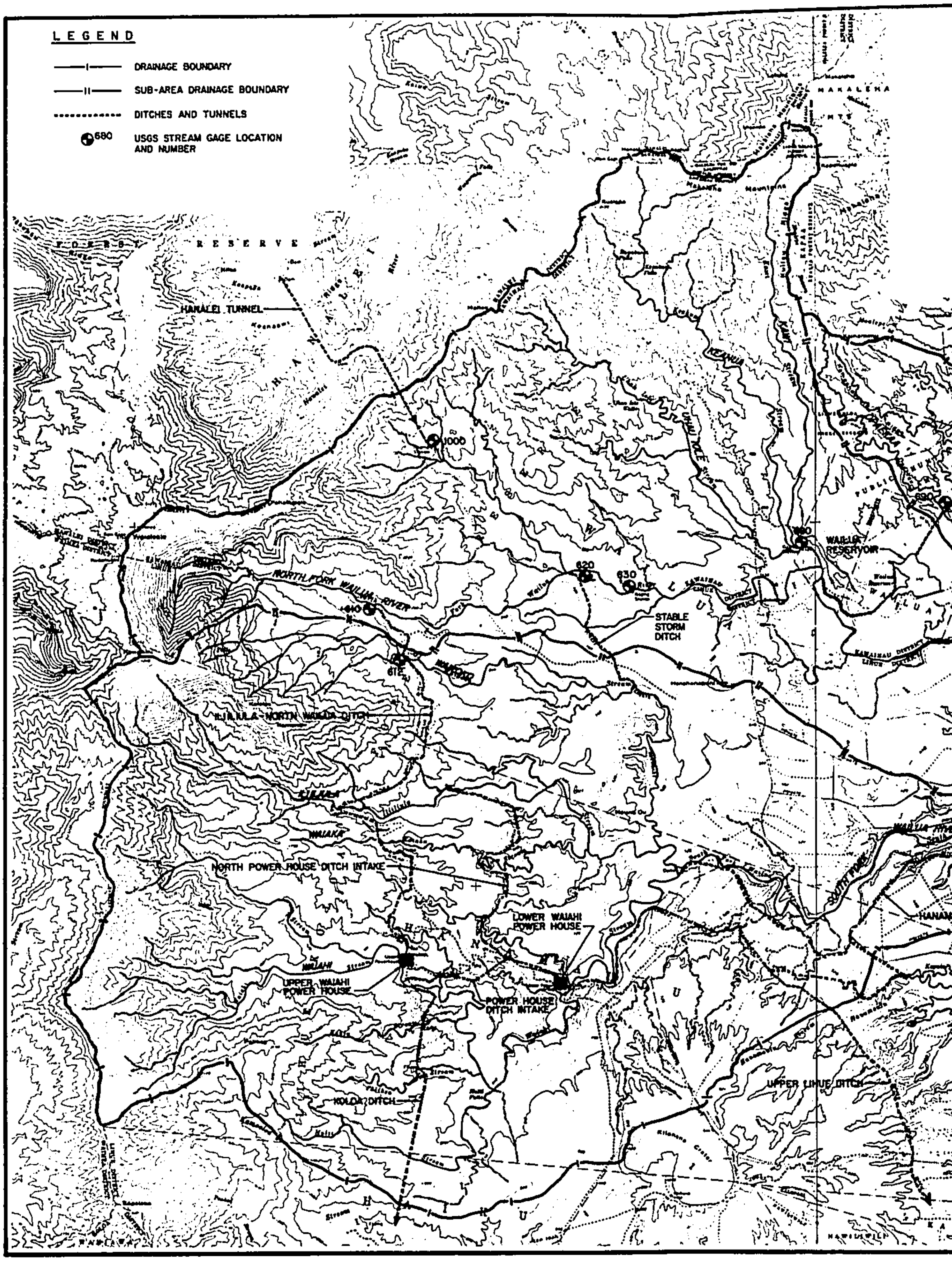
Climate. Kauai is located just south of the Tropic of Cancer. It enjoys a relatively mild and uniform temperature condition because of its location in mid-ocean and the small seasonal variation in the amount of energy received from the sun. Mean annual temperature is 74°F at Lihue Airport, located about 4.5 miles south of Wailua. Also, extreme temperatures recorded at the airport of 50°F in January and 90°F in October are representative of the seaward areas of the Wailua basin. The features of the Wailua River basin are shown in Figure 3.

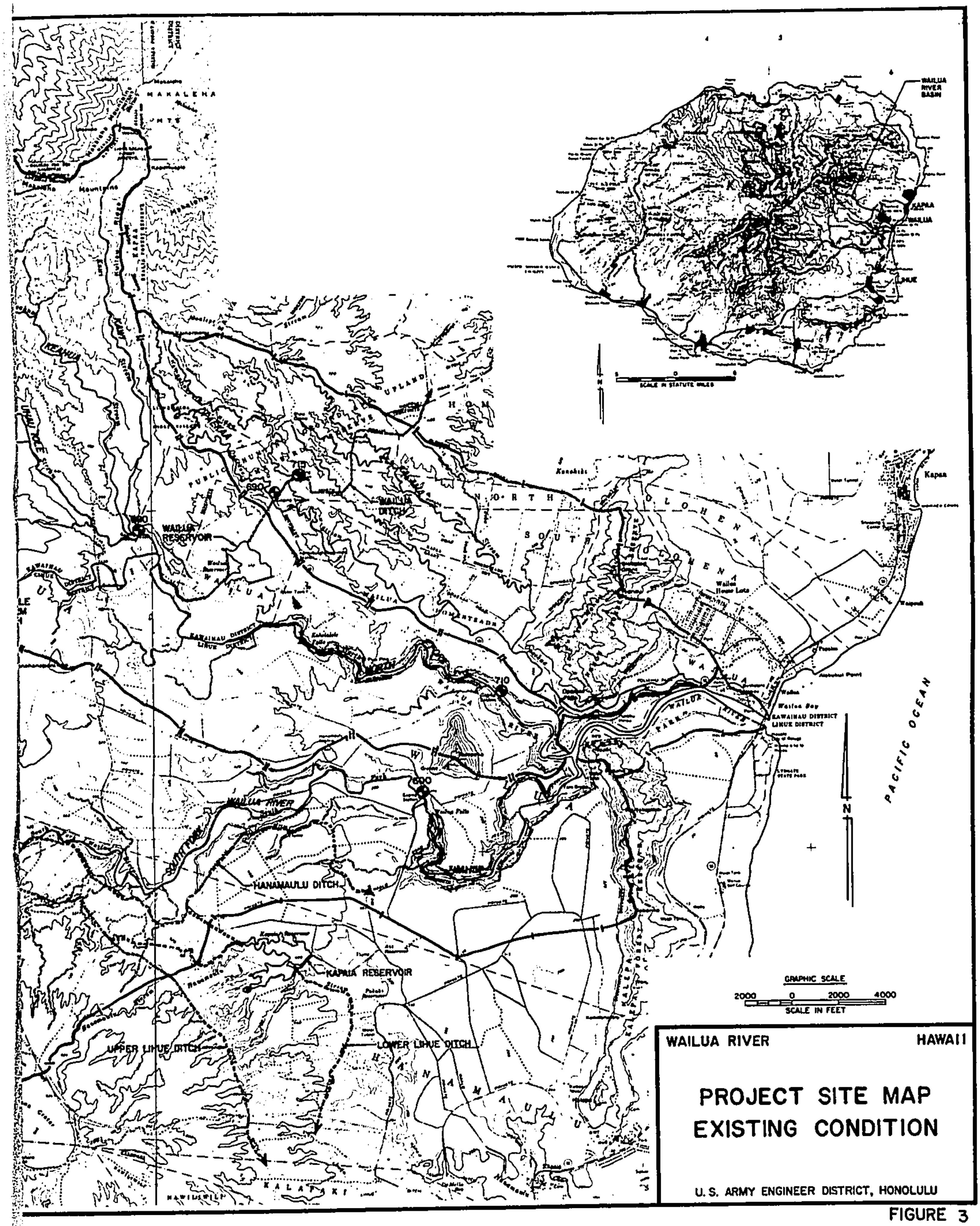
In contrast to the equable temperature conditions, the interaction between the moist tradewinds and the island's high mountains result in extreme variation of rainfall. Average annual rainfall in the Wailua basin varies between 50 inches near the coastline to over 450 inches at the summit. The Wailua basin has a distinct wet and dry season. The wet season is usually from October through April and the dry season from May through September.

Geology and Physiography. The island of Kauai is the summit of one of the principal volcanic mountains of the partially submerged Hawaiian range. This range extends for a distance of 1,500 miles across the Pacific Ocean floor. Kauai has a complex geologic structure as a result of volcanic activities, separated by intervals of erosion and decomposition combined with faulting.

The Wailua River is located on the east flank of the volcano in what is known as the Lihue depression, a broad caldera formed by the collapse of the volcano's summit. Volcanism following the collapse covered the floor of the depression with gently sloping lava aprons and streams from the rainy uplands have since cut deep and relatively short gorges. Wailua Falls is one of the most renowned erosional features of Kauai. The falls are the result of headward erosion of thick basalt layers overlying mudflow deposits of the Wailua River.

Hydrography. The Wailua River basin is on th eastern side of the island of Kauai. The pear-shaped basin is about 52 square miles in area and extends 11 miles from the ocean to the 5,000 foot summit of Waialeale Mountain in the central part of the island. The topography is generally hilly and rugged in the upper sections with a rolling plain in the central portion terminating in a small flat area at the coast. The relatively high rainfall and moderate temperatures are conducive to heavy vegetation and grass, shrubs, ferns and trees pervade the entire drainage basin. Sugarcane occupies most of the central plains. Rainfall in the upper regions is channeled into three principal tributaries to Wailua River: North Fork Wailua River, South Fork Wailua River, and Opaekaa Stream. The North Fork and South Fork, with drainage area of 18.5 and 26 square miles, respectively, merge into Wailua River about 2 miles from the ocean. Opaekaa Stream drains an area of 6.4 square miles and discharges into the Wailua River at a point about 5/8 of a mile from the ocean. The Wailua River is a perennial river with range of flow (at Wailua Falls) varying from 2 cubic feet per send (cfs) to 89,000 cfs. Similar to typical Hawaiian rivers, the flows are highly variable. The median discharge is 36 cfs.


LEGEND
DRAINAGE BOUNDARY
SUB-AREA DRAINAGE BOUNDARY
DITCHES AND TUNNELS
USGS STREAM GAGE LOCATION AND NUMBER
680
HANALEI TUNNEL
1000
NORTH FORK WAILUA RIVER
610
615
620
630
680
WAILUA RESERVOIR
STABLE STORM DITCH
IIILIULA-NORTH WAIAKA DITCH
NORTH POWER HOUSE DITCH INTAKE
LOWER WAIAHI POWER HOUSE
UPPER WAIAHI POWER HOUSE
POWER HOUSE DITCH INTAKE
KOLOA DITCH
UPPER LIHUE DITCH


WAILUA RESERVOIR
WAILUA DITCH
WAILUA RIVER
HANAMAULU DITCH
KAPAIA RESERVOIR
UPPER LIHUE DITCH
LOWER LIHUE DITCH
PACIFIC OCEAN
Kapaa
Wailua Bay
KAWAIHAU DISTRICT
LIHUE DISTRICT
WAILUA RIVER BASIN
KAPAA
WAILUA
LIHUE
SCALE IN STATUTE MILES
GRAPHIC SCALE
2000
0
2000
4000
SCALE IN FEET
N
WAILUA RIVER
HAWAII
PROJECT SITE MAP
EXISTING CONDITION
U. S. ARMY ENGINEER DISTRICT, HONOLULU
FIGURE 3

SOCIO-ECONOMIC RESOURCES

Institutions. The State of Hawaii is governed by a bicameral legislature, a judiciary and an executive branch where power is vested in a governor. The principal executive department responsible for the management of the State's public lands, water and mineral resources, fish and game resources, forest reserves, and State parks, including historic sites is the Department of Land and Natural Resources (DLNR). The Division of Water and Land Development, within the DLNR, provides for the development of water resources, including hydroelectric power facilities. The DLNR is administered by the Board of Land and Natural Resources, headed by its chairman. As the authorized representative of the Governor, the chairman may execute agreements, within his powers, on behalf of the State.

The promotion of long-range socio-economic development, including general planning, technical analyses, redevelopment, and employment is a function of the Department of Planning and Economic Development (DPED). The Energy Division within the DPED compiles detailed information on energy and fuel consumption, sales, generation, and shipment. In addition, DPED is charged with management of State energy research and development funds and coordination of inter-agency
energy developments, including hydroelectric power.

Electric generating companies servicing the public in the State of Hawaii are governed by the rules set forth by the Public Utilities Commission (PUC) of the State of Hawaii under the Department of Budget and Finance. This commission was created and is chartered under Chapter 269, the revised laws of Hawaii 1955, as amended. The Commission examines the propriety of rates, capital expenditures, and regulates standards of electrical service. Companies generating power primarily for their own use, such as sugar companies, are not directly controlled by the PUC.

Local government in the Wailua River basin is vested in the County of Kauai. The County of Kauai includes the islands of Kauai and Niihau, adjacent waters and islets within three nautical miles of their shores. The executive power of the County is exercised by the Mayor. The principal local agencies involved with hydroelectric development are the departments of Public Works, Planning and the Office of Economic Development.

The only electric utility on the island of Kauai is the Kauai Electric Division of Citizens Utilities Company whose corporate headquarters are located in Stamford, Connecticut. Approximately 60 percent (as of 1981) of the system energy is developed at the Port Allen main thermal plants, the balance being purchased energy from industrial sugar companies.

Unlike the mainland United States there does not exist any National Electric Reliability Council Region (NERC) similar to the Western Systems Coordinating Council (WSCC) for the area west of the Rocky Mountains. There are no Federal projects supplying public power in Hawaii; hence there are no Department of Energy Power Marketing Administrations (PMA's) in the area.

Population. Island population levels on Kauai remained relatively stable during the 1950-1970 period. In the 1970's, however, population growth was somewhat faster than had been anticipated. Hawaii Department of Planning and Economic Development (DPED) projections had predicted growth during the 70's to 36,500 by 1980. Census figures reveal that this estimate has been exceeded, as 1980 population was 39,082, about 7% higher than the forecast.

This translates into an equivalent annual growth rate from 1970-1980 of about 2.6%, compared to a growth rate for the entire State of Hawaii of about 2.3% annually for the same period. Future growth will most likely fall into the range of 1.4% to 2.2% annually through the year 2000, leveling off to less than one percent annual growth in the period 2000-2030. These projections are derived from DPED forecasts as well as the 1980 projections by the Bureau of Economic Analysis, US Department of Commerce for non-SMSA portions of Hawaii. Population in the Lihue, Kawaihau Districts of Kauai, which surround the immediate study area, also rose faster in the 1970's then had been expected by DPED. By 1980, these districts had grown to a combined population of just over 19,000 about 14% higher than projected.

Economic Development. Hawaii is a prosperous State with a growing population and economy. Between 1950 and 1980, the total resident population increased by over 92 percent from 500,000 to 964,624. The gross state product increased over tenfold between 1950 and 1979, from $900 million to $10.3 billion. The three largest contributors to the State economy are tourism, defense expenditures and agriculture. The bulk of agricultural activity is in the production of sugar and pineapple. The most rapid growth in the past decade has been in the tourist industry. Tourist arrivals increased from 243,000 annually in 1959 to 3,934,000 in 1980. Visitor expenditures have grown by an average of over 17 percent annually since 1959, when they amounted to $109 million. Estimated 1979 visitor expenditures were over $2.6 billion. While visitor expenditures increased by a factor of 20 over this period, defense expenditures tripled. The trend in tourist industry growth will probably continue, although at a slower pace, together with the State economy in general.

Until recently, sugar was the mainstay of Kauai's economy. At it's peak, eight sugar plantations on Kauai produced over one-fifth of the State's total sugarcane yield. Pineapple was at one time a major sector of the Kauai economy, but has not been cultivated since the closing of the county's last cannery in the early 1970's. The largely agrarian base of the island's economy has changed with the surge in tourism in the past decade. Sugar is still a major economic base, but tourism is now the island's leading industry. Lihue is the center of economic activity in the county, with the two major transportation facilities, Lihue Airport and Nawiliwili Harbor, located nearby. Plans for airport expansion exist in anticipation of continued growth in interisland traffic. There are also petroleum storage facilities situated in the Lihue area.

Major employers in the island's economy are the visitor industry and agriculture. Other important employers are Federal, State, and County governments, as well as commercial and business services. Table 1 shows some selected statistics for recent years for the County of Kauai.

Table 1. SELECTED STATISTICS, COUNTY OF KAUAI1/

	1976	1977	1978	1979	1980	1981
Population, Resident	34,000	36,200	37,000	38,100	39,082	NA
Per Capita Personal Income ($)	5,762	6,633	7,147	7,673	8,472	NA
Civilian Labor Force	17,150	18,550	18,350	18,500	20,000	20,700 p
Employment	15,550	17,350	17,100	17,450	19,050	19,100 p
Unemployment	1,600	1,200	1,250	1,050	950	1,650 p
Unemployment Rate (%)	9.4	6.5	6.8	5.6	4.6	7.9 p
Estimated Westbound Visitors (1000's)	699.3	740.5	837.7	825.4	781.4	513.8 p
Intended Length of Stay-- Westbound (Days)	2.85	2.97	3.08	3.29	3.40	3.53
Hotel Inventory (Rooms)	3,724	3,868	4,097	4,064	4,435	5,207
Hotel Occupancy (%)	76.8	80.6	83.3	76.5	69.0	60.7
Sugar Production, raw sugar 96° (thousand tons)	217	232	223	232	223	134
Diversified Agriculture (million $)	5.3	6.5	7.4	9.5	10.4	NA
Crops	2.3	2.9	3.1	5.1	4.7	NA
Livestock	3.0	3.6	4.3	4.4	5.7	NA

NA = Not available p = preliminary

1/ From Economic Indicators, First Hawaiian Bank, November 1981 and October 1982.

Kauai's visitor industry has suffered the effects of three consecutive visitor years of progressively worsening visitor totals. This major sector of the economy has in turn contributed to a measurable decline in business activity in 1980. Although the unemployment rate is at its lowest level in several years, the island's economy is presently suffering somewhat of a decline. While the sugar industry might ordinarily have countered such a trend with increased production, a substantial drop in 1981 sugar prices made receipts significantly lower than in 1980. The sugar industry in the State suffered a devastating $83.5 million loss in 1981. Losses on the island of Kauai totalled approximately $22 million.

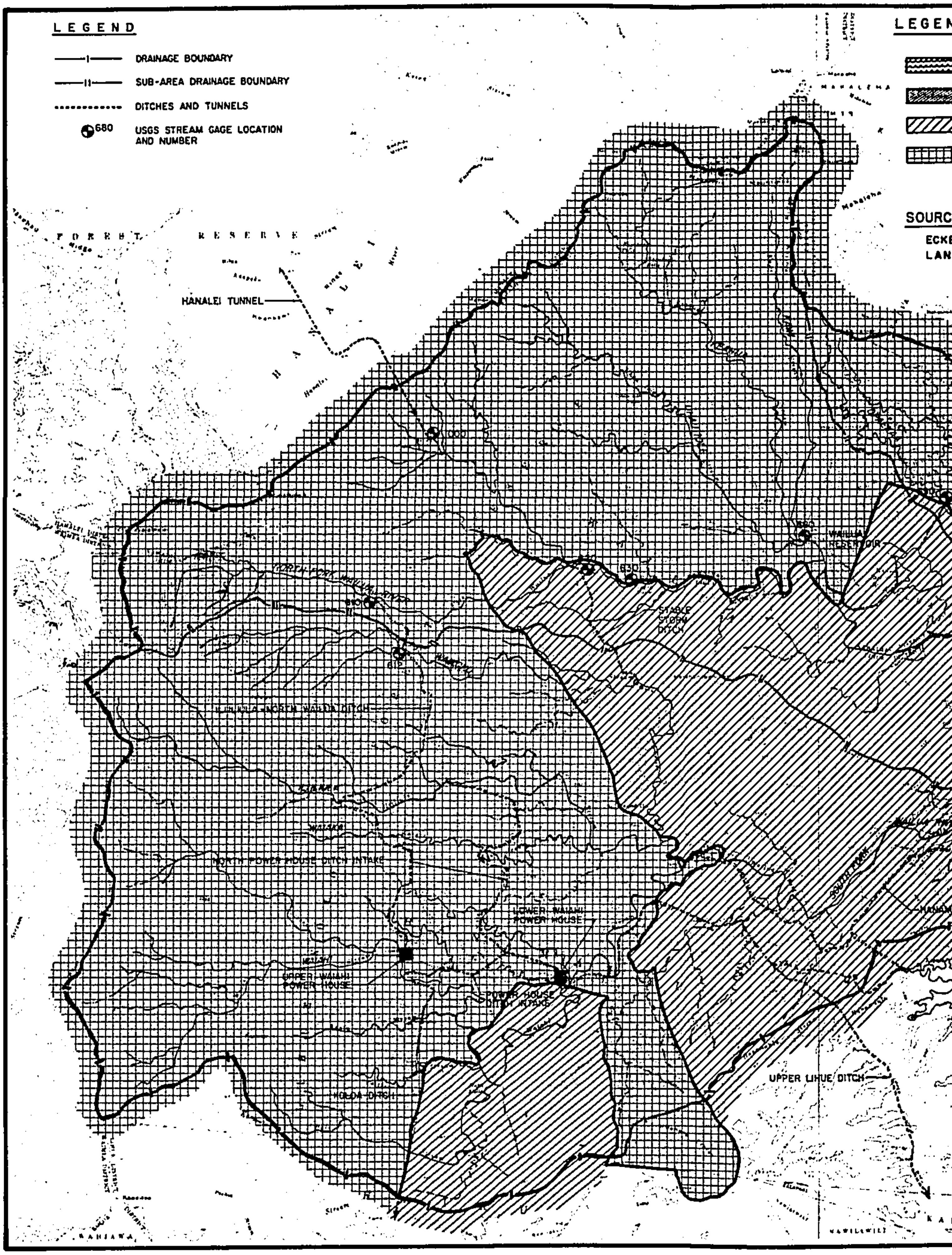
However, prospects for long term prosperity and stability are encouraging. Major developers at one of Kauai's resort destinations, Poipu Beach, are well along in additional developments, and the county administration has made revival of tourism a top priority, having begun a program of heavy promotion in cooperation with the private sector and the Hawaii Visitors Bureau. Master plans are being developed for fishing and agriculture, and the Administration is pushing for high technology enterprise to strengthen the economy's base. Despite efforts to diversity and thereby further stabilize the economic growth prospects of the island, particularly in view of an uncertain sugar industry future, agriculture continues to be a dominant sector of the economy. Guava and papaya are significant areas of promising cultivation.

On 23 November 1982, Hurricane Iwa struck the Hawaiian Islands causing an estimated $92 million public and private property damage on Kauai. Shortly thereafter on 27 November 1982, the President declared the State of Hawaii a Federal disaster area, enabling the Federal Emergency Management Agency (FEMA) to provide assistance. Damages blacked out the electrical system over the island and services were not restored at most community for two weeks. Although there were no fatalities on Kauai, recovery and reconstruction operations will be extensive and are expected to take many months.

Kauai has taken a step toward energy self-sufficiency by increasing its capacity to generate electric power from nonfossil fuel sources. In November 1980, Lihue Plantation Company's new bagasse-fired powerplant entered the electric power generating service on Kauai. Turning sugarcane fiber into electricity, the plant produced 32 percent of Kauai's 1981 electrical energy need. Prior to this new service, only about 26 percent of the island's electricity came from nonfossil fuel sources, but the new plant has increased this level to about 44 percent for the total plantation and utility system. Kauai Electric has also been looking into the area of wind energy development. The county is considering other biomass fuel development programs involving municipal refuse, and cane trash. Kauai has also adopted an energy self-sufficiency plan, stressing conservation and efficient government energy use.

Land Use. Land use on Kauai is characterized generally by forest land covering the fairly rugged interior, with small concentrations of urban development scattered along the coastline, and agricultural development (predominantly sugarcane) in a belt adjacent to the ocean. There is neither urban use nor agricultural use on the rugged northwest coastline. The major land use, constituting over half of the island's area is forest, forest reserve, and recreation. Agricultural use accounts for another approximately 1/3 of the island. The remainder, less than 10%, is in urban and urban-related uses. This pattern of land use is generally the same for the State of Hawaii as a whole with the exception that Oahu, the major population center is more urbanized than the "neighbor islands" of Hawaii, Molokai, Lanai, Maui, Niihau, and Kauai. As with the rest of the neighbor islands, Kauai's land use tendencies give the island a rural, agrarian flavor. The Wailua River basin is approximately equally divided between conservation and agricultural land use districts. Small portions in the lower reaches adjacent to the river are designated as rural and urban districts. A generalized land use map of the Wailua River basin is shown on Figure 4.

Land Ownership. The lands in the upper watershed of the Wailua River basin are divided between the State of Hawaii and Lihue Plantation Company, Ltd., an industrial company involved in irrigation, production, and processing of sugarcane. The parent company of Lihue Plantation is Amfac, Inc., a diversified commercial, development, and agribusiness enterprise. A limited area including lands in the lower watershed and at the mouth are under private ownership. Approximately, four miles of the lower North Fork Wailua River on high ground form part of the Wailua Homestead Lots. As described under "Water Rights," the use of water has been historically tied to land rights. The Wailua River basin generalized land ownership map is shown on Figure 5.



LEGEND
DRAINAGE BOUNDARY
SUB-AREA DRAINAGE BOUNDARY
DITCHES AND TUNNELS
680 USGS STREAM GAGE LOCATION AND NUMBER
HANALEI TUNNEL
NORTH FORK WAILUA
WAILUA RESERVOIR
STABLE STORM DITCH
NORTH POWER HOUSE DITCH INTAKE
LOWER WAIAHI POWER HOUSE
UPPER WAIAHI POWER HOUSE
POWER HOUSE DITCH INTAKE
KOLOA DITCH
UPPER LIHUE DITCH
LEGEN
SOURC
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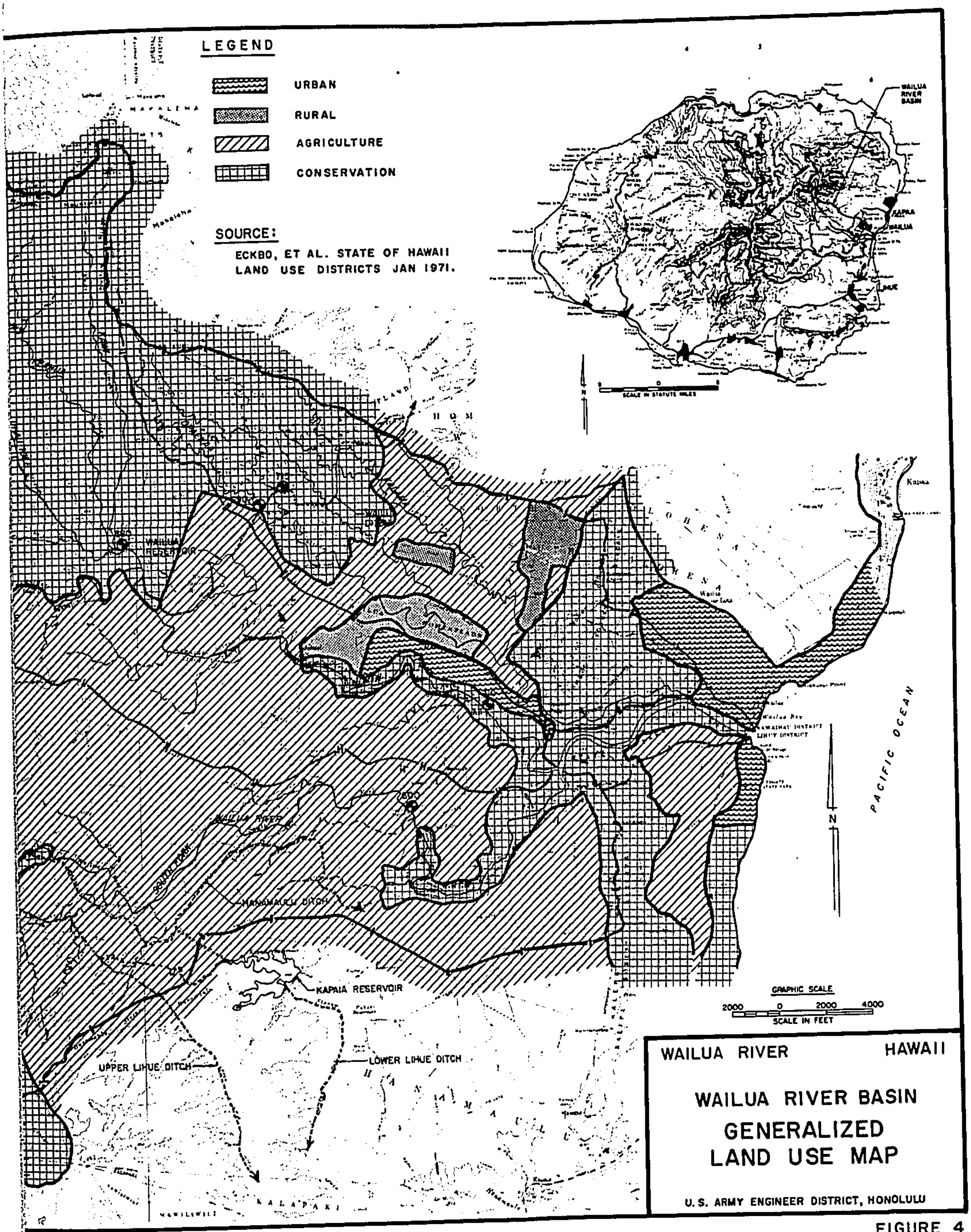
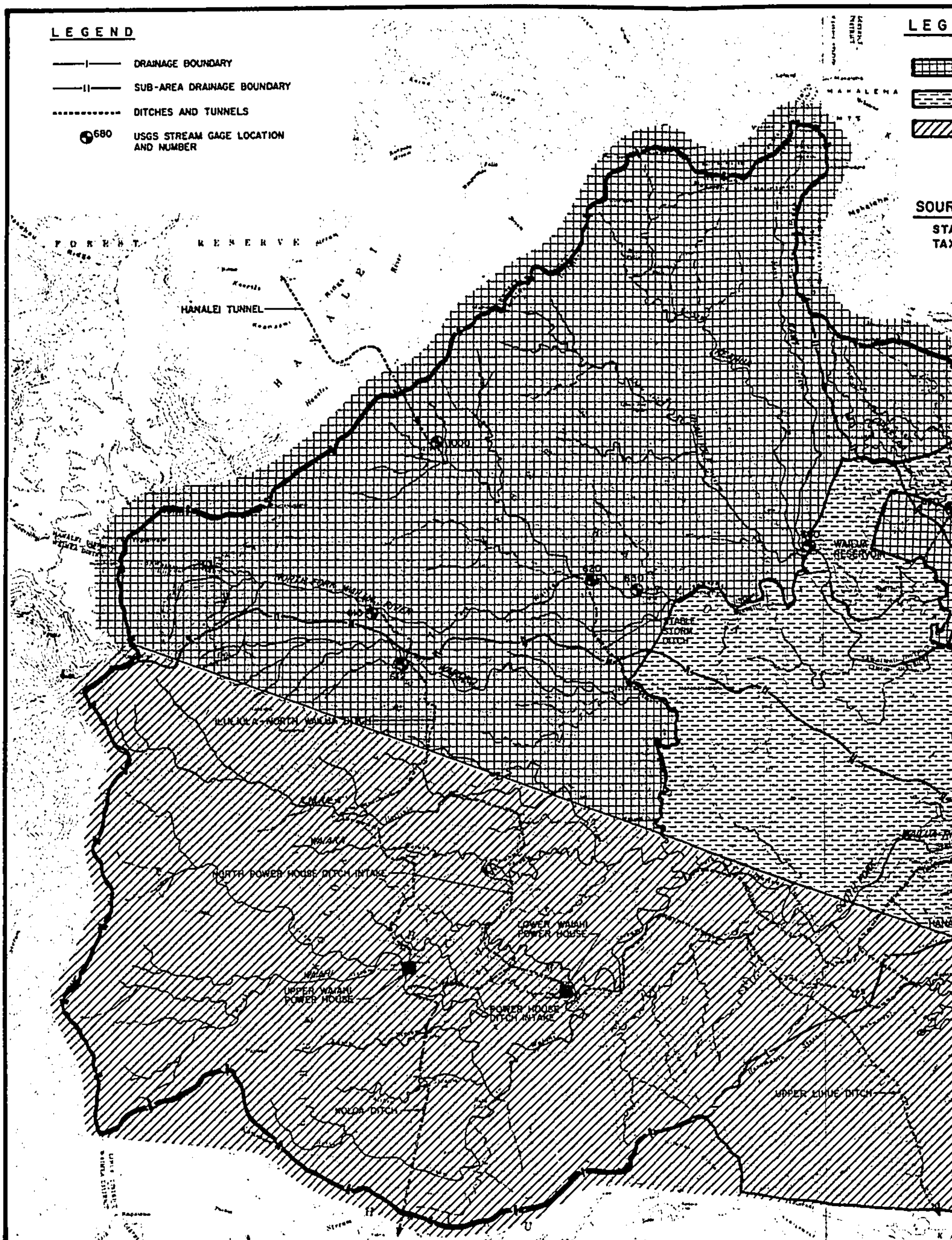

LEGEND
URBAN
RURAL
AGRICULTURE
CONSERVATION
SOURCE:
ECKBO, ET AL. STATE OF HAWAII
LAND USE DISTRICTS JAN 1971.
WAILUA RIVER BASIN
KAPAA
WAILUA
WAILUA RESERVOIR
WAILUA RIVER
SOUTH FORK
HANAMAULU DITCH
KAPAIA RESERVOIR
UPPER LIHUE DITCH
LOWER LIHUE DITCH
PACIFIC OCEAN
GRAPHIC SCALE
2000 0 2000 4000
SCALE IN FEET
WAILUA RIVER
HAWAII
WAILUA RIVER BASIN
GENERALIZED
LAND USE MAP
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 4


LEGEND
DRAINAGE BOUNDARY
SUB-AREA DRAINAGE BOUNDARY
DITCHES AND TUNNELS
680 USGS STREAM GAGE LOCATION AND NUMBER
FOREST RESERVE
HANALEI
HANALEI TUNNEL
WAIALEALE
NORTH FORK WAILUA DITCH
WAILUA RESERVOIR
STABLE STORM DITCH
ILIILIULA-NORTH WAILUA DITCH
WAIAHI
NORTH POWER HOUSE DITCH INTAKE
LOWER WAIAHI POWER HOUSE
UPPER WAIAHI POWER HOUSE
POWER HOUSE DITCH INTAKE
KOLOA DITCH
UPPER LIHUE DITCH
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SOUR
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TAX

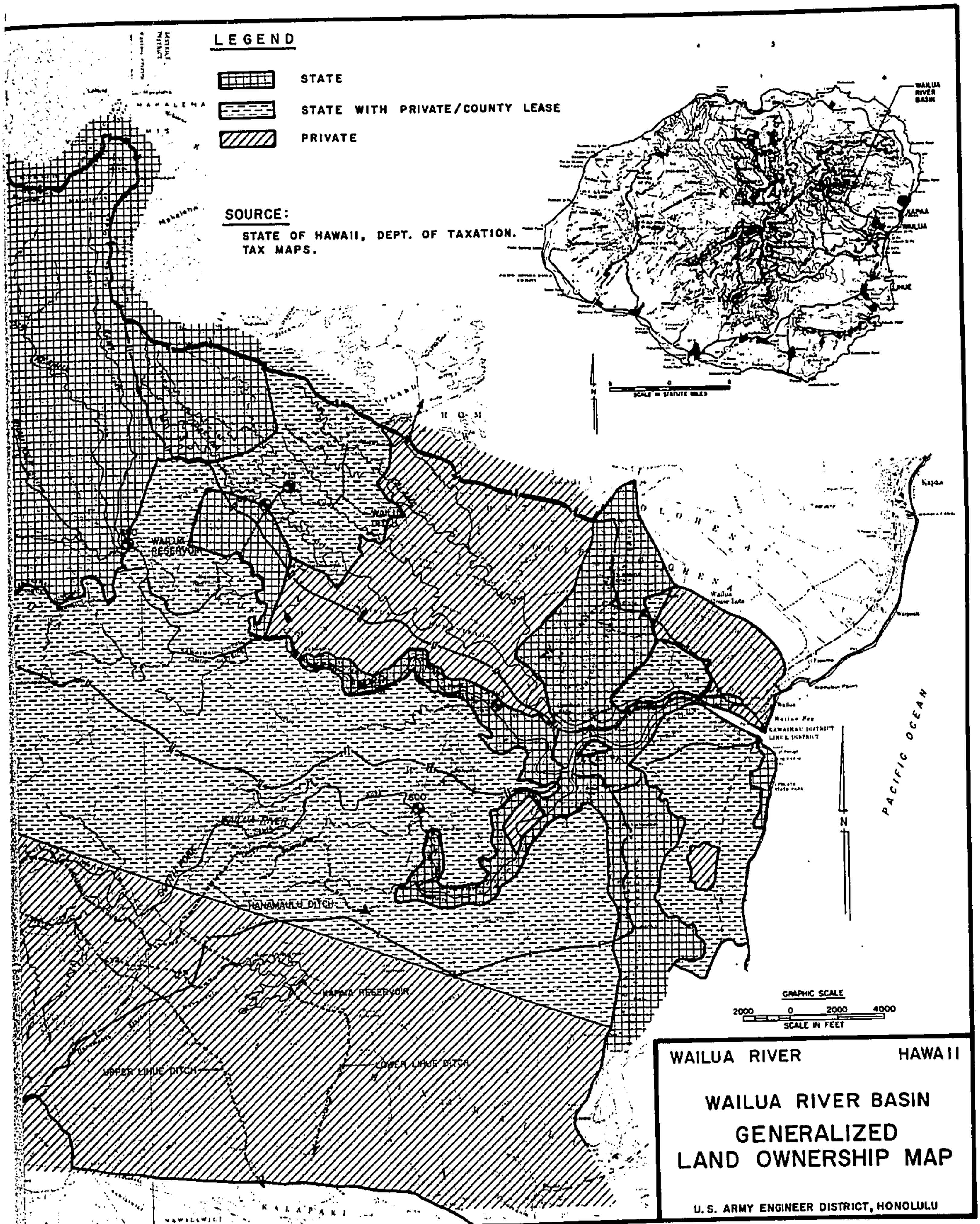

LEGEND
STATE
STATE WITH PRIVATE/COUNTY LEASE
PRIVATE
SOURCE:
STATE OF HAWAII, DEPT. OF TAXATION.
TAX MAPS.
WAIALUA RESERVOIR
WAILUA DITCH
WAILUA RIVER
HANAMAULU DITCH
KAPAIA RESERVOIR
UPPER LIHUE DITCH
LOWER LIHUE DITCH
PACIFIC OCEAN
GRAPHIC SCALE
2000 0 2000 4000
SCALE IN FEET
WAILUA RIVER
HAWAII
WAILUA RIVER BASIN
GENERALIZED
LAND OWNERSHIP MAP
U. S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 5

ENVIRONMENTAL RESOURCES

Water Quality. The State of Hawaii does not regularly monitor water quality within the Wailua River; therefore, there are no long-term water quality records available which describe the physical and chemical environment. Limited seasonal data does exist. The data indicate nitrates and turbidity are higher in waters associated with irrigation discharges.

The major influence on both the quality and quantity of water within the Wailua River has been and continues to be commercial sugarcane production. A complicated network of diversion dams, intakes and ditches divert a significant proportion of flow from both the North and South Forks of the Wailua River. Analysis of residual streamflow below the lowest diversion ditch on the South Fork reveals that flows approached zero during the months of April through October 1953 (driest year over the past 30 years). Average residual flow in the South Fork normally exceeds 16 cfs. This substantial reduction of flow in concert with the introduction of exotic species has altered the structure of the river's biological community. In many areas where flows are sluggish or intermittent, small pools of stagnant water form. These pools are not buffered from solar irradiation and may become heated above 30°C. Pools often become eutrophic. Reduced flow also allows excessive siltation of the streambed. Freshet discharge is normally turbid with suspended terrigenous sediments which have runoff from surrounding agricultural lands.

Aquatic Fauna. The aquatic fauna above Wailua Falls is dominated by introduced species which come from both Asia and continental North America, including the smallmouth bass (*Micropertus dolomieui*), Chinese catfish (*Clarius fuscus*), and the wild guppy (*Poecilia reticulata*). Along with the bass and catfish, the less abundant bluegill sunfish (*Lepomis macrochirus*) provides a sport and subsistence fishery on Kauai. The middle and upper reaches of the river are devoid of native Hawaiian fishes or mullusks; however, diadromous mountain shrimp (*Atya bisulcata*) has been found above the lip of Wailua Falls. The introduced Tahitian prawn *Macrobrachium lar* occurs uncommonly above the falls. A significant number of native, diadromous species occur in the stream below Wailua Falls. Apparently, because of the geological configuration of the face of Wailua Falls, most diadromous species are not able to ascend beyond the falls and thus do not inhabit the mid and upper reaches of the river. Those that do are subject to intensive predation by smallmouth bass and bluegill.

Avifauna and Mammals. Three species of endemic waterfowl, the Hawaiian coot, gallinule and duck are found in the Wailua River basin. The coot and gallinule have been observed in the upper reaches of the South Fork above the proposed project site but occur most commonly below the convergence of the North and South Fork and in adjacent taro fields. All three birds are listed endangered species. Other water birds associated with the river system include the black-crowned night heron and cattle egret. Non-waterbird avifauna include the shama, melodious laughing-thrush and northern cardinal within the hau thicket bordering the streams. Western meadowlark, ring-necked pheasant and spotted dove are associated with the canefields and open pasturelands within the river basin.

Mammals within the Wailua River basin include dogs, cats, feral pigs, cattle, horses, rats and mongoose. No wetlands, wildlife sanctuaries or refuges occur within the proposed project area.

Flora. The entire watershed of the South Fork Wailua River is dominated by sugarcane cultivation. Only the headwaters lie in steep, heavily forested areas. The dominant riparian vegetation along the South Fork Wailua are exotic species (hau, California grass, Java plum). Indigenous plants such as tis, gingers, and a variety of ferns and mosses are also common along the stream.

Cultural and Historical Resources. There are no historic properties in the area of potential environmental impact currently listed or eligible for listing on the National Register of Historic Places. Outside this area at the mouth of the Wailua River is the Wailua Complex of Heiaus which contains four heiaus, a city of refuge, royal birthstones and a sacrificial rock. The Wailua Complex of Heiaus is listed on the National Register and is also considered a paramount national significance, being a National Historic Landmark. Long the home of the ruling chiefs (alii nui) of Kauai, the ahupuaa of Wailua has been a major center of cultural development and political activity on the island from the earliest times. Upland of the river mouth area, the entire area of potential impact lies within the traditional ahupuaa of Wailua. Handy and Handy writing in 1940, describe the ahupuaa as having (presumably prehistoric) agricultural terraces in both the North and South Forks of the Wailua River, particularly immediately above the Wailua Falls, as well as in the flatlands and lower courses of small tributaries to the North and South Forks. Studies conducted for the Wailua River State Park Plan identified prehistoric or early historic agricultural terraces on the slopes along the South Fork beginning about 3,000 feet below the Wailua Falls and continuing intermittently all the way to the sea. A small heiau or platform was also reported above the northern bank about 3,500 feet below the falls. The legend of Kapunohu and Kemamo tell of the cave named Kawelowai beneath the river above Waiehu (now called Wailua Falls), which is believed to be located near the Lihue Plantation Company ford. An archaeological survey conducted for this study found no sites along the Stable Storm Ditch. Neither that survey nor the State Park survey found any remains of significant agricultural terraces or irrigation systems at the proposed powerplant sites. An abandoned plantation railroad bridge lies about 400 feet above the falls.

Recreational and Aesthetic Resources. Lihue Plantation Company oversees an unmanaged smallmouth bass fishery along 21 miles of the South Fork of the Wailua River which is used primarily by plantation workers. The Company also offers restricted access to public hunting areas and game-bird reserves. The terminal estuary near the coast is a popular, recreational area which accommodates water skiing, boat rides, fishing and crabbing and tours of a botanical garden.

The three principal waterfalls in the study area, Wailua Falls on the South Fork, Kaholalele Falls and Opaekaa Falls on the North Fork of the Wailua River, lie within the sinuous Wailua River State Park. In FY79, an estimated 2.5 million visitors toured the park. Opaekaa Falls is the most readily accessible to tourists being only 2 miles inland of State Highway Route 56. Wailua Falls and Kaholalele Falls are less accessible each at approximately 4 miles from Route 56. Wailua Falls provide the sole destination of State Route 583, which ends at a turn-around overlooking the falls about 4 miles from the main highway. A typical scene from the lookout is shown on Figure 6. Informal trails lead down to the top of the falls.

WAILUA FALLS

6 Jan 82 Discharge = 440 cfs

FIGURE 6

KAUAI ELECTRICAL UTILITY SYSTEM

System Features. Prior to 1964 the island of Kauai's electrical facilities were under ownership by the sugar plantations. From 1964 to 1969, independent electrical generation facilities were owned and operated by Amfac, Inc. Since 1969 the major electrical features have been owned and operated by the Kauai Electric Division (KED) of Citizens Utilities Company. However, smaller purchased power facilities and associated transmission lines remain under sugar plantation jurisdiction. All the principal KED generation units are petroleum-based fueled plants. Internal combustion diesel units and gas turbine units utilize Number 2 diesel fuel and the steam unit utilizes Number 6 Bunker C fuel oil. There are no nuclear, coal nor hydropower plants operated by KED. A general map of the system is shown on Figure 7.

The transmission lines parallel the road transportation system except for the cross-island connection between Wainiha and Port Allen. The principal transmission lines are rated at 57.1 kv; secondary lines are at 12.47 kv, 11.5 kv and 6.9 kv. The major 57.1 kv lines, totalling approximately 113 miles in length, are under lease or ownership by Kauai Electric.

The island's electrical generation and consumption are restricted to Kauai; electrical inter-ties between the islands do not exist.

Installed Capacity and Energy Production. All energy generation for the utility system's plant is located at Port Allen. The KED system includes a mix of diesel, oil-fired steam, and gas turbine units. The bulk of the capacity (64%) is provided by the gas turbine units. A summary of the plant inventory is shown in Table 2. The gas turbines are also operated in combined cycle with flue gases firing the waste heat boiler of the steam unit.

The mix of electrical utility generation by fuel type for Kauai differs radically from the typical mix in the United States, as a whole. Nationwide oil accounts for roughly 9 percent of utility generation whereas in Kauai it accounts for 60 percent of electrical utility energy. Bagasse totals a significant 33 percent of energy in Kauai whereas solid waste and other sources total an insignificant 0.3 percent in the U.S. A graphical display of the relative proportions of fuel types is shown in Figure 8.

Table 2. KAUAI ELECTRIC DIVISION PLANT INVENTORY 1/

Location, Unit Type & Year Installed		Installed Capacity, Mw	Generation (Net) 2/ million kwh	Demand 4/ On Plant Mw
PORT ALLEN				
Diesel				
#1	1964	2.0		
#2	1964	2.0		
#3	1968	2.75		
#4	1968	2.75		
#5	1968	2.75		
		12.25	17.0	7.7
Steam	1969	10.0	53.2	7.5
Gas Turbine				
#1	1972 (Hitachi) 3/	17.65	18.6	--
#2	1977 (John Brown) 3/	22.18	35.8	19.5
TOTAL		62.08	124.6	34.7

1/ Year ending 31 December 1981. Excludes Lihue Plantation 12.0 Mw purchased capacity. Data provided by KED, 1982.
2/ Inclusive of energy consumed by in-plant use
3/ Operated also in combined cycle mode.
4/ At time of peak.

In addition to the Kauai Electric Division owned and operated powerplant and system features, KED maintains separate agreements with the four island sugar plantations for purchased capacity and energy. The four sugar plantations (Lihue, McBryde, Kekaha, and Olokele) use a combination of hydroelectric, diesel, and bagasse steam plants to produce electrical energy for their respective plant operations. As of 1981, approximately 46 percent of the industrial energy output or 94 million kwh was transferred to KED. This total also constituted approximately 43 percent of the energy output of KED. The distribution of sugar plantation energy generation by fuel type is shown on Table 3.

Since 1969 the proportion of purchased energy has decreased from approximately 50 percent to 15 percent in 1980. From 1969 to 1976 KED maintained agreements for purchasable capacity; 1977 to 1980 required no purchasable capacity (except for emergencies). In March of 1981 a 20 MW bagasse-fired powerplant became fully operational at Lihue Plantation. In accordance to an agreement with KED, Lihue would furnish 12.0 MW firm capacity and a minimum of 55.6 million kwh per year. The plant became fully integrated into the KED system and operations are directly controlled from KED's Port Allen headquarters. The proportion of purchased energy rose to 43 percent in 1981. The relative impact of the purchased and KED plants is shown on Table 4.

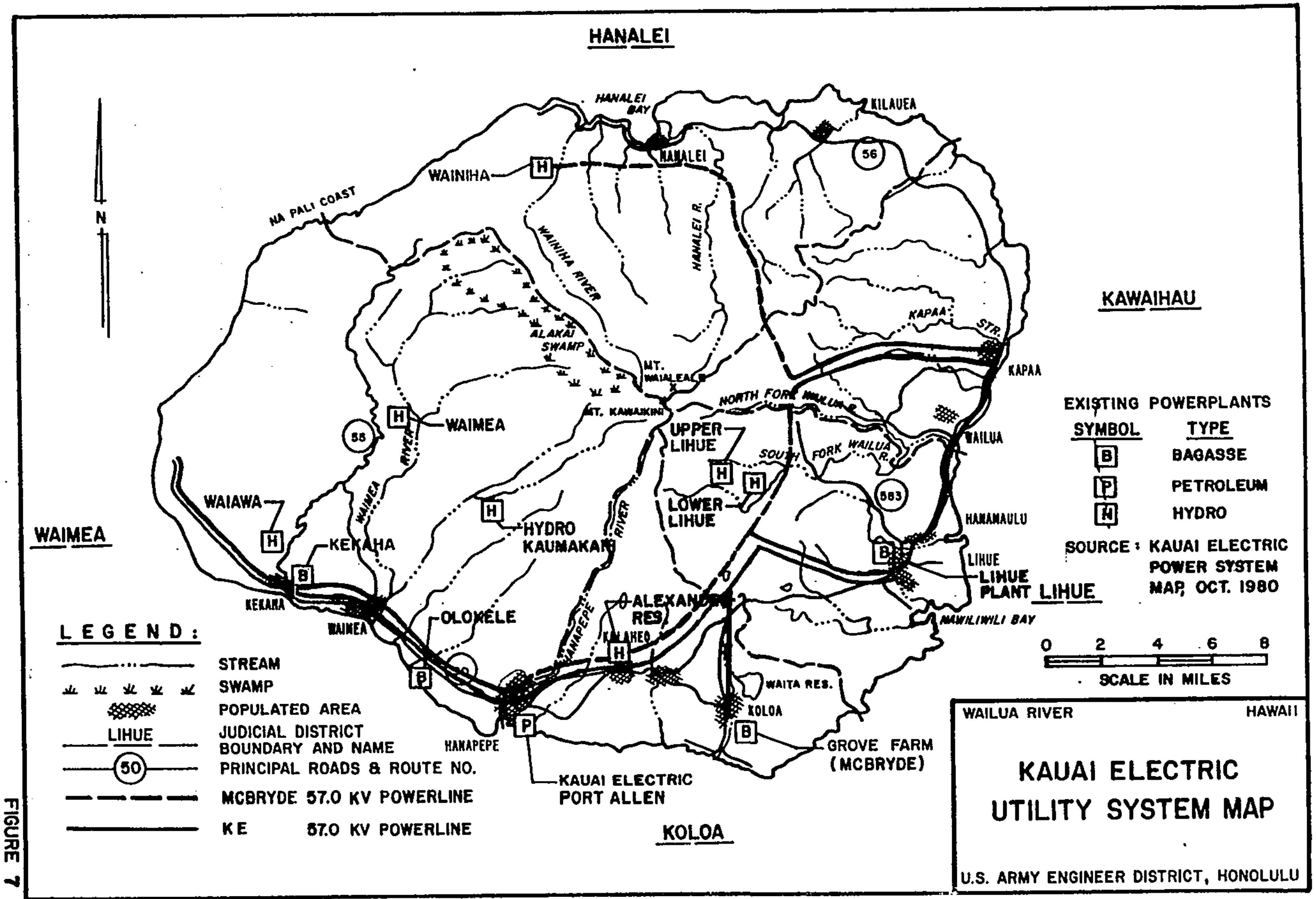


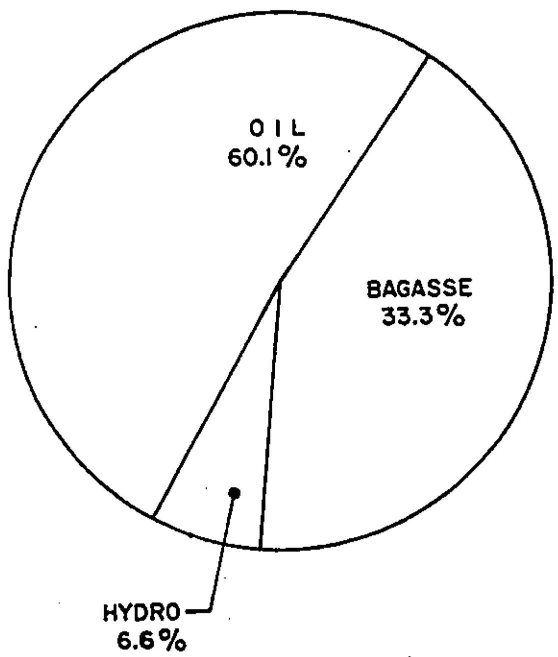
FIGURE 7

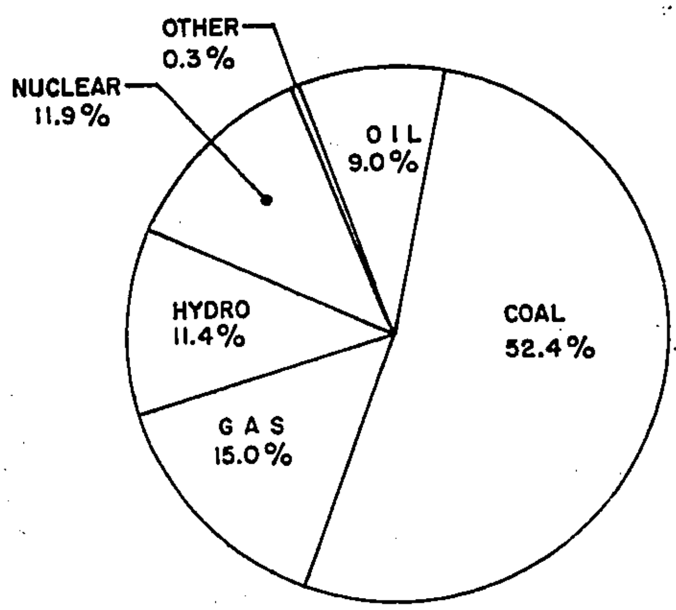
FIGURE 7

ISLAND OF KAUAI

ANNUAL TOTAL GENERATION = 219 MILLION KWH

SOURCES:
KINOSHITA, 1981
& PUC, 1981





UNITED STATES

ANNUAL TOTAL GENERATION = 2,293,000 MILLION KWH

SOURCE:
DOE, ELECTRIC POWER MONTHLY, DEC 1981.

WAILUA RIVER — HAWAII

UTILITY ELECTRIC GENERATION BY FUEL TYPE, 1981

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 8

Table 3. ELECTRICAL GENERATION ON KAUAI BY FUEL TYPE - 1981 1/

	Fuel Type			
	Petroleum	Bagasse	Hydro	Total
Total Plantation & Utility System				
Plantation Generation, million kwh	11.0 2/	146.1 3/	48.7	205.8
Percent by Fuel Type	5.4	71.0	23.6	100.0
Utility, Generation, million kwh	124.6	0	0	124.6
Percent by Fuel Type	100.0	--	--	100.0
Total Generation, million kwh	135.6	146.1	48.7	330.4
Percent by Fuel Type	41.0	44.2	14.8	100.0
Electrical Utility System				
Plantation Generation Sold to Utility, million kwh	6.9 4/	72.7 4/	14.4 4/	94.0
Percent of Total Generation	--	--	--	43.0
Utility Generation, million kwh	124.6	0	0	124.6
Percent of Total Generation	--	--	--	100.0
Total Generation, million kwh	131.5	72.7	14.4	218.6
Percent by Fuel Type	60.1	33.3	6.6	100.0

1/ Sources: Kinoshita, C.M. "Energy Inventory for Hawaiian Sugar Plantations - 1981" Honolulu: 1981; State of Hawaii, Public Utilities Commission, "Annual Report of Kauai Electric Division...1981."

2/ Diesel units plus percent of total boiler generation based on utilization of boiler fuel oil.

3/ Total boiler generation less fuel oil generation. Also includes an estimated 2.6 million kwh generated by wood chips.

4/ Estimated based on generation proportion by fuel type for the individual plantations.

Table 4. KAUAI ELECTRIC DIVISION AND SUGAR PLANTATION POWERPLANTS

Summary for Year Ending 31 December 1981 1/

Plant	Power, MW		Energy, Million kwh	
	Installed Capacity	Utility Demand	Generation by Sugar Companies	Purchased/ Generated by KED
Kauai Electric at Port Allen 2/	62.1	34.7	--	124.6
Purchased Power/Energy				
Lihue	21.3	12.0 3/	105.5	71.1
McBryde	19.7	3.6 3/	60.0	16.4
Kekaha	8.0	1.0 3/	28.9	5.9
Olokele	4.2	0.2 3/	11.4	0.6
Total (KED)	74.1	39.5	--	218.6
Total (System)	115.3	--	205.8	--

1/ Sources: Kinoshita, C.M. "Energy Inventory for Hawaiian Sugar Plantations - 1981" Honolulu: 1981; State of Hawaii, Public Utilities Commission, "Annual Report of Kauai Electric Division...1981."

2/ Excludes 12.0 MW capacity purchased from Lihue Plantation.

3/ Not coincident with peak demand.

Distribution and Load Centers. The load or service areas are designated by judicial districts. The largest peak demand and total energy consumption are located in Lihue District. The 1980 FPC data indicates the Lihue District was provided approximately 58.0 million kwh and experienced a peak demand of 12.0 MW. In the Lihue District the largest consumer area is the industrial sector constituting approximately 43 percent of the distribution or 25.1 million kwh. However, on an island-wide basis, the non-farm residential is the largest user category at 66.9 million kwh (39 percent), followed closely by the industrial user category of 64.5 million kwh (34 percent). The summary of the system load and associated population by judicial district is shown in Table 5. The distribution of load and population is illustrated in Figure 9.

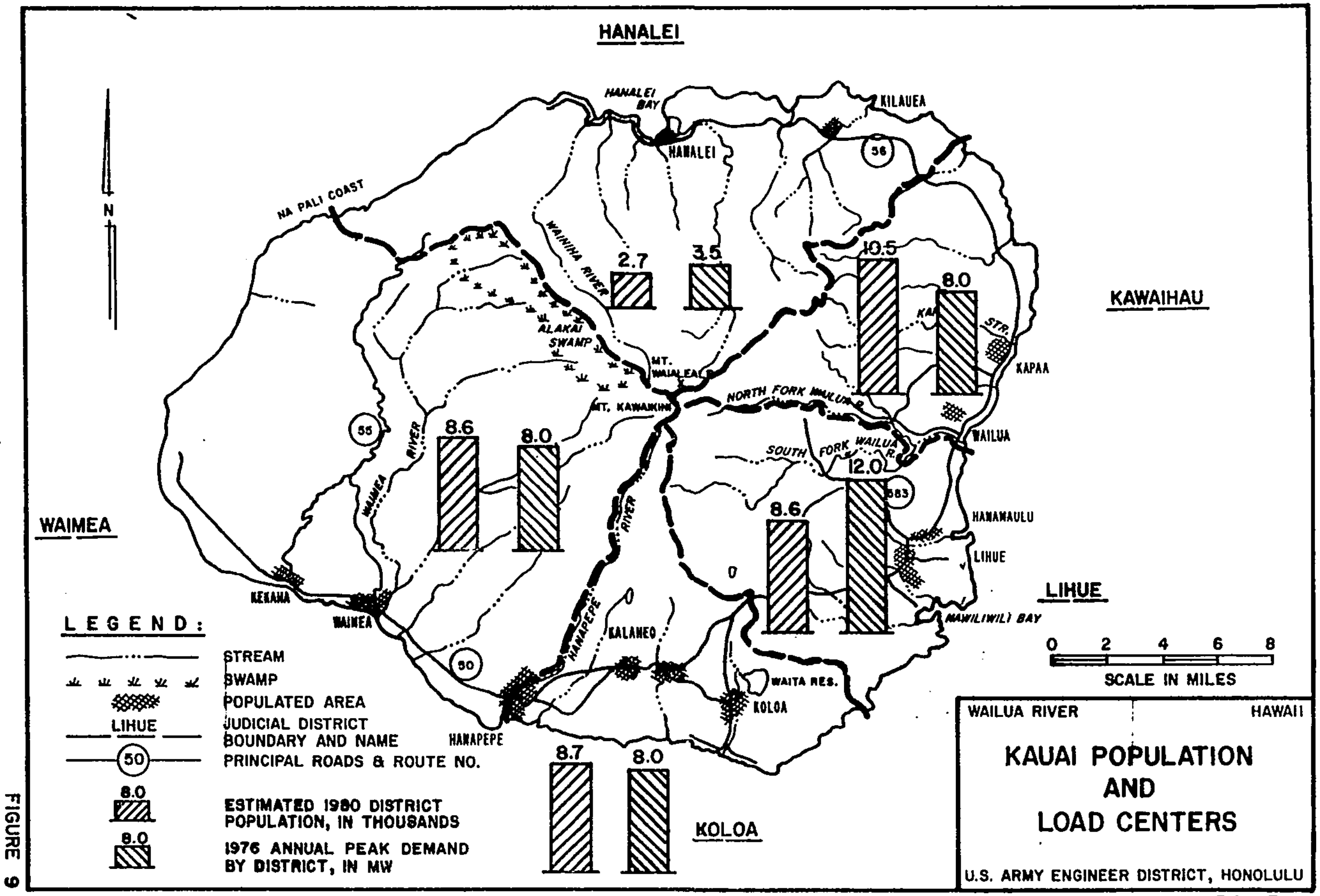

HANALEI
HANALEI BAY
HANALEI
KILAUEA
56
NA PALI COAST
N
WAINIHA RIVER
2.7
3.5
10.5
8.0
KAWAIHAU
STR.
KAPAA
ALAKAI SWAMP
MT. WAIALEALE
MT. KAWAIKINI
NORTH FORK WAILUA R.
WAILUA
SOUTH FORK WAILUA R.
12.0
583
55
WAIMEA RIVER
8.6
8.0
HANAMAULU
8.6
LIHUE
WAIMEA
HANAPEPE RIVER
KEKAHA
WAIMEA
KALAHEO
LIHUE
NAWILIWILI BAY
0 2 4 6 8
SCALE IN MILES
50
WAITA RES.
KOLOA
HANAPEPE
8.7
8.0
KOLOA
LEGEND:
STREAM
SWAMP
POPULATED AREA
LIHUE
JUDICIAL DISTRICT BOUNDARY AND NAME
50
PRINCIPAL ROADS & ROUTE NO.
8.0
ESTIMATED 1980 DISTRICT POPULATION, IN THOUSANDS
8.0
1976 ANNUAL PEAK DEMAND BY DISTRICT, IN MW
WAILUA RIVER
HAWAII
KAUAI POPULATION AND LOAD CENTERS
U.S. ARMY ENGINEER DISTRICT, HONOLULU
FIGURE 9

FIGURE 9

Table 5. DISTRIBUTION OF SYSTEM LOAD [2/]

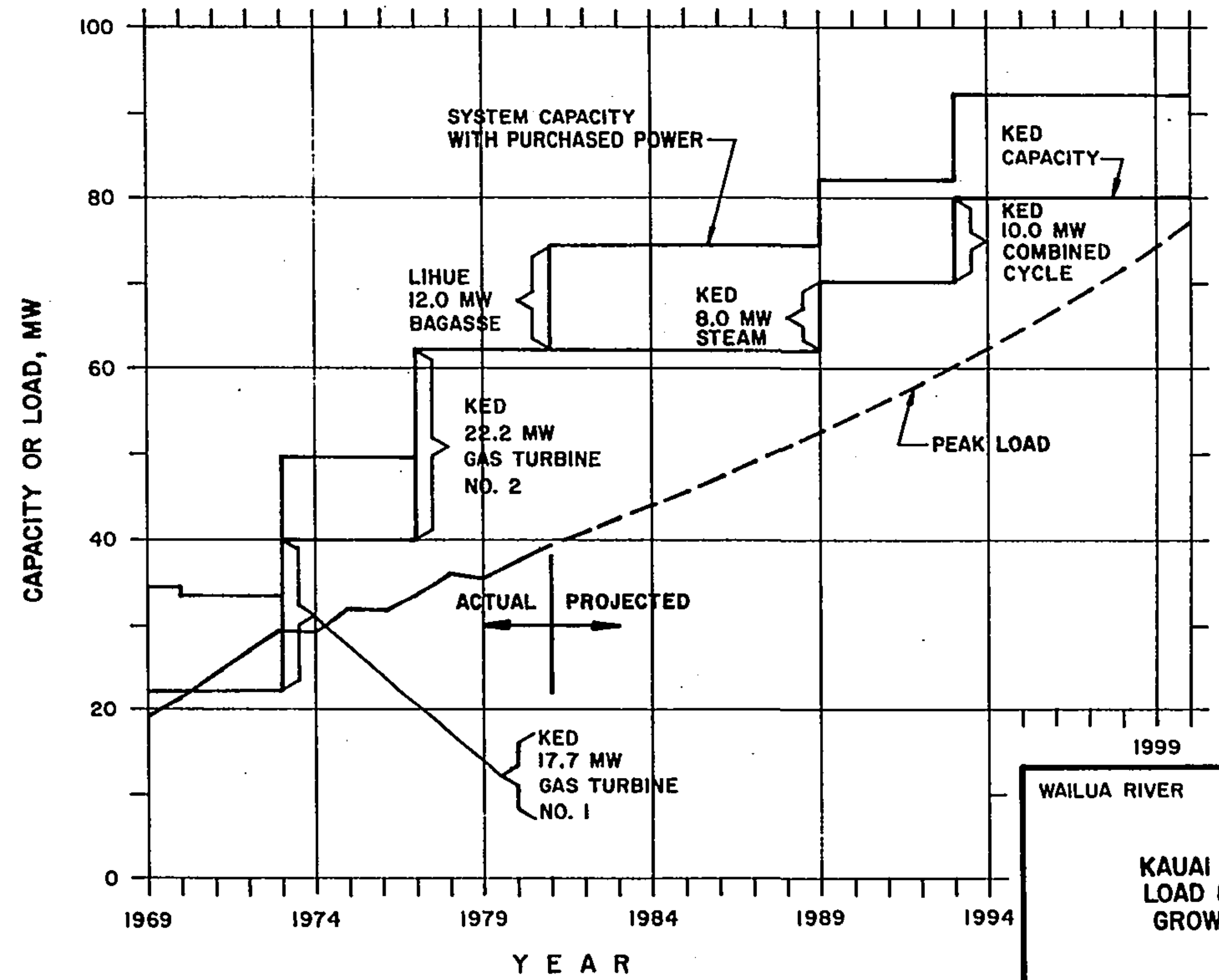
Load Area (Judicial District)	Population[1/] 1980	Energy Sold Total Million kwh	Energy Sold %	Peak Demand MW	Annual Load Factor	Energy Classification User Category	%
Waimea	8,593	34.8	19.1	8.0	52	Nonfarm residential	32.0
						Commercial	17.9
						Industrial	48.5
						Other	1.6
						Total	100.0
Koloa	8,734	31.5	17.3	8.0	54	Nonfarm residential	52.0
						Commercial	31.5
						Industrial	14.8
						Other	1.7
						Total	100.0
Lihue	8,590	57.9	31.8	12.0	62	Nonfarm residential	23.6
						Commercial	32.0
						Industrial	43.3
						Other	1.1
						Total	100.0
Kawaihau	10,497	44.3	24.3	8.0	62	Nonfarm residential	44.2
						Commercial	21.6
						Industrial	32.9
						Other	1.3
						Total	100.0
Hanalei	2,668	13.7	7.5	3.5	48	Nonfarm residential	44.5
						Commercial	30.4
						Industrial	24.2
						Other	0.9
						Total	100.0
Total		156.1				Nonfarm residential	39
						Commercial	26
						Industrial	34
						Other	1
						Total	100

1/ Preliminary 1980 Census. State of Hawaii, DPED Data Book 1981.
2/ FPC Form 12. Year ending 31 December 1980.
(Energy data reflects 1976 condition).

FUTURE POWER AND ENERGY REQUIREMENTS

Peak Demand Forecast. The annual rate of increase in the peak demand has gradually decreased since 1969 from an initial 12 percent down to approximately 4 percent per year. However, since 1969 the demand has doubled from 19.6 MW to 39.5 MW in 1981. According to officials of KED, the annual increase should remain steady at 3.6 percent compounded per year up to and including 1991 (Figure 10). Historical and projected data on peak demand and related capacities of KED are shown on Table 6.

The monthly peak load distribution has remained relatively constant over time. The highest peak demand occurs in the fall during the months of September to November, corresponding to main sugar plantation operations. The remainder of the year is relatively constant in demand. A distribution of monthly peak load for the years 1970 and 1980 is shown in Table 7. The peak hourly loads occur generally between the hours of 6 p.m. to 9 p.m. The period of low demand occurs in the early morning hours and varies between 45 to 50 percent of the peak hourly load. Typical monthly and hourly system load charts are shown in Figure 11.



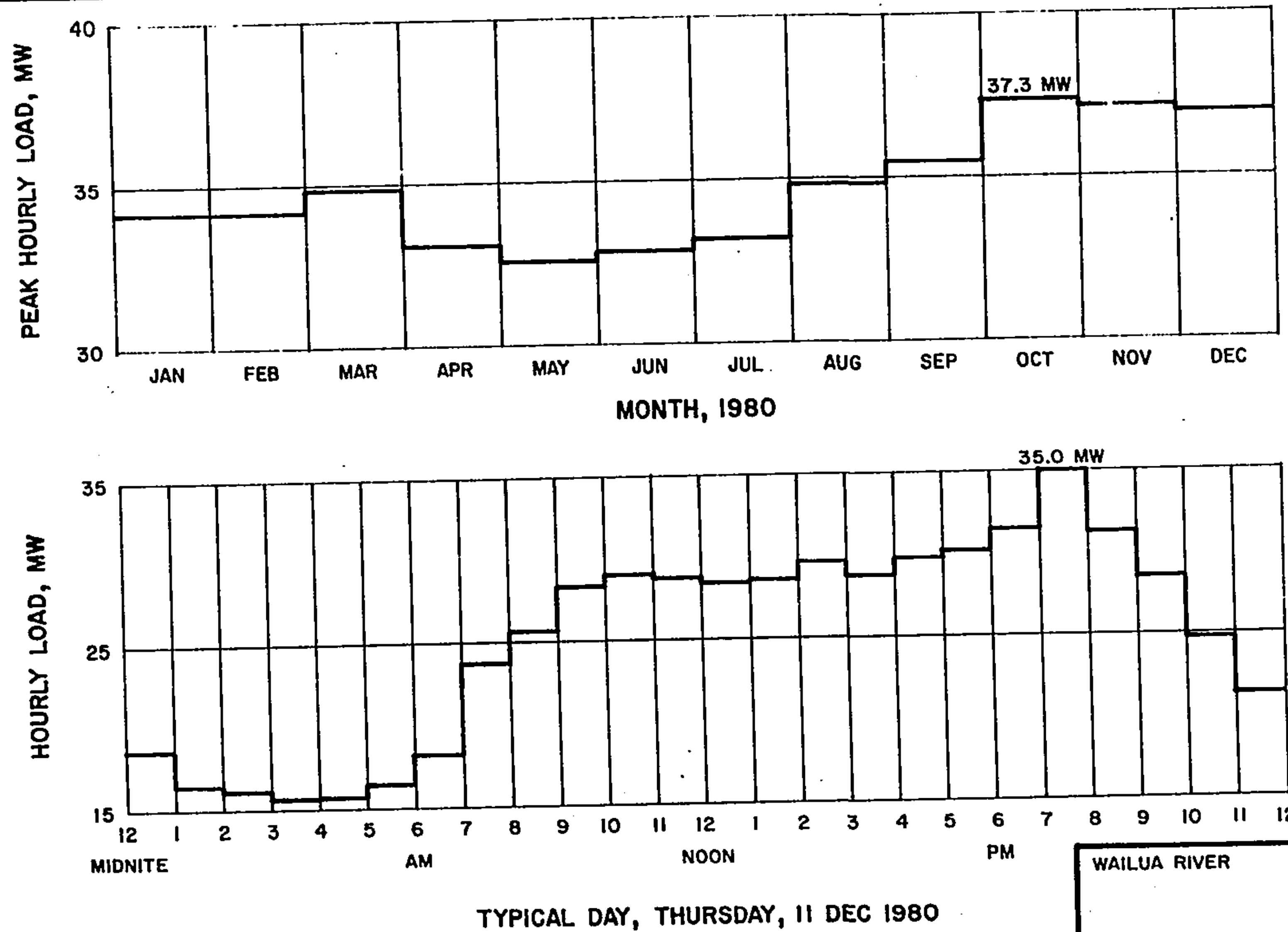
WAILUA RIVER HAWAII

KAUAI ELECTRICAL LOAD & CAPACITY GROWTH CHART

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 10

FIGURE 10



SOURCE:

UNITED STATES DEPARTMENT OF ENERGY, ENERGY INFORMATION ADMINISTRATION, 1980 POWER SYSTEM STATEMENT, FPC FORM 12 FOR CITIZENS UTILITIES, KAUAI ELECTRICAL

WAILUA RIVER HAWAII

TYPICAL SYSTEM LOADS

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 11

FIGURE 11

Table 6. HISTORICAL & PROJECTED GROWTH OF PEAK DEMAND/CAPACITY
Capacity or Demand, MW

(1) Year	(2) Addition to Capacity	(3) Total KED Capacity	(4) Available Purchasable Capacity	(5) Total Utility Capacity Col (3)+(4)	(6) Peak Demand	(7) Reserve Capacity Col (5)-(6)
1969	10.0	22.2	12.0	34.2	19.6	14.6
1970		22.2	11.2	33.4	21.9	11.5
1971		22.2	11.2	33.4	24.3	9.1
1972		22.2	11.2	33.4	27.0	6.4
1973	17.7	39.9	9.5	49.4	29.4	20.0
1974		39.9	9.5	49.4	29.4	20.0
1975		39.9	9.5	49.4	31.9	17.5
1976		39.9	9.5	49.4	31.7	17.7
1977	22.2	62.1	--	62.1	33.7	28.4
1978		62.1	--	62.1	35.9	26.2
1979		62.1	--	62.1	35.7	26.4
1980		62.1	--	62.1	37.3	24.8
1981		62.1	12.0	74.1	39.5	34.6
1982		62.1	12.0	74.1	40.9 2/	33.2
1983		62.1	12.0	74.1	42.4 2/	31.7
1984		62.1	12.0	74.1	43.9 2/	30.2
1985		62.1	12.0	74.1	45.5 2/	28.6
1986		62.1	12.0	74.1	47.1 2/	27.0
1987		62.1	12.0	74.1	48.8 2/	25.3
1988		62.1	12.0	74.1	50.6 2/	23.5
1989	8.0 2/	70.1	12.0	82.1	52.4 2/	29.7
1990		70.1	12.0	82.1	54.3 2/	27.8
1991		70.1	12.0	82.1	56.2 2/	25.9
1992		70.1	12.0	82.1	58.3 3/	23.8
1993	10.0 2/	80.1	12.0	92.1	60.4 3/	31.7
1994		80.1	12.0	92.1	62.6 3/	29.5
1995		80.1	12.0	92.1	64.8 3/	27.3
1996		80.1	12.0	92.1	67.1 3/	25.0
1997		80.1	12.0	92.1	69.6 3/	22.5
1998		80.1	12.0	92.1	72.1 3/	20.0
1999		80.1	12.0	92.1	74.7 3/	17.4
2000		80.1	12.0	92.1	77.3 3/	14.8

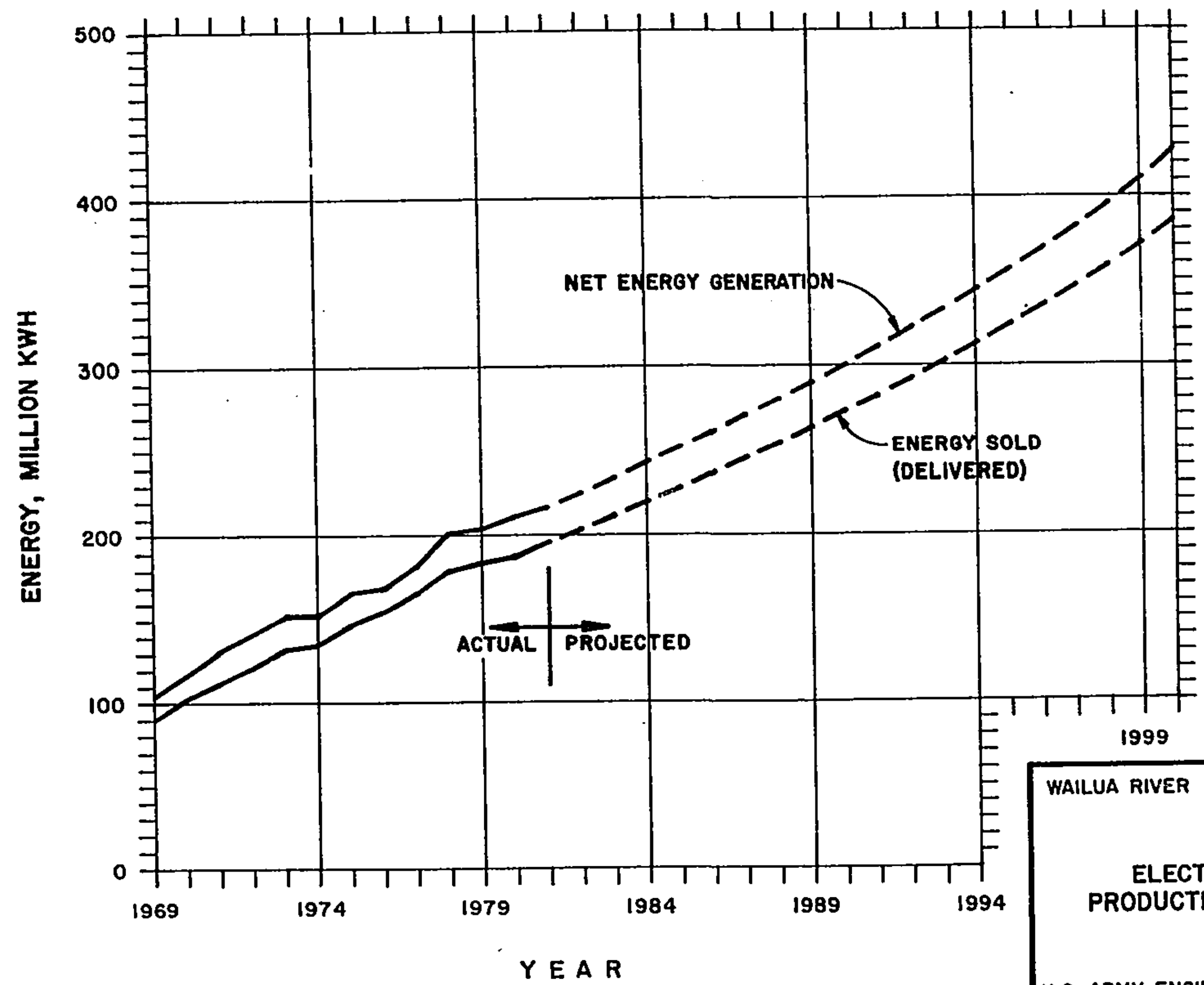
1/ Hawaii, State of, DPED. State Energy Plan, 1980
Pacific Analysis Corp. An Inventory & Analysis of the Electric Energy Industry in the State of Hawaii, 1977.
Hawaii, State of, Public Utilities Commission. "Annual Report of Kauai Electric Division." Various Years.
2/ Communication from KED Officials, Feb 1982: Projected at 3.6 % increase.
3/ Extrapolated at 3.6% increase.

Table 7. HISTORICAL MONTHLY SYSTEM PEAK LOAD[1/]

Month	1980 Load MW	1980 Load Factor, %	1980 Percent of Peak, %	1970 Load, MW	1970 Load Factor %	1970 Percent of Peak, %
Jan	34.2	66.5	91.7	17.8	63.6	81.3
Feb	34.2	67.1	91.7	18.9	61.5	86.3
Mar	34.9	65.4	93.6	18.9	67.1	86.3
Apr	33.1	69.6	88.7	19.1	66.4	87.2
May	32.6	72.1	87.4	19.3	68.9	88.1
Jun	32.9	72.4	88.2	19.9	65.1	90.9
Jul	33.2	74.6	89.0	20.7	68.0	94.5
Aug	34.9	72.1	93.6	20.5	70.5	93.6
Sep	35.5	70.9	95.2	21.7	65.3	99.1
Oct	37.3	68.1	100.0	21.9	62.1	100.0
Nov	37.2	67.0	99.7	21.7	62.3	99.1
Dec	37.0	65.0	99.2	20.9	58.7	94.5

1/ U.S. Dept of Energy. "Power System Statement" (Covering Kauai Electric Division) FPC Form 12. Years 1970 and 1980.

Energy Projection. Similar to the peak demand projections, the energy required has increased at comparable rates of increase. During the initial years of complete operations, KED system energy requirements were increasing at approximately 12 percent per year. In recent years the rate of increase has declined to 4 percent per year. The transmission and distribution losses have declined from approximately 15 percent to 10-1/2 percent. The energy sold has doubled from approximately 90 million kwh in 1969 to 189 million kwh in 1980. Similar to the peak demand projections, KED officials estimate that the annual increase in energy should remain constant at 3.6 percent per year up to and including 1991 (Figure 12). Historical and projected data on energy generation and energy sold are shown on Table 8.



WAILUA RIVER HAWAII

KAUAI
ELECTRICAL ENERGY
PRODUCTION & PROJECTION
CHART

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 12

Table 8. HISTORICAL & PROJECTED GROWTH OF ENERGY GENERATION

(1) Year	(2) KED Net Generation	(3) Purchased Energy	Million kwh (4) Net for System Col (2)+(3)	(5) Transmission & Distribution Losses	(6) Energy (Sold) Delivered Col (4)-(5)
1969	54.1	52.2	106.3	16.0	90.3
1970	88.2	30.7	118.9	16.2	102.7
1971	87.3	44.7	132.0	20.1	111.9
1972	103.5	38.3	141.8	20.6	121.2
1973	119.4	32.8	152.2	20.6	131.6
1974	111.9	42.4	154.3	18.7	135.6
1975	133.5	34.1	167.6	19.1	148.5
1976	131.9	37.7	169.6	13.6	156.0
1977	148.6	34.7	183.2	15.9	167.3
1978	179.3	21.7	201.0	21.4	179.6
1979	177.7	26.5	204.2	19.4	184.8
1980	184.4	26.7	211.1	21.9	189.2
1981	124.6	94.0	218.6	19.2	199.4
1982			226 3/		204 2/
1983			234 3/		211 2/
1984			243 3/		219 2/
1985			252 3/		227 2/
1986			261 3/		235 2/
1987			270 3/		243 2/
1988			280 3/		252 2/
1989			290 3/		261 2/
1990			300 3/		271 2/
1991			311 3/		280 2/
1992			322 3/		290 4/
1993			334 3/		301 4/
1994			346 3/		312 4/
1995			358 3/		323 4/
1996			371 3/		334 4/
1997			385 3/		347 4/
1998			398 3/		359 4/
1999			413 3/		372 4/
2000			428 3/		385 4/

1/ Pacific Analysis Corp. An Inventory & Analysis of the Electric Energy Industry in the State of Hawaii, 1977.
US Dept. of Energy, Energy Information Adm. "Power System Statement" for Kauai Electric Division. FPC Form 12. Various Years.
2/ Communication from KED Officials, Feb 1982: Projected at 3.6% increase.
3/ Based on 1.11x Col (6) Projection.
4/ Extrapolated at 3.6% increase.

System Operational Characteristics. The Kauai Electric Division (KED) power system is operated, similar to normal electrical utilities, by a computer dispatch model. The computer assesses the operational costs of each component of the system and adjusts the power output from both the KED and purchased sources. As a result, depending on the load and time of day, the capacity for each component may vary.

The critical month for operation appears not to be in the period of October through December during periods of peak demand but in the month of January. During this entire month the Lihue 12.0 MW bagasse plant is normally shut down (in accordance to the contract) because of the cessation in sugar mill operations. The actual reserve capacity would decrease from 33.2 MW (for 1982, noted in Table 7) to 21.2 MW which is less than the capacity of the largest gas turbine unit (22.2 MW). The possibility of simultaneous shutdown of both the 12.0 MW Lihue plant and the 22.2 MW gas turbine No. 2, although remote, is of concern to KED officials. Hence, KED is required by the State Public Utilities Commission to maintain at least 22.2 MW reserve capacity in the absence of additional utility or purchasable capacity.

The combined cycle operation of the gas turbine units is definitely an economic asset for KED. The exhaust gases of the gas turbine units are utilized to charge the waste heat boiler of the 10 MW unit. As a result, the combined cycle operation cannot be operative if both gas turbines and the steam units were on-line simultaneously.

The potential additions to the KED system further considers utilizing the advantages of steam boiler and gas turbine. The 18 MW steam turbine is planned for construction in 1989. However, it will be operated at 8 MW utilizing the steam from the existing heat recovery steam generator (HRSG) unit. In 1993 the capability will reach 18 MW when a new HRSG will be hooked up independently with the existing gas turbine No. 1, operating in a combined cycle mode.

HYDROPOWER RESOURCES

Hydropower Perspective. The basic physical resources required for hydropower energy extraction are differences in elevation or head for the captured water, the rate of water flow, and the stability of flow over a time period (reflecting water storage and/or high perennial flows). The man-made resources required are a structure in the river to impound or capture the waters, a waterway to transport the waters, and electromechanical devices (turbines and generators) to convert the fall of flowing water ultimately to electrical energy.

Existing Hydropower Developments. The island of Kauai, benefitting from topographic and hydrologic conditions combined with historical development, produces more energy from hydropower sources than any of the Hawaiian islands. The existing hydropower facilities were originally installed by the sugar industry in conjunction with their irrigation, pumping, or mill operations. Table 9 shows the characteristics of the existing hydropower facilities.

Conventional hydropower developments are in general categorized in terms of operational type, capacity, and head requirements. The physical operational categories are storage, run-of-the-river, and conduit and are illustrated in

Figure 13. All of the existing hydropower facilities in the State of Hawaii and the island of Kauai (except for Alexander Reservoir) are considered conduit hydropower. A conduit system for hydropower development operates on instantaneous streamflow. The flows are diverted to a powerplant by means of a diversion system (dam, channel, canal, or tunnel) with limited pondage. The head to be developed depends on the difference in elevation between the penstock intake point and the powerplant location. Power generated by a conduit system depends on streamflow fluctuations and may not be significant nor dependable during low flow periods.

In terms of capacity, hydropower developments are usually categorized in terms of large (greater than 30 MW), small (0.1 MW to 30 MW), and micro (less than 0.1 MW). All existing hydropower plants in Hawaii and any foreseeable development are small scale or smaller. Finally, in terms of head requirements hydropower formulation are usually categorized as normal head (greater than 20 meters or 65.8 feet), low head (5 meters to 20 meters), and ultra low head (less than 5 meters or 16.4 feet). All existing and any new facilities in Kauai would be normal head facilities. There are no large, high rate of flow rivers in Kauai which warrant significant low head facilities.

A total of nine hydropower plants owned by the four sugar plantations and two businesses are currently operational at various stream and ditch locations on the island (Figure 14 and Table 9). The total capacity is 7.9 MW and the average annual energy is 46.9 million kwh. By far the most productive hydropower plant is the Wainiha plant operated by McBryde Sugar Company. The Wainiha plant produces approximately 27 million kwh of energy annually and essentially runs at full capacity throughout the year.

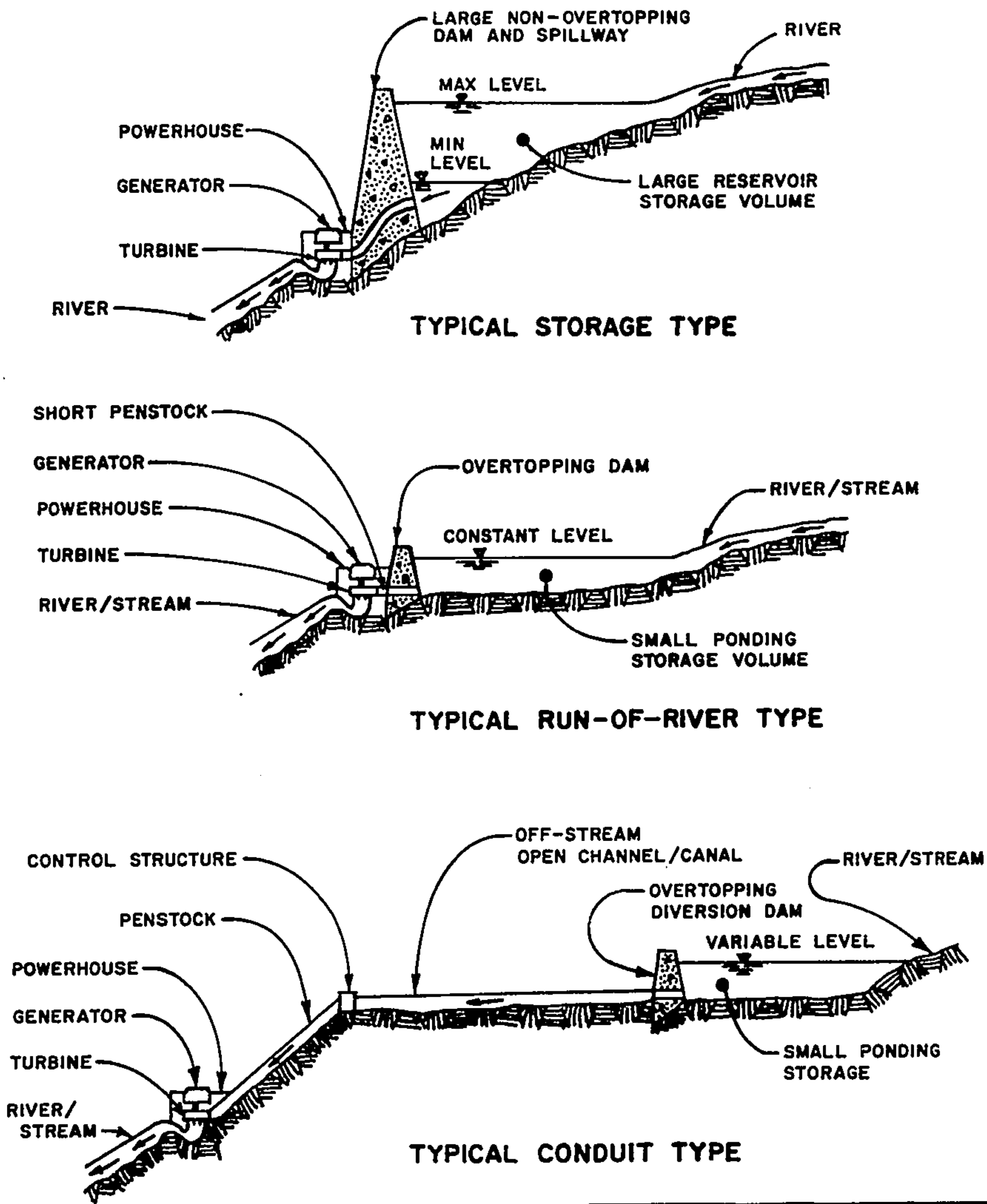
When energy at all hydropower plants is developed beyond the needs of individual plantations, the excess is transferred to the Kauai Electric Division for the utility's electrical system. As of 1980 (last year of complete published data) and based on pro-rated figures, approximately 14 million kwh of hydropower-developed energy was delivered. This transfer corresponded to 30 percent of the total hydroelectric energy production of the island.

Planned Hydropower Developments. There have been a number of proposals for hydropower development or rehabilitation in Kauai since the last significant plant was constructed in 1954. Pertinent data on the projects are provided in Table 10. The two principal areas of new development are Waimea/Kokee and the Wailua area. The Waimea/Kokee area is the location of the Kokee, Olokele, Kekaha, Kitano, and Puu Opae-Mana improvements. The Wailua area includes the Waialeale and Lihue projects.

The most ambitious projects were the Kokee Water and the Waialeale Hydropower projects. Each project involved substantial dam/reservoir and penstock construction and powerplant on the order of 10 MW. However, neither has progressed beyond the feasibility stage and currently appears less favorable because of high financial commitments required. The Kokee project had been deferred indefinitely principally because of lack of Federal funding from the U.S. Department of Interior's Bureau of Reclamation. Activity for the Waialeale project has been suspended because of infeasibility and the high cost of ($72 million, 1978 price level) construction.

The projects under current construction or investigation are much less massive in scope. Capacities vary between 0.7 to 3 MW and average annual energy vary between 3 to 10 million kwh. The projects have received high level of interest primarily because of the energy pricing impact of the Public Utility Regulatory Policies Act of 1978 (PURPA). Essentially, PURPA requires rates for purchases by utilities shall be based on "avoided cost" or the incremental cost to the utility for energy or capacity that the utility would generate itself or purchase from other sources. In accordance with this basic principle, the Kauai Electric Division has been receptive to higher energy rates paid to sugar companies.

Based on existing planning information, none of the proposed projects would be impacted by other small hydropower improvements in the Wailua River system. The Lihue upgrading project proposed by Lihue Plantation/Amfac involves rehabilitation of two existing run-of-the-river hydropower plants and increasing the ditch diversion capacity leading to the respective turbines. Both Lihue powerplants (Upper Lihue and Lower Lihue) are located at the ditches in the upper South Fork Wailua drainage area.



SOURCE: U.S.A. CORPS OF ENGINEERS
NATIONAL HYDROPOWER STUDY
ENVIRONMENTAL ASSESSMENT
(DRAFT, JULY 81)

WAILUA RIVER HAWAII

TYPICAL SCHEMATIC PROFILES OF CONVENTIONAL HYDROPOWER OPERATIONAL TYPES

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 13

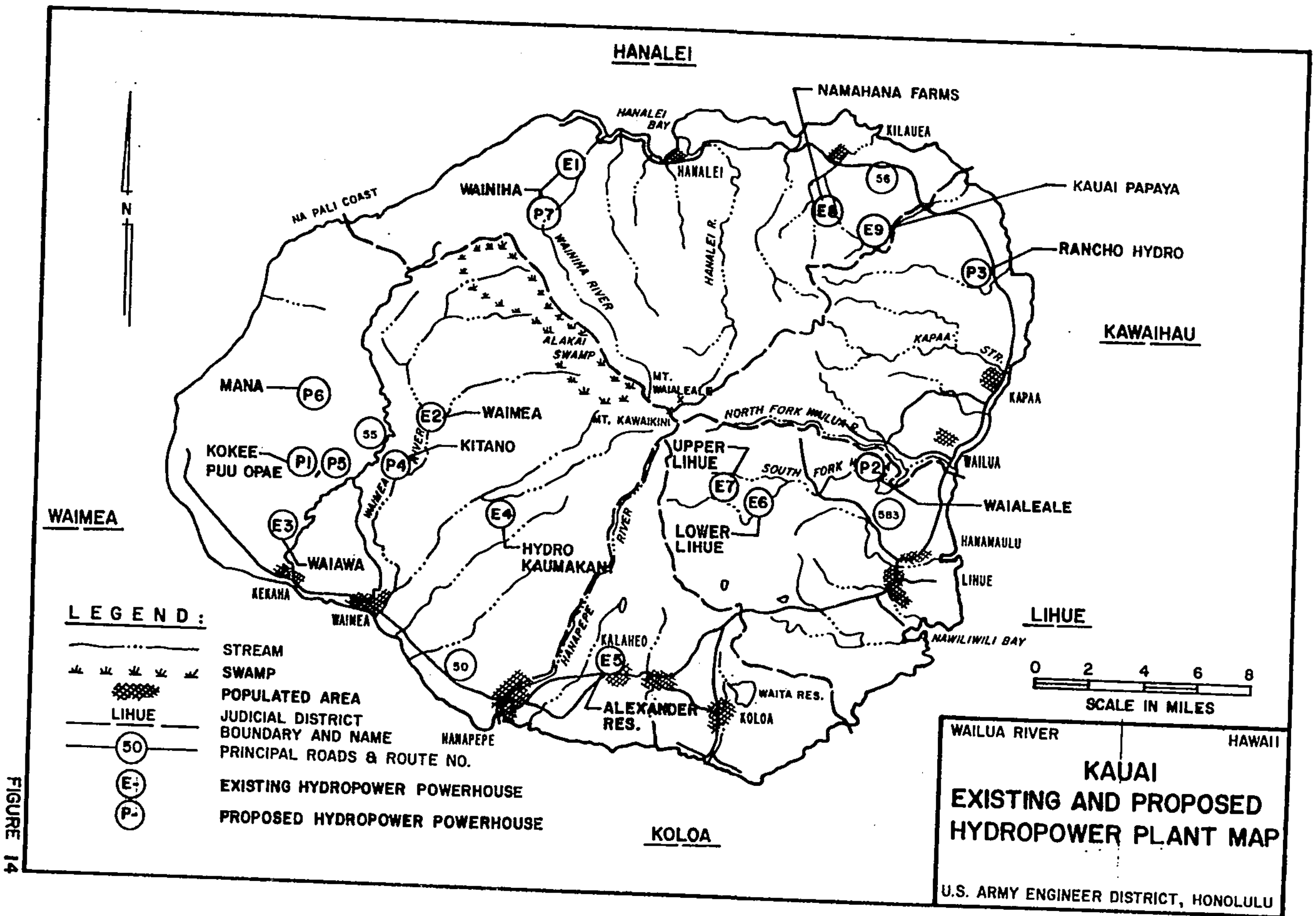

HANALEI
NAMAHANA FARMS
HANALEI BAY
KILAUEA
HANALEI
56
KAUAI PAPAYA
WAINIHA
NA PALI COAST
RANCHO HYDRO
WAINIHA RIVER
HANALEI R.
ALAKAI SWAMP
KAWAIHAU
KAPAA STR.
MT. WAIALEALE
KAPAA
MANA
P6
WAIMEA
NORTH FORK WAILUA R.
MT. KAWAIKINI
55
KITANO
UPPER LIHUE
SOUTH FORK
KOKEE
PUU OPAE
WAILUA
WAIMEA RIVER
WAIALEALE
583
WAIMEA
LOWER LIHUE
HYDRO KAUMAKANI
HANAMAULU
WAIAWA
RIVER
LIHUE
KEKAHA
WAIMEA
LIHUE
HANAPEPE
KALAHEO
NAWILIWILI BAY
LEGEND:
STREAM
SWAMP
POPULATED AREA
LIHUE
JUDICIAL DISTRICT BOUNDARY AND NAME
50
PRINCIPAL ROADS & ROUTE NO.
EXISTING HYDROPOWER POWERHOUSE
PROPOSED HYDROPOWER POWERHOUSE
ALEXANDER RES.
WAITA RES.
KOLOA
HANAPEPE
0 2 4 6 8
SCALE IN MILES
WAILUA RIVER
HAWAII
KAUAI
EXISTING AND PROPOSED
HYDROPOWER PLANT MAP
U.S. ARMY ENGINEER DISTRICT, HONOLULU
KOLOA
FIGURE 14

FIGURE 14

Table 9. EXISTING HYDROPOWER PLANTS IN KAUAI [1/]

Code	Plant Name	Stream	Owner	Static Head, feet	Installed capacity MW	Average Annual Energy million kwh	Year First Operated
E1	Wainiha	Wainiha	MBSC	565	3.6	26.6	1906
E2	Waimea	Waimea	KESC	265	1.0	5.0	1954
E3	Waiawa	Kahoana	KESC	275	0.5	1.9	1907
E4	Hydro Kaumakani [2/]	Makaweli	OLSC	211	0.5	3.1	1920
E5	Alexander Res [3/]	Wahiawa	MBSC	700	1.0	2.1	1928
-	Malumalu	Waihohonu	MBSC	150	0.128*	---	1919
E6	Lower Lihue [4/]	North Wailua & Iliiliula Ditches	LIPC	206	0.8	5.0	1941
E7	Upper Lihue [4/]	North Wailua & Iliiliula Ditches	LIPC	247	0.5	3.1	1930
E8	Namahana Farms	--	Namahana Farms	270	5.0 kw	0.025	1980
E9	Kauai Papaya	--	Kauai Papaya	177	14.0 kw	0.10	1981

1/ Sources:
a. "Alternate Energy Sources for Hawaii," Hawaii Natural Energy Institute, University of Hawaii, and Department of Planning and Economic Development, State of Hawaii, February 1975.
b. Input from owners, 1979-1982.
c. Energy generation estimated by the Pacific Ocean Division, U.S. Army Corps of Engineers.
d. Personal communication with Ms. JoAnne Yukimura, October 1982.

2/ Also known as Nonopahu or Kaumakani.
3/ Also known as Kalaheo.
4/ Also known respectively as Lower Waiahi and Upper Waiahi.

Abbreviations:

MBSC - McBryde Sugar Co., Ltd.
KESC - Kekaha Sugar Co., Ltd.
OLSC - Olokele Sugar Co., Ltd.
LIPC - Lihue Plantation Co.
* Denotes inactive sites

Code: Map location designation

Table 10. PLANNED HYDROPOWER IMPROVEMENTS IN KAUAI 1/ 2/

Code	Name of Project/ Stream or Affected Plant	Developer	Stage of Investigation/ Status	Type of Improvement	Development Capacity MW	Development Energy million kwh
P1	Kokee Water Project/ Kawaikoi Stream, Kokee Ditch	State of Hawaii, U.S. Dept of Interior	Feasibility/Deferred indefinitely	240-ft high dam, 13,700 ft penstock, powerhouse	10.0	29.2
P2	Waialeale Hydropower Project/ South Fork Wailua River	State of Hawaii	Feasibility/Suspended indefinitely	219-ft high dam, 22,700 ft penstock, powerhouse	9.2	50.0
-	Olokele Upgrading Project/ Hydro Kaumakani Plant	Olokele Sugar Co.	Under construction/ POL: Early 83	New turbogenerator powerline, electrical line, work at existing powerhouse	1.25	9.0
P3	Rancho Hydro/ Anahola Stream	John D. Harder	Under construction/ POL: Mid 83	New turbogenerator, diversion	0.0015 (1.5 kw)	0.005 (5,000 kwh)
-	Lihue Upgrading Project/ Upper Lihue Powerplant	Lihue & Amfac	Engineering/Environmental, Economics 75% complete. POL: Post 1984	Increase ditch/tunnel capacity, second turbogenerator for upper powerplant	0.8	5.7
	Lower Lihue Powerplant			Increase ditch/tunnel capacity, larger turbine for lower powerplant	1.0	7.1
-	Kekaha Upgrading Project/ Waiawa Powerplant	Kekaha & Amfac	Engineering/ POL: post 1986	Upgraded turbogenerator at existing plant	0.55	3.5
P4	Kitano Hydroplant Project/ Kokee Ditch	Kekaha & Amfac	Feasibility/study completed, engineering pending completion late 1982, POL: 1984	Diversion intake, 9,100 ft penstock, powerhouse	1.5	8.0

Table 10. PLANNED HYDROPOWER IMPROVEMENTS IN KAUAI 1/ 2/ (Cont)

Code	Name of Project/ Stream or Affected Plant	Developer	Stage of Investigation/ Status	Type of Improvement	Development Capacity MW	Development Energy million kwh
P5, P6	Puu Opae-Mana/ Kawaikoi Stream, Kokee Ditch	Amfac & State of Hawaii	Feasibility pending completion mid-1983/ status uncertain	#1 14,000 ft penstock, powerplant (Puu Opae)	0.7	Approx 3.0
				#2 18,000 ft penstock, powerplant (Mana)	2.0	Approx 9.0
P7	Wainiha/Wainiha River	McBryde Sugar	Feasibility pending completion early 1983	Improve existing project and new upstream project	3.0	Approx 19.0

1/ Listed in approximate order of project planning

Code: Map location designation

2/ Sources:
a. Hawaii, State of, Board of Land & Natural Resources. Kokee Water Project Report R22. Honolulu: 1964
b. Belt, Collins & Assoc. Waialeale Hydropower Study. Honolulu: 1978
c. Personal communication with Mr. H. Poppinga, Olokele Sugar Co., 1981/82
d. U.S. Dept of Army Permit PODCO-O 1602-S, May 1981
e. Broadbent, Ned. "Upgrading Potential of Existing Hydroelectric Units at Lihue Plantation Co., Ltd. and Kekaha Sugar Co. Ltd., Jan 1980
f. Personal communicaton with Messrs B. Hatton and N. Broadbent, 1981/82
g. Tudor Engineering Co., Feasibility Report on the Potential Development of the Kitano Hydroplant, San Francisco, July 1981
h. Personal communication with Mr. J. Harder, April 1982
i. EDAW, Inc. Wainiha Hydroelectric Project - Planning Report. Prepared for McBryde Sugar Co., Ltd., March 1982

OTHER PLANNING ISSUES

FEDERAL PARTICIPATION IN HYDROPOWER DEVELOPMENT

The Corps of Engineers through various legislative acts of Congress, has been charged with responsibility for hydroelectric power within the scope of water resources development projects. This continuing responsibility has historically included planning, design, construction, and operation of projects to assure maximum sustained public benefits. The Corps will carry out the feasibility studies, the advanced engineering and design, supervise construction, as funded for these functions through Congressional appropriations.

Hydroelectric power facilities must be economically justifiable, financially feasible, and environmentally sound for project recommendation. These facilities may be included in the recommendation to Congress for authorization as a project purpose in multiple purpose projects.

The total cost of providing hydroelectric power is repaid by the users through the Federal marketing agencies. Although the Corps determines the project cost to be repaid by non-Federal interests, the designated U.S. Department of Energy marketing agency determines the rate at which the power may be sold. In accordance with the Flood Control Act of 1944, the determined rate also must be approved by the Federal Energy Regulatory Commission (FERC). Permit and license requirements by FERC are not applicable to Federal projects developed by the Corps.

New cost sharing policies between Federal and non-Federal interests for hydropower projects have not been approved by Congress. The Administration position has been to support those projects for which non-Federal interests provide significant financing for project first costs. Ultimately all Federal hydropower costs, except for preauthorization studies, will be included in the project first costs and be subject for repayment by non-Federal interests through power receipts.

PLANS AND POLICIES OF OTHER AGENCIES

Hawaii Region Level B Study. In 19 January 1978 a regional Level B water and related land plan for the Hawaiian Archipelago was completed and submitted to the U.S. Water Resources Council. The study was under management by the State of Hawaii Department of Land and Natural Resources (DLNR) with the participation of the Corps of Engineers and other government agencies. Among the numerous water and land resource elements, hydropower energy production was a recognized developmental opportunity. Recommendation Number 19-1 called for the investigation of the potential for increasing hydroelectric power production and included the specific action of developing hydropower plants. The State DLNR was designated the lead agency in implementation of the program.

State Functional Plans. The State of Hawaii pursuant to Chapter 226 of the Hawaii Revised Statutes established the mandate for a Statewide planning system. Among the 12 functional areas plans are the State Water Resources Development Plan and the State Energy Plan. These plans were declared by the Governor on 3 May 1982 as interim State policy and will be presented in future State legislative session for adoption. The intent of the plans are to serve as a coordinating guide for the various sectors of government and private industry. The plans would serve as a basis of activities including program and capital improvement project (CIP) appropriations, budgetary review processes, land use decisionmaking processes, and environmental clearinghouse coordination.

State Water Resources Development Plan. Among the wide-ranging management resources addressed in the State Water Resources Development Plan is water for industry and energy production. One of the stated objectives is to "encourage the development of self-supplied industrial water and the production of water-based energy." Energy production will continue to receive strong statewide attention and the striving for energy self-sufficiency will result in the development of more domestic sources of energy. The Wailua River area is a recognized prospective hydropower site. The designated implementing organization for the generalized objective is the State of Hawaii Department of Planning and Economic Development with the assistance of the Department of Land and Natural Resources.

State Energy Plan. The State Energy Plan serves a functional area similar to other plans. The State Department of Planning and Economic Development was charged with the plan preparation. The basic objective in alternate energy resources development is to "accelerate the transition to an indigenous renewable energy economy by facilitating private sector activities to explore supply options and achieve local commercialization and application of appropriate alternate energy technologies." Among the recommended actions is implementation of the Wailua River Hydropower Project. The Corps of Engineers is the lead organization for this action with the assistance of the State Department of Land and Natural Resources.

WATER RIGHTS

The water rights in the State of Hawaii are based on a series of Judicial decisions since 1920. These judicial decisions reflect a particular brand of riparian doctrine originating from native Hawaiian "kuleana" land and water rights. In the 1974 McBryde v. Robinson case, the Hawaii State Supreme Court ruled that the State as the owner of all surplus water and land owners of appurtenant lands cannot divert waters outside the drainage area. In effect, it mandates that the natural flow of the stream may be legally enforced as a minimum level of stream flow. The case is still under consideration by the courts. However, historically for irrigation and on Kauai, stream waters were considered owned by the land owners subject to prescriptive rights and use of water. In the specific case of the Wailua River and its associated irrigation diversion system, land ownership are divided between Lihue Plantation and the State of Hawaii (Figure 5). The lower 6 miles of the South Fork Wailua River are under direct ownership or under lease from the State of Hawaii. Lands of Hanalei River and the North Fork Wailua River from which diverted flows influence the South Fork River are also under control of State. Remaining upstream areas of the South Fork River are under ownership of Lihue Plantation.

Lihue Plantation, as administrative successor to East Kauai Irrigation Company, maintains a water lease agreement with the State of Hawaii for waters affecting the North Wailua, Kapaa, Anahola, and Hanalei Rivers. Based on the financial limits of the lease, Lihue Plantation would divert an average discharge of 190 cfs for the four drainage areas. The lease expires May 1994.

If the McBryde Decision is to be rendered binding, the State, as both land owners and local sponsor for this particular hydropower project may be required to uphold conflicting positions. The diversions would be subject to cessation or control to uphold natural streamflows and in the same instance, the continuity of existing and future diversions would be necessary for sugar and hydropower development. The resolution and implementation of necessary water rights are local responsibilities.

MINIMUM STREAMFLOW

Of major concern from the standpoint of maintenance of the existing stream ecosystem is establishment of a minimum instream flow which would exceed the flow rate below which stream dependent organisms may experience serious biological stress. U.S. Fish and Wildlife Service through their preliminary analysis of annual water flow characteristics and flow requirements of aquatic organisms within the Wailua River system have tentatively determined a 10 cfs minimum flow at the Falls. Approximately 30% of the time mean daily flows in the South Fork Wailua are less than 10 cfs. In addition, over any 7-day period of the year, the probability that the low flow would be less than 10 cfs would be 90 percent (Appendix B). The lowest mean daily flow of record was approximately 1.7 cfs at USGS streamgage 600 near the Falls (year 1953).

AESTHETIC VALUES

Located within Wailua River State Park, Wailua Falls provides one of the more important aesthetic and recreational resources in the project area. The falls and park are popular tourist destinations and are also frequently visited by local residents. Aesthetic impact of water diversions on the Wailua Falls overlook is a major planning concern. Preliminary analysis indicates that a 10 cfs minimum flow for maintenance of the aquatic ecosystem below the diversion will also satisfy flow requirements for the aesthetic qualities of the falls.

Other aesthetic considerations would involve the visibility of any man-made structures, including the diversion dam, powerplant, conduits, and transmission lines. The acceptability of the improvements would be dependent on the magnitude of the features relative to the natural surroundings, the extent of natural foliage, and their relationship to recreational enjoyment of the area.

POTENTIAL CONSUMER IMPACTS

A significant public concern in power projects is the impact on the electric reates to the consumer. Based upon a comprehensive energy survey during the period of December 1978 to March 1979 conducted under the Hawaii Integrated Energy Assessment (HIEA) Project, the public overwhelmingly agree that an energy problem exists. This public awareness clearly stems from the obvious measures in costs for auto fuel and electricity, and to a lesser extent for prices for consumer goods in general.

Residential electrical rates have risen significantly over the part decade. As shown in Table 11, the utility rates have more than tripled from 46 mills/kwh, in 1971 to approximately 160 mills/kwh (or 16¢/kwh) in 1981. Due principally to the fixed term nature of many energy and oil contracts and their impact on regulated rates, the actual residential rates have periodically risen step-wise rather than at a rate consistent with energy prices. The annual rate of change of the utility rates have fluctuated from basically no change to over 30 percent increase. The residential utility rates for Kauai are about double the rates for other cities in other regions of mainland United States (Table 12).

Among the rules of the Federal Public Utility Regulatory Policies (PURPA) Act of 1978 administed by the Federal Energy Regulatory Commission, the rates paid to small power production facilities must be just and reasonable to the electric consumer of the electric utililty and in the public interest (Section 292.304). By logical extension, the public may assume that electrical utility rates should tend to decline if significant cheaper alternative energy sources are implemented. However, in the HIEA survey previously cited, 64 percent of the residents of Kauai believed that energy prices will never go down even with new community energy sources (such as biomass, geothermal, and other alternative sources). Evidently the surveyed public perceived that the regulated utility pricing policy would be insensitive to non-fossil fuel technologies. This understanding is relatively accurate in the context that rates are generally established on the basis of existing and foreseeable costs of fuel supplies, amortization of capital expenditures, and operational costs of the utility.

The impact of any small energy production facility (hydropower or other alternative energy source) may potentially postpone capital expenditures for additional costly fossil fuel plants or tend to offset current production of fossil fuel plants. However, the contribution of any single small power facility to the utility system would tend to be relatively small. In addition, the continual large influence of expenditure for the operations of existing fossil fuel plants will be the most significant factor in rates. The price of fuel oil is expected to continue to escalate and, depending upon international political events, may again increase far above the normal inflation rates. Hence, if a single small hydropower project was implemented, the beneficial impact of utility rate to consumers would probably be small or negligible. However, the cumulative impact of many non-fossil fuel power sources could be a significant element in the establishment of appropriate rates. For example, assuming all planned hydropower plants 1/ are on-line and existing bagasse and hydroplants remain in production in 1990, the contribution of non-fossil fuel facilities would total 60 percent of the 1990 demand. The establishment of future electric utility rates would be within the jurisdiction of State of Hawaii Public Utilities Commission.

1/ Olokele Upgrading, Lihue Upgrading, Kekaha Upgrading, Kitano Hydro, Puu Opae-Mana, Wainiha, and Wailua hydropower projects considered.

Table 11. RESIDENTIAL ELECTRIC SALES AND RATES FOR KAUAI 1/

Year	Energy Sales million kwh	Annual Percent Growth Rate	Residential Utility Rate cents/kwh 2/	Annual Percent Growth Rate
1969	35.8	7.9	3.98	-0.6
1970	38.5	7.5	4.33	9.0
1971	41.6	8.2	4.62	6.6
1972	44.8	7.7	4.65	0.7
1973	48.3	7.7	4.80	3.2
1974	49.7	2.9	6.05	25.9
1975	52.7	6.2	6.73	11.4
1976	56.7	7.5	7.33	8.9
1977	60.3	6.2	7.94	8.3
1978	63.5	5.3	8.60	8.3
1979	67.2	5.9	10.69	24.3
1980 3/	70.1	4.3	13.98	30.8
1981 3/	73.1	4.3	15.09 4/	7.9

1/ Hawaii, State of, DPED. Hawaii Integrated Energy Assessment, Vol IV: 1980 (except as noted).

2/ Total net revenue divided by total energy for residential sales classification of Residential Combined Lighting, Heating, and Small Power (Sched D) and Electric Service for Employees.

3/ Hawaii, State of. Public Utility Commission, "Annual Report of Kauai Electric Division" Years 1980 and 1981.

4/ Varies from the nominal retail price from 500 kwh consumption shown on Table 12.

Table 12. COMPARATIVE RESIDENTIAL ELECTRICAL RETAIL PRICES FOR SELECTED CITIES IN THE UNITED STATES, DEC 1981 1/

City and State	National Electric Reliability Council Region	Retail Price, 1/ Cents/kwh
New York, NY	Northeast Power Coordinating Council (NPCC)	14.68
Washington, DC	Mid-Atlantic Area Electric Reliability Council (MAAC)	5.74
Atlanta, GA	Southeastern Electric Reliability Council (SERC)	5.89
Minneapolis, MN	Mid-Continent Area Reliability Coordination Agreement (MARCA)	6.35
New Orleans, LA	Southwest Power Pool (SWPP)	6.49
Denver, CO	Western Systems Coordinating Council (WSSC)	5.91
San Francisco, CA	Western Systems Coordinating Council (WSSC)	7.79
Hawaiian Islands		
Island of Hawaii	None	12.13
Island of Maui	None	12.10
Island of Molokai	None	18.67
Island of Oahu	None	12.38
Island of Kauai	None	16.27

1/ US Dept of Energy, Electric Power Monthly, Dec 1981 and State of Hawaii, Department of Commerce, Consumer Affairs, Division of Consumer Advocacy. Based on typical 500 kwh energy consumption charges and demand charge.

THE WITHOUT-PLAN CONDITION

The "without-plan condition" is the projection of the basic demographic, economic, and physical parameters to the project area. This projection condition is assumed to exist prior to the implementation of the selected plan of improvement and is used to evaluate the effects of each of the alternative plans.

PLANNING CONSTRAINTS

Based on the foregoing analysis of the existing condition and future plans, the without-plan condition is limited by certain planning constraints which may constrain the attainment of the desired levels of economic or environmental output.

The nature of the existing powerplant features and the state of energy technology clearly point to the continuation of conventional fossil - fuel plants for the electrical utility on Kauai. The most likely alternative system will be the utilization of fossil fuel units. This scenario is generally consistent with the evaluation provided by the Federal Energy Regulatory Commission.

The consumption of electrical energy will continue to be a function of the long term economic growth and normal increases in population. However, unless consistent and concerted effort is provided through a combination of personal initiative, normal technological changes, economic elasticity effects, and governmental programs, the overall growth in both peak demand and energy is expected to remain at current projected levels.

The topographic and landform features of the Wailua River basin make large scale dam and reservoir features relatively costly to construct. The general drainage slope although mild by Hawaii standards, is steep enough to limit effective reservoir impoundment. In addition, as demonstrated by the prior State of Hawaii Waialeale study, locating a large structure upstream would not fully control hydrologically significant portions of the drainage area.

Although Wailua River is perennial, and by practical application, one of few commercially navigable rivers in the State of Hawaii, the firm flow is demonstrably low. At the USGS streamflow station 600, the discharge has historically been as low as 1.7 cubic feet per second. Hence, any proposed small hydropower facility would be relatively limited in scope consistent with hydrologic limitations.

The Wailua River watershed is substantially influenced by irrigation facilities, sugarcane lands, agricultural roadways, and other facilities related to the sugarcane industry. The upper elevations are designated conservation lands under ownership and use-control by the State of Hawaii. However, the lower areas above the urbanized strips along existing roadways are largely in active sugarcane production use by Lihue Plantation. Most of the lands under sugarcane operation are under long term lease by Lihue Plantation from the State of Hawaii. Lihue Plantation Company, Incorporated and its parent company, Amfac Incorporated, do not plan to significantly change operations or use of their agricultural lands.

The environmental attributes of the Wailua River basin are highly influenced by man's utilization of the area. Only the headwaters contain heavily forested vegetation relatively secure from human encroachment. Areas below approximately elevation 600 feet (msl) and above Wailua Falls are dominated by introduced vegetation and aquatic organisms. A number of native diadromous species are located below the falls and due to topography limited to lower stream reaches. There are no known endangered species, wildlife refuges, sanctuaries, designated municipal water supply or prime natural recharge areas within the Wailua River reaches affected by the project.

The aesthetic resources include the natural waterway and adjoining lands of the Wailua State Park, and the Opaekaa, Kaholalele, and Wailua waterfalls. The State park reach, especially from the mouth to the famous Fern Grotto has been a popular scenic tourist destination. The Opaekaa Falls is the primary scenic attraction due to its ease of accessibility along State Highway 580. Wailua and Kaholalele Falls although not as popular as Opaekaa, do have significant appeal and potential for scenic development.

Although the Wailua area has been a major center of cultural and political development in ancient Hawaiian times, there are currently no historic properties listed or eligible for listing on the National Register of Historic Places in the potential area of improvement. A cultural reconnaissance survey was undertaken and no cuturally significant remains were found. However, portions of the area contain agricultural terraces which may contain material appropriate for further investigation or preservation.

The economy of Kauai prior to the early 1960's was dominated by the sugar industry. However, during the last two decades tourism has reached a prominent position. Business, labor, and associated commercial enterprises will continue to reflect these two major industries.

Kauai, similar to the islands of Molokai, Maui, and Hawaii, is less populated and more rural in lifestyle and activities than Oahu. Various commercial and private development projects over the past several years have generated public attention and interest. Community sentiment appears, in general, to support the relatively non-urbanized setting and living patterns.

DESCRIPTION OF THE "WITHOUT-PLAN" CONDITION

In summary, the without-plan condition will be considered to consist of the following technical, economic, environmental, and socio-institutional elements.

Technical. The existing mix of powerplant types available to the island's utility will continue and be relatively unaffected by potential new hydroelectric plant facilities. The current patterns of peak demand and rate of growth for both demand and energy will continue at present levels. The existing state of irrigation ditches and diversions will continue at existing locations and rates of flow.

Economic. The economic growth of Kauai will continue to progress at present rates. The major dependent elements will be the progress and contribution of the tourism and agricultural sectors of the economy. The sugar industry will also continue to exist at present locations and extent. Any significant change in the role of sugar is highly subject to individual management decisions by the respective parent companies of the plantations related to worldwide sugar prices and U.S. support. Hence, any projections of decline or expansion of the sugar industry would be speculative.

Environmental. The existing ecological, aesthetic, and cultural resources will continue to exist in the present condition. The flora and fauna will propagate without significant external encroachment and adversity.

Socio-Institutional. The public will continue to value the worth of the scenic and agricultural setting of the Wailua Valley. This perception is especially important in view of the physical and financial aspects of large construction projects. The State of Hawaii (through the Department of Land and Natural Resources) and the County of Kauai as well as the local utility will also maintain their present open and receptive positions regarding construction, energy, and public works endeavors. The Federal government will continue to provide institutional and financial support for new hydropower development.

SUMMARY OF STUDY PROBLEMS AND CONSTRAINTS

In terms of significance of problems and constraints, the following major items must be addressed in the project's impact analysis and contribution to national economic development.

a. Dependence on Petroleum-based Powerplants. The island of Kauai is currently and will, in the foreseeable future be highly dependent on petroleum-based fuels for electrical utility generation. The immediate problem is the alleviation of this dependence such that economic productivity and growth will not be stymied by external oil price fluctuations.

b. Recreational and Aesthetic Resources. The Wailua Falls is one of the attractive recreational and aesthetic resources on the island. It is important to provide power but concurrently to preserve at least a reasonable magnitude of discharge for aesthetic enjoyment.

c. Potential Consumer Impacts. The principal public concern is the potential impact on consumer electric utility rates. This concern is related to dependence on petroleum-based fuels. If the dependence is decreased then the rate of price increase will tend to decline.

d. Federal Participation in Hydropower Development. The potential implementation of the project will be highly dependent on the financial participation by Federal and local interests.

PLAN FORMULATION

MANAGEMENT MEASURES

In any given engineering investigation there exists a wide variety of technical and institutional means to satisfy the project purpose and national objectives. All appropriate measures are to be identified regardless of Corps of Engineers, local governmental agency, or other institutional capabilities. The consideration of various measures should include various opportunities factors:

a. National Objectives. Measures should be developed which offer significant differences in their contributions to the National Economic Development (NED) and Environmental Quality (EQ) objectives.

b. Structural/Nonstructural Measures. Traditional measures which involve physical modification to the existing natural environment are structural plans. For hydropower projects these measures would normally include dams, waterways, and powerplant structures. In contrast, nonstructural measures are defined as plans which make minimum use of traditional structural measures and also contribute to national objectives. Nonstructural plans are to be fully considered in the development of alternatives.

c. Plans of Other Agencies. Plans of other agencies regardless of jurisdictional control, may offer contributions to the national objectives and should be considered.

d. Other Considerations. Plans may consider changes in statutes and laws or be in compliance with existing laws. Plans should consider effects of reduced water demand or conservation. Mitigation measures are to be included where appropriate. Finally, various implementation schedules are to be considered which would result in favorable mixes of NED and EQ effects.

PLAN FORMULATION RATIONALE

The formulation and analysis of alternative plans were based on the Water Resources Council's Principles and Standards, and related Corps regulations and guidelines. Each alternative was considered on its relationship to technical, economic, environmental, and socio-institutional factors.

TECHNICAL CRITERIA

The following technical criteria were established in the plan formulation process:

a. Any structural features should be designed to withstand the maximum reasonable external and internal loading conditions to minimize failure potential.

b. The improvements should be sized in a manner for efficient utilization of the surface water resources for energy development.

c. Features should be designed to provide for adequate accessibility for operation and maintenance purposes.

d. Electrical generation and tie-in should be compatible with the existing utility system.

e. Any change in flow rate should not adversely affect the existing irrigation operations.

ECONOMIC CRITERIA

To realize economic benefits the following criteria were established:

a. The plans under consideration should, as far as practicable, maximize net NED benefits.

b. The relative benefits and costs should be expressed in quantitative economic terms. The evaluation should be expressed for a 100-year period of analysis and at the current discount rate established for national water resources projects.

ENVIRONMENTAL CRITERIA

The following environmental criteria were established for the plan formulation process:

a. The plans should not significantly disrupt or destroy existing ecosystems within the area of improvement.

b. The plans should not significantly impair the scenic beauty of Wailua Falls through physical structures or major diminution of flow.

c. Any increases in flows along man-made or natural channels should be within reasonable capacity of the facility and not cause failure of banks or significant increase in sedimentation.

d. Potential cultural features exposed or documented through investigation in the area of improvement should be evaluated for preservation or other measures.

SOCIO-INSTITUTIONAL CRITERIA

The following socio-institutional criteria should guide the evaluation of alternative plans:

a. The plans should be consistent with County and State agency plans for the vicinity.

b. The plans should be acceptable to the general public and various interest groups.

c. The plans should be compatible to the maximum extent practicable with existing laws, regulations, and public policies.

POSSIBLE SOLUTIONS

IDENTIFICATION

To effectively undertake plan formulation, all possible measures must be listed regardless of their potential contribution to the national objectives or to the established technical criteria. Preliminary screening was performed to narrow the selection to candidate plans meriting detailed examination. Table 13 lists possible solutions categorized in accordance to the opportunity factors previously described. These solutions are itemized in terms of generalized features and qualitative evaluation without specific quantitative dimensions or impacts. The potential contributions are simply listed in terms of significantly positive (++), positive (+), uncertain (?), negative (-), and significantly negative (--) contributions.

DISCUSSION OF POSSIBLE SOLUTIONS

No Action. In accordance with current Principles and Standards regulations, the alternative of taking no action is to be fully considered in the planning process. In the no action alternative, the future scenario would be no growth in either peak demand or energy consumption. Under this setting, no additional powerplants or conservation measures would be warranted. The basis of this scenario would be essentially a static or declining population and accompanying economic rate of growth. The current projections of Kauai's economy and general planning direction do not support this hypothesis. Hence, no further consideration of this alternative was warranted.

New Fossil Fuel Powerplant. The existing diesel, oil, and gas turbine fueled powerplants will continue to function as dependable energy sources. The local utility has projected that, subject to other developments, new powerplants may be required in 1989 (8 MW) and 1993 (10.0 MW) to meet peak demand and energy growth of the island. As shown in Table 14, the price of Number 2 (diesel) and Number 6 (bunker) oils were fairly stable prior to 1974. However, as a result of the 1973-1974 Arab fuel embargo in 1974, the prices of both fuels took a quantum jump to practically double their former levels. In 1980 the fuel prices rose again sharply such that the prices of No. 2 and No. 6 oils experienced 6-fold and 9-fold increases, respectively, since 1969. As of the end of 1981 the fuel oil price was $28.90 per barrel and that of diesel oil, $41.57 per barrel. Despite the current world oil surplus, the long-term outlook of oil availability and prices do not appear favorable. High dependence on fossil fuel plants will simply be a continuation of high dependence on external and potentially unstable world-wide conditions. Based upon these considerations, it is very desirable that alternative methods of generation be implemented. For the purposes of general evaluation, the current dependable powerplant will be utilized to evaluate the benefits of other systems.

Table 13. POSSIBLE SOLUTIONS

Measure	Opportunity Factors Addressed	Potential Contributions
a. No action	NED objective	--
	EQ objective	--
	Nonstructural	--
	Plans of Other Agencies	--
b. New fossil fuel Powerplant	NED objective	+
	EQ objective	?
	Nonstructural	--
	Plans of Other Agencies	+
c. Electrical interties	NED objective	--
	EQ objective	?
	Nonstructural	+
	Plans of Other Agencies	--
d. Conservation and solar hot water heating	NED objective	+
	EQ objective	++
	Nonstructural	++
	Plans of Other Agencies	++
e. New bagasse powerplant	NED objective	+
	EQ objective	-
	Nonstructural	--
	Plans of Other Agencies	-
f. Wind powerplant	NED objective	--
	EQ objective	-
	Nonstructural	-
	Plans of Other Agencies	-
g. Hydropower retrofitting and development at existing damsites	NED objective	--
	EQ objective	?
	Nonstructural	-
	Plans of Other Agencies	--
h. New conduit hydropower diversion and powerplant	NED objective	+
	EQ objective	?
	Nonstructural	-
	Plans of Other Agencies	+
i. New dam/reservoir and hydropower plant	NED objective	--
	EQ objective	--
	Nonstructural	--
	Plans of Other Agencies	+

Table 14. LIQUID FUEL COST FOR ELECTRICITY GENERATION, KAUAI 1/

	Fuel Oil (No. 6)		Diesel (No. 2)	
Year	Cost, $/bbl	Avg Annual % Growth	Cost, $/bbl	Avg Annual % Growth
1969	2.78	--	6.03	-7.5
1970	2.95	6.1	5.88	-2.5
1971	4.11	39.3	6.20	5.4
1972	4.34	5.6	6.21	0.2
1973	4.84	11.5	6.92	11.4
1974	12.21	152.3	12.57	81.6
1975	11.50	-5.8	14.10	12.2
1976	11.96	4.0	13.96	-1.0
1977	12.57	5.1	16.28	16.6
1978	12.69	1.0	16.58	1.8
1979	16.23	27.9	23.96	44.5
1980 2/	24.21	49.2	35.53	48.3
1981 2/	28.90	19.4	41.57	17.0

1/ Average price of fuel consumed during calendar year. Sources 1969-1979: State of Hawaii, DPED. Hawaii Integrated Energy Assessement. Vol IV, Honolulu: 1980.

2/ Sources: Hawaii, State of, Public Utilities Commission. "Annual Report of Kauai Electric Division of Citizens Utilities Co." for years ending December 31, 1980 and December 31, 1981.

Electrical Interties. The Kauai Electric Division system is completely self-contained within the island of Kauai. The utility is one of the two smaller utilities in the state, the other being Molokai Electric Company. The remaining systems in the islands of Oahu, Maui, Lanai, and Hawaii are controlled by the larger Hawaiian Electric Company (HECO). Kauai Electric, as a result, does not have financial and institutional ties to the other islands' utilities.

Technically, submarine high voltage power cables to the depths required between islands are still in the developmental stage. To date (June 1981), the deepest high voltage direct current cables are deployed in water depths of 1,800 feet. The depths of Kauai Channel between Oahu and Kauai is deepest among all the major Hawaiian Islands, down to 10,800 feet and would have to be 73 miles (at the water surface) long. Plans are currently underway to initiate a $12.4 million feasibility study to investigate intertie between the islands of Hawaii and Oahu. The maximum depths would be 7,500 feet and a distance of 150 miles. The technical difficulties of structural/mechanical stresses, water tightness, sheathings, and conductors have not been resolved for very deep cables. Due to the institutional and technological problems and potential enormous cost (on the order of $1 million per mile)1/ this potential solution would not be considered further.

1/ Hawaii, State of, DPED. Hawaii Integrated Energy Assessment Vol II. Honolulu: 1981.

Conservation and Solar Hot Water Heating. Conservation measures, including solar hot water heating, have received considerable publicity, commercial advertising, and government support. The encouragement of energy conservation has been one of the pillars of the national energy programs since the President's address to Congress of 20 April 1977 and has been adopted as one of the evaluation criterion in the Other Social Effect (OSE) account of Principles and Standards.

Outside of existing biomass (bagasse-fueled steam plant) and hydropower alternative energy sources, the other existing technology which will significantly contribute to Kauai's electrical system is solar energy. Although ultimately all sources of energy are directly or indirectly attributable to solar radiation, the three principal categories of solar technologies are solar thermal energy conversion (STEC), photovoltaic (PV) conversion and solar collector/heat exchange systems. STEC systems are large, centralized power facilities which include collectors, thermal storage, and turbogenerators. The PV conversion system utilizes direct conversion of solar energy to electrical current when sunlight strikes semiconductor cell devices. The economic application of either solar thermal energy conversion or photovoltaics in Kauai is estimated to be approximately 10 years in the future. Significant technological development and marketing techniques still remain. Hence, no further discussion of these two categories of solar technologies will be presented.

The remaining solar technology applicable for Kauai is solar collector/heat exchange. Solar hot water systems have been highly accepted systems in Kauai as well as other Hawaiian islands. Unlike STEC and PV systems, solar hot water systems do not generate electricity, are consumer/conservation oriented and are decentralized and not directly controlled by the central utility entity. The system consists of flat plate collectors, liquid heat conductor elements, thermal storage and backup alternative thermal heating element.

Energy conservation is expected to make significant contribution to increasing the State's and Kauai's energy independence. Conservation will enable the island to consume petroleum fuels at a slower rate and serve as a partial moderator until effective alternative energy technologies are implemented. The qualitative evaluation of opportunity factors suggest that this potential solution does offer potential as a viable solution. Additional discussion is contained in the following section.

New Bagasse Powerplant. Bagasse is the fibrous material remaining after the extraction of juices in sugar mill operations. This waste product is the plantation's main source of fuel. The gross heat value of bagasse fiber is 8,350 Btu/lbs and roughly 1 ton of bagasse will produce as much steam as 1 barrel of number 6 fuel oil when both fuels could be burned in the same boiler. Historically, because the electric utility system on Kauai originated from the sugarcane industry, bagasse-fueled powerplants have continued to be a significant energy source. In 1980, prior to the implementation of the new Lihue Powerplant, bagasse contributed 78 million kwh, islandwide, of which 18 million kwh 1/ was sold to Kauai Electric Division (KED). This sold energy amounted to 8.4 percent of the total electrical energy supplied by the utility.

With the rise in high petroleum cost and receptiveness of the public utility to price negotiations for bagasse-fueled energy, bagasse has risen in importance. The most significant development stemming from the new financial scene, has been the completion of the Lihue Plantation's 20 MW boiler. The plant was the largest single construction project on the island of Kauai, completed at the end of 1980 with base cost of $25 million. The 1981 impact of this single project was that the bagasse-fueled contribution on the island rose to 146 million kwh, of which 73 million kwh 1/ sold to Kauai Electric. This added energy increased the bagasse contribution to the electric utility to 33.3 percent. Including the use of boiler fuel oil, the new Lihue powerplant produced 99.8 million kwh in 1981. As a result, the older 10 MW Lihue units installed in 1939, 1949, and 1957 have been essentially shutdown. Although the implementation of the Lihue powerplant provides a lead step in the direction of energy self-sufficiency for Kauai, the contribution of new bagasse power facilities remains uncertain.

The future of bagasse-fueled power is highly dependent on the long term and economic well-being of the sugar industry in Hawaii. All 14 sugar companies in the State are either wholly- or partially-owned subsidiaries of five major agri-business corporations: C. Brewer, Ltd.; Castle and Cooke, Inc.; Theo. H. Davies, Ltd.; Alexander and Baldwin, Ltd.; and Amfac, Inc. The sugar companies own interest in the California and Hawaiian Sugar Company (C&H) which refines and markets almost all (96 percent) of Hawaii sugar at its Crockett, California refinery. Hawaiian sugar plantations supply approximately 10 pecent of the nation's sugar needs. On the island of Kauai, sugar is by far the dominant agricultural crop, totalling 45,800 acres out of approximately 48,000 acres or 95 percent of agricultural acreage. 2/ The extent of sugar lands is shown on Figure 14A. However, considering the 22-month sugarcane growing cycle, the actual 1981 harvested area totaled 21,800 acres. Although over the past 20 years statewide sugar yields and acreages have remained relatively constant there have been ominous signs of economic problems. In recent years three planations have closed operations (Kahuku on Oahu, Kilauea on Kauai, Kohala on Hawaii) and one has been scheduled for closure in 1984 (Puna on Hawaii).

1/ Excludes contribution of boiler fuel oil.

2/ Hawaii, State of, Department of Planning and Economic Development. The State of Hawaii Data Book, 1982. November 1982.

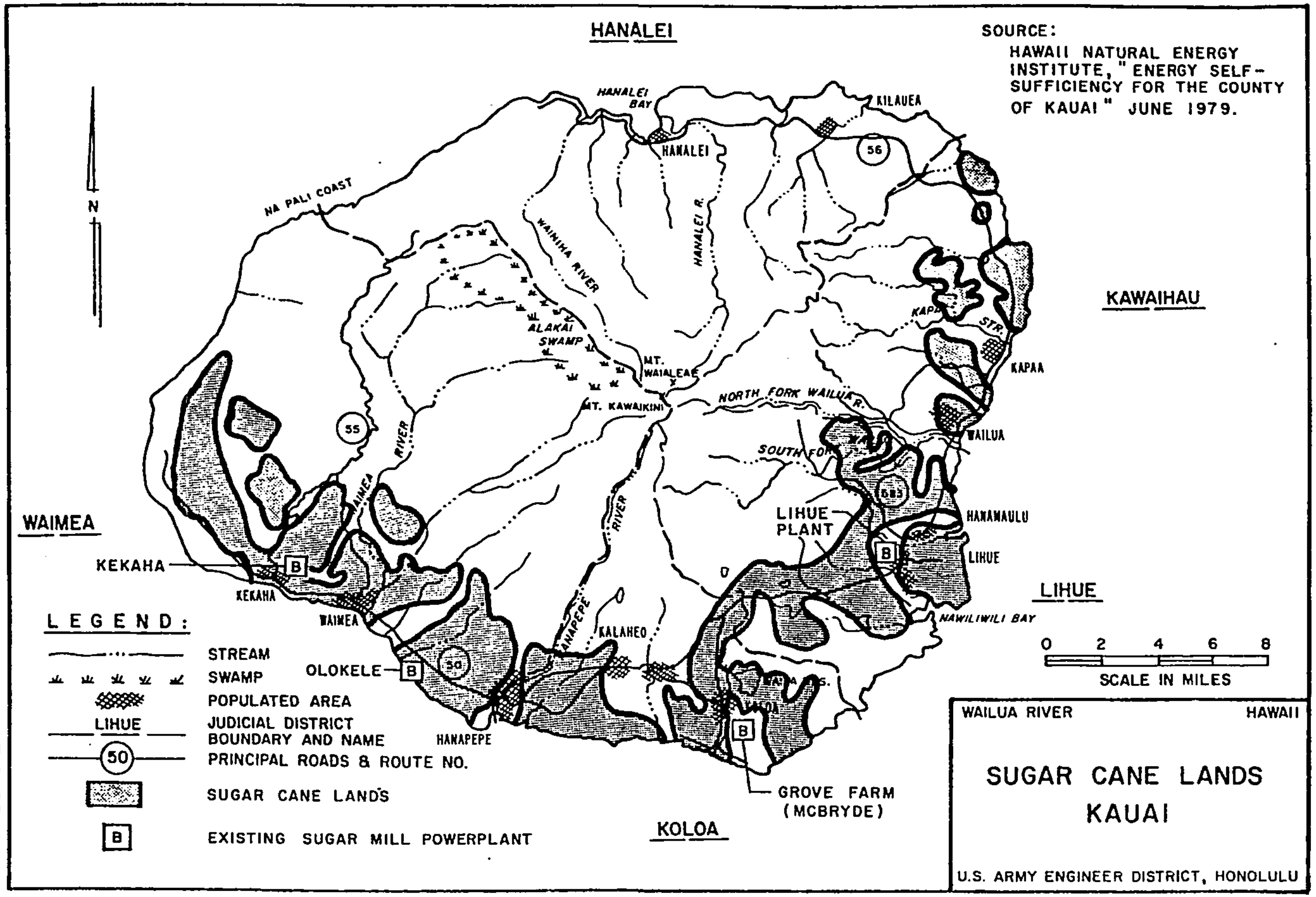

HANALEI
SOURCE:
HAWAII NATURAL ENERGY INSTITUTE, "ENERGY SELF-SUFFICIENCY FOR THE COUNTY OF KAUAI" JUNE 1979.
N
NA PALI COAST
HANALEI BAY
HANALEI
KILAUEA
56
WAINIHA RIVER
HANALEI R.
KAWAIHAU
ALAKAI SWAMP
MT. WAIALEALE
MT. KAWAIKINI
NORTH FORK WAILUA R.
KAPAA
WAILUA
55
WAIMEA RIVER
SOUTH FORK
583
HANAMAULU
LIHUE PLANT
LIHUE
WAIMEA
KEKAHA
KEKAHA
WAIMEA
HANAPEPE
KALAHEO
NAWILIWILI BAY
LIHUE
0 2 4 6 8
SCALE IN MILES
OLOKELE
50
HANAPEPE
KOLOA
GROVE FARM (MCBRYDE)
KOLOA
LEGEND:
STREAM
SWAMP
POPULATED AREA
LIHUE
JUDICIAL DISTRICT BOUNDARY AND NAME
50
PRINCIPAL ROADS & ROUTE NO.
SUGAR CANE LANDS
B
EXISTING SUGAR MILL POWERPLANT
WAILUA RIVER
HAWAII
SUGAR CANE LANDS
KAUAI
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 14A

In retrospect and potentially in the future, several factors will both restrict and endanger the Hawaiian sugar industry. First, there are continued urban pressures upon the land. Several plantations are relatively close to urban areas (e.g., Oahu Sugar Company on Oahu, Pioneer Mill on Maui, Lihue Plantation on Kauai). Higher use and worth of lands may eventual cause the plantations to grant the development rights or to divest themselves of unprofitable lands. This may lead to decreased productivity and adverse economic scale effects for the remaining lands. Second, labor cost in Hawaii for sugar production are among the highest in the world. Unlike most mainland United States sugarcane workers, field and factory hands are unionized. In 1981, the industry-wide average annual wage was $16,700.1/ Third, the sugar industry has been subject to considerable uncertainty in world sugar prices. Most sugar-producing countries trade in controlled markets stabilized by government ownership, tariffs, subsidies, and related methods. Since 1950, the world's sugar prices fluctuated from 4¢ to 42¢ per pound and sugar is acknowledged as the most volatile of 40 major commodities on the international market. 2/ Although the U.S. sugar market currently is price controlled, there remains the danger of reverting to the "free" market, subject to strong price fluctuations. Hence, the sugar industry lobby keeps abreast of possible adverse Congressional action.

Partially due to adverse prices, Hawaiian sugar industry has suffered dramatic losses. In 1981, the industry lost an estimated $83.5 million, of which Kauai's loss was approximately $22 million. In the seven-year period from 1976 through 1982, the industry has had five years of losses. 3/ The net result in planning has been general conservatism and reluctance for costly capital and land improvements.

Bagasse production is not, a course, the principal purpose of the sugar industry. The sugar industry has no projection of bagasse quantities. However, in analysis of the past production and availability of bagasse will provide insight on its future energy production. As shown by Table 14A and Figure 14B, there has been a slight decline in bagasse production since 1973. An important trend has been the decline in the quantity of discarded bagasse. This apparently reflects a greater utilization of bagasse for the plantation's powerplant. Assuming the harvested acreage of Kauai sugar industry remains relatively constant, the net long-term annual value of discarded bagasse amounts to less than 1 million kwh. The sugar industry on Kauai is effectively utilizing its bagasse resources. In fact, during 1981 only one plantation disposed of excess bagasse.

1/ Hawaii, State of, Department of Planning and Economic Development. The State of Hawaii Data Book, 1982. November 1982.

2/ Hawaii, State of, Department of Planning and Economic Development. Hawaii's Sugar Industry. April 1981. Constant 1979 dollars cited.

3/ Honolulu Star Bulletin. "Hurricane Iwa Intensifies Plight of Sugar" 1 December 1982.

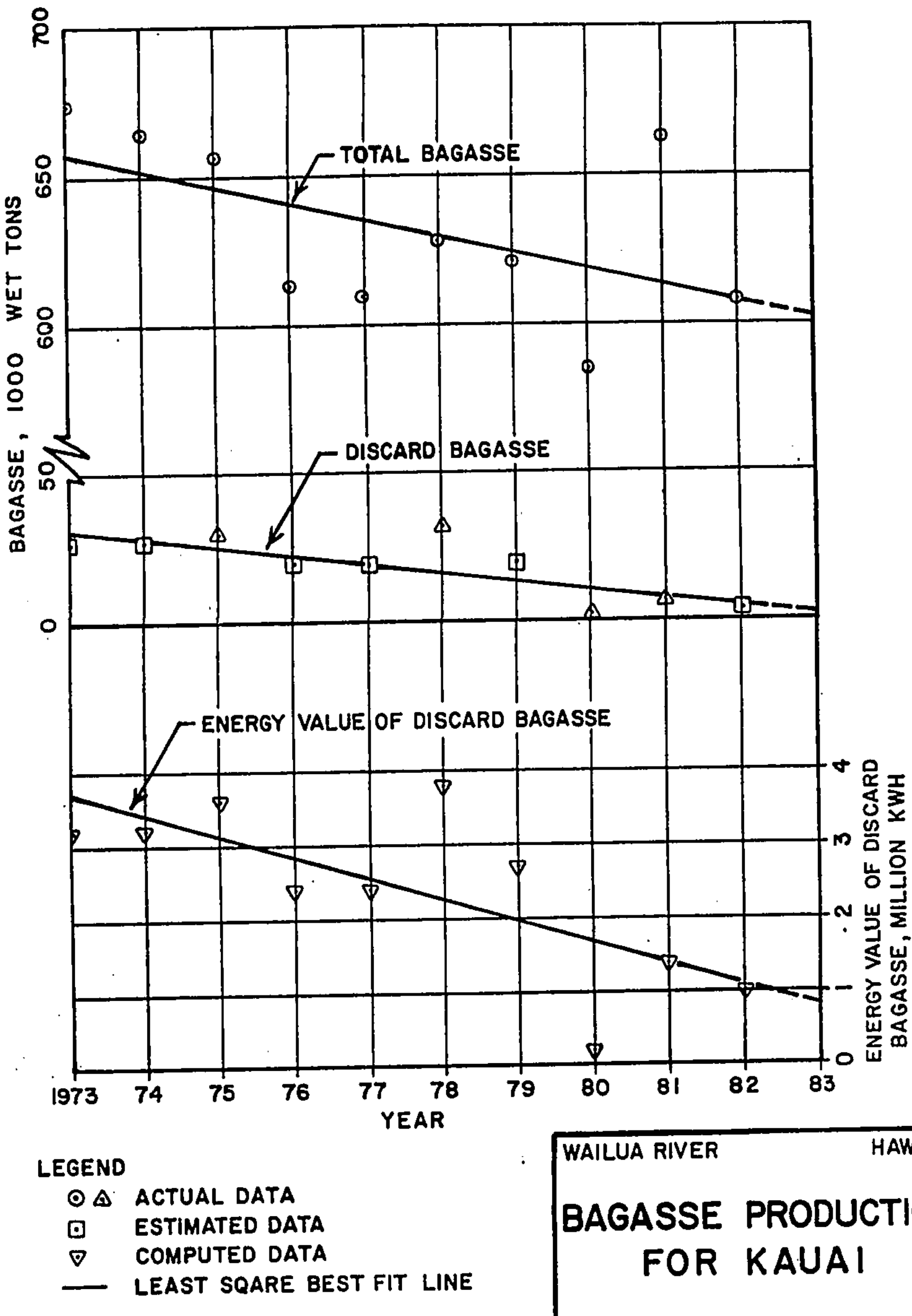
Table 14A. HISTORICAL BAGASSE PRODUCTION, ISLAND OF KAUAI

Year	Bagasse Production, 1,000 Wet Tons: Total 1/	Bagasse Production, 1,000 Wet Tons: Discarded 2/	Energy Value of Discarded Bagasse, million kwh 3/
1973	674	27	3.2
1974	665	27	3.2
1975	657	30 1/	3.6
1976	614	20	2.4
1977	610	20	2.4
1978	628	32 1/	3.8
1979	621	20	2.7
1980	585	2 1/	0.2
1981	663	6 1/	1.4
1982	608	4	1.0

1/ Actual data derived from Hawaiian Sugar Planter's Association and individual plantations.

2/ Estimated except as noted.

3/ Computed.



WAILUA RIVER HAWAII

BAGASSE PRODUCTION FOR KAUAI

U.S. ARMY ENGINEER DISTRICT, HONOLULU

Rev. Jun 83

FIGURE 14 B

The potential contribution of bagasse-fuel power on Kauai remains relative constant. The Hawaii Integrated Energy Assessment 1/, the latest comprehensive analysis of the State's energy needs has projected a constant capacity and energy contribution of plantation steam plants (utilizing both bagasse and oil) under the baseline scenario. In the projection condition, it is recognized that bagasse production could be increased by growing high fiber sugar and utilizing marginal lands for fiber production. However, this would effectively alter the entire goal of the plantations from sugar production to fiber production, a change of far reaching consequences that no one is prepared to support at this time.

The Lihue 20 MW powerplant has undoubtedly been beneficial to all interested concerns. The powerplant was implemented by favorable institutional arrangement between Foster-Wheeler Corporation (the manufacturer), Lihue Plantation/Amfac (processing plant and land owner), and Kauai Electric Division (utility). The Foster-Wheeler Corporation, one of the nation's largest boiler manufacturers, financed, built, and are the owners of the steam plant. In return for the investment, they will receive income from the energy produced from the plant over a 20-year period. Lihue Plantation provided the site location, would operate the plant, and would share in electric revenues beyond the minimum 55.6 million kwh of energy. Kauai Electric would pay for the energy produced and control the plant operation to match the load. The KED contract was signed for a 20-year period and provided an escalated rate of energy prices depending upon the sugar grinding seasons, consumer price index, and price of oil at Port Allen. The total base cost of $25 million did not include the existing bagasse house, nor included the implementation of an improved conveyor system, cooling tower, and wet stack scrubbers which would add an estimated $3.3 million. 2/ When escalated to the October 1982 price level (from the base price level of October 1978), and including the effects of economic worth of lands and interest during construction, the investment cost would increase to $42.7 million, or $2,100 per kilowatt of capacity. If the plant were down sized to a comparable small hydropower plant of 5 megawatts, the high fixed cost would boost the unit cost up to $5,400 per kilowatt. This unit cost is not favorable when compared with hydropower facilities.

Due to economies of scale, it would be infeasible to install small modular boiler turbo generators unless the excess low pressure steam were marketable in addition to the energy sales. Rehabilitation of existing steam generators has been considered by several plantations. However, because of uncertain economic future of the industry the plans have not progressed beyond concepts.

1/ Lawrence Berkeley Laboratory, University of California and State of Hawaii, Department of Planning and Economic Development, Hawaii Integrated Energy Assessment. Vol. I, June 1981.

2/ Personal communication with officials of Foster-Wheeler, E. E. Black, and Amfac. May 1983.

Finally, the implementation of the Lihue powerplant may be considered practically unique in its institutional setting amidst a favorable economic climate. The financing of such a large private endeavor requires the availability of funds (as in Foster-Wheeler case), feasibility of improvements at an existing sugar plant (as with Lihue Plantation), receptiveness of the local utility (Kauai Electric) and accompanied by governmental approvals (State Public Utilities Commission and the US Environmental Protection Agency). A related project on Oahu, formerly known as Honolulu Program of Waste Energy Recovery (H-POWER), designed to extract energy from solid municipal waste has met significant political and social opposition and uncertainty for the past two years. There would also be a large risk of hurdling the financial, institutional, and social elements for a similar biomass powerplant on Kauai.

In summary, the factors of the uncertainty of the sugar industry, the effective negligible quantities of additional bagasse, the relatively high fixed cost of comparable bagasse-fuel powerplant and the unlikely repetition of a financial/institutional arrangement similar to the Lihue powerplant, makes the implementation of the new bagasse power system improbable for the near future. For these reasons, the bagasse system was deleted from further consideration.

Wind Powerplant. Wind power has historically been in use since the 14th century for irrigation, pumping, and grinding grain. However, in recent times most technical programs were phased out with the advent of inexpensive gas and oil fuels. By the early 1970's with the shortages of cheap petroleum, developmental programs were resurrected by leading industrial nations. From FY 1977 to FY 1983 the US Department of Energy (DOE) had been authorized almost $300 million for various programs for demonstration and commercialization of wind energy conversion systems (WECS). 1/ In the State of Hawaii, the principal result has been the data acquisition, construction experience, and performance study of the joint DOE/Hawaiian Electric Company 0.2 megawatt MOD-OA model turbine located at Kahuku, island of Oahu. From May 1980 to November 1981, the unit had generated 1.2 million kilowatt hours and registered a plant factor of 46.3 percent.

With this increase emphasis on alternative energy systems, estimates of wind regimes power potential throughout the State have been prepared. According to estimates prepared under the Hawaii Integrated Energy Assessment (HIEA) program, Kauai would achieve significant wind generating capacity by the year 1995 2/. Under the baseline future scenario ("Future 1"), as much as 22 megawatts of capacity and an additional 77 million kilowatt hours of energy would be possible. Prior to 1995, the wind contribution would be negligible. Admittedly, the "potential" for wind power is not well defined and must be tempered with the knowledge of other considerations.

The wind environment on Kauai is not as advantageous compared to other counties. For example, based on the same HIEA projection condition, for Honolulu, Maui, and Hawaii counties the wind potential would be 370 megawatts, 82 megawatts, and 51 megawatts, respectively. The key factors related to favorable siting are high mean wind speed, minimal local turbulence, reliable wind turbo-generating hardware, available and institutionally approved lands, proximity of high voltage transmission lines, and construction accessibility. These factors are very site and project specific. However, generalizations may be inferred from a locational analysis of mean wind speed. To implement a feasible utility-type WECS, mean wind speeds of 15 miles per hour are desirable. As related to wind power densities, a site should be located in wind power classes 6 or 7 (at 10 meters in height). On Kauai, as shown by Figure 14C, there exists only two suitable small areas, one located near Kilauea and the other at Poipu. In contrast, on the island of Oahu, the entire Koolau mountain range, Waianae mountain range and the Kokohead areas are designated within these classes. The islands of Molokai and Hawaii also have similar favorable, large areas.

With the incentives of Federally-funded research and development, energy tax credits, and competitive marketing by numerous wind turbine manufacturers, there have been a number of WECS installed throughout the State. Despite the optimistic forecast, none have been installed as either part of an island's utility system or which would provide capacities approaching utility application (equal or greater than 0.1 MW). The cumulative total capacity of all small scale WECS, installed Statewide, is approximately 1.5 MW. The

1/ Personal Communication. U.S. Department of Energy, Honolulu Area Office. May 1983.

2/ Lawrence Berkeley Laboratory, University of California and State of Hawaii, Department of Planning and Economic Development. Hawaii Integrated Energy Assessment. Vol I, June 1981.

largest facility planned to date is an 80-megawatt windfarm located near Kahuku, Oahu. The proposal has been delayed since development plans were initiated in 1979 due primarily to lack of a satisfactory turbine system. The target unit cost is $3,500 per kilowatt of installed capacity. In terms of location, the Kahuku site is the only one in the State suitable for large wind turbines (equal or greater than one megawatt, each) 1/.

The only commercial WECS installation on the island of Kauai is a 10 kilowatt Jacobs unit located at the Dairy Queen, Eleele. The wind powerplant, completed in July 1982, has averaged 57 kwh per day or at a 24 percent plant factor. The actual installed unit cost was $3,800 per kilowatt. 2/ There are no other wind powerplants on Kauai under construction or in known planning stages.

Among the wind turbines on the market, only a few equal or exceed 100 kilowatts in capacity. In fact, among 85 models identified by the State of Hawaii as commercially available, only five models are 0.1 MW or greater in capacity. 3/ The turbine for the Kahuku Windfarm previously described has not been selected because of performance problems. The state-of-the-art does not appear to be yet at the stage for practical large scale utility application.

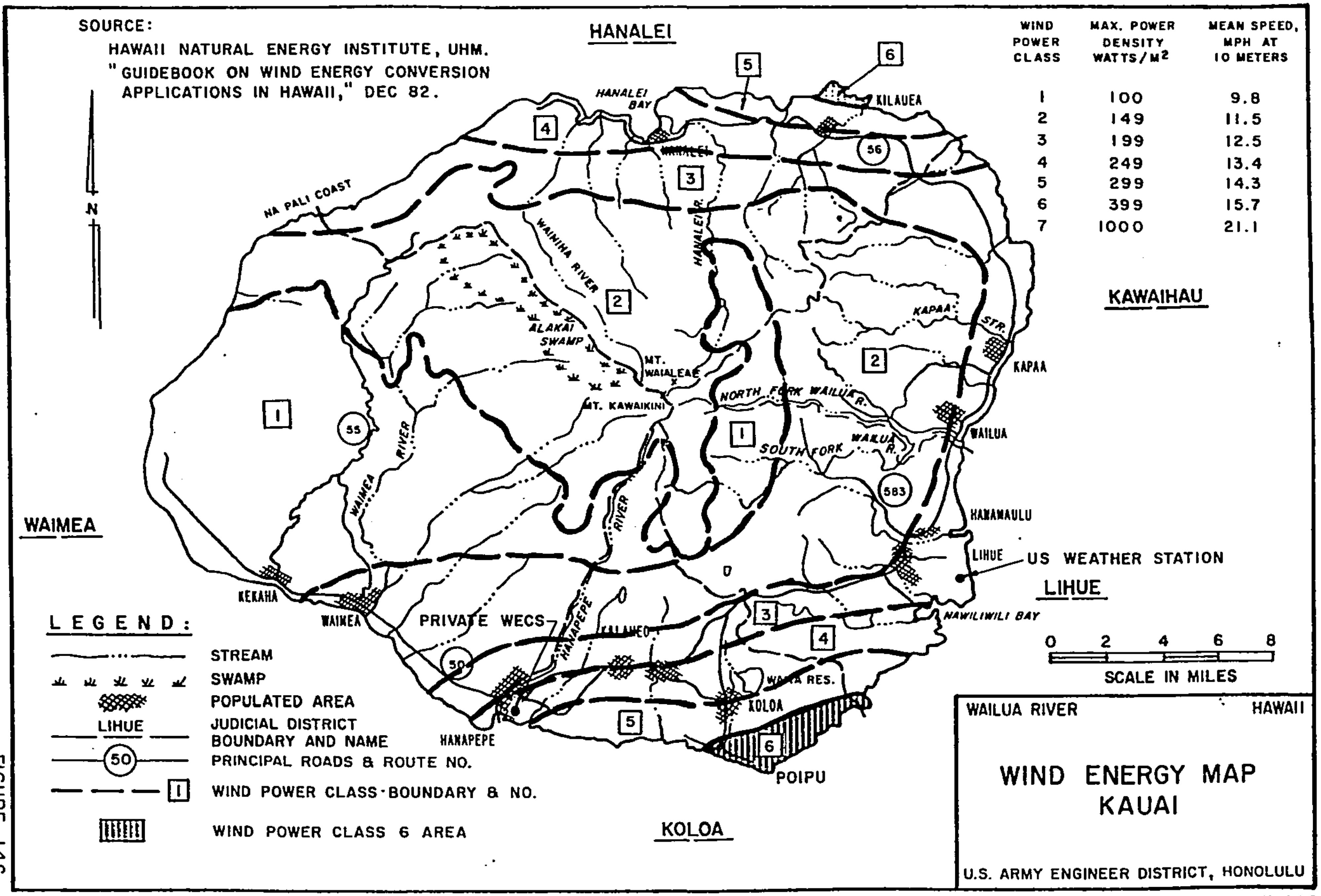
Finally, the implementation of WECS is extremely dependent on continuation of government incentives. Currently 35 percent of the cost can be written off as tax credits (15 percent Federal alternate energy credit, 10 percent State alternate energy credit, 10 percent capital investment tax credit). 3/ The individual investor obviously considers these credit essential for project's financial feasibility. If the Federal tax credits are allowed to terminate on the scheduled expiration date of December 1985, the planning and implementation of WECS would be adversely affected.

Based upon the above, wind powerplants on Kauai will not be significant for the utility system nor would be implemented on a wide scale in the near future. In comparison to other islands in the State, Kauai has relatively low wind potential. Investors and businessmen would naturally look to other places before considering Kauai (such as Kahuku on Oahu, east Molokai, and Kohala/Waimea on Hawaii). The turbo-generator hardware has not been sufficiently developed for practical electrical utility application. With large units, performance becomes critical and is compounded by potential problems in construction and maintenance. The cost also appears relatively high compared to hydropower systems. Excluding government credits, the current range of cost appears to be $3,000 to $4,000 per installed kilowatt of capacity, well above the unit cost of a hydropower plant. The uncertainty of continued tax credits also casts a cloud on future implementation. As a result of these findings, the wind powerplant was deleted from further consideration.

1/ Personal communication with Mr. Thomas Morton, Project Manager, Wind Farms, Ltd. April 1983.

2/ Personal communication with Mr. Doug Cravalho, Manager, Dairy Queen, April 1983.

3/ Hawaii Natural Energy Institute, University of Hawaii. Guidebook on Wind Energy Conversion Applications in Hawaii. 2d Ed. Dec 1982.



WIND POWER CLASS	MAX. POWER DENSITY WATTS/M2	MEAN SPEED, MPH AT 10 METERS
1	100	9.8
2	149	11.5
3	199	12.5
4	249	13.4
5	299	14.3
6	399	15.7
7	1000	21.1

FIGURE 14C

FIGURE 14C

Hydropower Retrofitting and Development at Existing Damsites.

In Kauai, similar to other areas of the United States, there exists a significant number of non-Federal dams being subject to evaluation in accordance to the National Program for Inspection of Dams (Public Law 92-367). The program investigated dams 25 feet or more in height or dams with impoundment capacity of 50 acre-feet or more. A total of 52 dams were categorized for Kauai, all of which are either currently or were historically used by the sugar industry for irrigation. All dams are of the earth-fill type and all except five were constructed during the period 1890 to 1932.

Among the Kauai dams, Alexander Dam, located on the Wahiawa Stream in the Koloa district, is the only facility with a hydropower plant. The dam, under the ownership of McBryde Sugar Company, is an earthfill structure with a height of 119 feet and a reservoir maximum capacity of 2,500 acre-feet. The powerplant is located approximately 8,000 feet downstream of the dam. Water is conveyed via open channel through a forebay and down a 5,000-foot, 30-inch steel penstock.2/ The installed capacity is 1.0 MW and the average annual energy produced is 2.1 million kwh. The parent company of McBryde Sugar, Alexander and Baldwin, indicates there are no major plans for major retrofitting at the existing Alexander Dam.

Under the Corps' National Hydropower Study conducted during the period 1978-1980, the analysis of Kauai sites revealed only one other existing damsite which had hydropower potential. The Koloko Reservoir located on a ditch near Kilauea, Kauai, was formerly an irrigation facility of the defunct Kilauea Sugar Company. However, a 70 kw potential capacity was judged to be incrementally too small for an effective powerplant.

Finally, based upon the U.S. Department of Energy's Program Research and Development Announcements and Feasibility Study and Licensing Program the State of Hawaii Natural Energy Institute (HNEI) and the U.S. Department of Energy attempted to elicit responses from existing dam owners to apply for hydropower assistance. Material and coordination during the period December 1977 to June 1979 did not result in any application for assistance from any Kauai dam owner. As a result of the above findings, it appears that there exists no significant potential for retrofitting or developing incremental hydropower of existing damsites in Kauai.

1/ Hawaii, State of, DPED. Hawaii Integrated Energy Assessment. Vol II. Honolulu: June 1981.

2/ U.S. Army Corps of Engineers, Pacific Ocean Division. "Phase I Inspection Report on Alexander Dam" Honolulu: June 1978.

New Conduit Hydropower Diversion and Powerplant.

Stemming from renewed interest in hydropower since 1977 various Federal agencies including the Corps, the Department of Energy and the Federal Energy Regulatory Commission have implemented combinations of studies, grants, new regulations, technical documents, and demonstration projects which address small scale hydropower facilities. In general, the advantages of conduit systems as compared to other energy technologies are:

a. Less massive physical modification and disturbance to natural conditions.

b. Minimal utilization of prime lands available for industry, agriculture, or urban development.

c. Less initial capital expenditures than large hydropower or new thermal plants.

d. Minimal development or technological advances required.

e. Institutional frameworks already established for governmental review and evaluation processes.

Prior studies performed by the Corps during the period 1970-78 under the same study authority included the South Fork Wailua River as a prime suggested study site on Kauai. The Wailua River also had been subject of study in 1978 with the State of Hawaii's Waialeale Hydropower Study. Finally for the Reconnaissance Study conducted under the current investigation, a potential conduit system appears in the realm of feasibility. Early results of the reconnaissance indicated capacities in the ranges of 2 to 11 MW and annual energy products of 4 to 25 million kwh depending on the scope of improvements.

New Dam/Reservoir and Hydropower Plant. A dam and reservoir system consists of a dam to store water, outlet structures to regulate flow, and powerplant. The powerplant may be located at the base of the dam or further downstream to obtain the necessary head. Power generated by a dam and reservoir system is generally dependable provided there is sufficient reservoir storage capacity. Storage type hydropower facilities have been previously proposed for Kauai for the Kokee (1964) and Waialeale (1978) studies. Both facilities although based on multipurpose benefit evaluation, were financially costly. Due to insufficient flows both facilities also required very long penstock to develop the power. The Waialeale project was estimated to cost $72 million (1978 prices) with a resulting benefit-to-cost ratio of 0.3.

For Kauai and the Hawaiian Islands in general, erosion has changed the topography of the islands from huge, gently sloping volcanoes to dissected and incisioned cliffs, valleys and basins. The topography of many of the drainage areas is characterized by relatively steep stream courses and steep, rugged basaltic formations. As a result, the streams generally do not meander and traverse through alluvial areas. Characteristic of Hawaiian topography impoundment of significant volumes for stable hydropower releases would require very massive dam structures. Combined with relatively low rates of streamflow, the generalized conclusion is that dam and reservoir projects would be very difficult to economically justify and finance. For these reasons, this potential solution was deleted for further consideration.

ALTERNATIVES TO BE CONSIDERED

The analysis of generalized alternatives indicated potential solutions worthy of further consideration are conservation/solar hot water heating and conduit hydropower. Each of these alternatives would provide contributions to meet the energy demands of the island. The quantitative contributions to the national objectives are the subject of the detailed evaluation and are contained in the following report section.

ASSESSMENT AND EVALUATION OF DETAILED PLANS

Based upon the results of the preliminary screening process, one basic final structural concept and one nonstructural concept were designated for detailed assessment and evaluation: conduit hydropower and conservation/solar.

EARLY FORMULATION EFFORTS

STATEWIDE STUDY

Prior to the initiation of this site-specific Wailua River study, the Corps conducted a statewide hydropower investigation under the same study authority during the period 1977-78 (as referenced on page 5, Main Report). In the early site identification process, 59 US Geological Survey stream gage sites on the island of Kauai were briefly evaluated for hydropower potential. In view of the ongoing State of Hawaii study of a large dam and reservoir complex in the same basin (Waialeale study), the Wailua basin was not selected for further investigation. Sites on Kauai which were considered in intermediate planning studies were in the Hanalei, Wainiha, and Lumahai river basins. Principally due to the prevailing evaluation method of not considering relative fuel cost escalation, all sites in the state, including on Kauai, were considered economically infeasible. The study was discontinued in October 1978.

ISLAND OF KAUAI SITES

Identification of Sites. The island of Kauai, as explained in prior sections, constitutes a single electrical utility area. Hence, to contribute to energy development, it was necessary to consider hydropower development on an island-wide basis. Among the 59 stream gage sites itemized under the state-wide hydropower study, only a fraction has been considered or identified from various studies for hydropower improvements. Many of the high potential areas have previously been investigated or currently under study by non-Federal interests. Other areas would be limited by significant environmental/social or institutional considerations. The potential types of hydropower improvements (retrofitting, new conduit, new dam/reservoir) and their applicability for Kauai were discussed in the prior section.

An early hydropower report for the State of Hawaii was published by the Bureau of Power (currently the Federal Energy Regulatory Commission) in 1968. At that time, there were two potential sites identified, at Wainiha and at Kokee, totalling 35 megawatts in capacity. Since the Arab oil embargo in 1974 and the passage of the Public Utilities Regulatory Policies Act (PURPA) in 1978, there has been a greater interest in the investigation of hydropower sites throughout the State. Based upon all available sources of information, a tabulation of sites is summarized in Table 14B. The site inventory combines the information shown in Tables 9 and 10 and Figure 14. The 19 drainage areas constitute all previously designated potential hydropower drainage areas.

TABLE 14B. EXISTING AND POTENTIAL HYDROPOWER SITES ON THE ISLAND OF KAUAI

1 Watershed 1/ /River or Stream	2 Existing Hydro in River Basin	3 4 Project Name of Potential or (Existing) Hydro 2/	5 References 3/	6 Type of Project	7 Potential Power (Incremental)	Assessment of Potential Hydro Project 4/ 8 Potential Economic Feasibility	9 Potential Environmental Impact	10 Land Ownership	11 Implementation Institution	12 Potential Federal Interest 5/
1. Hanalei: Kalalau to Anahola										
Wainiha River	E	(Wainiha)	3,4,7-10,17,19	C,R	M	P	M	P	P	N
Lumahai River	-	-	9,7,10,17,19	C	M	P	H	P	-	N
Hanalei River	-	-	9,7,8,10,15,19	C,D	M	P	H	S	-	N
Halaulani Stream	E	(Namahana Farms)	-	-	-	-	-	P	-	-
		-	17,8	C	L	M	L	P	-	N
Puu Ka Ele Stream	E	(Kauai Papaya)	17	C	L	-	L	P	-	N
Anahola Stream	-	Rancho Hydro	16,8,11,17	C	L	P	L	P	P	N
2. Lihue: Anahola to Nawiliwili										
Kapaa Stream	-	-	17,8	C	L	N	L	S/P	-	N
Wailua River	-	Wailua River	18,7-10,15,17	C	H	P	M	S/P	P	P
	-	Waialeale	1,7,8,15	D	H	N	H	S/P	S	N
Hanalei Tunnel	-	-	9,7,10	C	M	M	L	S	-	N
Waiahi Stream	E	(Lower Lihue & Upper Lihue)	2,12	R	M	M	L	P	P	N
Hanamaulu Stream (Kapaia Res)	-	-	15	R	L	-	L	P	-	N
3. Koloa: Nawiliwili to Hanapepe										
Wahiawa Stream	E	(Alexander Res)	-	-	-	-	-	P	-	-
Hanapepe River	-	-	17,8	C	L	N	M	P	-	N
4. Waimea: Hanapepe to Waimea										
Makaweli River	E	(Hydro Kaumakani)	13,8,15,17	R	L	P	L	P	P	N
Waimea River	E	(Waimea)	15,8,17	R	M	-	L	S	-	N
Kokee Ditch	-	Kitano, Puu Lua	14,7,9,10,15,17	C	M	P	M	S	P	N
Koaie Stream	-	-	17,8	C	L	-	-	S	-	N
Kawaikoi Stream	-	Kokee	6,4,15,17	D	H	M	H	S	S	N
	-	Puu Opae-Mana	12	C	M	M	H	S	S/P	N
5. Kekaha : Waimea to Kalalau										
Kahoana Stream	E	(Waiawa)	2,12	R	L	P	L	S	P	N

Footnotes to Table 14B

1. Major watersheds in accordance with reference 5. Areas cited described from north Kauai counter clockwise around island.
2. Names of existing hydropower facilities shown parenthetically. Names are shown for potential projects in which implementation institution defined.
3. First cited reference is principal or primary reference for potential project. See reference list below.
4. See legend below
5. For narrative reason see Table 14C.

LEGEND TO TABLE 14B.

Column	Item	
2	Existing Hydropower Development in River Basin	= E
6	Type of Project	
	Retrofit	= R
	New Conduit	= C
	Dam/Reservoir	= D
7	Potential Power	
	High ($\geq$5 MW)	= H
	Moderate (1-5 MW)	= M
	Low($<$1 MW)	= L
8	Potential Economic Feasibility	
	Likely Positive	= P
	Marginal	= M
	Likely Negative	= N
	Unknown	= -
9	Potential Environmental Impact	
	Highly Negative	= H
	Moderate	= M
	Low or Insignificant	= L
	Unknown	= -
10	Land Ownership	
	State	= S
	Major Private Landowner	= P
11	Implementation Institution	
	Federal	= F
	State	= S
	Private	= P
	Not Established	= -
12	Potential Federal Interest	
	Likely Positive	= P
	Likely Negative	= N
	Not Applicable, Existing Facility	= -

References to Table 14B

1. Belt, Collins and Associates, Waialeale Hydropower Study. Prepared for the Division of Water and Land Development, Department of Land and Natural Resources, State of Hawaii. Honolulu: Nov 1978.
2. Broadbent, Ned. "Upgrading Potential of Existing Hydroelectric Units at Lihue Plantation Co., Ltd. and Kekaha Sugar Co. Ltd.," Jan 1980.
3. EDAW, Inc. Wainiha Hydroelectric Project - Planning Report. Prepared for McBryde Sugar Co., Ltd., March 1982.
4. Federal Power Commission, Bureau of Power. "Planning Status Report - Water Resources Appraisals for Hydroelectric Licensing - Hawaii River Basins." 1969.
5. Hawaii, State of Hawaii Water Resources Plan. January 1979.
6. Hawaii, State of, Board of Land and Natural Resources. Kokee Water Project, Island of Kauai, Hawaii. Report R22 Honolulu: 1964.
7. Hawaii, State of, Department of Land and Natrual Resources. State Water Resources Development Plan. Honolulu: Oct 1981.
8. Hawaii, State of, Hawaii Natural Energy Institute and Department of Planning and Economic Development. Alternate Energy Sources for Hawaii. Feb 1975
9. Hirai, W.A. and Associates, Inc. Hydroelectric Power in Hawaii - A Reconnaissance Survey. Prepared for the State of Hawaii Department of Planning and Economic Development. Honolulu: Feb 1981.
10. Lawrence Berkeley Laboratory of the University of California and State of Hawaii Department of Planning and Economic Development. Hawaii Integrated Energy Assessment. Honolulu: Jan 1981.
11. Personal communication with Mr. J. Harder, April 1982.
12. Personal communication with Messrs B. Hatton and N. Broadbent, 1981/82.
13. Personal communication with Mr. H. Poppinga, Olokele Sugar Co., 1981/82.
14. Tudor Engineering Company, et al. Feasibility Report on the Potential Development of the Kitano Hydroplant. Prepared for the Kekaha Sugar Company. San Francisco: July 1981.
15. U.S. Army Corps of Engineers, North Pacific Division and Pacific Ocean Division. National Hydroelectric Power Study: Regional Assessment, Alaska and Hawaii. Prepared for the U.S. Army Corps of Engineers, Institute for Water Resources. Fort Belvoir: September 1981.
16. U.S. Department of Army Permit PODCO-O 1602-S, May 1981.
17. U.S. Army Engineer District, Honolulu. Plan of Study for Hydroelectric Power and Allied Purposes - State of Hawaii. Honolulu: Sep 1977.
18. U.S. Army Engineer District, Honolulu. Reconnaissance Report for Hydroelectric Power, Wailua River, Kauai, Hawaii. Honolulu: Jan 1981.
19. U.S. Army Engineer District, Honolulu. Summary Report for Hydroelectric Power - State of Hawaii. Honolulu: Oct 1978.

Measures of Federal Interest. The technical measures for potential study and implementation are the engineering scope, economic feasibility, and environmental/social acceptability. Potential projects with very low power potential would be more appropriate for private or local governmental agencies to implement. For micro-hydropower projects, the unit cost would be expected to be high in comparison to alternative higher capacity plants and may result in economic infeasibility. If there are potentially severe environmental problems, such as the existence of relatively undisturbed organisms and endangered species in the area, then compliance to environmental statutes and mitigation measures would be extremely difficult to carry out. Certain projects also may have unresolved social constraints. For example, potential projects in the north Kauai area are expected to have social problems based upon opposition to general public works and development projects.

In addition to the strictly technical concerns (engineering, economic, and environmental/social measures), institutional impacts are critical for the assessment of potential Federal interest. The basic considerations for Federal study are whether prior Federal interest has been established, the determination of providing widespread public benefits, and the policy of encouraging non-Federal initiatives.

The issue of prior Federal interest is not applicable on Kauai because there are no authorized Federal hydropower facilities nor any Federal dam/reservoirs on the island. Regarding public benefits, a project should be implemented for widespread public benefit and not directly provide windfall benefits to a major private entity. Projects involving retrofitting facilities which are currently under private ownership or implementation of new facilities which would be sited on major private lands 1/ would be questionable in terms of public benefit. Finally, if non-Federal interests, (either State or private interests) have ongoing investigations, the Federal Government would encourage this action when not in conflict with the law or clear public interests. Hence, those potential projects on Kauai which already have ongoing non-Federal action would not be considered for further Federal investigation.

Assessment of Federal Interest. Considering the above items, an assessment was made on each drainage area with hydropower potential. Table 14B lists all known existing and potential drainage areas on Kauai suitable for hydropower development accompanied by a qualitative evaluation.2/

1/ Defined in State inventories as lands under title of entities owning 5,000 or more acres, Statewide.

2/ In comparison to the 1968 Bureau of Power study, if all sites that are currently considered nearing implementation (Olokele, Lihue, Kekaha, Kitano, Puu Opae-Mana, Wainiha, and Wailua) were put on-line, 14 megawatts of additional capacity would be achieved.

A supplemental narrative on the reasons for lack of Federal interest on the 19 sites is provided in Table 14C. Of the 19 sites, nine were deleted because of shortcomings in technical issues (engineering, economic, environmental/social) and ten were deleted because of institutional problems (potential lack of public benefits, non-Federal prior or current action). Among the sites deleted because of technical issues, three were dropped due to engineering problems (Halaulani, Kapaa, Koaie), two were elminated due to potential economic feasibility problems (Wailua-Waialeale, Hanalei Tunnel), and four were dropped because of environmental problems (Lumahai, Hanalei, Kawaikoi-Kokee, Kawaikoi-Puu Opae/Mana). Among the sites deleted because of institutional issues, five were dropped because of the existence of private facilities (Anahola, Hanamaulu-Kapaia, Makaweli, Waimea, Puu Ka Ele), one was eliminated due to potential legal problems (Hanapepe), and the remaining four sites were deleted because private interests were already investigating the sites' hydropower potential (Wainiha, Waiahi, Kokee, Kahoana). As a result of the evaluation conducted, there appeared only one drainage area suitable at this time for potential Federal investigation; the Wailua River drainage area.

RECONNAISSANCE REPORT

Following initiation of the Wailua River study, the Corps formulated several preliminary plans to determine the advisability of further investigative efforts. The results were documented in the Reconnaissance Report, published in January 1981. The base data included available US Geological Survey topographic maps (at a scale of 1 inch = 2,000 feet horizontal and 40-foot contours) and existing streamflow records. In compliance with the intent of assessing small-scale run-of-the-river hydropower improvements in the Wailua River basin, four preliminary schemes were formulated. The principal consideration were the relative locations of the diversion structure and powerplant considering the potential for flow control and available difference in elevation between the respective locations. Facilities were sited based on inspection of the existing topography and stream confluence locations.

The two principal tributaries of the Wailua River system are the North Fork Wailua River and the South Fork Wailua River. The South Fork Wailua River drainage area, in contrast with the North Fork Wailua River, is relatively unencumbered by adjacent urban areas. For approximately 4 miles along the left bank of the North Fork, there exists urban and rural residential housing. The two waterfall on the North Fork, the Kaholalele Falls (80-foot drop) and the Opaekaa Falls (120-foot drop) provide a lower elevation difference than the Wailua Falls (160-foot drop) on the South Fork. In addition, the North Fork waterfalls are located in narrower, more confined gorges than the Wailua Falls. For these reasons, in conjunction with prior local interest investigations in the same area, the South Fork was the selected tributary of investigation.

Among four schemes, three involved a powerplant located below Wailua Falls. Clearly, the Wailua Falls location offered the steepest elevation difference along the river. The only scheme (Scheme 2) which included the powerplant above the falls resulted in the lowest capacity (1.9 MW) and the highest cost per unit energy developed (exceeding 120 mills/kwh). The other remaining schemes varied in capacity between 3.4 MW to 11.7 MW. However, in all schemes, the waterway lenghts were inordinately long, 12,000 feet for Schemes 1 and 4 and approximately 22,000 feet for Schemes 2 and 3.

TABLE 14C. SCREENING OF HYDROPOWER SITES FOR FEDERAL INTEREST

River or Stream or Potential Hydropower Facility	Reason for Negative Federal Interest: Principal Reason	Reason for Negative Federal Interest: Secondary Reason(s)
Wainiha River	Private interests are underway in investigations.	Existing lands and existing hydropower plant under private control.
Lumahai River	Site is in pristine, undisturbed valley. Significant environmental problems anticipated – endangered species.	Social/institutional acceptability problems expected.
Hanalei River	River is site of National Wildlife Refuge. Potential severe environmental problems.	Social/institutional acceptability problems expected.
Halaulani Stream	Very low power potential anticipated (125 kw)	
Anahola Stream	Private interests are underway in construction	
Kapaa Stream	Very low power potential anticipated (230 kw)	
Wailua River – Waialeale	State of Hawaii already conducted study – determined economically infeasible.	Alternative development plan for same site conflicts with conduit scheme.
Hanalei Tunnel	Very long penstock (8,000 LF +) through existing tunnel with potential construction and economic feasibility problems.	
Waiahi Stream	Private interests are underway in investigations.	
Hanamaulu Stream – Kapaia Reservoir	Private Reservoir	Very low power potential (120 kw)
Hanapepe River	Legal problems regarding water rights. Action in courts since 1974.	Existing lands and irrigation under private control.
Makaweli River	Private interests are underway in construction.	Existing lands and existing hydropower plant under private control.
Waimea River	Existing hydropower facility under private control.	
Kokee Ditch	Private interests are underway in investigations.	
Koaie Stream	Relatively low power potential (300 kw) without very long penstock.	Very rugged terrain will result in constructability problems.
Kawaikoi (Kokee)	Potentially severe environmental problems – wetlands and endangered species.	Site investigated by State of Hawaii. Alternative development plan for same site with Puu Opae – Mana.
Kawaikoi (Puu Opae – Mana)	Potentially severe environmental problems – wetlands and endangered species.	Joint State/private study underway.
Kahoana Stream	Private interests are underway in investigations.	Existing hydropower plant under private control.
Puu Ka Ele Stream	Existing hydropower in drainage area.	Very low power potential (50 kw)

An ideal penstock alignment would maintain a positive hydraulic gradient and minimize losses resulting from excessive horizontal and vertical grade changes. However, the assessment of the originally conceived long penstocks would involve considerable tunneling, excavation, and bridging over gulches or steep river banks. As a result, the prior four schemes, although sound in principle, were judged impractical, and necessitated additional project formulation.

NEW FORMULATION ANALYSIS

Based on fundamentals of hydropower development, the highest power potential results from harnessing the highest discharges at locations of steepest elevation change. As shown in Appendix B, a preliminary hydrographic analysis was conducted considering the rleative effects of discharge and topographic relief. For purposes of preliminary sizing analysis of run-of-the-river or conduit systems, a 20 percent value of the daily flow duration curve was selected as an appropriate discharge criterion. In addition, to provide a relatively economical system, a limit of 1 mile length of waterway was

specified to evaluate locations of powerplants. As itemized on Table B-4 (Appendix B), the analysis substantiates visual inspection of the topography. The location of Wailua Falls provides for the largest elevation difference with relatively high discharge. High elevation difference do exist at upper river reaches; however, the discharge rapidly diminishes due to lack of tributary drainage area. Sites below Wailua Falls are located at very flat slopes without significant additional discharge. Hence, to take advantage of the maximum contributing drainage area and change in elevation over a short distance, the diversion structure would be located above the falls and the powerplant below the falls.

INTAKE AND POWER PLANT SITING

Considering that the intake structure should be sited just upstream of the Wailua Falls, the intake of the conduit alternative would be in a relatively fixed location. However, the power plant site would be variable. The first obvious location would be immediately downstream of the falls. This plan would involve minimal waterway/penstock length. However, there also exists minimal available open area below the top cliff and access would be difficult. The second power plant site would be located approximately 9,000 feet downstream of the falls. This location would benefit from approximately 60 feet of additional elevation change but at a cost of approximately 3,000 feet of conduit (the conduit would take a shorter overland route, meeting the river downstream). The downstream site would be easily accessible and sufficient area would be available. Although there are innumerable other potential combinations of intake and powerplant locations, topographical analysis demonstrated that none would achieve as significant changes in elevation in relatively short distances.

STABLE STORM DITCH ADDITIONAL DIVERSION

An additional consideration was the potential for increasing the available flow on the South Fork Wailua River. As described in the prior Reconnaissance Report, there is a possibility of increasing the existing diversion capability of the Stable Storm Ditch which connects the North Fork and South Fork Rivers. The additional discharge would add to the seasonal flow stability of the South Fork River for hydropower development. The additional discharge would result in increased power capacity and energy generation. However, consideration would be given to the potential additional costs of diversion modification at the North Fork, larger capacity of the conduit from the South Fork intake to accommodate larger design flows, and finally, higher power plant costs for the additional power capacity.

INTERMEDIATE PLANNING

During the intermediate planning activities four alternatives emerged as possible plans. The first alternative (Alternative 1A) involved the powerplant located near the falls with additional diversion from the North Fork Wailua River. A potential variation (Alternative 1B) was identical to Alternative 1A except that no additional diversion would be provided beyond the existing flows. The second basic alternative (Alternative 2A) involved the powerplant located approximately 9,000 feet downstream with an additional diversion from the North Fork Wailua River. Similar to the initial set of alternatives, Alternative 2B was formulated, being identical to Alternative 2A except that no additional diversion would be provided.

"WITHOUT DIVERSION" ALTERNATIVES

The evaluation revealed that including the additional diversion would double the net NED benefits. In addition, the physical impact of improving the Stable Storm ditch diversion would not adversely affect the environment nor would significantly affect the consumption use of waters downstream. The additional cost of improving the diversion capability of the Stable Storm Ditch would be more than offset by the benefits from the additional energy generated. Hence, the "without additional diversion alternatives" (1B and 2B) were deleted from further detailed analysis.

CAPACITY SCOPING

As described in Appendix C, the powerplant size required scoping. In this planning effort, due to the physical constraints, the head was relatively constant and the design discharge was the key variable. The civil works facilities (diversion structure, conduit, and penstock) were relatively fixed, escalating mildly as a function of increased discharge. The powerplant costs (turbo-generators, electrical works) also varied with increased discharge. The civil and powerplant costs were combined to obtain a total project cost and was essentially a function of the discharge.

Characteristically if conduit hydropower facilities (where no storage is available), the optimization of plant capacities requires maximum utilization of available discharges, graphically shown on flow duration curves. The actual computational process utilized a variant of the flow duration curve, the power duration curve, essentially a cumulative frequency curve of power as function of percent of occurence. The results showed that the costs were a linear function of capacity and the benefits curvilinear, after achieving a peak value. Based upon the differences between the two functions, the approximate plant capacities were selected.

SINGLE TURBINE/DOUBLE TURBINE

In a similar analysis, the relatively steep descent of the flow duration surve severely limited the effectiveness in a single sized turbine unit. In general, turbines can operate over a limited range of discharges. A single turbine would not effectively capture all flows for streams exhibiting steep flow duration curves. Hence, a single turbo-generator unit would incur relatively high initial powerplant costs and would forego generating energy from either high or low discharges. In contrast, the two turbine concept although more costly, would capture a wider range of flows and would develop correspondingly greater amounts of energy. Hence, the single turbine concept was deleted from the final analysis.

SUMMARY OF ADDITIONAL CONDUIT HYDROPOWER ALTERNATIVES

Based on the above formulation description, two conduit hydropower configurations were adopted for detailed assessment and evaluation. Alternative 1A would involve the power plant immediately below Wailua Falls on the right bank (facing downstream) and additional diversions from the Stable Storm Ditch. Alternative 2A would involve the power plant located 9,000 feet downstream on the left bank and would include additional diversion from the Stable Storm Ditch. The other basic alternatives (Alternate 3) would be a conservation/solar hot water systems plan. The technical data including appropriate graphic details of hydrology and hydraulics are contained in Appendix B. The hydropower potential analysis and scoping of powerplant capacities are shown in Appendix C. Also, the construction cost estimate are provided in Appendix B and economics summarized in Appendix E. Environmental impacts are described in the Environmental Impact Statement with supplementary environmental description provided in Appendix H. In addition, the project costs are not apportioned between Federal and non-Federal interests nor do the costs reflect required non-Federal cash contribution. These considerations have not been completely resolved at the Federal administrative and Congressional levels. The following section summarizes the project description and impacts of each final alternative.

ALTERNATIVE 1A
POWERPLANT NEAR FALLS WITH ADDITIONAL DIVERSION

DESCRIPTION

Alternative 1A would consist of the basic hydropower features of hydraulic control and conduit structures, powerplant, transmission line, and access facilities. The general locations of the features are shown on Figures 15 and 16. Near the confluence of the Stable Storm Ditch and the North Fork Wailua River (Figure 15), the existing culvert would be improved and the existing weir at the USGS gaging station 620 would be raised. These improvements would provide a minimum of 92 cfs higher flow into the South Fork Wailua River than under existing conditions. Improvements to the existing Stable Storm Ditch would not be required for hydraulic capacity. Access to the facilities are available along existing cane haul roads.

The downstream improvements (Figure 16) would include the principal water transmission and power development features. The concrete diversion dam, located approximately 300 feet upstream of the falls, would be 13.5 feet high and have a crest length of 220 feet. The ponded water would flood approximately 4.4 acres upstream of the dam to an elevation of 255.0 feet msl. An intake structure adjacent to the dam would be connected to the 108-inch, 560-foot long reinforced concrete pipe conduit. A minimum conservation flow of 10 cfs would be maintained for the river. At the upper end of the pipe would be a gatewell structure, providing a means for closure and inspection. The concrete conduit would be constructed by cut-and-cover method and upon completion would be completely below ground. At the terminus of the conduit would be a head box control structure leading into a 282 foot long, 72 inch steel penstock. The penstock would be constructed on the surface, mounted on concrete supports. An additional access road would be provided on the right bank to the diversion dam. In conjunction with the existing roadway (Route 583) a lookout would be provided at the diversion dam.

The base of the penstock would lead directly into the powerhouse, located approximately 480 feet on the downstream right bank of the South Fork Wailua River. The powerhouse dimensions would be approximately 65 feet (transverse to penstock) by 36 feet. Housed would be 2 - turbo-generators with a total capacity of 5.0 Mw developing 11.28 million kwh of average annual energy. The plant will be not operative during periods of low flow and as a result no firm capacity can be provided to the existing utility system. Access to the powerhouse will be provided by a tramway mounted above the penstock. The transmission line would consist of a 12 kv, 3.5 mile long overhead pole line utlimately connected to the existing Kauai Electric Lydgate substation.

IMPACT ASSESSMENT

Alternative 1A would result in temporary increases in turbidity both inthe immediate project area and downstream during project construction. Concurrent temporary increases in sedimentation of stream habitat below the falls could alter composition of the aquatic community in the affected area. The diversion dam would increase the area of the pool behind the falls to approximately 4.4 acres, increasing the area of preferred small mouth bass habitat proportionately. Approximately one acre of prime agricultural land would be disturbed during construction of the conduit from the diversion dam to the powerplant. The land would be restored to its previous state subsequent to completion of the project.

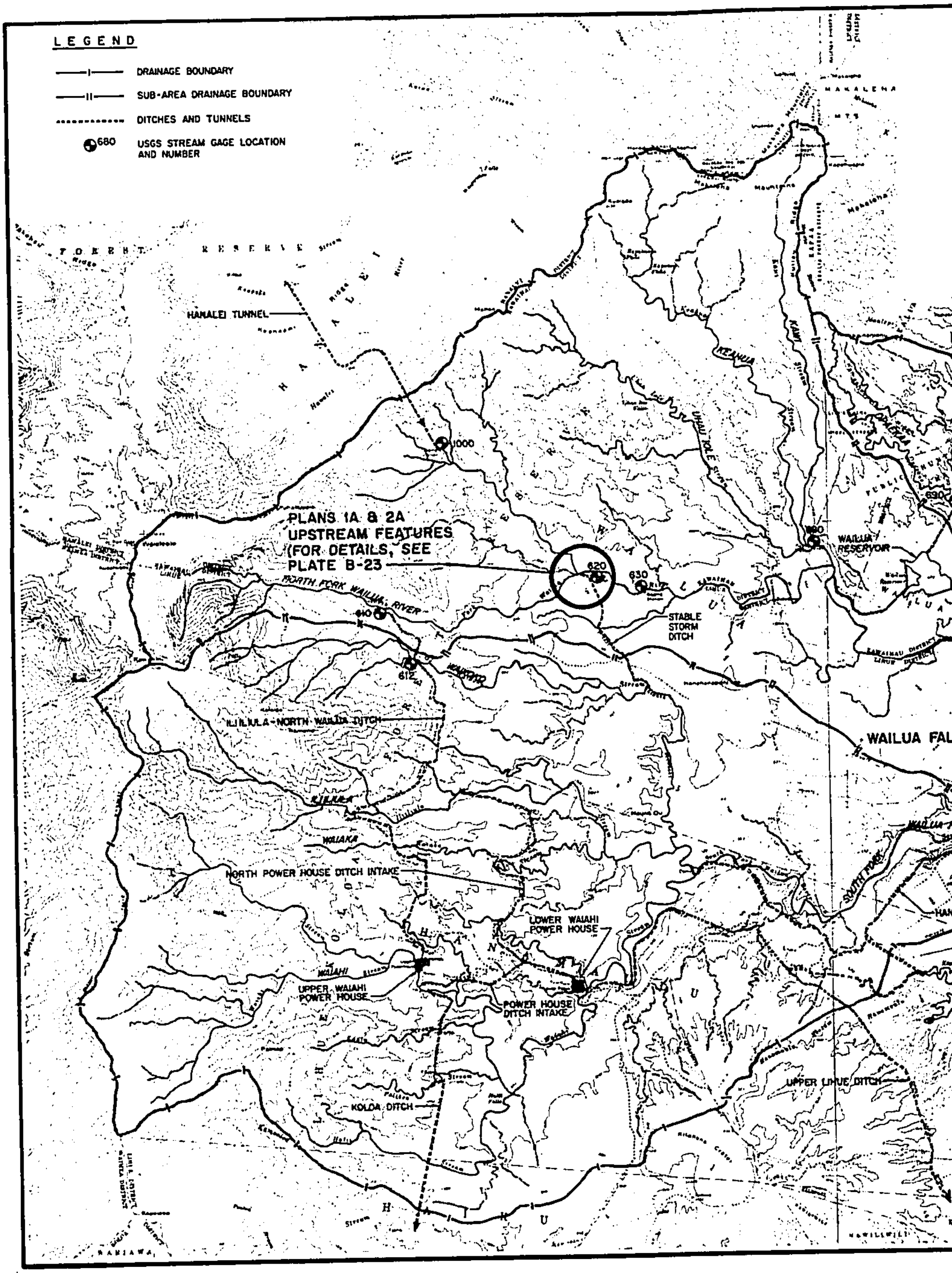
During the construction period temporary disruption of Wailua Falls viewing area would occur. The most significant long-term affect would be the intermittant impact on Wailua Falls resulting from hydropower water diversion above the falls. Based on hydrologic analysis the minimum flow to be maintained on the South Fork would be 10 cfs. Under natural conditions for a 7 day period during any year, the probability that the low flows in the South Fork Wailua River would be less than 10 cfs is ninety percent. Data on potential flow impacts are shown on Table 18. The diversion would have an adverse impact as compared to existing conditions on the 800 foot reach between the diversion dam and the powerplant turbine. This reach would also include the Wailua Falls. Based upon the cumulative daily flow duration curves, there would be a 22 percent increase in occurrence of low discharges in the range of 10 cfs or less and a 8 percent increase in the range 10 to 75 cfs. Correspondingly, under project conditions, the percentage of time for flows exceeding 75 cfs would decrease. The falls would be relatively unaffected for natural flows exceeding 900 cfs (2 percent of the time and less).

In the South Fork Wailua River downstream of the powerplant tailrace, the flow regime would be enhanced by additional flows. As described in Appendix B, there would be a 20 percent reduction in the percentage of time during which flows would be 10 cfs or less. Also the percentage of time for flows in the range 10 to 75 cfs would be increased by 6 percent. In the North Fork Wailua River, the added diversion into the Stable Storm Ditch will increase the frequency of low flows. For flows less than 100 cfs, the frequency will increase from 79 percent to 94 percent of time.

Beneficial environmental effects would include greater accessibility to the stream by means of the proposed tramway. This would increase the recreational potential and provide an appreciation of in-stream values. An extension of the existing Route 583 would provide an additional visual vantage point of the stream and diversion structure. The diversion structure, located 300 feet upstream of the falls would not be visible from the existing lookout.

Publicly owned lands would be exclusively involved. Acquisition or displacement of farms and residences would not be required.

The economic impacts would be significant and beneficial. The benefits are derived solely from displacement of Kauai Electric's system energy assuming fuel price escalation (Appendix E) and power-on-line effective date of 1990. Alternative 1A would contribute significantly toward the goals of the alleviation of oil dependence and increased energy self-sufficiency. The plan would supplant the need to import 24,800 barrels of oil annually and would service an equivalent of 2,300 households or 7,400 individuals, assuming the current rates of fuel oil utilization and household demands are maintained.


LEGEND
DRAINAGE BOUNDARY
SUB-AREA DRAINAGE BOUNDARY
DITCHES AND TUNNELS
680 USGS STREAM GAGE LOCATION AND NUMBER
HANALEI TUNNEL
1000
PLANS 1A & 2A UPSTREAM FEATURES (FOR DETAILS, SEE PLATE B-23
620
630
610
612
NORTH FORK WAILUA RIVER
STABLE STORM DITCH
WAILUA RESERVOIR
ILIILIULA-NORTH WAILUA DITCH
WAILUA FAL
NORTH POWER HOUSE DITCH INTAKE
LOWER WAIAHI POWER HOUSE
UPPER WAIAHI POWER HOUSE
POWER HOUSE DITCH INTAKE
UPPER LIHUE DITCH
KOLOA DITCH
SOUTH FORK

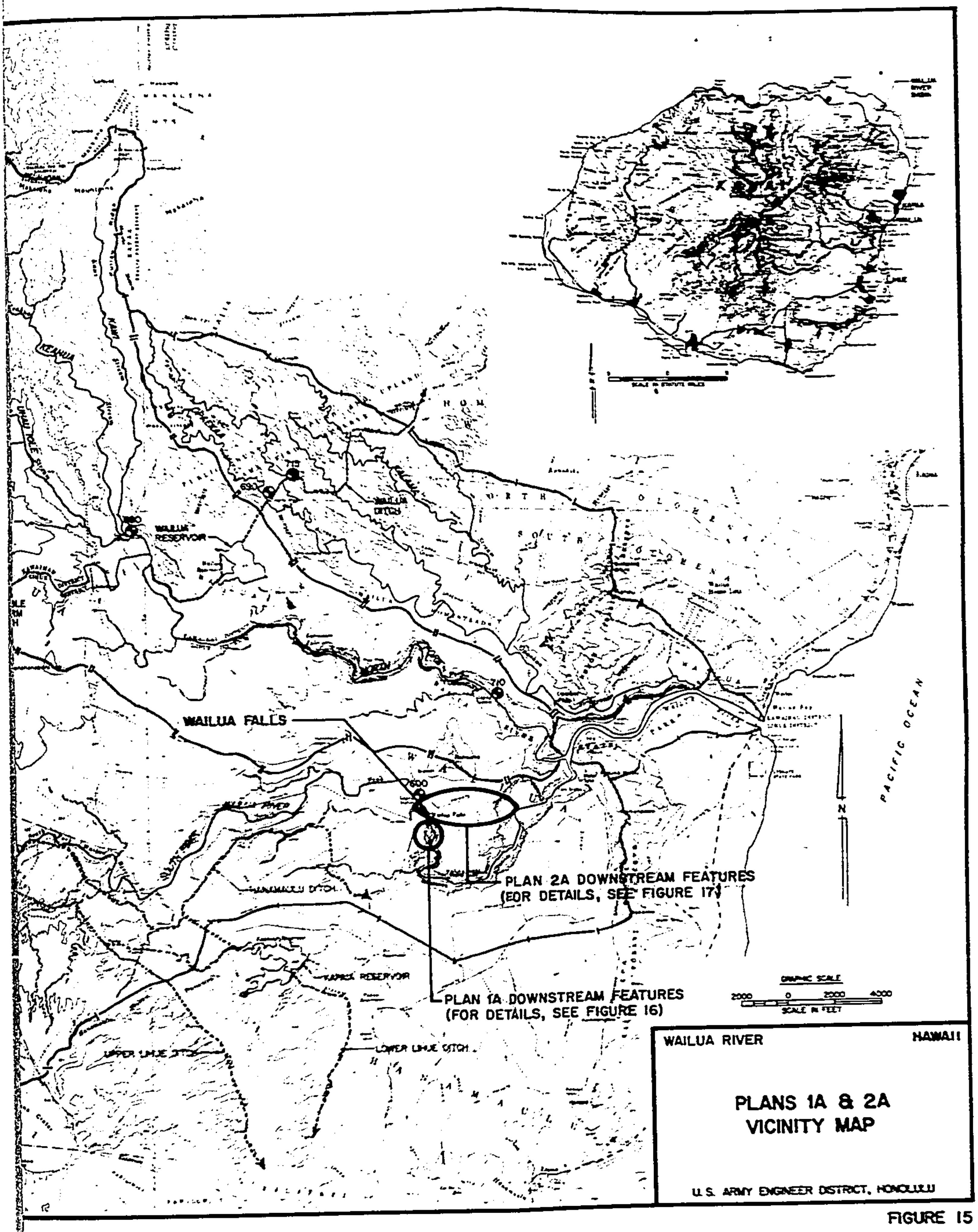
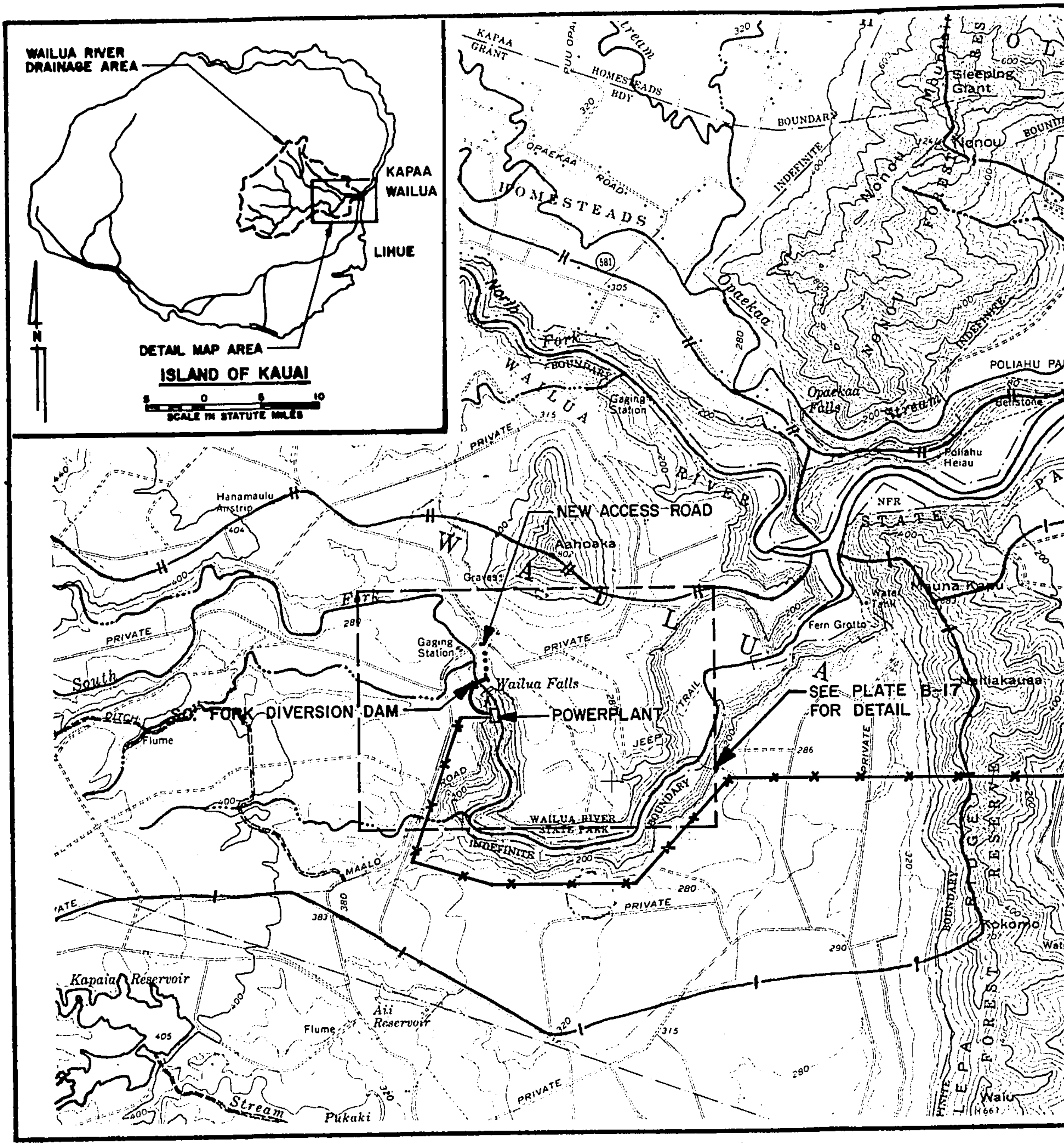
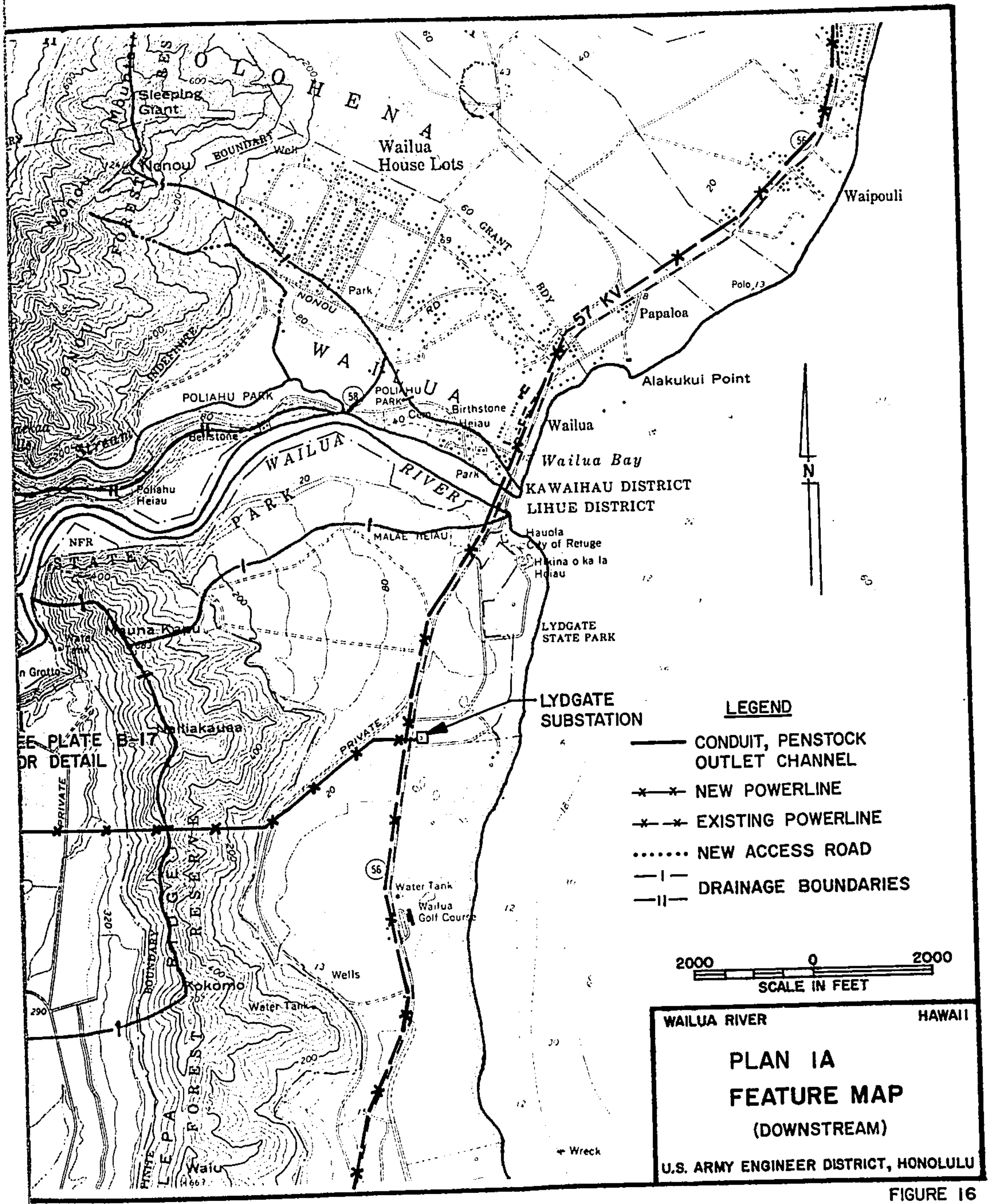

WAILUA FALLS
WAILUA RESERVOIR
WAILUA DITCH
PLAN 2A DOWNSTREAM FEATURES
(FOR DETAILS, SEE FIGURE 17)
PLAN 1A DOWNSTREAM FEATURES
(FOR DETAILS, SEE FIGURE 16)
KAPAIA RESERVOIR
UPPER LIHUE DITCH
LOWER LIHUE DITCH
PACIFIC OCEAN
N
GRAPHIC SCALE
2000 0 2000 4000
SCALE IN FEET
WAILUA RIVER
HAWAII
PLANS 1A & 2A
VICINITY MAP
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 15


WAILUA RIVER DRAINAGE AREA
KAPAA
WAILUA
LIHUE
DETAIL MAP AREA
ISLAND OF KAUAI
SCALE IN STATUTE MILES
NEW ACCESS ROAD
SO. FORK DIVERSION DAM
POWERPLANT
SEE PLATE B-17 FOR DETAIL
Wailua Falls
Gaging Station
Aahoaka
Hanamaulu Airstrip
Fern Grotto
Opaekaa Falls
Sleeping Giant
Nonou
Poliahu Heiau
Bellstone
Kapaia Reservoir
Aii Reservoir
Pukaki
Kokomo
Walu
WAILUA RIVER STATE PARK
HOMESTEADS
PRIVATE
BOUNDARY
INDEFINITE



WAILUA RIVER HAWAII

PLAN IA
FEATURE MAP
(DOWNSTREAM)

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 16

Since firm capacity is not claimed, no capacity benefits were included. The construction costs were weighed against the value of the energy and are summarized below:

Project Investment Cost	$8,188,000
Average Annual Benefits 1/	$ 891,000
Average Annual Costs 1/	677,000
Average Annual Net NED Benefits	214,000
NED Benefit-to-Cost Ratio	1.3

1/ Annual Costs were based on 7-5/8 percent, 100-year economic life, excluding construction inflation. Power-on-line date of 1990.

ALTERNATIVE 2A
POWERPLANT DOWNSTREAM WITH ADDITIONAL DIVERSIONS

DESCRIPTION

Alternative 2A would include the same elements as Alternative 1A except that the powerplant would be sited in a river bend depositional area approximately 9,000 feet from Wailua Falls. The general location of the features are shown in Figures 15 and 17. The Stable Storm Ditch features of Alternative 2A would be identical to that of Alternative 1A.

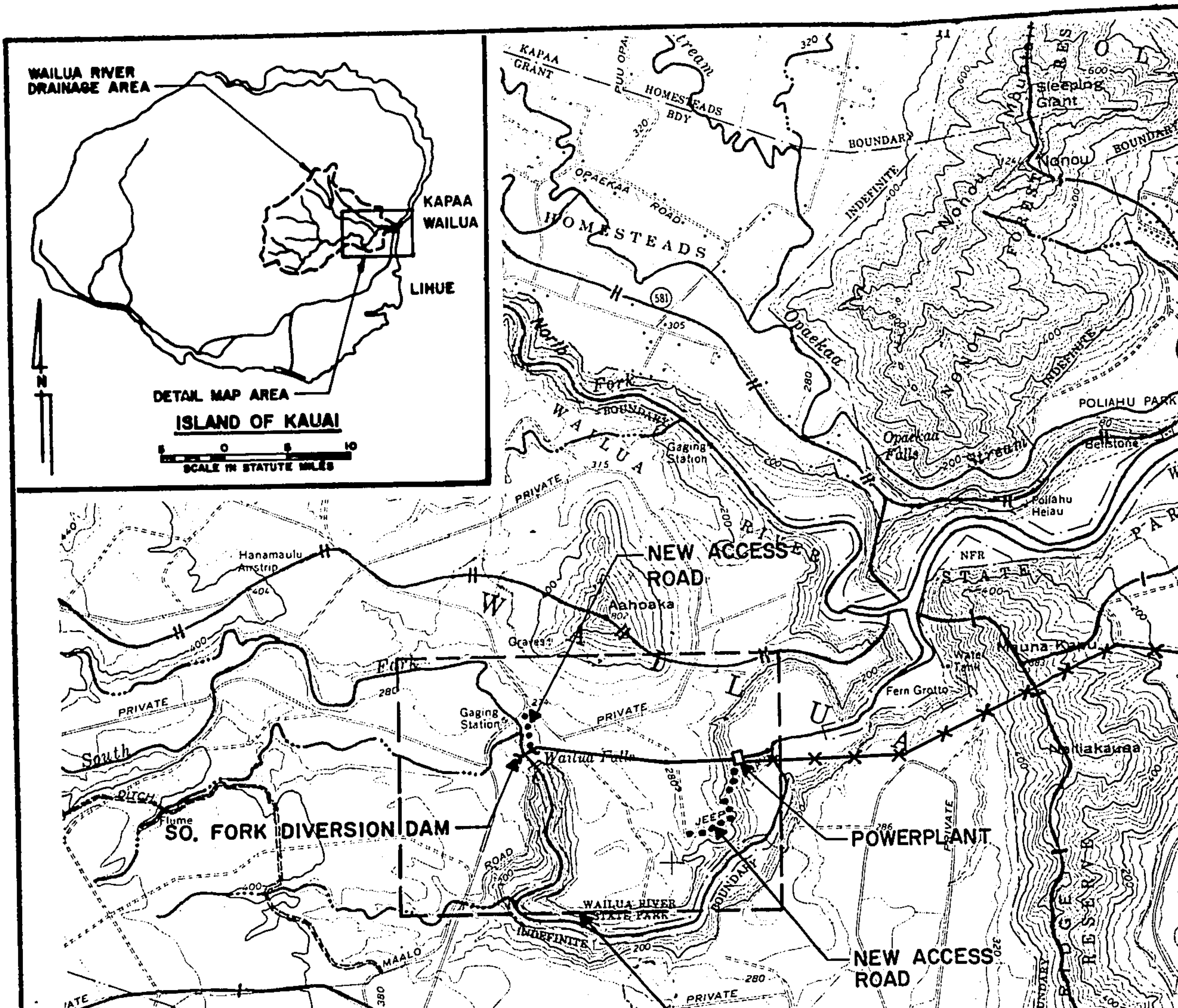
The diversion dam structure would be sited and have the same physical features as in Alternative 1A. The intake structure and gatewell would also be similar but would be located on the left bank (looking downstream). The 108-inch diameter reinforced concrete conduit would be considerally longer than in Alternative 1A, extending 3,100 feet across existing sugar cane fields and meeting the South Fork Wailua downstream. The headbox would also be provided as in Alternative 1A. The penstock would be 467 feet long, mounted on the surface with concrete supports. An existing roadway down to the powerplant site would be improved. In addition, a walkway would be provided above the Falls to enable an operator's access in the event of floods inundating the existing river crossing. An access road would be provided to maintain the diversion dam area.

The powerhouse, sited at the end of the penstock, would be approximately 61 feet (transverse to the penstock) by 31 feet. The two turbo-generators would be rated at 5.65 Mw and would develop 13.84 million kwh of average annual energy. Similar to Alternative 1A, the lack of continuous high discharges and storage capability will result in non-firm capacity. The transmission line would consist of a 12 kv, 2.2 miles long overhead pole line and would be connected to the existing Lydgate substation. The alignment of the transmission line would result in crossingof the river at the powerplant.

IMPACT ASSESSMENT

Many of the features of Alternative 2A are identical to Alternative 1A; hence most of project impacts are similar. Plan 2A would have a less severe effect on water quality since the powerplant is located further downstream in an area less prone to erosion and sedimentation. The effects of sedimentation of stream habitat should likewise be less for Plan 2A. The intermittent diversion of water for hydropower generation, leaving a conservation flow of not less than 10 cfs, would affect a greater area of stream habitat; a 1.7 miles reach vs. 0.1 mile. Temporary impacts on prime agricultural lands would also be greater; this alternative would affect approximately 9 acres of sugar lands during construction of the conduit and penstock. Clearing a corridor for powerline construction from the plant to the substation at Lydgate Park could have a possible adverse effect on agricultural terraces and other unknown archaeological sites that may be located along the alignment.

Similar to Alternative 1A, the diversion of water upstream of Wailua Falls will result in changes in the flow regime, especially in the reach between the diversion point and the power discharge. The rationale for the minimum flow is identical to that of Alternative 1A. Appropriate data derived from the



WAILUA RIVER DRAINAGE AREA
KAPAA
WAILUA
LIHUE
DETAIL MAP AREA
ISLAND OF KAUAI
SCALE IN STATUTE MILES
NEW ACCESS ROAD
SO. FORK DIVERSION DAM
POWERPLANT
NEW ACCESS ROAD
SEE PLATE B-17 FOR DETAIL
Wailua Falls
Gaging Station
Fern Grotto
Opaekaa Falls
Hanamaulu Airstrip
Kapaia Reservoir
Aahoaka
Sleeping Giant
Nonou
Kokomo
Poliahu Heiau
WAILUA RIVER STATE PARK

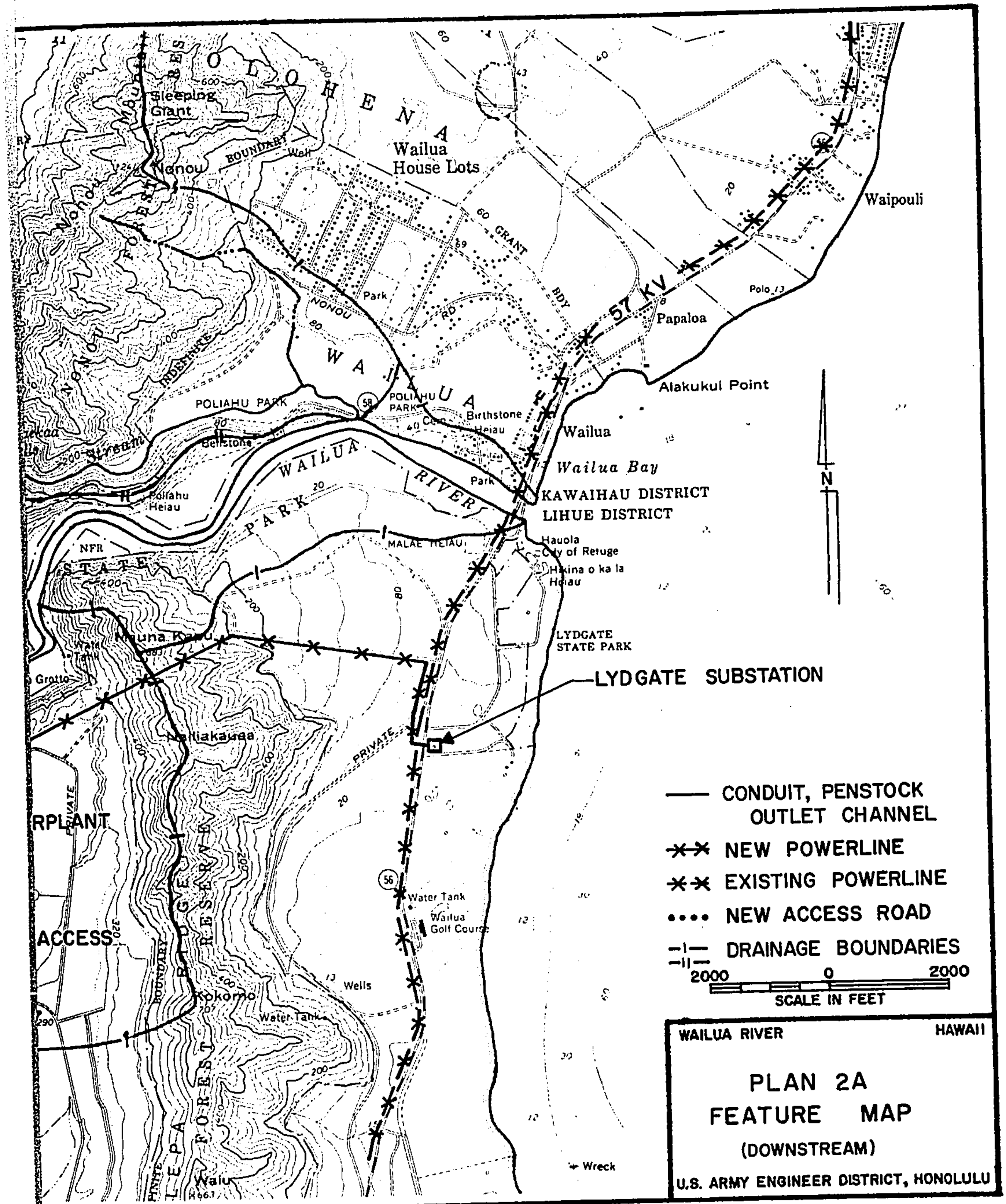

Sleeping Giant
Nonou
Wailua House Lots
Waipouli
57 KV
Papaloa
Alakukui Point
POLIAHU PARK
Birthstone
Wailua
Wailua Bay
WAILUA RIVER
KAWAIHAU DISTRICT
LIHUE DISTRICT
Hauola City of Refuge
LYDGATE STATE PARK
LYDGATE SUBSTATION
Water Tank
Wailua Golf Course
Wells
Kokomo
Wreck
N
CONDUIT, PENSTOCK OUTLET CHANNEL
NEW POWERLINE
EXISTING POWERLINE
NEW ACCESS ROAD
DRAINAGE BOUNDARIES
2000 0 2000
SCALE IN FEET
WAILUA RIVER
HAWAII
PLAN 2A
FEATURE MAP
(DOWNSTREAM)
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 17

cumulative daily flow duration curve are shown in Appendix B. The flow impacts are similar to the impacts of Alternative 1A because of the similar turbine design discharges. As in Alternative 1A, for the 1.7 mile affected reach, there will be a 22% increase in frequency of low flows, 10 cfs or less. However for the river downstream of the powerplant, there would be a 20% reduction in the same range of flows. The flows downstream of the powerplant reflects the beneficial effect of added inflow from the North Fork Wailua River. The flow impacts to the North Fork Wailua River would be identical to that of Alternative 1A.

The beneficial affect in terms of recreational enhancement would be relatively the same as Alternative 1A. However, the accessiblity and impact near the falls may be diminished because of the distance between the end of Route 583 and the powerplant roadway.

The powerplant site, tailrace, and portions of the powerplant access roadway would involve privately owned land. However, the area required would be relatively minimal and powerplant improvements would not preclude continuation of agricultural activities in the surrounding areas.

Alternative 2A would contribute significantly toward the goals of the alleviation of oil dependence and increased energy self-sufficiency. The plan would supplant the need to import 30,400 barrels of oil annually and would service an equivalent of 2,800 households or 9,000 individuals.

Similar to Alternative 1A, the economic benefits would accrue from displacement of overall system energy. The economic impacts are summarized below:

Project Investment Cost	$12,325,000
Average Annual Benefits 1/	$ 1,093,000
Average Annual Costs 1/	968,000
Average Annual Net NED Benefits	125,000
NED Benefit-to-Cost Ratio	1.1

1/ Annual Costs were based on 7-5/8 percent, 100-year economic life, excluding construction inflation. Power-on-line date of 1990.

ALTERNATIVE 3
CONSERVATION/SOLAR

DESCRIPTION

Alternative 3 consists of a combination of solar collector/heat exchange system for residences in Kauai and volunteer conservation measures by the public in concert with other measures affecting energy use. The plan was developed as an extension of information provided in the 1981 State document entitled Hawaii Integrated Energy Assessment. The three principal elements of energy savings involve decreased appliance demand, installation of residential solar hot water systems, and government conservation incentives.

Demand Reduction for Residential Uses. The State projection of residential demand disaggregated the energy demand into components. The basic premise in the demand reduction is that reasonably prudent consumers will self-regulate their consumption patterns. Historical growth patterns for both energy and capacity have been altered from earlier projections of a decade ago. This apparently is a nationwide phenomena as a direct result of public perceptiveness and action following rise in homeowner electric utility costs. The model involved discreased demand for each residential end use as shown in Table 15. The factors reflect a combination of individual conservation and improved appliance efficiencies. The technical specifics of appliance efficiencies or its contribution compared to conservation were not defined. However, the model affords a relatively good basis of the potential savings contribution of each residential end use. Included in the total savings and not further disaggregated is the impact of solar hot water systems.

The net effect of the improved appliance efficiencies and conservation efforts is a reduction in the consumption growth. For Kauai County the baseline macro-econometric model included the effect of the II-F Hawaii Macroeconomic Model Simulation, the DOE High Series C oil prices and no conservation measures. The results of the baseline projection indicated a 5.7 percent average annual growth over the period 1977 to 1990. The baseline increase was projected to total 290 million kwh in 1990. However, under the savings scenario (Table 16), the Kauai energy increase would total 3.4 percent average annual growth rate. The differences between the baseline and the savings scenario increases would be 49 million kwh in the year 1990. The baseline energy scenarios closely approximate the current projections of Kauai Electric Division of Citizens Utilities Company. Under KED's assessment, the average annual increase for the same time period of 1977 to 1990 was projected to be 4.8 percent. A summary of the scenarios is provided in Table 16.

Solar Hot Water Systems. Among current non-fossil fuel measures, the solar collector/heat exchange system remains a practical and realistic technology. It is also a highly visible implementation program. Public awareness has been generated through commercial enterprises, State-sponsored education programs, and continued legislative support. Solar systems are currently operational for commercial and residential use.

The attractiveness of solar systems are based on several factors. First, the Hawaiian Islands has the highest insolation (incoming solar radiation) rate in the United States. The mean daily solar radiation for locations in Kauai

TABLE 15. DEMAND REDUCTION FACTORS FOR ELECTRICITY SALES, KAUAI COUNTY 1/

End-Use 2/	Percentage Of Total Use	Year 1980	1985	1990	1995	2000
Residential Rates						
Lighting	13.0	95	90	85	80	80
Heating and cooling	0.0	95	95	90	90	80
Water heating	25.0	95	80	65	50	35
Refrigeration	26.0	95	87	79	71	63
Electric cooking	8.0	95	90	85	80	80
Dryer	5.0	95	90	85	80	80
TV-Radio	8.0	100	100	100	100	100
Dishwasher	5.0	95	90	85	80	80
Miscellaneous	10.0	95	95	95	90	90

1/ Hawaii, State of, DPED. Hawaii Integrated Energy Assessment. Vol III, Table 37. Honolulu: June 1981.
2/ These figures represent the reduction in consumption for various end-uses brought about by improved appliance efficiencies and other energy conservation measures.

TABLE 16. KAUAI ENERGY CONSUMPTION FORECASTS WITH CONSERVATION MEASURES 1/

Energy Demand, Million KWH 2/

Year	KED Projection 4/	Baseline Macroeconomic	Baseline with Savings	Macro-Saving Difference
1977	167 3/	167	167	0
1980	189 3/	191	181	10
1985	227	237	211	26
1990	271	290	241	49
1995	323 5/	339	272	67
2000	385 5/	379	287	92
2005	-	416	300	116

1/ Hawaii, State of, Department of Planning and Economic Development and University of California, Lawrence Berkeley Laboratory. Hawaii Integrated Energy Assessment. Vol III Honolulu: June 1981.
2/ Total energy sales
3/ Actual data
4/ Table 8
5/ Extrapolated from KED rate

varies between 340 to 500 langleys (Figure 18). Also the seasonal variability due to its low latitude is relatively minimal. Second, installation is financially attractive to individual consumers. For an average single family home of four members with a monthly consumption of 500 kwh, the electrical rate is 16 cents per kwh (as of 1981). Offsetting even a portion of this high-cost energy is a fast-return, financially prudent investment. Also there currently exist considerable tax savings by the State of Hawaii 10 percent and Federal 30 percent tax credit programs. Third, the savings to the individual homeowner's energy bill is made more attractive by the high proportion of the bill that is attributable to hot water heating. For the typical family in Kauai, approximately 25 percent of the electrical utility bill is generated by the electric water heater load. This proportion contrasts with the typical energy utilization for residences in the United States. In the nation, approximately 67 percent of the homeowner's load is for space heating and only 15 percent for water heating. As shown by Table 15, the water heating end-use demand offers the greatest potential among all appliances for energy savings. By the year 2000, the State model has projected that the demand of water heating will be reduced to 35 percent of the actual use in 1977.

The basic elements of a solar hot water system are illustrated diagrammatically in Figure 19. The major elements for a simple system are solar collector panels, heat exchange piping, hot water storage tank, plumbing and accessory controls. For a typical residential unit the collector area will vary generally between 40 to 100 square feet and storage tank between 80 to 150 gallons capacity. The major parameters in the design are the collector type, collector area, location, and hot water delivery temperature. The effectiveness of the systems in any locale is directly related to the solar radiation.. However, as experienced by solar contractors, there has been no apparent concentration of systems in any location on Kauai. Due to the relatively high initial investment cost, installation location is related largely to the affluence of residential neighborhood.

Although the number of solar hot water systems installed in Kauai is currently low compared to Oahu and Maui, the total contribution in energy savings will be substantial. According to commercial enterprises, the island of Kauai has the largest proportion of solar hot water units of any island in the State, as compared to the total number of residences. Based upon an industry survey, as of June 1981 approximately 2,000 solar units have been installed in Kauai.

Based upon information developed in the Hawaii Integrated Energy Assessment and projections of residential solar hot water systems, an estimate was developed for the solar contribution (Table 17). The relative demand associated with water heating would decrease with time, in effect reflecting the contribution of the solar systems. In 1990 the estimate shows an approximate 10 million kwh in energy savings. This constitutes about 20 percent of the entire conservation energy savings. However, the overall impact of solar hot water systems will total about 4 percent of projected energy sales for Kauai. Table 17 also summarizes the total conservation savings and the equivalent number of solar hot water systems.

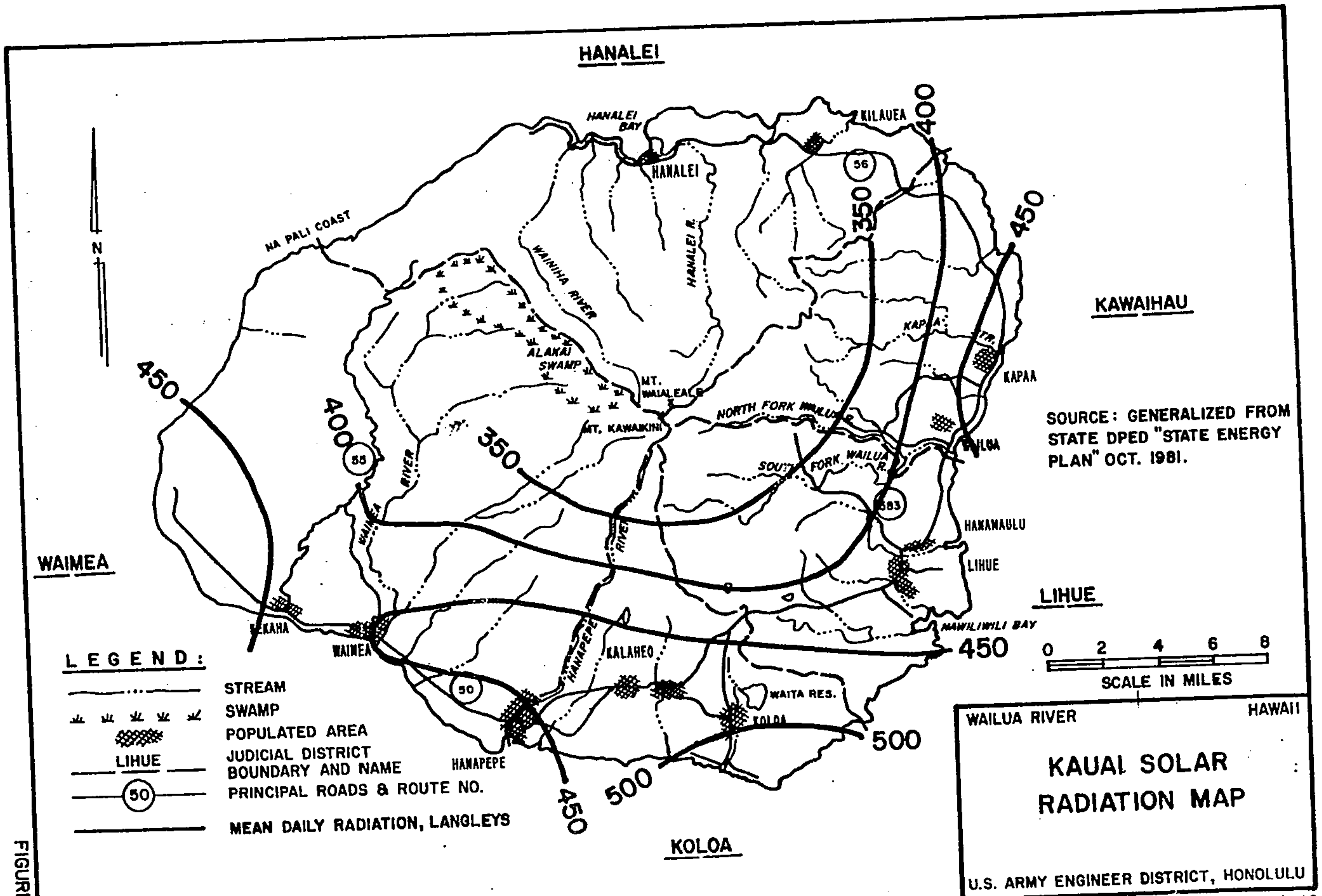
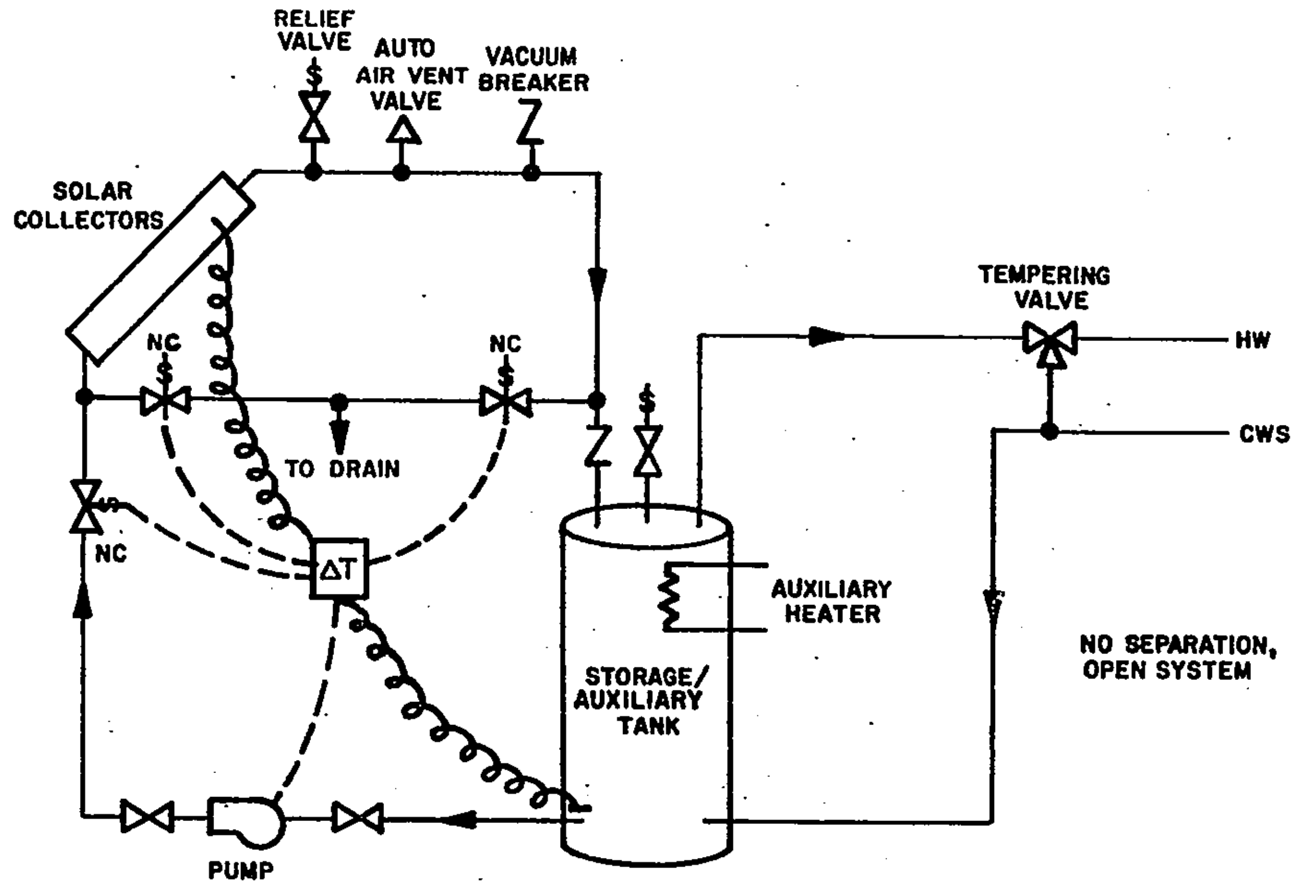


FIGURE 18

FIGURE 18



SOURCE: "SINGLE TANK, DIRECT, DRAIN-DOWN BUILDING SERVICE HOT WATER SYSTEM" IN SOLAR ENERGY RESEARCH INSTITUTE, SOLAR DESIGN WORKBOOK (DRAFT), JUNE 1981

WAILUA RIVER HAWAII

SOLAR HOT WATER SYSTEM DIAGRAM

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 19

FIGURE 19

TABLE 17. SOLAR HOT WATER ENERGY SAVINGS

Year	Total Conservation Energy Savings, Million Kwh 1/	Solar Energy Savings, Million Kwh 2/	Percent Solar Contribution 3/	Equivalent Number of Solar/Hot Water Systems 4/
1977	0	-	-	-
1980	10	1	10	700
1981	18	3	14	2,000
1985	26	5	19	3,300
1990	49	10	20	6,700
1995	67	16	24	10,700
2000	92	24	26	16,000

1/ Table 16
2/ Computed as: 39% of baseline projection times (25 percent minus projected water heating use percent). The 39% reflects the current non-farm residential energy classification.
3/ (Solar Energy Savings/Conservation Savings) in percent
4/ (0.25)(6000 kwh/year/residence) per each solar system unit

Government Conservation Incentives. Since 1977 both the State of Hawaii (10 percent) and the Federal government (40 percent) have made available tax credits for installation of energy saving solar systems. Undoubtedly these tax incentives have favorably contributed to the growth of the solar industry and have spurred individual interests. However, the tax credit system tends to discriminate against low income families: due to their low tax liability they may be prevented from effectively utilizing the credit.

Other mechanisms have been proposed to financially encourage and subsidize the industry. For example, several of the following proposals have been considered in other sun belt states:

a. Tax Credit With Rebate. This would aid the low income consumer.

b. Solar Bank. A government supported institution could be established for consumer loans.

c. Secondary Financing Institutions. Other existing institutions (Fannie Mae, Ginnie Mae, etc.) may be utilized for solar loans.

d. Direct Utility Loans. This mechanism may be utilized to encourage solar implementation in designated areas.

e. Utility Credits. Periodic or lump sum payments may be provided to the consumer against the utility bill.

f. Protection for Solar Access. This proposal would encourage individuals and communities to plan and legally protect accessibility to solar radiation.

Opportunities still exist for the expansion of financial and legal incentives for solar systems. However, other than the continuation of tax credits, no new State or Federal legislation appears likely to be implemented. If the Federal credits are not extended or reduced significantly beyond calendar year 1985, the implementation of solar hot water systems would be drastically reduced.

The State of Hawaii has recently issued an updated State Energy Plan (October 1981) which includes energy conservation as one of the principal components. The main elements which would affect electrical consumption are grouped into three areas:

a. Support of personal energy consumption efficiency.
b. Identification of conservation measures in buildings.
c. Implementation of building codes, energy targets, and procurement systems.

The support of personal energy consumption efficiency includes promotion of measures through the Consumer Energy Conservation Program (a mobile diagnostic van) and the State Energy Extension Service (technical assistance and workshops). The identification of conservation measures would be performed through energy audits provided on a limited basis for commercial buildings, residences, schools, hospitals, non-profit institutions, and government buildings. Specific building codes, energy targets and procurement systems would apply to new and significantly renovated government buildings. The program would be implemented by the respective County building departments, and State building agencies (primarily the Department of Accounting and General Services).

IMPACT ASSESSMENT

Alternative 3 would have no significant adverse effects on the environment. Obviously, the institutional and legal measures will tend to influence the utilization and conservation of energy. However, the measures and other construction effects of solar systems would affect only urbanized areas and would not impact the natural environment.

The conservation/solar plan would conserve approximately 10 million kwh of energy by 1990. Part of the conservation/solar plan exists now. The system on Kauai totals 2,000 units accompanied by other governmental conservation programs. The 1990 energy conserved would be equivalent to an annual consumption of 22,000 barrels of oil and the energy needs of 2,000 household or 6,400 individuals.

The economic impacts, although definable, would not be comparable to a single large construction project. The conservation measures would be institutionalized and no direct monetary costs were determined. The individual solar systems would be extremely costly if implemented at one time but is possible if distributed over decades. The implementation of solar hot water systems would be highly dependent on individual preferences, the influence of the marketplace as well as important government incentives. Hence, although the benefits, determined from displaced energy would be substantial, the decentralized nature of solar systems and lack of definitive implementation would make economic comparison with a single-event construction project not meaningful. In addition, a highly important consideration is that these individual systems may be implemented with or without any hydropower facility.

According to the Federal NED economic criteria the net benefits to Kauai would be marginal. The average annual benefits of $811,000 would be offset by the average annual costs. However, the intangible benefits of supporting the energy conservation ethic and realizing energy self-sufficiency remain strong reasons for consideration of this nonstructural program. In addition outside of the NED analysis, if credit were determined for an individual homeowner's tax savings and the effects of increased residential market value, the benefits to an individual homeowner would be substantial. Without the effects of increased housing market value, the equivalent net benefit would range from $4 to $9 per month to each average household. As a result of these considerations this nonstructural plan has been retained in the comparison of final alternatives.

COMPARISON OF DETAILED PLANS

EVALUATION

Two basic structural plans and one non-structural plan were evaluated in terms of their contribution to the national objectives and various other measures. An overview summary of the impacts and the analysis of the systems of accounts is provided in Table 18.

Alternative 1A would involve significantly less construction than Alternative 2A primarily reflecting the much shorter conduit length (560 feet vs. 3,100 feet). Additional effects of the conduit are that Alternative 1A would adversely disturb approximately one acre of prime sugar cane land as compared to nine acres for Alternative 2A. Also the river length adversely affected by flow diversion would be considerably longer in Alternative 2A, 1.7 miles as compared to Alternative 1A of 0.1 mile. Both alternatives would require an electrical transmission line crossing through the Kalepa Forest Reserve conservation area. However, Alternative 2A minimizes lengthy connective lines, and would require a crossing of the South Fork River at the powerplant location.

The construction impacts in the vicinity of Wailua Falls will be more apparent in Alternative 1A as compared to Alternative 2A. The diversion structure, penstock, powerplant, and the transmission lines will all be in close proximity. However, the powerplant will be located at the base of a steep river cut and will be out of sight from the bluff. The penstock, although at the surface, would also be located away from the direct line of sight of the falls. Similarly, although the diversion dam would be visible directly at the structure, it would not be apparent from the falls. From a public information and recreational appreciation viewpoint, an advantage of Alternative 1A over 2A is that recreational access would be provided into the stream from an existing vantage point. The diversion dam and powerplant could also be accessible to the interested public.

In contrast, Alternative 2A would involve a powerplant located almost two miles downstream along the river. Although the construction impacts to the falls area would not be as apparent, there would not be the recreational opportunity provided through access into the river bottom of the falls. The powerplant of Alternative 2A does not directly impact on the existing Wailua River State Park. However, the State master plan does indicate future recreational use for the areas. The likelihood of any park improvements in the near future is remote. The potential powerline crossing of Alternative 2A would be an adverse impact for the park. However, similar to other areas on Kauai, the powerline could be constructed high enough to avoid an obstrusive visual impression. Finally, in contrast to Alternative 1A, relatively shorter length of powerline of Alternative 2A would not skirt edges of the State Park for an additional one mile length.

The power developed for Alternative 2A (5.65 Mw) would be slightly larger than Alternative 1A, (5.0 Mw). Correspondingly, the average annual energy developed would be 13.84 million kwh for Alternative 2A as compared to 11.28 million kwh for Alternative 1A. The differences are due to the slightly

TABLE 18. SUMMARY COMPARISON AND SYSTEM OF ACCOUNTS

ITEM	BASE AND WITHOUT CONDITION	WITH CONDITION: PLAN 1A	WITH CONDITION: PLAN 2A	WITH CONDITION: PLAN 3
A. PLAN DESCRIPTION	NO SIGNIFICANT ACTION.	POWERPLANT NEAR FALLS.	POWERPLANT DOWNSTREAM.	CONSERVATION/SOLAR.
1. DESIGNATION	N/A	NED PLAN	-	LED PLAN.
2. TYPE	N/A	STRUCTURAL	STRUCTURAL	NONSTRUCTURAL
3. FEATURES	CONTINUAL DEPENDENCE ON PETROLEUM FUELD, UNDER UTILIZATION OF WATER RESOURCE ENERGY POTENTIAL.	ADDITIONAL DIVERSION FROM NORTH FORK WAILUA, DIVERSION STRUCTURE IN SOUTH FORK WAILUA, 560-FT LONG CONCRETE CONDUIT, 282-FT LONG STEEL PENSTOCK, 5.0 MW POWER-PLANT, 30-FT CHANNEL. TAILRACE, 3.5 MI TRANS-MISSION LINE.	ADDITIONAL DIVERSION FROM NORTH FORK WAILUA, DIVERSION STRUCTURE ON SOUTH FORK WAILUA, 3,100-FT LONG CON-CRETE CONDUIT, 467-FT LONG STEEL PENSTOCK, 5.6 MW POWERPLANT, 500-FT RCP TAILRACE, 2.2 MI TRANSMISSION LINE.	900 ADDITIONAL SOLAR HOT WATER UNITS PER YEAR, INCREASED APPLIANCE EFFICIENCIES, GOVERNMENT INCENTIVES.
B. RELATIONSHIP TO NATIONAL ACCOUNTS				
1. NATIONAL ECONOMIC DEVELOPMENT (NED) ACCOUNT				
a. BENEFICIAL IMPACTS ($) TOTAL ANNUAL NED BENEFITS (ENERGY DISPLACEMENT)		$891,000	$1,093,000	$811,000
b. ADVERSE IMPACTS ($) TOTAL ANNUAL NED COSTS (CONSTRUCTION/O,M&R)		$677,000	$ 968,000	N/A
c. NET NED BENEFITS ($)		$214,000	$ 125,000	N/A
d. NED BENEFIT TO COST RATIO (BCR)		1.3	1.1	N/A
2. ENVIRONMENTAL QUALITY (EQ) ACCOUNT				
SIGNIFICANT RESOURCES:				
a. WATER QUALITY	MIDDLE AND UPPER REACHES OF S.FORK WAILUA RIVER ARE CLASS 2 INLAND WATERS PROTECTED FOR FISH AND WILDLIFE PROPAGATION, AGRICULTURAL, AND INDUS-TRIAL WATER SUPPLY AND RECREATION. NO ANTICIPATED CHANGE IN EXISTING CONDITION.	TEMPORARY INCREASE IN WATER TURBIDITY BOTH IN THE PROJECT AREA AND DOWNSTREAM DURING PROJECT CONSTRUCTION. NO LONG-TERM EFFECT ON STREAM WATER QUALITY.	SAME AS PLAN 1A.	NO EFFECT.
b. AQUATIC RESOURCES	AQUATIC FAUNA ABOVE WAILUA FALLS IS DOMINATED BY INTRODUCED SPECIES IN-CLUDING SMALL MOUTH BASS AND CHINESE CATFISH. BELOW THE FALLS, A NUMBER OF NATIVE DIA-DROMOUS SPECIES OCCUR.	TEMPORARY INCREASE IN SEDI-MENTATION OF STREAM HABITAT BELOW WAILUA FALLS DURING CONSTRUCTION. INCREASE IN AREA OF POOL BEHIND FALLS (PREFERRED SMALL MOUTH BASS HABITAT) of 4.4 ACRES AS A RESULT OF DIVERSION DAM.	SAME AS PLAN 1 EXCEPT THAT APPROXIMATELY 1.7 MILES OF STREAM WOULD BE AFFECTED BY REDUCED STREAM FLOWS.	NO EFFECT.

TABLE 18. SUMMARY COMPARISON AND SYSTEM OF ACCOUNTS (CONTD)

ITEM	BASE AND WITHOUT CONDITION	WITH CONDITION: PLAN 1A	WITH CONDITION: PLAN 2A	WITH CONDITION: PLAN 3
b. AQUATIC RESOURCES (CONTD)	NO ANTICIPATED CHANGE IN EXISTING CONDITION.	INCREASED LOW FLOW FREQUENCY DUE TO HYDROPOWER DIVERSION ALONG A 0.1 MILE REACH OF SO. FORK AND NO. FORK WAILUA.		
c. ENDANGERED SPECIES	NO LISTED OR PROPOSED SPECIES KNOWN TO OCCUR IN IMMEDIATE PROJECT AREA. NO ANTICIPATED CHANGE IN EXISTING CONDITION.	NO EFFECT.	NO EFFECT.	NO EFFECT.
d. PRIME AGRICULTURAL LANDS	LANDS ADJACENT TO THE WAILUA RIVER IN THE VICINITY OF THE PROJECT AREA ARE CLASSIFIED AS PRIME AGRICULTURAL LANDS. NO ANTICIPATED CHANGE IN EXISTING CONDITION.	APPROXIMATELY 1 ACRE OF PRIME AGRICULTURAL LAND WOULD BE DISTURBED DURING CONSTRUCTION OF THE CONDUIT. LANDS WOULD BE RESTORED TO PREVIOUS USE SUBSEQUENT TO COMPLETION OF THE PROJECT.	APPROXIMATELY 9 ACRES OF PRIME AGRICULTURAL LAND WOULD BE DISTURBED DURING CONSTRUCTION OF THE CONDUIT. LANDS WOULD BE RESTORED TO PREVIOUS USE SUBSEQUENT TO COMPLETION OF THE PROJECT.	NO EFFECT.
e. CULTURAL AND HISTORIC RESOURCES	NO NATIONAL REGISTER SITES. EARLY 19TH CENTURY RR BRIDGE REMNANT UPSTREAM OF WAILUA FALLS. EARLY AGRICULTURAL TERRACES IN LOWER REACH S. FORK. UNKNOWN SITES WITHIN POWERLINE CORRIDOR ON KALEPA RIDGE.	RR BRIDGE AND AGRICULTURAL TERRACES UNAFFECTED. POSSIBLE EFFECT ON UNKNOWN SITES IN POWERLINE CORRIDOR.	RR BRIDGE UNAFFECTED. POSSIBLE EFFECT ON AGRICULTURAL TERRACES AND OTHER UNKNOWN SITES IN POWERLINE CORRIDOR.	NO EFFECT.
f. RECREATIONAL AND AESTHETIC RESOURCES	WAILUA RIVER STATE PARK POPULAR VISITOR ATTRACTION INCLUDING WAILUA FALLS. SMALL MOUTH BASS FISHERY UPSTREAM OF FALLS AND ON NO. FORK WAILUA. LONG-RANGE PARK PLAN MAY GRADUALLY BE IMPLEMENTED.	APPROX 94% OF TIME FLOWS WILL BE LESS THAN 75 CFS AS COMPARED TO 64% OF TIME UNDER EXISTING CONDITIONS. UPSTREAM FISHERY MAY BE ENHANCED. VISITS TO FALL REDUCED. LOW FLOW FREQUENCY INCREASED FROM 14% TO 83% MAY AFFECT FISHERY RESOURCE ON NO. FORK.	SAME AS PLAN 1A EXCEPT POWERPLANT SITING CONFLICTS WITH LONG RANGE PARK PLAN TO DEVELOP A LAGOON-RECREATIONAL AREA IN VICINITY. LESS DISRUPTION TO FALLS VISITATION LEVEL.	NO EFFECT.
3. OTHER SOCIAL EFFECTS (OSE) ACCOUNT				
a. URBAN AND COMMUNITY IMPACTS	AREA OF IMPROVEMENT ENTIRELY IN AGRICULTURAL OR CONSERVATION LAND USE DESIGNATIONS. NO ANTICIPATED CHANGE.	NO EFFECT.	NO EFFECT.	NO EFFECT.

TABLE 18. SUMMARY COMPARISON AND SYSTEM OF ACCOUNTS (CONTD)

ITEM	BASE AND WITHOUT CONDITION	WITH CONDITION: PLAN 1A	WITH CONDITION: PLAN 2A	WITH CONDITION: PLAN 3
b. LIFE, HEALTH, AND SAFETY	PROJECT AREA NOT WITHIN REGULATORY FLOOD ZONES BUT ARE WITHIN THE KNOWN 500-YEAR FLOOD AREA. NO ANTICIPATED CHANGE.	MAJOR DIVERSION STRUCTURE DESIGNED TO WITHSTAND PROBABLE MAXIMUM FLOOD. POWERHOUSE ABOVE 500-YEAR FLOOD LEVEL.	SAME AS PLAN 1A EXCEPT POWERHOUSE SEALED.	NO EFFECT.
c. DISPLACEMENT	NO RESIDENCES IN PROJECT AREA. AREA UNDER SUGAR CANE OR PASTURE USE.	MINOR CONSTRUCTION DISTURBANCE TO 1.3 AC SUGAR CANE LANDS PLUS 1.4 AC FOR POWERLINE.	SAME AS PLAN 1A EXCEPT SUGAR CANE LANDS 9.0 AC AND OTHER PRODUCTIVE LANDS 1.0 AC.	NO EFFECT
d. LONG TERM PRODUCTIVITY	NO CHANGE.	NO EFFECT.	NO EFFECT.	NO EFFECT.
e. ENERGY REQUIREMENTS AND ENERGY CONSERVATION	APPROX 40% OF UTILITY GENERATION FROM RENEWABLE ENERGY SOURCES. NO FORESEEABLE CHANGE IN IMMEDIATE FUTURE.	WOULD PROVIDE 11.28 MILLION KWH ADDITIONAL GENERATION FROM RENEWABLE ENERGY SOURCE; HYDRO POWERPLANT WOULD DISPLACE 24,800 BBLS OF FOSSIL FUELED RESOURCES.	SAME AS PLAN 1A EXCEPT WOULD PROVIDE 13.84 MILLION KWH ADDITIONAL GENERATION DISPLACEMENT OF30,400 BBLS OF OIL.	TOTAL CONSERVATION SAVINGS PROJECTED TO TOTAL 49 MILLION KWH IN 1990, INCL SOLAR SAVINGS OF 10 MILLION KWH. DISPLACEMENT OF 22,000 BBLS OF OIL.
4. REGIONAL ECONOMIC DEVELOPMENT (RED) ACCOUNT				
REGIONAL INCOME AND REGIONAL EMPLOYMENT	NO CHANGE.	DETAILED REGIONAL INCOME AND EMPLOYMENT ANALYSIS NOT PERFORMED. PROJECT AREA AND REGIONAL EVALUATIONS NOT SEPARABLE. NED ACCOUNT APPLIES TO REGION.		
C. PLAN EVALUATION				
1. RESPONSE TO FORMULATION TESTS				
a. COMPLETENESS	NO CHANGE.	REQUIRES CONSUMMATION OF MARKETING CONTRACTS WITH PREFERENTIAL ENTITIES.	SAME AS PLAN 1A.	REQUIRES CONTINUATION OF TAXATION & CONSERVATION PROGRAMS OF FEDERAL & STATE GOVERNMENTS.
b. EFFECTIVENESS	NO CHANGE.	EFFECTIVE IN PROVIDING A SOLUTION.	EFFECTIVE.	EFFECTIVE.
c. EFFICIENCY	NO CHANGE.	COST EFFECTIVE.	LESS COST EFFECTIVE.	COST EFFECTIVE.
d. ACCEPTABILITY	NO CHANGE.	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE
2. IMPLEMENTATION RESPONSIBILITY	NOT APPLICABLE.	STATE OF HAWAII, US ARMY CORPS OF ENGINEERS, AND WESTERN AREA POWER ADMINISTRATION.	SAME AS PLAN 1A.	PRIVATE INITIATIVE.
3. PLAN RANKING	NOT APPLICABLE.	1	2	3

larger net head available for Alternative 2A, (225 feet compared to 178 feet), which would offset its smaller maximum turbine design discharge (260 compared to 234 cfs). The resulting benefits derived from displaced energy are directly proportion to the energy developed. Alternative 2A would provide the energy needs of 500 more households (or 1,600 persons) and would obviate the need to import 5,600 barrels less than Alternative 1A.

Alternative 3, the nonstructural plan, does not impact the Wailua River Basin. The conservation/solar plan would decrease the need to import 22,000 barrels. In the absence of hydropower improvements Alternative 3 could be implemented. However, the improvements would involve a combination of government incentives and individual construction of solar hot water systems. Centralized institutional measures would not be required for implementation of the conservation/solar alternative; the marketplace must provide the favorable economic setting.

DESIGNATION OF NED PLAN

The National Economic Development (NED) plan provides the greatest net economic benefits compared to all other plans investigated. As shown in Table 18, Alternative 1A would provide the largest net NED benefits at $214,000. Hence, Alternative 1A is designated the NED plan.

DESIGNATION OF EQ PLAN

The Environmental Quality (EQ) Plan is the alternative plan which provides the highest net positive contributions to the EQ account. Among the plans investigated in detail, none would provide positive contribution in terms of enhancement or improvement of the existing physical or ecological systems. In lieu of designating an EQ Plan, the plan which is Least Environmentally Damaging or LED Plan would be designated. An LED Plan may not provide net positive EQ benefits but may temporally or quantitatively minimize adverse consequences. Alternative 3, the Conservation/Solar Plan clearly impacts the natural environment least among the three final plans. Therefore Alternative 3 is the designated LED Plan.

SELECTED PLAN

The total evaluation of each alternative plan's contributions to the System of Accounts is documented in Table 18, the Summary Comparison and System of Accounts. Based on the developed information, the ranking of the plans was as follows:

Order	Plan
1A	Powerplant Near Falls with Additional Diversion
2A	Powerplant Downstream with Additional Diverson
3	Conservation/Solar

Alternative 1A offers the highest NED benefits and is the Selected Plan of Improvement: The relative benefits of Alternatives 2A and 3 and any adverse impacts of Alternative 1A are not sufficiently significant to displace the selection. The benefits are derived solely upon the value of displaced energy of the existing Kauai Electric Division utility system.

FUNCTIONAL ELEMENTS

The selected plan would consist of improvements sited near the confluence of the Stable Storm Ditch and the North Fork Wailua River approximately five miles upstream of the Wailua Falls, improvements near the actual falls, and finally electrical powerlines to the existing powerlines along the coastal highway (Route 56), approximately three miles from the falls. The Stable Storm Ditch improvements, relatively minor in construction effects would increase the diversion capability of the existing structure to provide more discharge into the South Fork River system than under prevailing conditions.

Improvements near the Wailua Falls would consist of a diversion dam to control the South Fork Wailua River waters, various water transmission and control structures, a powerplant, and access features. The diversion dam, located approximately 300 feet upstream of the falls would be a gravity, overtopping type structure, 13.5 feet high and with a crest length of 220 feet. The structure would be designed to withstand overtopping by the Probable Maximum Flood.

The area ponded upstream would be approximately 4.4 acres. Although a small storage value of 23.5 acre-feet would be provided, as a conservative measure, storage has not been considered for power diversion capability. The ponding would, however, add to the stability of flows.

The major water conveyance feature would be a buried 108-inch diameter, 560-foot long reinforced concrete pipe located on the right side of the river. The pipe would transport diverted flows from the diversion dam to the top edge of the cliff, approximately 500 feet downstream of the Wailua Falls. A 72" diameter, 282-foot long steel penstock would transport pressure flows down to the powerhouse. The penstock would be mounted at the surface with reinforced concrete supports. Other control and water conveyance structures along the transmission route are the intake structure, gatewell, headbox, and tailrace.

The powerplant would be sited at the base of the penstock. The concrete structure would encompass an area of approximately 2,400 square feet (65' x 36'). Inside would be housed two horizontal Francis type water turbines. The larger unit, rated at 3.33 Mw, would be designed for flows ranging from 130 cfs to 260 cfs at a net head of 178 feet. The smaller unit, rated at 1.67 Mw, would be designed for flows ranging from 65 cfs to 130 cfs. The duel turbine concept would allow operation over a wide range of flows. Due to the non-firm nature of discharges and the minimum discharge required for turbine operation, the powerplant will be in operation 50 percent of the time. Natural flows in the South Fork Wailua River must exceed 75 cfs for operation under the current design. Wicket gates and butterfly valves would be provided to control inflow into the turbines. The generator would be of the horizontal shaft synchronous type, directly connected to the turbine. Additional electrical and mechanical equipment would be provided.

The powerhouse station would be unmanned and remotely controlled. The 12 kv powerlines would be mounted on poles and would extend from the powerhouse, around the periphery of the bluff and connected to the existing Lydgate substation along Route 56. The total length of powerlines would be 3.5 miles.

PLAN ACCOMPLISHMENTS

The selected plan would provide an additional source of energy for the island of Kauai, effectively utilizing the available Wailua River flows. The benefits were derived from power values furnished by the Federal Energy Regulatory Commission (FERC) and were based on displacement of system energy. Since the facility is a conduit hydropower plant with no effective storage capability, no capacity credit was provided in the benefit evaluation.

The recipients of the estimated $891,000 average annual benefits derived from 11.28 million kwh of energy would be the people of Kauai and the Nation. The projected implementation date is 1990.

The existing electrical utility system is highly dependent on fuel and diesel oils (60 percent as of 1981) for electrical generation. Although according to latest demand projection; the local utility company has sufficient reserve capacity, its capability is limited when its major purchased capacity is shut down. Any additional capacity, especially from non-fossil fuel generated sources would be beneficial.

The proposed facility would not conflict with the operation of any water resource facility. The irrigation systems of Lihue Plantation would continue to be operative with existing diversions. There are no authorized nor constructed Federal dam or hydropower facilities on the island. In addition, there are no existing permits or licenses issued by FERC for potential hydropower facilities in the area.

Although there are no public cooperatives or publically owned utilities on the island of Kauai, there is potential for the establishment of such entities. In accordance with existing Federal law, the power and energy developed from a Federal project would be made available on first priority basis to preference customers. The existing average annual energy demand from public entities exceed the project output. In the event excess energy is developed beyond the needs of the public entities, the balance could be exchanged or sold to the local utility. The Western Area Power Administration has indicated the developed energy would be marketable and competitive and that the distribution to public preference entities could be incorporated into the project authorization document (see Appendix F).

The selected plan addresses the major study problems previously enumerated in the "Problem Identification" section of the Main Report. The plan of improvement would decrease the dependence of the island of Kauai on petroleum-based fuels and would add to its energy self sufficiency goal. Based on current fuel oil utilization rate, the plan would displace the need to import approximately 24,800 barrels of oil annually. The plan would add to the energy supply of the local utility and would provide the equivalent energy service to approximately 2,300 households on the island.

The electrical rates to consumers, although important for public accountability, would be indirectly affected for the implementation of this project. The energy developed from the selected plan would constitute approximately four percent of the total required system energy. However, in the broader perspective, this plan would constitute one among several planned hydropower projects. If all the existing and planned hydropower projects as well as existing bagasse powerplants contribute to the utility system, approximately 60 percent of the 1990 energy demand could be satisfied. Hence, although the selected plan, as an isolated project, would not be monetarily significant to the consumer, its part in the overall contribution would be significant and would ease the acceleration of rate increases.

The recreational resources would be enhanced by the implementation of an additional visitor area and access by means of a tramway into the river bottom. The project would have a negative aesthetic impact for the reach between the diversion point and the power discharge point. However, a reasonable minimal flow would be retained for the continued aesthetic enjoyment of the Wailua Falls.

The final significant issue, the extent of Federal financial participation in hydropower improvements has not been resolved as of this date. However, the selected plan has been designated as marketable by the Western Area Power Administration and revenues received from the energy produced is expected to be financially fully recoverable by the Federal Government.

EFFECT ON THE ENVIRONMENT

The impacts of the selected plan have been provided in the designation of the alternatives and in the environmental statement. The majority of the effects are related to construction impacts. The significant considerations would be the aesthetic diminution of Wailua Falls resulting from the increased frequency of low flows. The social acceptability of a new man made structure at or near a largely undeveloped site may also be a public concern. The beneficial effects would be greater accessability of the river bottom for recreational purposes and increased appreciation of the river and natural surroundings. There are no endangered or threatened species affected in the project site. Also, there are no listed or nominated sites on the National Register of Historic Sites which would be disturbed from construction activities. There would be diminution of flows on the North Fork Wailua River. Related to this impact is the existence of a small-mouth bass fishery on the North Fork Wailua River. There is expected to be some impact on the habitat. However, the future progress of the fishery and its required riparian habitat remain subjects of definition by the US Fish and Wildlife Service and local interests in post-authorization investigations.

The effects of the selected plan on principal resources and compliance with designated environmental statutes are shown on Tables 19 and 20, respectively. Specific evaluation reports pursuant to the Coastal Zone Management Act, Executive Order 11988, Fish and Wildlife Coordination Act, Endangered Species Act, and the Clean Water Act are provided in Appendix G.

TABLE 19. EFFECTS OF THE SELECTED PLAN ON RESOURCES OF PRINCIPAL NATIONAL RECOGNITION 1/

TYPES OF RESOURCES	UNITS	MEASUREMENT OF EFFECTS
a. Air Quality	Square miles where State air quality classification would change.	Air quality not significantly affected.
b. Areas of Particular Concern (APC) Within the Coastal Zone	Estimates of gains or losses by APC.	No effect to designated APC's.
c. Endangered and Threatened Species Critical Habitat	Acres of each critical habitat affected.	No endangered or threatened species affected; no habitat affected.
d. Fish and Wildlife Habitat	Acres of each habitat affected.	Approximately 20 acres of fish waterways affected on South & North Fork Wailua Rivers.
e. Floodplains	Acres gained or lost.	No change.
f. Historic and Cultural Properties	Number and type of listed or eligible properties affected.	None affected under current inventory.
g. Prime and Unique Farmland	Acres of each farmland type gained or lost.	No long-term impact. Temporary construction affects to 10 acres.
h. Water Quality	Acres of water body where State water quality classification would change.	No change to classification.
i. Wetlands	Acres of each wetland type gained or lost.	No gain or loss of wetlands.
j. Wild and Scenic Rivers	Miles of each river type gained and lost.	None in project area.

1/ Source: 18 CFR 711 (29 Sep 80)

TABLE 20 . COMPLIANCE OF THE SELECTED PLAN WITH US WATER RESOURCES COUNCIL - DESIGNATED ENVIRONMENTAL STATUTES 1/

FEDERAL STATUTE	COMPLIANCE 2/
Archaeological and Historic Preservation Act: 16 USC 469, et seq.	Full: subject to final SHPO and ACHP concurrence.
Clean Air Act, as amended: 42 USC 1857h-7, et seq.	Full.
Clean Water Act (Federal Water Pollution Control Act): 33 USC 1251, et seq.	Full: subject to exemption upon future authorization.
Coastal Zone Management Act: 16 USC 1451, et seq.	Full.
Endangered Species Act: 16 USC 1531, et seq.	Full
Estuary Protection Act: 16 USC 1221, et seq.	N/A
Federal Water Project Recreation Act: 16 USC 460-1(12), et seq.	N/A
Fish and Wildlife Coordination Act: 16 USC 661, et seq.	Full.
Land and Water Conservation Fund Act: 16 USC 460/-460/-11, et seq.	Full
Marine Protection, Research and Sanctuary Act: 33 USC 1401, et seq.	N/A
National Environmental Policy Act: 42 USC 4321, et seq.	Full: subject to filing requirements and coordination under NEPA.
National Historic Preservation Act: 16 USC 470a, et seq.	Full: subject to final SHPO and ACHP concurrence.
Rivers and Harbors Act: 33 USC 403, et seq.	N/A
Watershed Protection and Flood Prevention Act: 16 USC 1001, et seq.	N/A
Wild and Scenic Rivers Act: 16 USC 1271, et seq.	N/A

1/ Source: 18 CFR 711 (29 Sep 80)

2/ Full Compliance: All requirements of the Statute met for the current stage of planning.
Partial Compliance: Some requirements of the Statute have not been met for the current stage of planning.
Non-Compliance: Statute requirement or requirements have been violated; explanation required.
Not Applicable: Specific compliance under the Statute is not required for the current stage of planning.

PLAN IMPLEMENTATION

DIVISION OF FEDERAL/NON-FEDERAL RESPONSIBILITIES

The responsibilities of the Federal and non-Federal interests for the selected plan include the design, construction, financing, marketing, and operation and maintenance of the project. For the purposes of the designation of respective institutional responsibilities, the traditional pre-1978 roles are described herein.

FEDERAL RESPONSIBILITIES

The Federal Government shall design and prepare detailed plans, and supervise construction, costs of which would be included in the total project investment costs subject to reimbursement. All lands, rights-of-way, and structures would be owned in fee simple by the Federal Government. The Federal Government shall assume all costs prior to project authorization (preauthorization studies). Furthermore the Federal Government under the aegis of the Secretary of Energy shall transmit and dispose of power and energy to encourage public utilization. Finally, the Federal Government shall provide for operation, maintenance, and replacement of project features.

NON-FEDERAL RESPONSIBILITIES

As provided in the River and Harbor and Flood Control Act of 1970 (Public Law 91-611), Section 221 states that the construction of any water resources project by the Corps shall not be commenced until the non-Federal interest has entered into a written agreement to furnish its required cooperation for the project.

The non-Federal interest shall agree to participate in cost-sharing and financing arrangements for the project, satisfactory to the President and the Congress; and shall assure minimum flows on the North and South Fork Wailua Rivers, stipulated in the authorizing document for hydropower generation and preservation of esthetic and fishery habitat quality.

SUMMARY OF COORDINATION, PUBLIC VIEWS, AND COMMENTS

During the course of this investigation, coordination was maintained with all relevant County, State, and Federal agencies. The description of activities conducted, list of draft report recipients, transcript of the final public meeting, and pertinent correspondence are contained in Appendix A.

In the initial period of the study from mid-1980 to early 1981, members of private and public organizations were apprised of the Corps' intent to pursue the study of hydropower development and to prepare an environmental impact statement. A Reconnaissance Report describing preliminary schemes, the need, and management schedules and budgets was issued in February 1981. In conjunction with this initial reconnaissance, a public workshop was held on 12 February 1981 in Kauai. Local organizations and individuals expressed considerable interest in the study. The public at-large appeared to be interested in conserving key elements of the environment but at the same time recognized the need to provide greater energy self-sufficiency for Kauai.

In the final stage of investigation, a formal public meeting was held on 28 July 1982 in Kauai. The number of participants of the meeting were almost twice that of the previous workshop. Issues that were raised included the cost of the project relative to private interests, effects of flow diversion on the North Fork Wailua and the Wailua Falls, and the depth impacts in the lower commercially navigable reaches of the river. Supportive statements were received from the County of Kauai, Kauai Electric Division, and Amfac, Incorporated.

The draft report was issued to all relevant public agencies as well as elected officials. Few significant comments were received. Concerns were raised regarding the impacts of the project on the financial capability of local interests, or the riparian habitat of fish, and on the diminution of flow for the South Fork Wailua Falls. Responses to all significant comments were provided and are contained in Appendix A.

The principal local agency which ultimately will be tasked to provide administrative support for the Federal project is the Department of Land and Natural Resources (DLNR), State of Hawaii. The staff of DLNR have been kept informed of the progress of the investigation at various study stages. The Chairman of the Board of Land and Natural Resources has provided a letter of assurance that local interests intend to comply with local cooperation requirements for the project (Appendix A).

CONCLUSIONS AND RECOMMENDATION

CONCLUSIONS

The purpose of this survey investigation, to establish the feasibility of potential hydropower improvements for the Wailua River basin, island of Kauai, Hawaii, has been fulfilled in accordance with applicable statutes and policies. The investigation followed the US Water Resource Council's guidelines for Federal water and related land development studies, Principles and Standards, September 1980. The basic scope of the study was limited to the Wailua River basin and was directed toward small-scale hydropower development.

The study process involved a brief examination of a number of energy development technologies. During the project formulation process, three plans emerged for detailed analysis. Alternatives 1A and 2A were structural plans: conduit-type nonreservoir hydropower improvements located near the Wailua Falls on South Fork Wailua River. Alternative 3 was a nonstructural plan involving principally installation of residential solar hot water system within an overall conservation program.

The bases for the selection of the plan of improvement are the assessment of each plans combined contribution to the national water resources objectives of National Economic Development (NED) and Environmental Quality (EQ) as well as the response to the formulation tests of completeness, effectiveness, efficiency and acceptability. The information developed and assessment conducted resulted in the selection of Alternative 1A.

The selected plan of improvement is a small hydropower facility rated at 5.0 megawatts which would produce 11.28 million kilowatt hours of average annual energy. The plan is economically feasible and competitive with other energy resources. The energy produced would be made available principally to public preference customers. The physical features of the plan would be consistent with the undeveloped nature of the river. The plan is substantially in compliance with applicable environmental statutes.

The plan would effectively utilize the existing natural water resources of the Wailua River and would provide added energy for the island of Kauai. The plan addresses the basic problem of decreasing oil dependency by displacing an equivalent of 24,800 barrels of oil annually. Hydropower, as a technologically mature alternative energy type of development, involves minimal operational and waste disposal problems as compared to most other energy systems. Hence, the plan conforms to the alternative energy development and self-sufficiency goals for the island of Kauai. Finally, the plan of improvement is consistent with the Water Resources Development Plan and the Energy Plan of the State of Hawaii.

RECOMMENDATION

I recommend authorization of a Federal project for hydropower improvements on the Wailua River, Island of Kauai, Hawaii, as described as Alternative 1A of this report, with such modifications as in the discretion of the Chief of Engineers may be advisable, at an estimated investment cost of $8,188,000 and with total estimated annual operation, maintenance and replacement costs of $85,000, and in accordance with cost recovery, cost-sharing and financing arrangements satisfactory to the President and the Congress, that the project power be marketed by the Department of Energy. Further, that authorization for Federal implementation would be without prejudice to completion of actions on license applications under consideration by the Federal Regulatory Commission at the time of authorization.

Alfred J. Thiede — 20 June 1983

ALFRED J. THIEDE
Colonel, Corps of Engineers
District Engineer

Date

FINAL ENVIRONMENTAL IMPACT STATEMENT
WAILUA RIVER HYDROPOWER PROJECT
KAUAI, HAWAII

The responsible lead agency is the U.S. Army Corps of Engineers, Honolulu District. The responsible cooperating agency is the U.S. Fish and Wildlife Service, Pacific Islands Office.

Abstract:

The Wailua River basin is located on the eastern side of the island of Kauai about 5 miles from Lihue, the principal urban center. The Honolulu District, U.S. Army Corps of Engineers has investigated the feasibility of hydropower generation on the South Fork Wailua River. Of the six conceptual plans initially considered, five were selected for detailed study. Three alternative plans have been developed consistent with national and local goals and the primary objective of providing alternative energy resource development. Plans 1A and 2A, the structural alternatives, both consist of conduit hydropower features of hydraulic control and conduit structures, powerplant, electrical equipment and access/maintenance facilities. Both structural plans would divert flow from above Wailua Falls for hydropower generation, resulting in periodic significant decreases in flow over the falls. The diversion structure would pond waters upstream creating an approximately 4-acre pond. The powerplant would be situated approximately 0.1 mile below the falls along the right bank in Plan 1A. In Plan 2A the powerplant site would be located farther downstream in a river bend, requiring approximately 3100 feet of conduit. For Plan 2A the reduction in streamflow would affect approximately 1.7 miles of stream decreasing the amount of aquatic habitat in this reach. Plan 3, the nonstructural alternative, would consist of a combination solar collector/heat exchange system for private residence and volunteer conservation measures by the public in concert with technological and regulatory measures affecting energy use. No federally-listed threatened or endangered species or their habitat would be affected. None of the plans would have significant adverse effects on known archaeological resources or sites eligible for or listed on the National Register of Historic Places. An evaluation of the discharge of fill material for Plans 1A and 2A under Section 404(b)(1) of the Clean Water Act of 1977 indicates that the site and fill material are suitable for this purpose.

Further technical information concerning the statement may be obtained from:

Dr. James E. Maragos
U.S. Army Engineer District, Honolulu
Building 230
Fort Shafter, HI 96858
Telephone: (808) 438-2263/64

NOTE: Information, displays, maps, etc., discussed in the main report and appendices are incorporated by reference in the Final Environmental Impact Statement.

FINAL

ENVIRONMENTAL IMPACT STATEMENT

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LIST OF TABLES

The following people were primarily responsible for preparing this Environmental Impact Statement:

LIST OF PREPARERS

Name	Discipline/Expertise	Experience	Role in Preparing EIS
Paul Mizue	Hydraulic Engineer/Civil Engineering and Water Resources Planning	BS, Civil Engineering MS, Civil Engineering 2 years Hydrology 3 years Program Management 2 years Civil Design 7 years Civil/Hydraulic Engineering with the US Army Corps of Engineers	Study Manager
James E. Maragos	Supervisory Environmental Biologist/ Marine Ecology	BS, Zoology, Ph.D, Oceanography 2 years Post-Doctoral Research 9 years Environmental Consultant 7 years EIS studies with the US Army Corps of Engineers	NEPA Coordinator
Robert Moncrief	Ecologist/Marine Biology	BA, Zoology 7 years Biologist with the US National Marine Fisheries Service 4 years Biologist with the US Navy 4 years EIS studies with the US Army Corps of Engineers	EIS Preparer
David G. Sox	Social Environmental Specialist/ Historical and Cultural Geography	BA, MA, Geography 6 years research 7 years EIS studies with the US Army Corps of Engineers	Social and Cultural Resource Assessment
John I. Ford	US Fish and Wildlife Service, Fishery Biologist/Limnology	BS, MS, Zoology 6 years research 4 years EIS studies with the US Army Corps of Engineers 1 year with US Fish and Wildlife Service	Fish and Wildlife Assessment
James Pennaz	Hydraulic Engineer/Hydraulic Engineering and Design	BS, Civil Engineering MS, Civil Engineering 1 year research 8 years Hydraulic Engineering with the US Army Corps of Engineers	Hydraulic Engineering and Design

1. Summary

a. Major Conclusions and Findings. The alternative plans are described in detail in section entitled "Assessment and Evaluation of Detailed Plans" of the Main Report and Appendices B and C. All three plans meet the primary objective in alternative energy resources development/conservation, contributing to the transition to an indigenous renewable energy economy. On the basis of having the highest annual project benefits, Plan 1A has been designated as the candidate National Economic Development (NED) Plan. None of the plans result in a net positive contribution to the environmental resources of the project area, which is the criterion for designation of an Environmental Quality (EQ) plan. Alternative Plan 3 is considered to be the least environmentally damaging plan because it would require no modification of the Wailua River or other natural environmental features. An evaluation of the effects of the discharge of fill material, in accordance with guidelines set forth in Section 404 of the Clean Water Act of 1977, indicates that the site and fill material are suitable for this purpose. No threatened or endangered species or their critical habitat would be affected by any of the three alternative plans. No known cultural resources eligible for or listed on the National Register of Historic Places would be affected by the proposed alternative plans. Alternative Plan 1A is being recommended based on NED criteria and lack of significant adverse environmental effects associated with it.

b. Areas of Controversy. Based on the public involvement program between January 1981 and the present, no areas of potential or existing controversy have been identified.

c. Unresolved Issues. None

d. Relationship to Environmental Requirements.

The relationship of the alternative plans to Federal and State environmental laws and regulations affecting this study are presented in Table EIS-1.

Table EIS-1.
Relationship of Plans to Environmental Requirements

Federal Statutes	PLAN 1A	PLAN 2A	PLAN 3
Archaeological and Historic Preservation Act	Full	Full	Full
Clean Air Act	Full	Full	Full
Clean Water Act	Full	Full	Full
Coastal Zone Management Act	Full	Full	Full
Endangered Species Act	Full	Full	Full
Estuaries Protection Act	NA	NA	NA
Federal Water Project Recreation Act	NA	NA	NA

Table EIS-1.
Relationship of Plans to Environmental Requirements (Cont)

Federal Statutes	PLAN 1A	PLAN 2A	PLAN 3
Fish and Wildlife Coordination Act	Full	Full	Full
Land and Water Conservation Fund Act	Full	Full	Full
Marine Protection, Research and Sanctuaries Act	NA	NA	NA
National Historic Preservation Act	Full	Full	Full
National Environmental Policy Act	Full	Full	Full
Rivers and Harbors Act	NA	NA	NA
Watershed Protection and Flood Prevention Act	NA	NA	NA
Wild and Scenic Rivers Act	NA	NA	NA
Executive Orders, Memoranda, Etc.			
Floodplain Management (E.O. 11988)	Full	Full	NA
Protection of Wetlands (E.O. 11990)	NA	NA	NA
Environmental Effects Aboard of Major Federal Actions (E.O. 12114)	NA	NA	NA
Analysis of Impacts on Prime and Unique Farmlands (CEQ Memorandum)	Full	Full	NA
State and Local Policies			
State Land Use Plan	Full	Full	Full
Coastal Zone Management Program	Full	Full	Full
Federal Coastal Zone Consistency Determination	Full	Full	Full
State Environmental Policy Act	Full	Full	Full
County General Plan	Full	Full	Full

Notes:

Full--Full compliance, having met all requirements of the statute, E.O. or other environmental requirements for the current stage of planning (either pre- or post-authorization).

NA--Not Applicable, there is no requirement for the statute, E.O. or other environmental requirement for the current stage of planning.

2. Need For and Objective of the Action

a. Study Authority

This report was prepared under the authority of Section 209 of the Flood Control Act of 1962 (Public Law 87-874). This section authorizes the Secretary of the Army, through the Chief of Engineers, to study water and related resources problems and needs in the State of Hawaii. The Honolulu District, U.S. Army Corps of Engineers, was requested to perform investigations for small-scaled hydropower development in the Wailua River, Kauai, by the State of Hawaii. This study is in response to that request.

b. Public Concern

The State of Hawaii is currently, and in the foreseeable future, will continue to be almost wholly dependent upon imported petroleum products for generation of power in the public utility system. The potential and technology for the development of power from water resources, although in existence in the islands, have not been fully assessed nor utilized. Currently, the State of Hawaii derives more than 90 percent of its energy from petroleum. Combined transportation (air, ground, and water) is by far the largest energy user, which accounted for 58 percent of the 1978 total. About one quarter of the State's petroleum consumption is for electricity generation. In 1979, consumers in the City and County of Honolulu (Oahu) used 83 percent of the State's total electricity, while consumers in the counties of Hawaii, Maui, and Kauai used, 7, 7, and 3 percent, respectively. Currently, there are seven principal hydroelectric plants operating in Kauai. They are operated by sugar plantations for their own industrial operations. Their total installed capacity is 7.9 megawatts (Mw), producing an average energy of 46.8 million kilowatt-hours (kwh) per year. Hydropower accounted for 7 percent of Kauai's electricity generating capacity and 14 percent of the publically-consumed electricity generated on the island in 1981.

The State Energy Plan was recently developed by the State Department of Planning and Economic Development. The basic objective in alternate energy resources development described in the State Energy Plan is to "accelerate the transition to an indigenous renewable energy economy by facilitating private sector activities to explore supply options and achieve local commercialization and application of appropriate alternate and energy technologies." Among the recommended actions is implementation of the Wailua River Hydropower Project. The Corps of Engineers is the lead organization for this action with the assistance of the State Department of Land and Natural Resources.

c. Planning Objectives

(1) National Economic Development (NED). The NED objective is the protection and enhancement of national economic development measures by contribution to the value of the National output of goods and services.

(2) Environmental Quality (EQ). The EQ objective is the protection and enhancement of environmental quality as measured by favorable changes in the ecological, cultural and aesthetic attributes of natural and cultural resources.

3. Alternatives Considered

a. Plans Eliminated from Future Study

(1) New Dam/Reservoir and Hydropower Plant. A dam and reservoir system consists of a dam to store water, outlet structures to regulate flow, and powerplant. The powerplant may be located at the base of the dam or further downstream to obtain the necessary head. Power generated by a dam and reservoir system is generally dependable provided there is sufficient reservoir storage capacity. Storage type hydropower facilities have been previously proposed for Kauai for the Kokee (1964) and Waialeale (1978) studies. Both facilities although based on multipurpose benefit evaluation, were financially costly and were not implemented. Due to insufficient flows both facilities required reservoirs and very long penstock to develop the power.

For Kauai and the Hawaiian Islands in general, erosion has changed the topography of the islands from huge, gently sloping volcanoes to dissected and incisioned cliffs, valleys and basins. The topography of many of the drainage areas is characterized by relatively steep stream courses and steep, rugged basaltic formations. As a result, the streams generally do not meander and traverse through alluvial areas. Characteristic of Hawaiian topography, impoundment of sufficient volumes for stable hydropower releases would require very massive dam structures, which would be very difficult to economically justify and finance. Environmental and social impacts associated with massive dam structures and impoundments could also make this alternative untenable. For these reasons, this potential solution was deleted from further consideration.

(2) New Conduit Hydropower Diversion and Powerplant.

As a result of renewed interest in hydropower since 1977, various Federal agencies including the Corps of Engineers, the Department of Energy and the Federal Energy Regulatory Commission have implemented studies, grants, technical documents and demonstration projects which address small scale hydropower facilities. Conduit hydropower systems have several advantages over other energy technologies. These include less massive physical modifications and disturbance to natural conditions; minimum utilization of prime agricultural, industrial or urban lands; less initial capital expenditures and institutional frameworks already established for governmental review and evaluation processes.

The Reconnaissance Study for small-scale hydropower conducted under current investigations proposed four preliminary conduit system alternatives.

Scheme 1. This alternative considered the construction of a low head diversion structure and intake at invert elevation 310 feet (msl) on the South Fork; a 36-inch diameter penstock totalling approximately 12,000 feet; and a powerplant and appurtenant facilities downstream from Wailua Falls. The effective head for this scheme would be about 260 feet. The powerplant will house two turbines, one with 50 cubic feet per second (cfs) design flow and 940 kw capacity and the other with 133 cfs design flow and 2,430 kw capacity. Annual energy generation is estimated to be 7.79 million kwh. Power transmission line would be approximately 2.5 miles.

Scheme 2. This scheme would involve the construction of an intake at the existing low head diversion dam near the confluence of Waiahi Stream and South Fork; a 42-inch diameter penstock of approximately 21,000 feet; and a powerplant and appurtenant facilities upstream from Wailua Falls. The effective head for this scheme would be about 145 feet. Design flows for the two turbines would be 50 cfs and 133 cfs with capacities of 500 kw and 1,400 kw, respectively. Annual energy generation is estimated to be 4.25 million kwh. Transmission would be approximately 3.5 miles.

Scheme 3. Under this scheme, facilities include a diversion structure near gaging station 620 and a 6,000-foot open channel to convey a maximum flow of 100 cfs from the North Fork to the South Fork; an intake at the existing low head diversion dam near the confluence of Waiahi Stream and South Fork; a 60-inch diameter penstock approximately 25,000 feet long; and a powerplant downstream from Wailua Falls. The effective head for this scheme would be about 360 feet. Sensitivity analyses for the installation of various numbers of turbines were examined and the concept of two turbines was found to be most cost effective. Design flows for the two turbines would be 125 cfs and 328 cfs, with capacities of 3,200 kw and 8,500 kw, respectively. Annual energy generation is estimated to be 25.18 million kwh. Power transmission line would be about 2.5 miles long.

Scheme 4. Scheme 4 would be basically the same as Scheme 1 with the exception that a diversion structure near gaging station 620 and a 6,000-foot open channel would be built to carry a maximum flow of 100 cfs from the North Fork to the South Fork. As a result, design flows for the turbines would be increased to 125 cfs and 328 cfs, and the capacities would be 2,300 kw and 6,100 kw, respectively. The diameter of penstock under this scheme would also be increased to 60 inches. The average annual energy output is estimated to be 18.7 million kwh.

Subsequent to the completion of the "Reconnaissance Report for Hydroelectric Power, Wailua River" in January 1981, more detailed photogrammetric surveys revealed rough terrain in the area of the potential penstock alignment. The planning initially considered penstocks lengths totaling 12,000 feet (Schemes 1 and 4) and 21,000 feet (Schemes 2 and 3).

An ideal penstock alignment would maintain a positive hydraulic gradient and minimize losses resulting from excessive horizontal and vertical grade changes. However, the assessment of the originally conceived penstock would involve considerable tunneling, excavation, and bridging over gulches or steep river banks. As a result, the prior four schemes, although sound in principle, were judged impractical and necessitated additional project formulation.

(3) During reformulation analysis two basic alternative plans were developed. These plans are described below under paragraph c, Plans Considered in Detail. Both plans were considered with and without provisions for additional flow via diversion from the North Fork Wailua River. The two plans that did not include additional flow from the N. Fork diversion were determined to result in substantially lower net benefits. Therefore, they were not included in the final array of alternative plans.

b. Without Condition (No Action)

The without condition assumes the absence of any action to address the planning objectives. In this case, local government agencies or private enterprise would assume the responsibility for implementation of hydropower or other renewable alternate energy resources available to the island of Kauai.

c. Plans Considered in Detail

(1) Nonstructural Measures. Plan 3, the nonstructural alternative, consists of a combination solar collector/heat exchange system for residences in Kauai and volunteer conservation measures by the public in concert with technological and regulatory measures affecting energy use. This plan has been designated the Least Environmentally Damaging Plan because it would require no modification to the Wailua River or other natural environment features.

Solar collector/heat exchange systems are currently operational for commercial and residential use. The attractiveness is based on several factors. First, the Hawaiian Islands have the highest insolation (incoming solar radiation) rate in the United States. Also the seasonal variability due to its low latitude is relatively minimal. Second, installation is financially attractive to individual consumers. Offsetting a portion of the current high-cost energy in a solar collector/heat exchange systems would result in a fast-return financial investment. Also there currently exists considerable tax savings by the State of Hawaii and Federal tax credit programs. Third, the savings to the individual homeowner's energy bill is made more attractive by the high proportion of the bill that is attributable to hot water heating.

Among current non-fossil fuel measures, solar collector/heat exchange system remains a practical and realistic technology, presently experiencing a highly visible implementation program. Public awareness has been generated through commercial enterprises, State-sponsored education programs, and continued legislative support.

(2) Structural Measures. Two alternative plan layouts were analyzed for potential hydropower generation on the South Fork Wailua River. Both plans consist of the basic conduit hydropower features of hydraulic control and conduit structures, powerplant, electrical equipment and access/maintenance facilities.

Alternative Plan 1A:

Alternative Plan 1A has been designated as the National Economic Development (NED) Plan and is also the tentatively selected plan. This plan involves a low, 13.5-foot high, 200-foot wide concrete diversion structure located approximately 300 feet upstream of Wailua Falls. The structure would be an overtopping spillway constructed to withstand the effects of a Probable Maximum Flood. Streamflows exceeding the conduit capacity would pass downstream. Under design conditions, the diversion would pond water upstream to an approximate elevation of 255 feet (msl). The intake would include a trash rack upstream from the conduit connector, and a sluice gate for debris cleanout. For the purpose of initial estimates, the design flow was established as equalling the 10% value of the flow duration curve. The design flow includes additional waters diverted from the North Fork Wailua River via the Stable Storm Ditch to augment flows available for hydropower development and to provide sufficient downstream flows for native fisheries. A 560-foot long, 108-inch diameter reinforced steel conduit pipe would be constructed along a semi-oval shaped route below the left side of the Wailua River (looking upstream), around Wailua Falls. At the terminus of the conduit, water would flow into a concrete headbox. Excess flows entering the headbox would be discharged into the river. The penstock would consist of a 72-inch diameter steel pipe. The pipe would be supported by anchors and supports along its 282-foot length.

Flows would enter the powerplant, to be located on the right bank of the Wailua River approximately 75-yards below Wailua Falls. The powerplant would be sized for 5.0 Mw, and would operate in the range of 65 to 390 cfs with a two-turbine system. Actual powerplant housing would require excavation into the side walls of the river channel. The floor of the powerplant would be set above the 500-year flood elevation.

The tailrace would be a trapezoidal-shaped, riprap lined channel approximately 30 feet long which would exit into the river. Access to the powerplant from the ridgeline road would be made possible by tramway system. A new access road would be constructed to the upstream diversion structure.

Electrical transmission lines would connect directly to the Kauai Electric Lydgate Substation located near Lydgate State Park.

In order to divert additional flows from the North Fork, Wailua River, structural changes would be necessary to the Stable Storm Ditch diversion. To supplement flow by 100 cfs, the existing 150-foot long culvert would be replaced by a 220-foot 5H' x 4V' box culvert. The existing USGS gage 620 weir will be depressed by one foot to allow additional flows into the Stable Storm Ditch.

Alternative Plan 2A:

The intake structure for this alternative would be functionally the same as that for Plan 1A; however, flow would be diverted through a 3,100-foot long, 108-inch concrete pipe conduit from the left streambank (looking downstream). The powerplant, designed for 5.6 Mw, would be located approximately 1.7 river miles below Wailua Falls. The tailrace from the plant would be approximately 500 feet long. An existing jeep trail would be improved to serve as the access road for the powerplant. Flow would be diverted from the North Fork as proposed in Plan 1A.

d. Comparative Impacts of Alternatives

Comparative impacts of the three alternative plans are presented in Table EIS-2, and additional comparison of alternative plans is contained in Table 18 of the Main Report.

TABLE EIS-2
COMPARATIVE IMPACTS OF ALTERNATIVES ON SIGNIFICANT RESOURCES

SIGNIFICANT RESOURCES	BASE CONDITION AND ALTERNATIVES						
	WATER QUALITY	AQUATIC RESOURCES	ENDANGERED SPECIES	PRIME AGRICULTURAL LANDS	CULTURAL AND HISTORICAL RESOURCES	RECREATIONAL AND AESTHETIC RESOURCES	FOREST RESERVE
Base Condition	Lower reaches within Wailua State Park are designated as Class Ia waters under the State DOH Water Quality Stds. Middle and upper reaches of S. Fork Wailua River are Class 2 inland waters protected for fish and wildlife propagation, agricultural, and industrial water supply and recreation.	Aquatic fauna above Wailua Falls is dominated by introduced species including small mouth bass and chinese catfish. Below the falls, a number of native diadromous species occur.	No listed or proposed species known to occur in immediate project area. The endangered Hawaiian coot, gallinule and duck inhabit the lower reaches of the Wailua River.	Lands adjacent to the Wailua River in the vicinity of the project area are classified as prime agricultural lands.	There are no historic resources listed on the National Register of Historic Places within the proposed project area. Potentially significant historic resources include an old railroad bridge 200 ft upstream of Wailua Falls and agricultural terraces in the lower river reach.	Recreational and aesthetic resources in the Wailua River area include a small mouth bass fishery, picnic and swimming area within Wailua River State Park and the scenic Wailua and Kaholalele Falls.	The Kalepa Forest Reserve has been classified by the State Division of Forestry as an exotic non-commercial forest, possessing less than 50% native cover. The forest is characterized by exotic trees including maole koa, guava, lantana, Christmas berry and Java Plum. Other intorduced tree species, planted for erosion control by the Division of Forestry, include eucalyptus, iron wood, monkey pod and paper bark. Much of the eastern flank of the reserve is grassland.
Without Condition	No anticipated change in existing condition.	No anticipated change in existing condition.	No anticipated change in existing condition.	No anticipated change in existing condition.	No anticipated change in existing condition.	No anticipated change in existing condition.	No anticipated change in existing conditions.
Plan 1A	Temporary increase in water turbidity both in the project area and downstream during project construction. No long-term effect on stream water quality.	Temporary increase in sedimentation of stream habitat. Increase in area of pool behind falls of 4.4 acres as a result of diversion dam. Possible reduction in small mouth bass habitat below the water diversion on the N. Fork. Flow reduction diversion on 0.1 mi. stream reach. A corresponding reduction in habitat is anticipated along this reach.	No effect.	Approximately 1 acre of prime agricultural land woul1 be disturbed during construction of the conduit. Lands would be restored to previous use subsequent to completion of the project.	No effect on possible RR bridge. Effects on unknown site along powerline corridor in Kalepa Ridge.	Increase in preferred small mouth bass habitat with potential increase in recreational bass fishery. Possible reduction in bass habitat below the diversion on the N. Fork. Temporary disruption of Wailua Falls viewing area during project construction. Long term intermittent effect on Wailua Falls resulting from hydropower water diversion above falls.	The transmission line alignment would require clearing of trees within a 30 foot wide corridor transecting the forest. (Figure 16 Main Report). Areas planted for erosion control would not be affected.
Plan 2A	Same as Plan 1	Same as Plan 1 except that approx 1.7 miles of stream would be affected by reduced stream flows.	No effect	Approx 9 acres of prime agricultural land would be disturbed during construction of the conduit. Lands would be restored to previous use subsequent to completion of the project.	No effect on RR bridge. Possible adverse effect on agricultural terraces and other unknown sites along powerline corridor.	Same as Plan 1.	Effects would be similar to Plan 1A. The distance across the Forest Reserve area with this alignment is slightly longer. (Figure 17 Main Report). It would also affect an area planted with beach box and eucalyptus for erosion control on the eastern margin of the forest reserve.
Plan 3	No effect	No effect	No effect	No effect	No effect	No effect	No effect

4. Affected Environment

Environmental Conditions

a. Environmental Setting

Kauai, the northernmost of the eight major Hawaiian Islands, is 103 statute miles west and slightly north of Honolulu. The roughly circular island is fourth largest in land area with 549 square miles. The study area is located in the Lihue and Kawaihau districts. The upper Wailua basin is primarily in agricultural use or forested, while the lowlands are sparsely populated and developed. The Lihue-Kawaihau area comprises the most populous area of Kauai. It is fairly heavily urbanized along the coastal plain and includes the towns of Lihue, Anahola, Hanamaulu, Kapaa, Kealia, and Wailua. Of the total area, however, state-classified Urban lands comprise only 7.3 percent, Rural lands comprise 2.7 percent, Conservation lands comprise 13.2 percent, and Agricultural lands 76.8 percent.

b. Physical Features

The island of Kauai is the summit of one of the principal volcanic mountains of the partially submerged Hawaiian range. This range extends for a distance of 1500 miles across the Pacific Ocean floor. Kauai has a complex geologic structure as a result of volcanic activities, separated by intervals of erosion and decomposition combined with faulting. The climate of the Wailua River basin is relatively mild and uniform in temperature, but due to the extreme topographic variation within the watershed, rainfall ranges from less than 50 inches per year at the coastal zone to more than 460 inches per year at Mount Waialeale. Mean monthly temperatures in the coastal area range from 69°F to 77°F.

The Wailua River basin (Figure 3, Main Report) is located on the eastern side of the island of Kauai. The pear-shaped basin is about 53 square miles in area and extends 11 miles from the ocean to the 5000-foot summit of Mount Waialeale.

Principal tributaries to Wailua River are the North and South Forks, and Opaekaa Stream. The North and South Forks merge into Wailua River about 2 miles from the ocean and drain areas of 20 and 26 square miles, respectively. Opaekaa drains an area of 6.4 square miles and discharges into the Wailua River about 0.5-mile upstream of the rivermouth. At the headwaters, the average slope of the tributaries exceeds 1000 feet per mile, while in the central portion the average slope varies from about 30-70 feet per mile. The lower reach of Wailua River has an average slope of about 10 feet per mile.

c. Geology

The bounding ridges of the Wailua River basin consist of eroded Pliocene lavas of the Napali formation (MacDonald, Davis and Cox 1960), which are considered part of the original dome. These lavas are highly permeable and confined much water to high elevations. The floor of the Lihue depression is believed to have been formed by the collapse of the dome on the eastern portion of the island. Headwater tributaries of the North and South Fork Wailua River indent the west wall of the depression forming deep and relative short gorges. About two miles upstream from the terminus, the Wailua River is incised in Pleistocene lava flows that overflowed the depression. The gap carved by the river between Kalepa and Nonou ridges marks the remains of the east wall of the depression. West of the gap, the headward erosion of waterfalls in both the North and South Forks has entrenched the lower reaches in 200 - 300 foot deep gorges.

Soils which form the stream channel and banks have been described only as rough, broken lands and rock outcroppings (USDA 1973). Kolokolo clay loam and Kolokolo extremely stoney clay loam also are found along a major portion of the stream course. Soils in the terminal reach of the stream are principally stream-laid gravel, sand and silt. This alluvium underlies the bottom lands along the Wailua estuary.

The transverse profile of the Wailua River watershed shows an average rise in elevation along the South Fork of only 70' per mile from the sea to the headwall. The precipitous headwater regions and broad, gradually sloping plain is characteristic of relatively older, well weathered stream valleys in Hawaii.

d. Human Resources

In the decade since 1970, islandwide population levels have grown somewhat faster than anticipated, rising from 29,524 in 1970 to 39,082 in 1980 according to the 1980 Census. The island population had been anticipated to grow at an average annual growth rate of about 2.1 percent to a projected level of 36,500 in 1980 compared with an actual rate of 2.8 percent. This compares to an average statewide increase of 2.3 percent per year. The island population is now projected to increase to about 40,600 by 1985, 46,500 by 1990, 53,100 by 1995, and 60,400 by the year 2000. The population levels of the Lihue-Kawaihau districts, which surround the study area, also rose faster than previously projected to a 1980 high of 19,112, about 2,400 more than previously projected. The greatest growth in the County occurred in the Hanalei District which rose over 125 percent during the past decade.

e. Land Use

Land use on Kauai is characterized generally by forest land covering the fairly rugged interior, with small concentrations of urban development scattered along the coastline, and agricultural development (predominantly sugarcane) in a belt adjacent to the ocean. There is neither urban use nor agricultural use on the rugged northwest coastline. The major land use, constituting over half of the island's area, is forest, forest reserve, and recreation. Agricultural use accounts for another approximately 1/3 of the island. The remainder, less than 10% is in urban and urban-related uses. This pattern of land use is generally the same for the State of Hawaii as a whole with the exception that Oahu, the major population center is more urbanized than the "neighbor islands" of Hawaii, Molokai, Lanai, Maui, Niihau, and Kauai. As with the rest of the neighbor islands, Kauai's land use tendencies give the island a rural, agrarian flavor.

The Wailua River basin is approximately equally divided between conservation and agricultural land use districts. Small portions in the lower reaches adjacent to the river are designated as rural and urban districts. The agricultural use is predominantly large-scale sugarcane cultivation.

f. Land Ownership

The lands in the upper watershed of the Wailua River basin are divided between the ownership of the State of Hawaii and Lihue Plantation, Inc. Portions of State lands utilized for existing sugarcane agriculture are also leased to Lihue Plantation Company, Ltd., an industrial company involved in irrigation, production, and processing of sugarcane. The parent company is Amfac, Inc., a diversified commercial, development, and agribusiness enterprise. A limited area including lands in the lower watershed and at the mouth are under private ownership. Approximately four miles of the lower North Fork Wailua River on high ground are properties of the Wailua Homestead Lots.

g. Economic Development

Until recently, sugar was the mainstay of Kauai's economy. At its peak, eight sugar plantations on Kauai produced over one-fifth of the State's total sugarcane yield. Pineapple was at one time a major sector of the Kauai economy, but has not been cultivated since the closing of the county's last cannery in the early 1970's. The largely agrarian base of the island's economy has changed with the surge in tourism in the past decade. Sugar is still a major economic base, but tourism is now the island's leading industry.

The urban area of Lihue is the center of economic activity in the county, with the two major transportation facilities, Lihue Airport and Nawiliwili Harbor, located nearby. Plans for airport expansion exist in anticipation of continued growth in interisland traffic. There are also petroleum storage facilities situated in the Lihue area.

Major employers in the island's economy are the visitor industry and agriculture. Other important employers are Federal, State, and County governments, as well as commercial and business services.

h. Wildlife Resources

Three species of endemic waterfowl, the Hawaiian coot, gallinule and duck are found in the Wailua River basin. The coot and gallinule have been observed in the upper reaches of the South Fork above the proposed project site but occur most commonly below the convergence of the North and South Fork and in adjacent taro fields. All three birds are listed endangered species. Other water birds associated with the river system include the black-crowned night heron and cattle egret. Non-water bird avifauna include the shama, melodious laughing-thrush and northern cardinal within the hau thicket bordering the streams. Western meadowlark, ring-necked pheasant and spotted dove are associated with the canefields and open pasturelands within the river basin.

Mammals within the Wailua River basin include dogs, cats, feral pigs, cattle, horses, rats and mongoose. No wetlands, wildlife sanctuaries or refuges occur within the proposed project area.

The entire watershed of the South Fork Wailua River is dominated by sugarcane cultivation. Only the headwaters lie in steep, heavily forested areas. The dominant riparian vegetation along the South Fork Wailua River are exotic species (hau, guava, kukui, California grass, Java plum). Indigenous plants such as tis, gingers, and a variety of ferns and mosses are also common along the stream.

Significant Resources

The determination of significance for environmental resources is based on previous environmental studies in the area, resources identified in laws, regulations or other institutional standards including Section 122 of the Rivers and Harbors Act of 1970 (P.L. 91-611), and resources specifically identified as a concern by public interests. After assessing environmental resources in or adjacent to the project area based on the above criteria, six resources were identified as being significant or potentially significant: (a) water quality; (b) aquatic resources; (c) endangered species; (d) prime agricultural lands; (e) cultural and historical resources; (f) recreational and aesthetic resources and (g) forest reserve areas.

a. Water Quality

The terminal and lower reaches of the Wailua River which fall within the boundaries of the Wailua River State Park have been designated Class 1.a. waters by the State of Hawaii, Department of Health Water Quality Standards. The objective of this classification is to protect waters in their natural state as nearly as possible with an absolute minimum of pollution from any human-caused source. Uses to be protected in Class 1.a. waters include scientific, educational, compatible recreation, aesthetic enjoyment and other nondegrading uses. The middle and upper reaches of the South Fork Wailua River are Class 2 inland waters protected for fish and wildlife propagation, agricultural and industrial water supplies, and recreation. The State of Hawaii does not regularly monitor river water quality, and there is a lack of recent data which describes the physical and chemical environment of this river system. The principal factors influencing water quality in the South Fork Wailua are the activities associated with large scale sugarcane cultivation: soil erosion, water diversion and stream dewaterment, channel modification (causeways, culverts and fords) and leaching of agricultural chemicals. A system of diversion dams, intakes and ditches exports a significant volume of flow from both the North and South Fork Wailua. Although average residual flow downstream exceeds 16 cfs, minimum flows approached zero during the lowest flow on record (October 1953).

b. Aquatic Resources

The aquatic fauna above Wailua Falls is dominated by introduced species which come from both Asia and continental North America, including the smallmouth bass, Chinese catfish, and the wild guppy. Along with the bass and catfish, the less abundant bluegill sunfish provides a sport and subsistence fishery on Kauai. The middle and upper reaches of the river are devoid of native Hawaiian fishes or mollusks; however, diadromous mountain shrimp has been found above the lip of Wailua Falls. The introduced Tahitian prawn occurs uncommonly above the falls. A significant number of native, diadromous species occur in the stream below Wailua Falls. Apparently, because of the geological configuration of the face of Wailua Falls, most diadromous species are not able to ascend beyond the falls and thus do not inhabit the middle and upper reaches of the river. Those that do are subject to intensive predation by smallmouth bass and bluegill.

c. Endangered and Threatened Species

Three listed Endangered Species, the Hawaiian coot, gallinule and duck, are found in the Wailua River basin. The coot and gallinule have been observed in the upper reaches of the South Fork above the proposed project site but occur most commonly below the confluence of the North and South Fork Rivers and in adjacent taro patches. The Hawaiian duck is also most common in the lower reaches of the river. According to the U.S. Fish and Wildlife Service, Office of Endangered Species, no listed or proposed species have been observed in the immediate project area.

d. Prime Agricultural Lands

Prime agricultural lands are defined as those which have soil quality growing season and moisture needed to produce sustained high yields of crops economically managed in accordance with modern farm techniques. The extensive sugarcane lands bordering the South Fork Wailua River are classified as prime agricultural lands by the State of Hawaii, Department of Agriculture.

e. Cultural and Historical Resources

There are no historic properties in the area of potential environmental impact currently listed or eligible for listing on the National Register of Historic Places. The area downstream of Opaeka'a Falls between and east of the Nounou-Kalepa Gap was known in ancient times as Wailuanuiho'anu (or "great sacred Wailua") and was known traditionally as one of the most sacred places on the island. The eight prehistoric Hawaiian heiau (temples), Pu'uhonua o Hauola (Place of Refuge of Hauola), petroglyphs and birthplaces of various mythical personages have caused this area to be designated a National Historical Landmark. Historical and archaeological surveys conducted in the project's area of potential environmental impact have not revealed any significant sites. A 1968 survey for the Wailua River State Park and a 1981 investigation for the Corps identified several agricultural terraces and an irrigation canal (auwai) near the site of the Plan 2A powerplant, but these features had been previously destroyed by modern agriculture in the actual zone of proposed construction. Another agricultural terrace complex, called Makea in 1896 lies intact--mainly subsurface--east of the Plan 2A powerplant. The two surveys also suggested that a legendary underwater cave known as Kawelowai might have been located about 800 to 1,500 feet above the Wailua Falls. The cave was not located. About 200 feet above the falls is an abandoned railroad bridge that was constructed by the Lihue Plantation Company between 1900 and 1910 and was in operation until 1957. Nothing remains of the railway. By itself the bridge has little historic significance, but as an integral part of the development of Wailua River State Park recreational facilities above the falls, the bridge take on greater importance. No prehistoric or historic properties were located along the Stable Storm Ditch. Historic property surveys have yet to be conducted along the right-of-way for the powerline which would connect the powerplant under either Plans 1A or 2A and the Lydgate Park substation near the coast. When the exact route of the powerline is established following selection of a plan, archaeological field surveys will be conducted during post-authorization engineering studies. For greater detail see Appendix H.

f. Recreational and Aesthetic Resources

Major portions of both structural plans lie within Wailua River State Park. The Park encompases, 1,113 acres of deep river gorges, outstanding waterfalls, a navigable estuary with the popular Fern Grotto, and Wailuanuiho'ainana, an ancient Hawaiian sacred zone around the estuary boasting many heiau (temples), and habitation sites. Since the late 1960's, visitor attendance to the Park has increased from 20 percent of the total statewide park attendance to a 30 percent share in 1981, about 4,432,000 visits. Of this figure an estimated 350,000 may travel up County Road 583 to view the 190-foot high Wailua Falls. Of those coming to the Falls, perhaps 25 percent climb down the river bank to walk around the upper Falls area during lower flow periods. Fewer climb down the arduous and precipitous cliff to the pool area, below the falls, which is a popular swimming spot during low flow. Approximately 30 percent of 17 miles of the South Fork Wailua River above the falls is an unimproved smallmouth bass fishery controlled by Lihue Plantation Company. Access is generally limited to plantation workers and their families who frequent the small slack water pools and rapids along the stream. The recreational smallmouth bass fishery also exists on the North Fork Wailua. The extent of this fishery on the North Fork has not been documented. However, the State Division of Aquatic Resources regards it as an important part of the total recreational resource. The 1970 Wailua River State Park Plan recommends development of the stream above and below the Falls for a horse stable and swimming/picnicking, respectively. The park plan also recommends development of a lagoon east of the Alternative 2A powerplant site where water-oriented recreational activities would occur.

g. Forest Reserve Areas

The Kalepa Forest Reserve extends from Hanamaula north to the Wailua River in a narrow strip approximately 1 mile inland from the coast. It has been classified by the State Division of Forestry as an exotic non-commercial forest, possessing less than 50% native cover. The forest area is characterized by exotic trees and shrubs including haole koa, guave, lantana, Christams berry and Java plum. In recent years considerable acreage along the western flank of the forest, originally grasslands, has been planted with several species of eucalyptus, ironwood, monkey pod and paperbark trees to control erosion. Some of these reforested areas may eventually produce commercially harvestable trees.

5. Environmental Effects

a. Water Quality

Both structural alternatives would result in short-term impacts to stream water quality. Construction activities including access roads, excavation and placement of fill material in the water would increase sedimentation of the river in the project area. Water turbidity would increase correspondingly both in the project area and downstream. The introduction of potentially toxic substances such as petroleum products from construction machinery would be a hazard during construction. Upon completion of the construction phase, sedimentation would diminish and eventually achieve preproject conditions. Based on observations at existing run-of-the-river (new conduit) hydropower plants on Kauai, no long-term effects such as thermal stress from powerplant effluent are anticipated. Alternative 3 would have no effect on stream water quality.

b. Aquatic Resources

Structural alternatives 1A and 2A could result in temporary degradation of productive habitat for native species below Wailua Falls due to increased sedimentation from construction activities. Displacement or destruction of aquatic fauna resulting from excavation, transport and placement of fill material in the water during construction of diversion and intake structures and outlet channel would be additional anticipated short-term effects. Measures which could be practicably employed to minimize construction related adverse effects on aquatic resource are as follows:

(1) Construction in the water and along the channel walls would be scheduled during June-September, the months of least rainfall.

(2) During construction of the diversion structure and conduit, allowance must be made to provide continuous streamflow downstream of the construction.

(3) Dredged and excavated material should be removed from the stream channel and not be temporarily stockpiled in the water.

(4) Movement of heavy construction equipment in the stream should be avoided or minimized.

Long-term impacts associated with Alternative Plans 1A and 2A include partial diversion of the stream causing reduction of flow below the diversion structure, alteration of normal seasonal flow regimes, subsequent habitat reduction and population decline of indigenous and exotic fauna inhabiting the lower stream course between Wailua Falls and the powerplant outfall. Approximately .1 mile and 1.7 miles of stream, for Alternative Plans 1A and 2A, respectively, would be affected by the diversion. The effects of partial dewaterment will be significantly reduced by supplementing existing flow with water diverted from the North Fork. The diversion structure would be designed to allow the continuous discharge of a conservation flow (minimum flow) of 10 cfs. Streamflows of less than 10 cfs and greater than 400 cfs would also pass through the diversion structure. The structure would also have the capability of allowing periodic passage of flows between 10 - 400 cfs when necessary to flush sediment accumulation from the lower stream course and to accommodate spawning requirements of the native fishery resources in the lower reaches of the South Fork.

The diversion structure above the falls will create an approximately 5-acre impoundment behind the diversion dam. Some of the riparian vegetation in this area will be submerged by the increased water level. The pool will provide additional habitat for the smallmouth bass fishery above Wailua Falls. Diversion of water from the North Fork Wailua River via the stable storm ditch could result in the loss of smallmouth bass habitat below the diversion.

Alternative Plan 3 would have no effect within the Wailua River watershed on aquatic resources.

c. Endangered and Threatened Species

Three species of endangered Hawaiian waterbirds, the gallinule, coot, and duck occur in the wetlands surrounding the terminal estuary and botanical garden. Of these, the Hawaiian duck (Koloa) has been observed infrequently in the reach of the Wailua River that will be affected by the proposed action. However, no adverse effects on the Koloa or other listed species resulting from any of the three hydropower project are anticipated.

d. Prime Agricultural Lands

Alternative Plan 3 would have no effect on prime agricultural lands. Alternative Plan 2A would require a 3100-foot conduit, 467-foot long penstock and 500-foot long access channel. A portion of Alternative Plan 1A conduit would traverse existing cane lands.

Reinforced concrete pipe would be used for the conduit. For Alternative Plan 2A, the conduit alignment would traverse approximately 2800 feet of sugarcane fields owned by Lihue Plantation. The pipe would be buried using a cut-and-cover technique to minimize stockpiling of excavated soil. The excavation would cut a swath approxmiately 140 feet wide through the sugarcane, affecting almost 9 acres of cane land. Lihue Plantation would be fully compensated for the resultant loss of crops. This would be a "one-time" temporary impact. Once the backfilling was completed the lands would be restored to their former use for sugarcane cultivation. Similarly, about one acre of Alternative Plan 1A land would be affected.

The tailrace of Plan 2A (outlet channel) would affect approximately 1 acre of pastureland. The outlet channel would consist of a 500-foot long 72" buried reinforced concrete pipe. Following construction, the area would be grassed and accessibility would be provided.

e. Cultural and Historical Resources

The impounded pool created by both Plans 1A and 2A above the diversion barrage could permanently inundate the mythical Kawelowai underwater cave above the falls. The abandoned 19th Century railroad bridge would not be adversely affected by any of the structural plans. Post-authorization planning for recreational use of the above-falls project features could result in adaptive use of the old bridge by such measures as stringing a walkway through the bridge to span the river. Construction of the powerline from the Plan 2A powerplant eastward to Lydgate Beach Park substation may adversely affect the agricultural terrace complex known in 1846 as Makea (Ching's Site 205, see Appendix H). The right-of-way for a powerline under both Plans 1A and 2A may also affect unknown historic properties in the Kalepa (Ridge) Forest Reserve, east of Wailua River.

f. Recreational and Aesthetic Resources

The recreational smallmouth bass fishery on the South Fork above Wailua Falls will not be adversely affected by any of the alternative plans. There is a possibility that the impoundment area behind the intake structure will enhance this fishery, creating additional preferred habitat and fishing area for bass. On the North Fork, diversion of water via the stable storm ditch to the the South Fork, would result in the loss of smallmouth bass habitat below the diversion.

Both structural alternatives will have short and long-term adverse effects on Wailua Falls, a popular tourist destination. Short-term effects would occur during construction of the intake structure for both Alternative

Plans 1A and 2A. Alternative Plan 2A would include construction of the conduit, penstock, powerplant and outlet structure, all in the vicinity of the falls.

Construction and operation of the powerplant under Plan 2A near the meadow that is proposed for long-range development as a lagoon by the Wailua River State Park plan could have a disruptive effect on the landscape and recreational activity carried out there. If the park plan is implemented, placement of powerlines and poles across the proposed lagoon would be disruptive. (see Figure H-3 in Appendix H).

A construction staging area would most likely impinge upon the existing visitor parking area and probably extend into the adjacent cane lands. Access roads and a tramway would be constructed to the project sites above and below the falls. Construction related traffic would impact the already limited access to the Wailua Falls overlook via the improved cane road. An alternative viewing site would be provided for visitors during construction but it is unlikely to have the same good view as the present site. Visitor frequency could diminish as much as 25%, depending on the degree to which visitors are warned in advance of the construction activities. Construction of this phase of the project would require 18 months. After completion of the project, restoration of the area would include improvements to the parking lot and viewing area and permanent trails accessing the diversion structure above the falls, and powerplant below the falls which could be utilized by visitors. An improved viewing area with permanent railing could also be incorporated in the plan. It is anticipated that, with these improvements, visitors frequency would increase due to easier and safer access to the stream above and below the falls. The hydropower generating facility may itself attract visitors. The diversion structure would be situated far enough back from the falls that it would not be visible from the visitor overlook. Similarly, the conduit would be buried and the penstock and power plant situated enough distance below the falls to be hidden from view at the lookout.

Long-term effects on this recreational/aesthetic resource would result from the diversion of water above the falls. The proposed powerplant design would limit plant operation to periods during which flows exceed 75 cfs. Flows less than 75 cfs, occurring approximately 50% of the time, would not be diverted. Flows in excess of 400 cfs would remain in the stream above the falls and contribute to the total volume of water over the falls approximately 2% of the time. Flows over the falls would be reduced to 10 cfs by the proposed project approximately 26% of the time during periods in which streamflows are between 75-400 cfs. The degree of loss of aesthetic appeal resulting from reduction of water flowing over the falls would be difficult to evaluate. However, during periods in which flows are reduced to 10 cfs as a result of the hydropower diversion, the visual impact of the falls would be far less spectacular than with greater flows under natural conditions. The significance of this impact can be related to the importance of Wailua Falls compared to other scenic waterfalls on Kauai and the other major Hawaiian Islands. The 1978 State Data Book lists 26 major named waterfalls in the State of Hawaii, Kauai having the largest number with eight. Major falls are defined as being at least 250 feet in height. Most of the waterfalls are defined as cascades with the highest on Kauai being Waipoo (800 feet for two falls). The highest sheer-drop waterfall on Kauai is Hinalele. Both falls are not readily accessible by automobile nor can they be easily seen from a distance. The most accessible falls are Wailua and Opaekaa Falls, 160 feet and 120 feet in height, respectively. Both these falls are close to each other and close to hotels in Wailua area. Both falls can be easily observed from overlooks with parking facilities which are part of the Wailua River State Park system. Access to the streambed above and below the falls is available only at Wailua Falls. Only the upper falls streambed can be reached safely. For the island of Kauai, Wailua Falls may be considered the most significant waterfall because of a combination of height, average discharge volume, and most importantly, accessibility. There are equally spectacular falls and cascades on Kauai and other islands, particularly, the island of Hawaii, but most of them must be viewed from a least a distance of several miles or more.

g. Forest Reserve Areas

A corridor approximately 30 feet wide would be subject to selective removal of trees and other high vegetation along the transmission line alignments. Only vegetation that could come in contact with the power lines would be affected. The length of these corridors through the Kalepa Forest Reserve is approximately 2000 feet, the alignment for Plan 2A being slightly longer (Figures 16 & 17 of the Main Report). The alignment for Plan 1A would not affect any areas planted for erosion control. The alignment for Plan 2A passes through two areas on the eastern margin of the forest reserve planted in bush box and eucalyptus for erosion control.

h. Resources and Values Identified in Section 122 of Public Law 91-611

Project related impacts on the environmental resources and values identified in Section 122 of P.L. 91-611 have been fully considered. Potential adverse impacts upon these resources resulting from project implementation are summarized below and in Table EIS-2.

(1) Air, Noise and Water Pollution. Air, noise and water pollution would be temporary impacts during construction of hydropower facilities. Effects on water quality have been discussed in paragraph a of this section. Minimization of these impacts would be effected by employment of construction methods that do not create excessive dust, hydrocarbon emissions, noise or turbidity. Environmental protection procedures and controls would be included in the project plans and specifications to insure compliance with applicable air, noise and water pollution regulations during construction operations.

(2) Man-made or natural resources, aesthetic values, community cohesion and availability of public facilities and services: The project would not affect man-made resources, community cohesion and the availability of public facilities and services. Project effects on natural resources and aesthetic values have been discussed in the preceding paragraphs of this section.

(3) Employment effects and tax and property value. Adverse employment effects and tax or property value losses would not result from implementation of the project.

(4) Displacement of people, businesses and farms. Implementation of project alternatives would not result in the displacement of people, businesses or farms.

i. Unavoidable Impacts

(1) Partial diversion of stream for hydropower generation would cause a reduction of flow between diversion structure and powerplant tailrace during periods of powerplant operation. This would result in a reduction in aquatic habitat in the affected stream reach. However, the diversion structure would allow for continuous conservation flow of 10 cfs during plant operation.

(2) Diversion above the falls would affect the scenic/aesthetic values of Wailua Falls. During plant operation flows over the falls would be significantly reduced.

(3) During construction, temporary disruption of 9 acres (Plan 1 A) or 1 acre (Plan 2A) of prime agriculture land would occur.

(4) Short-term increase in silt load in stream waters adjacent to and downstream of the project site during project construction.

(5) Temporary degradation of productive habitat for native aquatic species below Wailua Falls due to increased sedimentation from construction activities.

(6) Disruption of the unimproved visitor parking and viewing areas at Wailua Falls would occur during construction of the project as a result of increased noise, dust and construction-related traffic.

j. Impact Mitigation

Although most of the proposed project impacts cannot be avoided altogether, many can be reduced or minimized by prudent construction practices and timing of the construction phases.

By limiting movement of heavy construction equipment in the stream, removing dredged and excavated material from the stream channel, and scheduling construction activities in the water or along the channel banks and walls to the months of least rainfall (June-September), degradation of the stream habitat can be greatly reduced.

Proposed improvements to the visitor parking and viewing area, including a visitor information center, would lessen or partially offset impacts in the vicinity of the falls, resulting from project construction activities.

6. Public Involvement

a. Public Involvement Program.

Detailed documentation of the public involvement process for this study is contained in Appendix A of the final report. A brief summary of this program is provided below. A notice of intent to prepare a Draft Environmental Impact Statement for the study was published in the Federal Register on 5 January 1981. An initial scoping meeting was held in early January with representatives of various Federal and State government agencies to identify significant issues, determine the extent of analysis required and define problems, opportunities and areas that may be affected by the project. An informal public workshop was conducted 12 February 1981 on Kauai to inform and discuss with the public the current planning status and afford local government agencies and interested individuals and organizations an opportunity to express their views.

After the draft report and EIS were circulated to Federal and local government agencies and interested citizens, a formal public meeting was held on 28 July 1982 in Lihue, Kauai, to obtain the public's views on the alternative plans. The meeting was well attended by the general public, government agencies and private entities. The overall tenor of the meeting appeared favorable. There is no opposition to the study or unresolved issues.

The draft Interim Survey Report with Enviromental Statement was issued to relevant governmental agencies for review on 30 June 1982. Notice of the report was provided in the Federal Register on 16 July 1982 (47 FR 137) and the comment period was scheduled to terminate on 30 August 1982. Several concerns were raised in response to the report. The State of Hawaii Department of Land and Natural Resources were concerned about the financial impacts to the sponsoring agency and impacts on a sport fishery located on the North Fork Wailua River. The US Environmental Protection Agency (EPA) expressed reservations on maintenance of water quality, on the impacts to the aquatic environment during low flows, and compliance to Section 404 guidelines. The US Department of the Interior commented on the aesthetic values and scenic quality of the Wailua Falls. Supportive statements were received from the Mayor, County of Kauai; the Governor, State of Hawaii; and the Chief Officer of the State of Hawaii Department of Land and Natural Resources. The balance of the responses received from agencies were without significant comment.

This Final Interim Survey Report and Environmental Statement has been submitted by the Division Engineer, Pacific Ocean Division to the Corps' Board of Engineers for Rivers and Harbors for final review and further processing.

b. Required Coordination.

(1) Coordination was initiated with the U.S. Fish and Wildlife Service at the inception of the study to fulfill the requirements of the Fish and Wildlife Coordination Act (FWCA). A preliminary report was submitted by FWS on 30 January 1981 describing fish and wildlife resources in the project area, and was utilized as a planning aid during the study. A preliminary FWCA report was submitted in June 1982 which evaluated impacts of various alternatives and made recommendations on mitigation and reducing impacts. The final FWCA report was submitted on 3 September 1982, addressing potential project impacts and appropriate mitigation measures. The final FWCA report is contained in Appendix G of the Survey Report.

(2) Endangered species coordination with the FWS Endangered Species Office was completed in August 1980.

(3) Coordination with the State Historic Preservation Officer (SHPO) has been initiated. A cultural reconnaissance survey was conducted and report submitted in April 1981. Determination of Effect based on survey findings was forwarded to SHPO for review and concurrence in June 1982.

(4) A coastal zone consistency determination report is provided in Appendix G of the Main Report and has been submitted for review to the State Coastal Zone Management Office. The consistency evaluation summarizes the project's conformance with the policies of the Hawaii State Coastal Zone Management Program.

(5) The US Environmental Protection Agency and the State Department of Health have reviewed the Draft Survey Report and Draft Environmental Impact Statement (DEIS) to evaluate the effects of the project on water, air and noise quality. EPA comments are included in Appendix A of the Report.

c. Statement Recipients. A list of agencies, groups and individuals who received copies of the combined Draft Environmental Impact Statement and Draft Survey Report for review is provided in Appendix A of the report, along with all letters of comment.

d. Public Views and Responses. An informal public workshop was held on 12 February 1981 during which the public was given the opportunity to comment on the progress of plan formulation activities and the tentative plans being carried into more detailed evaluation. Organizations represented included the U.S. Fish and Wildlife Service, Soil Conservation Service, Kauai Electric Company, Kauai Community College, Sierra Club, Lihue Plantation, and Kekaha Sugar Company. Although there were no formal statements presented, there were many informal views shared on several issues. Important items raised were the need to consider a large storage structure, possibility of increasing diversions to the Wailua River drainage area, and the evaluation of impacts on aesthetics and stream habitat.

In further compliance with the intent of the National Environmental Policy Act (NEPA), a second EIS scoping meeting was held during the same week as the public workshop. The scoping meeting was held on 13 February 1981 at the County Civil Defense Headquarters, Lihue, Kauai. A letter was issued to significant organizations and individuals prior to the meeting. The purpose of this meeting was to give local island of Kauai interests and officials an opportunity to participate in the EIS process. Personnel at the meeting included representatives of County and State agencies, the U.S. Fish and Wildlife Service, and Lihue Plantation. Significant issues included concern for effect on the electric rates and beneficiaries, the potential turbidity effects in the stream, the protection necessary for native stream life and aesthetic impacts.

A public meeting was held to obtain the public's views on the alternative plans, after circulation of the draft report and EIS. Public views and concerns expressed at that meeting and written comments received during the review period are contained in Appendix A of the Survey Report.

TABLE EIS-3. INDEX, REFERENCES & APPENDICES

WAILUA RIVER HYDROPOWER
WAILUA, KAUAI

WAILUA RIVER HYDROPOWER PROJECT
KAUAI, HAWAII

PUBLIC INVOLVEMENT

APPENDIX A

APPENDIX A

PUBLIC INVOLVEMENT

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PUBLIC INVOLVEMENT PROCESS

OBJECTIVES

1. The public, as broadly interpreted by the U.S. Army Corps of Engineers, is any affected or interested non-Corps of Engineers entity; other Federal and state government entities and officials; public and private organizations, and individuals. In this study, the public participation program was directed to maintaining information flow, achieving a mutual understanding and acceptance of the problems and opportunities, and attainment of interest level for proper decision making. Without an active program, a well-formulated and socially acceptable solution would not have been achieved.

2. The objectives of the public participation program were:

a. To inform citizens of the current Corps of Engineers planning process and direction.

b. To surface key planning issues and concerns so that they are given full consideration.

c. To help formulate and review potential plans of improvement.

d. To offer technical, historical, and localized information pertinent to the study.

e. To provide a communicative forum between the Corps, local agencies, advocacy groups, and interested citizens on the subject plan and problems.

TECHNIQUES

3. The types of public participation forums in this study were small meetings, workshops, formal meetings, and correspondence.

a. Informal Meetings. These meetings were of less than 10 persons with specific invited agency personnel, group representatives, or citizens. These meetings were undertaken at various intervals throughout the study, usually in conjunction with site visits to help the planners obtain information and address certain issues.

b. Workshops. These meetings were informal exchange sessions numbering from 10 to 50 persons. The purpose was to promote the full airing of various views in recognition of current Corps' planning efforts. Public information fact sheets were issued to interested parties prior to the meetings.

c. Public Meeting. A public meeting was held at the key point in the study effort. The purpose was to notify all interested parties of the planning effort to date and to obtain views of the various items on the agenda. The meeting, presided by the District Engineer, included a summary of findings to date, an informal question and answer period, a presentation of formal statements of others, and tentative conclusions. A public notice of the meeting was issued to the media and to the general public.

d. Correspondence. Government agencies, other organizations, and individuals were invited to submit comments during various phases of the reporting process.

ACTIVITIES CONDUCTED

4. Study Announcement. The initiation of survey investigations was publically announced to interested public agencies, special interest groups and individuals on 24 June 1980.

5. Interim Inter-Agency Meetings. During the period February 1980 through December 1980, Corps representatives were active participants in the inter-agency Committee on Small Hydroelectric Power Systems, sponsored by the Department of Planning and Economic Development (DPED), State of Hawaii. Members of this committee included representatives of the sugar industry, utilities, the State university, the State water resources and energy agencies, and the Corps. Considerable information was exchanged regarding the status and plans of the various entities in the field of hydropower development.

6. Notice of Intent and Initial Scoping Meeting. A Notice of Intent to prepare a Draft Environmental Impact Statement and to conduct a project scoping meeting was issued 11 December 1980 for publication in the Federal Register (Noticed in 46 FR 1005, 5 Jan 81). All interested agencies and the public were invited to attend. The initial scoping meeting was held 5 January 1981 at the offices of the Honolulu District, U.S. Army Corps of Engineers. Representatives of the U.S. Fish and Wildlife Service, National Park Service, U.S. Geological Survey, State Fish and Game, State Parks, State Division of Water and Land Development, and the Corps were in attendance. Potential project impacts to sports fishery, to instream flows, and recreational/ aesthetic opportunities were brought to attention.

7. Reconnaissance Report. The initial report describing the need, justification, and schedule of activities for the Wailua River investigation was issued to the Corps' Office of the Chief of Engineers (OCE) on 5 February 1981. Approval of the report was granted 20 February 1981. Subsequently, the report was made available for information to the public agencies and the general public.

8. Public Workshop. A public notice was issued on 19 January 1981 announcing a public workshop for the study. The workshop was held on 12 February 1981 at the Kapaa Neighborhood Center, Kapaa, Kauai. The purpose of the informal meeting was to obtain local information which would aid the formulation and evaluation of plans. The meeting, presided by the project engineer, elicited considerable responses from the 25 persons in attendance. Organizations represented included the U.S. Fish and Wildlife Service, Soil Conservation Service, Kauai Electric Company, Kauai Community College, Sierra Club, Lihue Plantation, and Kekaha Sugar Company. Although there were no formal statements presented, there were many informal views shared on several issues. Important items raised were the need to consider a large storage structure, possibility of increasing diversions to the Wailua River drainage area, and the evaluation of impacts on aesthetics and stream habitat.

9. Final Scoping Meeting. In further compliance with the intent of the National Environmental Policy Act (NEPA), a second EIS scoping meeting was held during the same week as the public workshop. The scoping meeting was held on 13 February 1981 at the County Civil Defense Headquarters, Lihue, Kauai. A letter was issued to significant organizations and individuals prior

to the meeting. The purpose of this meeting was to give local island of Kauai interests and officials an opportunity to participate in the EIS process. Personnel at the meeting included representatives of County and State agencies, the U.S. Fish and Wildlife Service, and Lihue Plantation. Significant issues included concern for effect on the electric rates and beneficiaries, the potential turbidity effects in the stream, the protection necessary for native stream life and aesthetic impacts.

10. Public Meeting. A formal public meeting was held on 28 July 1982 at the Wilcox Elementary School Cafetorium, Lihue, Kauai, presided by the District Engineer. The combined draft Interim Survey Report and Environmental Statement was issued to public agencies prior to the meeting. The transcript of the meeting is contained within this appendix. The meeting was well attended (39 signees, excluding Corps personnel) by the general public, government agencies and private entities. Represented were personnel from the County of Kauai, the State of Hawaii Department of Land and Natural Resources, the State Public Utilities Commission, Kauai Electric Division (KED), Amfac, and Lihue Plantation. Two persons provided formal written testimony, Mr. Alton Miyamoto, Engineering Manager for KED, and Mr. E. W. Broadbent, Vice President of Amfac, Incorporated. Each were supportive of the Corps project planning. Mr. Miyamoto, however, expressed a reservation that KED would prefer to control all energy output in lieu of offering preferential rates to governmental and public entities. Mr. Broadbent indicated that the project is worthy of further consideration but added as presently formulated, the project would not be financially attractive for private investment. A local resident of the North Fork Wailua River area, Mr. Frank Marrero was concerned about impacts on the flow regime, construction noise and activities of the South Fork Wailua and the North Fork Wailua. Two other persons, including Mr. Walter Smith of Smith's Motor Boat Service were concerned if the plan would significantly impact the depths near the boat excursion area. The overall tenor of the meeting appeared favorable. There was no opposition to the study nor any unresolved issues raised.

11. Comments on Draft Report. The draft Interim Survey Report with Environmental Statement was issued to relevant governmental agencies for review on 30 June 1982. Notice of the report was provided in the Federal Register on 16 July 1982 (47 FR 137) and the comment period was scheduled to terminate on 30 August 1982. Several concerns were raised in response to the report. The State of Hawaii Department of Land and Natural Resources were concerned about the financial impacts to the sponsoring agency and impacts on a sport fishery located on the North Fork Wailua River. The US Environmental Protection Agency (EPA) expressed reservations on maintenance of water quality, on the impacts to the aquatic environment during low flows, and compliance to Section 404 guidelines. The US Department of the Interior commented on the aesthetic values and scenic quality of the Wailua Falls. Supportive statements were received from the Mayor, County of Kauai; the Governor, State of Hawaii; and the Chief Officer of the State of Hawaii Department of Land and Natural Resources. The balance of the responses received from agencies were without significant comment.

12. Power Marketing Agency Coordination. In conjunction with the Western Area Power Marketing Administration's work effort for their Power Marketing Study (Appendix F), several informal meetings were held 22 to 23 September 1982 at the Lihue Plantation conference room, Lihue, Kauai. The meetings were

conducted by Western personnel through the assistance of the Office of the Mayor, the County Council of the County of Kauai, and Lihue Plantation. The purposes of the meetings were to obtain public views on the sale of energy and the views of specific public organizations for power and energy demand related to the potential establishment of public preference entities. The public organizations and individuals attending the meetings and related briefings expressed optimism for the need and use of alternative energy system. The officials of the local utility, KED, repeated their preference that all energy developed should be under their direct control.

13. Final Report. This Final Interim Survey Report and Environmental Statement has been submitted by the Division Engineer, Pacific Ocean Division to the Corps' Board of Engineers for Rivers and Harbors for final review and further processing.

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TRANSCRIPT

WAILUA RIVER HYDROPOWER IMPROVEMENTS
28 JULY 1982

LTC SPRAGUE: It looks like we have a fairly good size representative group here. We may have a few more come in. Welcome to the Corps of Engineers public meeting on hydropower improvements for the Wailua River here on Kauai. I am LTC Ken Sprague. I am the Honolulu District Engineer which is part of the Pacific Ocean Division of the Army Corps of Engineers and both the District and the Division are located at Fort Shafter, Hawaii. Our purpose here tonight is to get your reactions and your comments to our Draft Interim Survey Report and Environmental Statement which this volume is a copy of. There are two copies here in the library that are available for public use and we brought three copies along with us tonight that are available at the conclusion of the meeting if someone has a need for them.

Our agenda this evening is to present the background of the study and go through the current investigation and, after that presentation, we will have an opportunity for any of you to give an oral presentation or, if you want to submit something in writing at this time, you can. In order for us to make a record of this, we have a verbatim transcript being made of the meeting so we make sure we get your concerns on record which will become part of the final report when it's done. To assist us, we have asked you all to fill out one of the blue cards. Frank Rezac is standing there in the middle and if you don't have a blue card he will provide one for you. On this card we ask if you would like to make a statement; that is just to help me with the organization of the meeting. But, if after you fill it out and you have indicated that you don't want to speak, later on if you do want to you will get an opportunity. This, as I say, is just to help me organize this meeting. We are using a portable recording system to assist in making the verbatim transcript so, when it comes time to speak or to ask questions, I ask that you come forward, state your name and, if you represent an organization, the name of the organization and then make your statement using the microphone so we can have the benefit of that clearly and concisely for the final report. The final transcript will be made available at a later date. We have some handouts up here at the front table that are available to you. One is the Notice of the Public Meeting if you didn't happen to be informed by this means. It has a brief synopsis of what we are going to do and a map showing the area on the back. There is a syllabus from this large report which pretty much synopsizes the information we are going to present tonight. There are plenty of copies of those available. In addition, we have a booklet on "Hydropower, the Role of the Corps" (meaning the Corps of Engineers). And finally, an engineer publication, "How US Army Corps of Engineer Projects are Conceived, Authorized, Funded and Implemented" and it tells how this type of project, along with all the others, fits into the scheme of things with Congress.

I would like to acknowledge any public officials we have here this evening. The cards I have so far indicate we have Mr. John Ford from the US Fish and Wildlife Service. John's the other uniformed member present tonight. And we have Mr. Don Heacock from the Division of Aquatic Resources, Department of Land and Natural Resources from the State. Do we have any other public officials, either elected or appointed? Alright, from the Department of Transportation, State of Hawaii, we have Mr. Carl Forsen. Do we have any other public officials? Well, I would like to introduce my staff. The one you see active now, Frank Rezac, is the Chief of the Public Affairs Office. The one that's the busiest tonight is Linda Tomlinson. She is responsible for this verbatim transcript to make sure we have everything accurate. And then finally we have Mr. Paul Mizue who is the project engineer and who will make the meat of the presentation this evening. Are there any questions on how we are going to conduct the meeting? OK. Paul.

MR. MIZUE: Thank you LTC Sprague. Before I get further into the background and current status of the project, I would like to review the general nature and conduct of our survey investigations conducted under the Corps of Engineers. I will be discussing this feasibility type of investigation and also the general nature of the project by means of slides. If any of you fail to understand what I say or can't hear what I say, please raise your hand and I will try to speak more clearly or more loudly.

The Corps of Engineers Civil Works Program is geared primarily toward the traditional roles of navigation, flood control and shore protection. However, hydropower is now considered the top priority type project as far as new investigations. Within each of these major areas, we perform a variety of functions as shown by the following slides. Of course, right now we are in the planning and design stage. We are performing these functions for other types of projects. And, unlike other Federal grant agencies like EPA, HUD or Commerce, the Corps performs most of its investigations through its own in-house personnel rather than through contract.

Now, implementing a water resources project through the Corps of Engineers process requires a number of steps shown above. We have to go through a number of Congressional authorization stages. We have already achieved a study authorization and study appropriation. We are attempting at this stage to achieve project authorization. The large red circles you find up there indicate where Congress gets involved. Provided we hurdle all the necessary environmental, institutional and technical requirements, the report will be submitted to Congress for final action. So you can see that there is a significant amount of work that has been done and there will be more action in the future.

The Corps of Engineers water resources types of investigations follow the national water resources objectives of National Economic Development and Environmental Quality. Every project that is submitted to Congress for authorization is scrutinized at various levels for institutional, economic, and environmental acceptability. And, unless there are significant overriding factors involved, such as possible loss of life, the project must have more dollar benefits than dollar costs.

Now let's get into more of the Wailua River Hydropower Study. The basic study authority that we are working under is the River and Harbor Act of 1962 commonly known as the Harbors and Rivers in Hawaii authority. This authority provides the Corps of Engineers a basis for wide range of water resources activities in the State of Hawaii, including hydropower. And, in conjunction with this, I will give you a short rundown of past activities in which we have entered in accordance with this authority. Many of you have attended several presentations that we conducted approximately five years ago. Under this same study authority, we initiated a statewide hydropower study in 1976. A public meeting was held right here in Wilcox School in March 1977 considering several sites on Kauai. However, based upon the accepted economic evaluation procedures at the time, the study did not result in any feasible projects.

Currently, we are initiating and are in the intermediate stage of the Wailua River Hydropower study begun in June 1980. In conjunction with the reconnaissance portion of the study, we held a public workshop in Kapaa in February 1981. And, during this stage, we looked at a variety and a number of schemes; however, following that time they were deemed to be infeasible.

Later, in March 1981, we started the final planning activities and the results are shown in the draft survey report that LTC Sprague mentioned. Now the basic study problem we have shown in the above slide is to alleviate oil dependence in energy production and in turn the realization of greater energy self-sufficiency for Kauai. One of the means would be to effectively utilize the island's water resources through hydropower development.

Of course, you are familiar with this, the island of Kauai. The Wailua River basin is shown in green. The island's total land area is approximately 550 square miles of which the Wailua River basin is approximately 52 square miles or about 10 percent of the total land area. And, within the Wailua River basin it is divided into major tributaries. The tributary which is being considered in this study, the most strongly, is the South Fork portion of the Wailua River basin. It's approximately 26 square miles or about one half the entire drainage area of the Wailua River basin.

The following slides show a number of different scenes around Kauai which you may be familiar with. This shows the current Wainiha River diversion dam located on the north part of the island. This is part of the Wainiha penstock and this shows the Wainiha powerhouse, I believe. The Wainiha powerplant is one of the largest energy producers for hydropower for the State of Hawaii and certainly the largest here on Kauai. It produces approximately 26 million kilowatt hours a year. It runs almost full blast all the way through the year. This is the interior; two Pelton 1.8 megawatt units each. And, you are familiar with this in town. This is the new 20 megawatt Lihue Plantation bagasse plant exterior. This is an interior shot. This is a portion of the existing Wailua River basin looking up toward the mountains, a portion of the South Fork area. And, of course, this is Wailua Falls. These pie charts are shown in the survey study report. The intent of this was to show the relative differences between the United States as a whole and the island of Kauai.

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As you can see there, the (I'm not sure you can make it out) oil and hydro. Oil is indicated by red, hydro by blue. They contribute approximately 11 percent of the total energy production of utilities in the nation. This is as of 1980. Nuclear is also about equal to oil and hydro. As of 1980, oil served approximately 80 percent of the electric utility system of Kauai. There was also portions purchased energy, bagasse and hydro amounting to about 12 percent. So obviously, Kauai is still pretty heavily dependent upon oil, Kauai Electric that is. This is a schematic map of the Kauai Electric system. The yellow lines indicate the existing major transmission lines and the solid squares indicate sugar plantation powerplants, either bagasse or hydro and also the petroleum powerplants of Kauai Electric. Each of the four sugar plantations have both bagasse-fueled powerplants and the hydropower plants and the excess energy not required to service their processing needs are transferred to Kauai Electric for general public use.

As of 1980, approximately 22 percent of the sugar plantation-developed energy was purchased by Kauai Electric. I think it's substantially increased now since the 20 megawatt plant of Lihue Plantation is on-line.

Now in our general investigation we looked at various alternative solutions to alleviation of energy in Kauai. Some of these have to be considered in terms of overall energy planning. Most of these were generally dismissed. And all the schemes were eliminated except for conservation or solar hot water heating and hydropower. I won't go further into the explanation of each one of the alternatives. If you are interested, I will explain later in the discussion. Now the following slides and several other slides that follow later are from the Corps of Engineers' national study known as the National Hydropower Study. So, some of them really apply to large scale dam and reservoir facilities but, in principle, most of the information is applicable to hydropower in general.

Now, the three principal forms of conventional hydropower types are storage, run-of-river and also a variant of run-of-river known as conduit hydropower. This schematic drawing was also shown in the report. Basically, in the storage type you need a large reservoir area, a large dam, a relatively short penstock, a large dam and a powerhouse. Now, all hydropower facilities require some means of capturing and controlling the water and I have attempted to show the differences between the three major types by the coloring, the retaining structures are shown in yellow. Now, the amount of power is directly proportional to the two factors of discharge and head. Water conveyance features, such as a penstock, are needed to transport the water to the powerhouse. The turbine and generator converts the kinetic energy of falling water to usable electrical energy.

This is a typical run-of-river type used on many locations on the Mainland. In this case, the powerhouse is usually located right below the dam. The significant feature is that usually the water level is constant and there usually is a large amount of water.

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Contrast this with the typical conduit type which is the prevailing type in Hawaii. There is usually an off-stream open channel which diverts the water to an area where there is a steep drop. The penstock brings the water down to the powerhouse. The difference between the typical conduit type and the typical run-of-river type is that the conduit type takes advantage of a large head and relatively low discharge, whereas, in contrast, the run-of-river type is predominantly large discharge and low head. All things equal, they can produce the same amount of power.

I am not sure whether you can read all of the numbers here but this slide shows the major entities or participants in hydropower development in the nation. As you can see, the Corps of Engineers is the dominant agency as far as production of electrical energy in the country, producing (as of 1980) approximately 63 billion kilowatt hours of energy at 66 different sites. The utilities, however, had the largest capacity amounting to 23,000 megawatts. And among Federal agencies, the Corps of Engineers, of course, is the largest, exceeding that of the Bureau of Reclamation and the Tennessee Valley Authority.

Now, one of the major reasons for consideration of hydroelectric power is that, first of all, it offsets use of scarce fuel. We all know that. It's a very competitive cost in relationship to other major forms of power development. These costs are somewhat dated although you can see from the relative numbers there. The environmental costs are relatively understood and predictable as contrasted with nuclear, coal or other forms of energy production. There is no thermal pollution, no waste disposal problem and no air pollution.

Also, it takes advantage of the strong industrial base. Hydropower is a relatively old technology. No new significant research is required similar to other alternative forms of energy. In fact, it's at 100-year old industry. The first US hydropower plant began operations on September 30, 1882 in Appleton, Wisconsin. And I believe the first Corps facility was constructed in 1909. So, although in the past, the technology of hydropower has not been fully taken advantage of, it's getting stronger and stronger as a result of higher fuel costs.

So, to summarize, hydropower offsets scarce fuels, it has competitive costs, the environmental costs are relatively understood and it makes use of a strong existing industrial base.

Now what sort of hydropower solutions did we consider in this particular study? We looked at, on a cursory basis, retrofitting at existing sites meaning installation of hydropower plants at dams, at existing dams, new conduit facility and new dam and reservoir. Now retrofitting was thrown out because of lack of suitable existing dam sites. New dams and reservoir were deleted because, basically, as demonstrated in the State's Waialeale Study, the construction and potential environmental costs would be very large. And the basis of this entire investigation was geared primarily toward small hydropower facilities.

Now, what sort of general steps did we take in the plan formulation process? We wanted to be compatible with existing criteria; technical, economic, environmental and institutional. To minimize costs, we wanted to minimize the water conveyance structures. To achieve the largest amount of power, we wanted to maximize the elevation difference or drop and make use of the maximum amount of flow. Relatively simple but, basically, it takes some work in order to develop acceptable technical concepts.

To summarize, we came out with three basic alternative plans as shown in the syllabus. Two are hydropower facilities, obviously plans which could involve Corps of Engineers' activity. The third is a nonstructural plan required under our planning guidance. We are required to address the nonstructural planning alternatives. The first one, 1A, involves a diversion dam and powerplant near the Wailua Falls. Plan 2A involves a diversion dam and powerplant located further downstream. And Plan 3 is a solar conservation plan.

The following general information is available in your syllabus handouts. I won't bother repeating detailed information, but basically, the concept of Plan 1A shows, I'm not sure whether you can see this clearly but, near the Wailua Falls would be located a diversion dam approximately 300 feet above the falls, a powerplant located further downstream approximately 500 feet from the falls and the water would be routed around the falls dropping into the powerplant. The long yellow leg shows the transmission line back to an existing substation of Kauai Electric. The main features of Plan 1A would involve a diversion dam located above (repeat requested by attendee of the basic plan of Plan 1A). This the essence of Plan 1A.

Plan 2A is similar in concept although it involves different features. The location of the diversion dam is similar, located approximately 300 feet above the falls; however, the route of the conduit open channel flow portion cuts across further downstream here on the left bank. The powerplant is located downstream approximately 9,000 feet from the falls, in terms of this waterway length. The electrical energy is transmitted to the same location, down to the Lydgate substation. The advantage of this plan would be a larger available head and subsequently a larger amount of power although the cost would be significantly increased because of the larger waterway length. Here you can see it's a relatively short waterway length from the diversion dam to the powerhouse, whereas, in this case, it's a relatively long waterway length.

<u>UNIDENTIFIED ATTENDEE</u>: How long would you say?

<u>MR. MIZUE</u>: Well, in this case here, 2A, it's about 9,000 feet basically if <u>you go</u> along the stream length but I think it's about 3,000 feet if you cut across this bluff area here.

<u>UNIDENTIFIED ATTENDEE</u>: What's the difference in head?

<u>MR. MIZUE</u>: I think, in this case here, it's approximately 220 feet and in <u>the other</u> case approximately 180 feet. In both plans the diversion from the North Fork, we plan to increase the diversion capability so that the water

from the North Fork can flow through the Stable Storm Ditch into the South Fork system. This existing Stable Storm Ditch would remain unimproved except for the short portion of the conduit right up here and also improvement of the diversion portion.

I don't have a schematic for Alternative 3, but Alternative 3 basically was taken off the 1981 study of the Department of Planning and Economic Development known as the "Hawaii Integrated Energy Assessment." Here we have the year 1990 and 1995. Conceivably, on Kauai, we could save a relatively large amount of energy through simple use of greater conservation measures combined with greater appliance efficiencies provided we still have government support for these endeavors. In another portion, we computed that amount which would be contributed by installation of solar panels for solar hot water systems. You can see that by 1990 it is conceivable that we could achieve about 10 million kilowatt hours of savings on Kauai alone.

Now to summarize the plan contributions, Plan 1A has a capacity of 5.0 megawatts producing approximately 11 million kilowatt hours. Alternative 2A has a capacity of 5.6 megawatts with almost 14 million kwh. And Alternative 3 does not involve any particular energy production although the conservation developed could be on the order of 10 million kwh. That is 1990. 1990 is the date for which we use as a basis for the evaluation of the hydropower plants.

<u>UNIDENTIFIED ATTENDEE</u>: Why?

<u>MR. MIZUE</u>: Why? Because we felt that was a reasonable date for which this <u>could be</u> implemented. We know for a fact, as I mentioned earlier in the program, that Corps of Engineers' projects are not developed and designed and constructed overnight. We know it takes an amount of time. We figured that 1990 was a reasonable amount of time to go through the authorization process and additional engineering studies and to construction. It's the power-on-line date.

Now, in the entire planning process, we considered these major issues and constraints. Of course, I went through dependence on petroleum-based powerplants. All of our plans would contribute to decreased dependence on petroleum based sources of energy and, depending upon the plan, the number of barrels of oil displaced could amount to as much as 20,000 to 30,000 barrels annually.

In terms of recreational and aesthetic resources, Alternative 1A would tend to add a certain intangible recreational value by providing a visitor viewing area near the diversion dam as well as access into the river area.

Alternative 2A would similarly provide a visitor area; however, the access to the falls would not be provided immediately below the falls but approximately a mile downstream.

Concerning the aesthetics, both hydropower plants would result in increased frequency of low flows between the diversion point and the tailrace. However, there will remain a conservation flow in the river, as noted in the report, of 10 cfs. During our very high flood stages, the effect on the falls would be negligible. The conservation/solar plan being not related to the river improvements, would not have any impact upon the recreational and aesthetic resources.

Now, the third plan listed above: the potential consumer impacts. The actual impacts upon the consumer utility bills would probably be very small if this is the sole consideration. The rate structure would continue to be under the jurisdiction of the State Public Utilities Commission and a project will not change this existing institutional framework. The proportion of the projected energy demand in 1990 would be relatively small for all three plans - on the order of 3 to 5 percent of the required energy output. However, it's important to be aware that every increment of nonfossil fuel energy produced or conserved is vitally important to this island.

I neglected to mention the last point, the Federal financial participation. As you know, under the current Reagan administration, there has been increased budgetary concerns and there has been increased emphasis upon local participation and action for water resources projects. In the past, for Corps projects, the hydropower portions of the multipurpose projects have been almost entirely Federally designed, constructed, and financed. However, the Corps is looking toward a greater role in local financial participation. It's uncertain, right now, how the scenario will look within the 5- or 10-year period during the project authorization process. But, we are certain that there will be greater amounts of local participation required, in other words, local financial participation.

We have here what we consider the major environmental considerations. The first and last items, aesthetics and recreation, I discussed briefly before. Water quality of the stream would be temporarily affected by the immediate construction. The excavation required at the diversion dam, powerplant and tailrace may cause temporary turbidity in the stream. However, upon completion of the project, we expect the stream quality to be stabilized. There will be certain adverse agricultural impacts. During construction, the cane lands affected by the conduits would be torn up but they will be ultimately restored to existing condition. Plan 2A would affect a larger area, approximately 9 acres, as compared to 1 acre for Plan 1A.

Now, as I indicated initially as far as the major national objectives in water resources planning, the bottom line is the economic feasibility. Plan 1A has investment costs of approximately 8 million dollars, the benefit-to-cost ratio right now being 1.3. For 2A the investment cost is approximately 13 million dollars with a benefit-to-cost ratio of 1.04. A similar cost analysis for Plan 3 was not performed because, first of all, the plan is totally independent of Federal action as far as the Corps of Engineers is concerned. Second of all, the conservation aspects of the plan, as well as implementation portions, may be performed by individual initiative and means and could be implemented independently of any Corps of Engineers projects. So, we may see for example, the conservation being realized on Kauai even without these other two hydropower concepts.

Now this slide intends to show the review process which we are undergoing right now. We have performed investigations. You have access to a complete draft report. If you desire a report and don't have one at your disposal, we will be happy to furnish one to you. We are currently receiving public comments on the report and, during this public meeting. Following receipt of all comments and expiration of the date of comment period, which is approximately 45 days from approximately June 1, we will complete the report. We will submit the report for our Washington-level review and, provided everything is satisfactory, the project will be authorized.

This concludes the general presentation of the Wailua River project. I didn't go into too much of the nitty gritty details as far as the technical, economic evaluation or environmental evaluation. If you decide to ask any questions, we will be happy to try to answer them. If we can't get the answer immediately, or if I don't know the answer, I'll try to get it for you and provide a response to you. Now I would like to turn this session back over to LTC Sprague for testimony and question and answer period. And, I would like to repeat that we would appreciate, if you desire to make any comments or a full presentation, that you identify yourself and come up to the microphone. Thank you.

LTC SPRAGUE: Before having the first person come up, I would like to recognize Mr. Jeremy Harris from the County Council. Is he still here? He just stepped out. OK. It appears I have three cards from people who have asked to make a statement and we'll go down through these. The first one I have is Bill Blanchard from the County of Kauai. OK Bill. Bill, I guess, is an alternate energy coordinator or energy coordinator?

MR. BLANCHARD: Economic development analyst.

LTC Sprague: Economic development analyst. OK.

MR. BLANCHARD: Some of the information that was put out here was that as for the total amount of electricity generated on the island of Kauai, in 1980 it was 38 percent from alternate energy, nonfossil fuel. In 1981 it jumped up 20 percent to 58 percent. Now, of course, that's not only what KE sells to the residents but also what the sugar companies use to produce the sugar. Just before I came here, I was watching Walter Cronkite on "Universe," Universe I think is the name of his program. And he was talking about three major inroads into alternate energy. Methane gas which is now being used in the United States and also here on Kauai in greater amounts. He also mentioned this new amazing thing called bagasse which has been used here for, I guess, nearly 80 years. And also hydro which is, of course, one of the most important things that we have on this island. Paul Mizue mentioned that the US Corps of Engineers started its first hydro in 1909. Here on Kauai,

McBryde started its first hydro in 1906. That's in Wainiha Valley - still running today. It's the largest one in the Hawaiian Islands, 3.6 megawatts. Kekaha Sugar started its in 1911 - same machinery is still running today. We now produce nearly 8 megawatts of power from hydro and that's not including the old Olokele 1.25 that just went into operation a few months ago. The Kitano one, which will be up in Kokee, again by Kekaha, is 1.6 megawatts. There is a study being done on the Wainiha to possibly double that output. We have investigations looking into the Hanalei River, the Hanalei Tunnel, Lumahai River which together would equal almost 6 megawatts. The potential in the Kokee Canyon area is probably somewhere between 25 and 30 with what's being produced there and what we have a potential for. With the Wailua, which would be 5.0 or 5.65 megawatts, and the Hanapepe River and some of the other ones that we haven't even touched yet, we probably have somewhere in the neighborhood of 45 to 50 megawatts of potential hydropower. The Wailua one is one of our first major steps forward and it's an important step toward electrical self-sufficiency on Kauai and so I urge support by everyone for it if it turns out to be as economically feasible as it looks like it will be. Thank you.

LTC SPRAGUE: Thank you Bill. The next card I have is from Alton Miyamoto representing Kauai Electric.

MR. MIYAMOTO: Thank you LTC Sprague. Good evening. My name is Alton Miyamoto and I am the manager of engineering for Kauai Electric. With their permission, I am going to read a letter that was given to the Corps which represents all our preliminary observation on the draft report and our comments.

Dear Mr. Mizue: We are the public utility providing electric power service to the island of Kauai. In 1981 our customers required 199.5 million kwh. This requirement represented a 5.6 percent increase in electrical energy over the year 1980. We project that our customers will need 210.5 million kwh this year which will be another 5.6 percent increase in energy over the year 1981.

In producing the 199.5 million kwh in 1981, approximately 47 percent was purchased from plantation sources largely produced from the burning of bagasse and hydroelectric sources. The balance was produced by Kauai Electric by burning oil. In producing this energy, Kauai Electric used 278,400 barrels of oil in 1981.

Our cost for the oil and purchasing energy from plantation sources amounted to $15.2 million in 1981 and represented over half of our customers' power bill.

Our company's policy is to reduce our dependency on oil-fired generation. We are at the end of a long tenuous supply line for oil and the interruption or curtailment of oil at the whims of others must be considered, even beyond the state and national interest in reducing oil dependence.

Geothermal and undersea cables do not appear to be a viable alternate for Kauai as they may be for the other counties. On the other hand, the development of hydroelectric power is a very real possibility at a number of sites on the island of Kauai including the Wailua project.

We fully endorse and support this important alternate energy project and trust that we will see it carried forward.

We have one significant reservation which we would like the Corps to consider in their draft. The Corps has tentatively adopted option 3 which basically calls for State ownership and operation of the proposed plant with power sold to <u>preference</u> customers at preferential rates.

Preference customers would include State and County buildings, military bases and the like. Such an arrangement would not be a benefit to the customers of Kauai Electric insofar as rates are concerned but rather would be a disadvantage.

We support a modification of option 3 in the draft study under which the power generated by the State-owned hydroelectric plant would be sold to Kauai Electric for distribution to its customers. Such an arrangement would have a beneficial effect on electric rates to the extent the energy was sold below our avoided cost. Thank you.

<u>LTC SPRAGUE</u>: Thank you. And the last card I have at this time is from <u>E.W. Broadbent</u> from Amfac Sugar.

<u>MR. BROADBENT</u>: Thank you Colonel. I would like to, if you don't mind, first <u>read a letter</u> with my Amfac Sugar hat on and, thereafter, I would like to make, if you don't mind, a few personal type observations which I will explain the reasons why.

The letter is addressed to you, Colonel Sprague, and it starts off by saying:

Thank you for the opportunity to review and comment on this very detailed study; in particular, your Mr. Paul Mizue should be congratulated on the interest and effort he has obviously put into this project.

As a major landowner and State lessee within the project basin, we would like to submit some comments and suggestions for your consideration.

a. While we believe there is no disagreement between us, we would like to reinforce the understanding that none of our existing water diversions for hydropower, irrigation, and factory purposes will be disturbed in order to satisfy this project's streamflow requirements. We are also concerned that our diversions from the North Fork Wailua Stream into our Wailua River system not be affected by the proposed increase in the Stable Storm diversions to the South Fork.

b. As noted in Table 10, we are planning an upgrading of our hydroelectric system. We do have two existing hydro units in the upper reaches of this Wailua Basin. An essential part of this upgrading will be increased diversions by what we call the Iliiliula-North Wailua Ditch to Waiahi Stream; this change will not in itself alter the combined North and South Fork Wailua River flows available for your proposed project, and would be approximately balanced by a corresponding decrease in our Stable Storm Ditch diversions.

c. As to the status of water rights, which was discussed in the report, we can only say that we necessarily reserve the exercise of all ownership rights over water originating on our fee lands, in accordance to the law at the time of such exercise.

d. Referring now to Figure 8 in the report, we believe the Kauai Island pie chart does not square with the Table 3 values. By the way, from now on I am getting into specific comments and suggestions. Kauai Electric does itself not generate any power from bagasse or hydro sources. I believe there is a little confusion in the heading. By the way, I did give Paul the courtesy of going over these comments with him beforehand. I am not hitting him cold turkey.

e. On Table 10: The description of our Lihue Upgrading Project should be revised as follows:

Stage of Investigation Status should be:

"<u>Engineering</u>, Environmental, Economic about 75 percent complete/Power on line: post 1984."

Type of Improvement should be:

"At the upper powerplant increased ditch/tunnel capacity and installation of a second turbogenerator"

"At the lower powerplant (both of these are Lihue units that we have) increased ditch/tunnel capacity and a larger turbine."

The development or after development capacities and energies should be:

"At the upper powerplant, 0.8 mw, 5.7 million kwh per year average"

"At the lower powerplant, 1.0 mw, 7.1 million kwh per year"

By the way, you will notice that the totals there would approximately equate with your project here.

f. Referring for a second to the Kekaha (Waiawa) unit which is included in the overall island survey, we are not now planning to rebuild or completely reconstruct that powerplant. We do plan a (I'm ad libbing here) rather homemade upgrading of the turbine. While it is true, if I can also ad lib, that's not the oldest powerplant on the island. It's only one year younger and I guarantee you it has a design and it's still working after 72 years, that would make the Smithsonian proud. The upgrading would result, and we estimate, 0.45 mw and it would produce, and this is a rough guess, about 3.5 million kwh per year.

g. Going on to the last paragraph of your report, page 34: If most of the proposed hydro projects become a reality, we believe that cumulative effect would be significant in Kauai's power resources. Also, hydropower is extremely dependent on the avoided cost principle contained in both the Federal PURPA and the State PUC Chapter 74.

h. One page B-16 a question: At least the implication is that mechanical and electrical equipment would be coming from the west coast United States. It isn't a positive statement but it's pretty close to that. It would seem to be fairly restrictive.

i. Project economics: Although the benefit-cost or BC ratio is positive for both of the alternates, the 7-5/8 percent interest rate used is almost certainly unattractive to any private capital investment, I should say at this time. We would like to offer three suggestions to Alternative 1A that may help to increase economic attractiveness.

First, relocation of the intake dam further upstream to reduce its height and cost. Second, substitution of an open channel, possibly unlined, between the diversion dam and the penstock headbox. The berm for this channel could also serve as the falls overlook road and viewing areas. It is true that the greater taking of cane land will increase payments to us, Lihue Plantation, but we believe this substitution can be a net benefit overall.

Third, and last, substitution or study that is, of the substitution of a single turbogenerator, the turbine for which could be a vertical shaft, multi-jet Pelton or Turgo unit. Two generators mean increased mechanical and electrical cost per kilowatt, and just as important, the minimum flow cutoff point inherent in the Francis turbines being considered here, is quite high and it's quite evident from the report that substantial amounts of low flows escape unharnessed. It is just a characteristic of the beast.

We hope this letter will be of assistance and we will be glad to respond to your further questions.

Taking that hat off and going to a little of the personal side. I guess some of you wonder how do these projects get started. Who is the original cage rattler? I've got to take the blame for that. It isn't the Corps trying to gin up a job all by itself. I do think there is a potential here but there are some major problems that have to be solved. I think it is worth reinforcing, and perhaps a little bit different wording. Kauai's, I think, rather dangerous vulnerability and dependence on imported oil is accentuated by, at least in my opinion, the fact that Kauai's isolation practically wipes out any chance of being tied into a state grid, be it vastly cheap geothermal

or vastly cheap something else. I believe that, at least in our lifetimes, Kauai's always going to have to flap its wings on its own and scrap around for what it can get. And what it can get is apt to be in small bits and pieces and rather expensive. And, with that in mind, I think it's worthy that any plan such as this gets serious attention. Thank you very much.

LTC SPRAGUE: Thank you. I do not have any other cards for anyone who has indicated that they wish to make a statement. Has anyone come in late who has not filled out a blue card? OK, we will get one to you. If there are no further statements, if any of you have questions that you would like to address, please come forward under the rules and state your name and affiliation if any. We will attempt to answer the questions at this time if we can. If we can't, we will make a note of the question for the record and we will get an answer back specifically to you but it will also be answered in the final report. So we have one taker back there. Please come forward.

MR. MERRERO: My name is Frank Merrero and I was concerned about the aesthetics of the Wailua Reservoir and of the Wailua Falls and what kind of impact it was going to have. In actually viewing you know, I have these this, than's and that's and low flows and rattatat. I want to know what it's going to look like to the falls after you take away how much water, with the low flow, you know, when it's the lowest down, how much water of the falls are you going to be taking out - half, a tenth, a fourth, has it rained for a week, what's the falls going to look like? How long is the project from the time they break ground to completion? What kind of machinery is involved? I noticed that in the map that you gave out, I took my little pencil and it said how many feet you were away from the subdivision and it was approximately 8,000 feet. And what kind of sound impact you are going to have relative to the Wailua Homesteads? That's all I have now. Thanks.

LTC SPRAGUE: Paul, do you want to take any particular one you would like?

MR. MIZUE: Well, regarding the aesthetics, perhaps it's kind of confusing in the report, perhaps not. Under natural conditions, the Wailua River is not full flowing, full bore as you see it right now for example. There are periodic times of the year in which the low flow is very low. In fact, if you just take a look at the report. All of you don't have a copy. But, there is what is known as a flow duration curve in our hydrologic analysis which basically shows a percentage of the time in which, a cumulative percentage of time, in which certain flows are determined. For example, at the site of the gage 600 which is right near the diversion point, approximately 70 percent of the time, under natural conditions, the flow is equal or less than 10 cfs. The picture you saw on the screen up there. That was taken January of this year. That was approximately 400 cfs. So, only 30 percent of the time the water is greater than 10 cfs. So you can see that even considering natural conditions, the flow is very, very small. Under the project conditions, of course, under the design of existing turbines, we would divert water whenever the flows exceeded approximately 80 cfs. So, for example, if the waters were 70 cfs, we would not divert any water. If the waters were 30 cfs, we would not divert any water because the turbines would not be able to handle it.

And this would amount to approximately 50 percent of the time that we wouldn't use the water. When the waters got up to 100 cfs, we would divert 90 cfs out of the 100 and leave 10 in the stream. If the waters got up to 1,000 cfs, we would divert up to the maximum capacity of the conduit which is about 400 cfs, leaving the balance, 600 cfs, going down the stream. And, under very high flood flows, approaching 10,000 or 100,000 cfs, there would be negligible impact. You wouldn't even see it. So there would be a measurable impact upon the waterfall during a large percentage of the time. But, you have to keep in mind that, even under existing conditions, the stream itself is under low flow conditions. We tried to illustrate this in one of these tables in the report for example, under existing conditions, 32 percent of the time the flows are from zero to 10 cfs. But, under project conditions, that frequency of time would increase to 54 percent. So, that means that approximately, there would be approximately 80 days more out of a year in which there would be very low flows. But you take a look at the impact upon the downstream, downstream of the South Fork beyond the point of releasing the water, there would actually be an improvement, so to speak, because under existing conditions, zero to 10 cfs would amount to 32 percent of the time, whereas, under project conditions, there would be only 12 percent of the time. So, between the diversion point and the release point, there would be an adverse impact. We acknowledge that but beyond the release point, further downstream of the powerplant, there would be an actual beneficial effect. So, it all depends on what particular flow you are interested in, where you are located at and how you are comparing it. But, there is going to be an impact. We don't have what would be desirable, of course, is a document which would completely describe all the possible conditions pictorially. For example, if we had pictures which documented 5 cfs flow, 50 cfs flow, 100 cfs flow, you could see for yourself, through this pictorial analysis, what conceptual impact it would have. Unfortunately, we don't have access to those pictures, but we are convinced that, if energy is to be developed, we must take a significant amount of water from that location and if the flows are not provided in a relatively high proportion, there won't be any powerplant. It's as simple as that because it won't be economical to produce that amount of energy.

Now, to answer your second concern about the effect upon the Wailua Homesteads is located on the North Fork of the Wailua River and it won't have any impact upon the location. The construction period is approximately 2 years, we considered it in the report. However, the actual time involved between the design of turbine, initiation of design to completion is approximately 3 years. It's too early, at this time, to really give a definite implementation date because, as I mentioned before in the slide presentation, we have to go through all this process of project authorization and all the mechanics of going through additional studies and achieving construction funds. You have to keep in mind that we are looking at a relatively long-range plan here. We are not going out on the street tomorrow and say "Hey folks, you better get out of the way. The Corps is moving ahead. We are building. Don't get in the way of us. We are going to charge ahead." That's not the case at all. In fact, this is the, really the beginning of the project you might say, because if this project goes through in terms of

the report, then there is a potential for possible construction in the future. I believe I have attempted to answer your questions there. I am not sure if I entirely satisfied you but, if there are any more concerns, you can talk to me after the meeting.

LTC SPRAGUE: Please, could you come up so we can get it all on the record.

MR. WEHRHEIM: What is the minimum flow that the turbines can handle?

LTC SPRAGUE: Would you give your name please.

MR. WEHRHEIM: My name is John Wehrheim.

MR. MIZUE: OK, as shown in the syllabus, the powerplants being considered right now are two Francis units. Of course, this outlook again depends upon final engineering stage. As mentioned by Mr. Broadbent, there are options of all types of turbines. We are not locked into the Francis units. The minimum stage flow for the Alternative 1A is 65 cfs and for 2A is 58 cfs. So you can see that, until we achieve that amount of discharge, it won't function properly.

MR. WEHRHEIM: I was just wondering if a smaller turbine that could perhaps go down below 58 cubic feet a second would be economical, since you are already investing in the intake works in the penstock, you have this low flow for quite a large percentage of the time.

LTC SPRAGUE: There is two things on that. One is the type of turbine that was anticipated and, it was mentioned by Mr. Broadbent, that there are other types that take advantage. The other thing is that maintaining some flow of the falls. If you have one that is, say, very efficient in, say, zero to 10 cfs, then all that water would be diverted and there wouldn't be anything going over the falls. So those are considerations as well. It's possible to have other turbines that could operate at more ranges.

MR. WEHRHEIM: Do you have aesthetic guidelines for the falls that you feel, do you have a minimum flow that would preserve the aesthetics of the Falls?

MR. MIZUE: That's largely the subject of the beholder. A person who would say that 50 cfs was satisfactory may not be adequate. You would want 500 cfs. A person may say 500 cfs is not adequate, we want 800 cfs. It's a very difficult subjective thing. We don't have the criteria which says automatically that the Corps of Engineers' standards says that for all waterfalls there will be 50 cfs. I mean, there is no such animal like that. The 10 cfs was evaluated primarily on the basis of natural ecological conditions that we want to maintain the natural wildlife further downstream. As far as the third turbine. It is possible to put third turbines or other types of units in. We did take a look at a single turbine, a horizontal Francis single turbine, but that was proved to be uneconomical because it wouldn't capture a large enough range in flows. If you add more turbines, of course, the capital cost is going to increase. And, as mentioned by Colonel Sprague, the more units you add, you could possibly deplete the entire amount of flows in the waterfall area.

MR. BIRNBAUM: My name is Howard Birnbaum. I understand from what has been said, that this will have no effect on the North Fork of the Wailua River. Is that correct? Second, I would like to ask, since this is a nonstorage structure, is it true to assume that the depth of water and rate of flow of the South Fork for an area of about a mile inland of Fern Grotto, will be about as it is now?

MR. MIZUE: OK, regarding the first question on the North Fork. The answer is negative. There will be a somewhat adverse effect upon the North Fork of the Wailua River. The intent of the additional diversion feature on the North Fork is to allow more water from the North Fork into the South Fork via the Stable Storm Ditch. We attempted to secure about 90 to 100 cfs additional flow from the North Fork. One of the limitations that we wanted to maintain, conditions in the North Fork, so that we have at least a minimum flow in the North Fork also. Now, given the 90 cfs we figured that water would not be usable in that amount of quantity for the South Fork so that we didn't attempt to divert more than about 90 or 100 cfs. So, for example, if for some reason 200 cfs was flowing down the North Fork, then we would just divert 90 cfs.

UNIDENTIFIED ATTENDEE: What if there was a 100?

MR. MIZUE: If there was a 100 flowing, then we would divert approximately 95 cfs of the 100. Leave 5 cfs in the North Fork. On the second question on the impacts of the flows. On the South Fork. The flows on the South Fork would actually be increased or enhanced, you might say, as a result of the North Fork diversion. So, there would be an increase in the actual flows of the South Fork but the visual impact or the ecological impact, we figure, are not significant. You won't be able to see, for example, whether the waters are flowing at 400 cfs or 500 cfs. I mean, that's almost imperceptible. So there will be an enhancement in that sense but not something that you could see.

MR. BIRNBAUM: The reason for my inquiry is that I have always regarded that area of about a mile inland from Fern Grotto as a prime recreational area on Kauai for canoeing and rowboating and possibly very low powered power boating. Not speedboating at all. And, apparently, this would enhance it and not affect it adversely.

MR. MIZUE: Well, at the confluence of the North Fork and the South Fork rivers, you wouldn't see any effect because, in effect, the waters are just being united at that junction. So, above Fern Grotto, you wouldn't be able to see anything. There wouldn't be any effect.

MR. BIRNBAUM: Thank you.

LTC SPRAGUE: There was someone over there. Yes, please.

MR. SMITH: My name is Walter Smith. I am sorry it's a little hard to understand you on that side. We were not all built for all out public speaking but what I wanted to find out - what is going to happen. We operate

the boats up the Wailua River. How is the depth of the river going to go? Are we still going to be able to operate or are we going to have to wait till you folks got through building the place or what?

MR. MIZUE: OK, regarding the boating operations, I can say, pretty safely, that there won't be any impact upon the boating. There won't be any impact upon depths. Although, as I mentioned before, there will be some changes in flows that would be imperceptible.

MR. TAKENOUCHI: My name is Glen Takenouchi. I am here as an interested individual. You had stated, Mr. Mizue, that the Federal funding probably would be pretty much smaller now with the Reagan administration. If that is so, and you said that we need local investments, which probably means the State, is the State willing to share in this investment?

LTC SPRAGUE: On hydropower type studies, in general, the funding is from the locals. When we say local, we are talking about a governmental entity - in this case, yes, it would be the State. Before we go very far down the line and seek to get the authorization, the State must give us a letter of assurance, and this is really is a gentlemen's agreement that says, yes, we intend to pursue this in the funding of this, to completion. But it is a handshake agreement. It is not a binding thing that goes down, and when we get the authorization to continue on, that if conditions change and say "hey, we can't do it," they'll say, "I'm sorry, you signed the contract and we're going to hold you to it." Not at that point. So, before we really go much farther than the survey study, yes, the State has to come forward and has to give us an assurance.

MR. MERRERO: My name is Frank Merrero again. And I wanted to ask you some questions relative to the North Fork Wailua and have you done studies on, like you did on the South Fork relative to, what is it, cfs flows and what are they? How much water will you be diverting of my river.

MR. MIZUE: As far as the hydrologic studies, we didn't go into depth on the North Fork as we did on the South Fork, although, I believe we do have a flow duration curve of the North Fork, similar in nature to the South Fork. On the North Fork, for example, 20 percent of the time under natural conditions, the flows exceed 100 cfs. So less than 80 percent of the time under natural conditions, it's less than 100 cfs in contrast. So, during that period of time, if we divert water from the North Fork up to 100 cfs, we would reduce that 80 percent of the time. So there would be a substantial impact upon the North Fork Wailua. That's true.

MR. MERRERO: Eighty percent of the time?

MR. MIZUE: Alright, 80 percent of the time the flows would be reduced from 100 cfs, say, to 95 cfs, I mean 5 cfs. So it would be flat like this, see? OK?

MR. MERRERO: Yes. Relative to Figure 15 in this little handout you gave us, the gaging station is going to be upstream of the Wailua Reservoir. Is that right? That's where you are going to take it from? So 80 percent of the time, the Wailua, the North Fork of the Wailua River is going to be only 5 percent of what it is now. Is that right?

MR. MIZUE: At that location. Yes. At that location, as I mentioned to you before, the amount of water flowing in the North Fork would be reduced substantially. However, if you can take a look at the drainage area for the North Fork, that amount on the North Fork river is only about, I believe, one third the drainage area of the North Fork river. So, additional water would continue to flow into the North Fork, downstream of the diversion.

MR. MERRERO: OK. How about at this point right here where it starts entering people area. Up here it's cane, but down here where it starts entering people that would enjoy the river, what kind of - now you are taking 95 percent of it up here but that's only one third of the input? Is that what you are saying?

MR. MIZUE: That's right.

MR. MERRERO: So, by the time it gets here, what percentage of input is coming from other sources?

MR. MIZUE: I cannot tell you that. We haven't analyzed that to that extent as far as the amount of water which is going to be realized at, for example, right at the Kaholalele Falls.

MR. MERRERO: How am I going to get that information. Can you do that for me?

MR. MIZUE: Well, I will have to develop that information. I cannot furnish you at this time.

MR. MERRERO: But, later?

MR. MIZUE: It's possible.

MR. KAI: My name is Kelvin Kai: I have just two questions. After the State - if we get to the point where it is time to construct the project, if the State does not provide a letter of assurance that they will finance the project, will a private enterprise be able to do it? And the second question is, I guess, to Paul. Whatever happened to Senator Gravel's bill - small hydropower?

MR. MIZUE: OK, to answer your first question. Since we operate in various stages of operation in getting the project approved and authorized and constructed, we must have assurances at each stage from the local sponsor. So, for example, if the State, at this time, decides to say "yes, we want to favor to the project and we want you to pursue it," they provide us local assurance letter. In the absence of a local assurance letter, we would

probably have to just drop the project and not even pursue it through Congress. If we get through, up to the point of advanced engineering and design, we need another letter from the State indicating, "yes, we continue to support your project, we continue to feel that we would be supportive of it," and we need another letter at that time, and so on down the line up to construction. When construction time comes around, we'll say that we need a signed letter of assurance at this time, signed by your local authorities. If they decline at that time, we'll drop it at that time. So, because we work in stages like this, and, over a long period of time, it's really impossible for either the Federal government or the local government to completely commit themselves to such a large scale effort. But, we must, at various stages, secure this support or intent to comply with our regulations. Regarding the possible private enterprise - if, for example, the State fails to provide the assurance, we cannot just transfer the work to a private enterprise. We would have to drop the study and leave it up to private industry to develop their own plan, possibly as a take-off of ours.

LTC SPRAGUE: His last question was on Senator Gravel's....

MR. MIZUE: Oh, on Senator Gravel's bill, this is concerning, for information, authority for the Corps of Engineers to design, construct small hydropower facilities under, I believe, 30 megawatts and under 15 million dollars for any single project. And this was proposed approximately 3 years ago. Unfortunately, Senator Gravel got defeated in his reelection bid. He is no longer in the Senate. Second of all, there doesn't seem to be any likelihood, from the Reagan administration, to pursue the special authorization. This special authorization would basically provide the Corps of Engineers authority to perform these functions without going to Congress each time for its action. We have this similar type of authority for small flood control and small beach erosion and small boat harbors. We don't have to go to Congress and say, "Hey, please, Congress, give us authority and give us extra bucks to construct." It's a relatively quick process. We can perform these small projects on the order of 3 to 5 years. Congressional studies, on the other hand, because we have to go to Congress each time for authorization and appropriations, take on the order of 10 to 15 years, at the minimum. Now, regarding a Gravel bill, we don't see any likelihood of it being resurrected within the next couple of years.

LTC SPRAGUE: Other questions? Just a comment on the time frame. Some of you may know that, on the island of Oahu, we are starting the construction of a new deep-draft harbor on the Barbers Point area. That was first authorized for study back in the mid-fifties. We are going to have the ground-breaking ceremony on August 5th of this year.

MR. ELKINS: My name is Jeff Elkins. I am with KUAI Radio but am representing myself. I have two questions. First of all, I didn't catch the exact percentage of the amount of time, but you said that the diversion was going to be shut off during times of low flow. I am wondering if this means that the powerplant is only going to work X percentage of the time? That's number one and number two is, I am wondering what will be the visual impact as far as buildings that you see from the parking lot at Wailua Falls and from the Fern Grotto and also from the highway below, if any.

MR. MIZUE: OK, regarding the amount of flow. During periods of low flow which currently we are conceiving of about 70 cfs as a minimum discharge of the turbine. Approximately 50 percent of the time, 40 to 50 percent of the time, the turbines would be shut down. It's as simple as that. There won't be any production of energy during that time. In excess of that, naturally, the flows in the river would be reduced down to 10 cfs. As far as the structures which may be visible, the visible structures on the powerplants, the powerplant for Plan 1A will not be visible from the current lookout. They will be actually hidden underneath the bluff. You won't be able to see it unless you are on the other side of the bluff, on the left bank looking downstream, or on the left side of the stream. On Plan 2A which is the larger plan, you will not be able to see it from the falls either because it would be hidden around the bend of the river. The visible structures, really, in both plans would probably be the penstock which would be, at least initially, sloping down from the top of the bluff into the powerplant. However, over a period of time, we anticipate that a certain amount of vegetation would grow over it and you may not be able to see portions of it. You could see the impact somewhat similarly from the slide I showed on Wainiha. The penstock there is visible in certain locations, although you can't see all of it at any one time.

LTC SPRAGUE: I think in the syllabus it gives a load factor for the two different plans, and this syllabus isn't put together the same way the rest of them are. I think it's about 26 percent. That's of the entire capacity of the plant. Like for 1A, it's a 5-megawatt capacity. It's not the same as many of the other hydropower plants that you have here on the island which run at full capacity nearly all the time. This one has a much larger capacity than many of the others but only runs part of the time at different flow rates, not always at the maximum. So, the overall load factor or power factor, if you will, is only about 26 percent of the 5 megawatts. That's where we come up with the value of about 11 million kilowatt hours per year for 1A. Hence, Kauai Electric could not shut down permanently or cease to increase, if necessary, additional plant capacity. This would merely be the variable cost of producing electricity. Instead of buying oil and burning that to produce electricity when the flow was suitable for generating the hydropower, you would run the, the hydropower plant would be running and you wouldn't have to burn the oil. That's where the benefit comes in. Other questions? Once again, you have until the 30th of August to submit written comments that will be incorporated in the final report. Our address is the Honolulu Engineer District, Building 230, Fort Shafter, HI 96858. I thank you very much for your comments, your attention and your interest in the project.

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Name	Representing	Address
Asing, Bill Kaipo	Self	P.O. Box 1643, Lihue, HI 96766
Barker, David S.	Self	P.O. Box 853, Kalaheo, HI 96741
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Birnbaum, H.F.	Self	RR #1, Box 259A, Kapaa, HI 96746
Blanchard, Bill	County of Kauai	4396 Rice St, Lihue, HI 96766
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Chuck, Robert T.	State Dept Land & Nat Resr	P.O. Box 373, Honolulu, HI 96809
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Humme, John	Kekaha Sugar Co., Ltd.	P.O. Box AA, Kekaha, HI 96752
Ibara, Tom	Self	Box 433, Waimea, HI 96796
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Kawakami, Nathan	Public Util Commission	P.O. Box 3078, Lihue, HI 96766
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Masaki, Kiyoji	Self	P.O. Box 288, Waimea, HI

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Moe, Owen	Kekaha Sugar Co., Ltd.	Box AA, Kekaha, HI 96752
Nakaya, Ed	Kauai Electric Division	P.O. Box 278, Eleele, HI 96705
Ogawa, Patrick	Alexander & Baldwin (McBryde)	P.O. Box 8, Eleele, HI 96705
Sa, Frank, Jr.	Self	RR #1, Box 276R, Kapaa, HI 96746
Salling, Michael R.	Lehua Fernandes Salling	1347 Ulu St, Kapaa, HI 96746
Sears, Winona	League of Women Voters of Kauai County	190 Lulo Rd, Kapaa, HI 96746
Smith, Walter J.	Smith's Motor Boat Service, Inc.	P.O. Box 141, Kapaa, HI 96746
Sollner, William J.	The Garden Island	Lihue, HI 96766
Steinhart, Carl	Self	P.O. Box 927, Kalaheo, HI 96741
Takenouchi, Glen	Kauai Electric	P.O. Box 278, Eleele, HI 96705
Thenet, J. A.	Kekaha Sugar Co., Ltd.	P.O. Box 414, Kekaha, HI 96752
Townsley, Paul	Kauai Electric	P.O. Box 260, Eleele, HI 96705
Wehrheim, John	Self	2749 Kapena St, Lihue, HI 96766

WAILUA RIVER HYDROPOWER STUDY

U.S. ARMY ENGINEER DISTRICT, HONOLULU   BUILDING 230   FORT SHAFTER, HAWAII 96858

The US Army Corps of Engineers, Honolulu District, has completed intermediate planning for hydropower improvements for the Wailua River, island of Kauai, Hawaii. This investigation is authorized by Section 209 of the River and Harbor Act of 1962 and is being conducted in cooperation with the State of Hawaii.

A public meeting is being held to notify the general public and interested agency personnel of study activities and to share views on the problems and potential solutions. The Corps has completed analyses of several alternative plans and has documented the results in a Draft Interim Survey Report and Environmental Statement. Among the plans being considered, a diversion structure and powerplant sited near Wailua Falls (see map on reverse side), appears to be a favorable solution. The meeting will be held on:

WEDNESDAY, 28 JULY 1982 AT 7:30 PM
WILCOX ELEMENTARY SCHOOL CAFETORIUM
4319 HARDY STREET, LIHUE, KAUAI

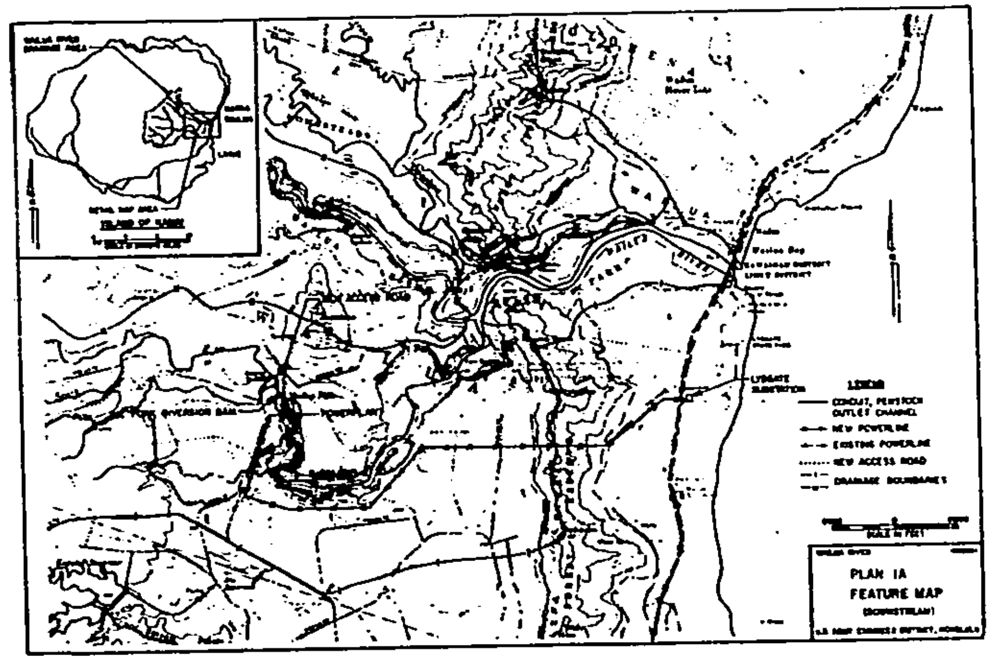
At the meeting, the possible impacts associated with the occupancy and modification of the floodplain (Executive Order 11988) and the possible effects of the discharge of dredged or fill material in the waters of the US (Clean Water Act of 1977) will be considered. Your attendance and participation will provide valuable input for the completion of the study. The draft report has been issued to relevant public agencies. Written comments prepared for the meeting and in response to the report are encouraged. The report is available for inspection at the Kauai Regional Library, 4344 Hardy Street, Lihue. Details of the report and further information may be secured from the following office:

Mr. Paul Mizue
US Army Engineer District, Honolulu
ATTN: PODED-PJ
Building 230
Fort Shafter, HI 96858, telephone: (808) 438-1307

For KENNETH E. SPRAGUE
Lt Col, Corps of Engineers
District Engineer

EDMUND A. THAL
MAJ, Corps of Engineers
Deputy District Engineer

Public Meeting



DEPARTMENT OF THE ARMY
HONOLULU DISTRICT, CORPS OF ENGINEERS
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DOD-314

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PUBLIC NOTICE INCLOSED

CITIZENS UTILITIES COMPANY

P.O. BOX 278 · ELEELE, KAUAI, HAWAII 96705

July 28, 1982

Mr. Paul Mizue
U.S. Army Engineer District,
Honolulu
Attn: PODED-PJ
Building 230
Fort Shafter, HI 96858

Dear Mr. Mizue:

We are the public utility providing electric power service to the island of Kauai.

In 1981 our customers required 199.5 million kwh. This requirement represented a 5.6% increase in electrical energy over the year 1980. We project that our customers will need 210.5 million kwh this year which will be another 5.6% increase in energy over the year 1981.

In producing the 199.5 million kwh in 1981, approximately 47% was purchased from plantation sources largely produced from the burning of bagasse and hydroelectric sources. The balance was produced by Kauai Electric by burning oil. In producing this energy, Kauai Electric used 278,400 bbls. of oil in 1981.

Our cost for the oil and purchasing energy from plantation sources amounted to $15.2 million in 1981 and represented over half of our customers' power bill.

Our company's policy is to reduce our dependency on oil-fired generation. We are at the end of a long tenuous supply line for oil and the interruption or curtailment of oil at the whims of others must be considered, even beyond the state and national interest in reducing oil dependence.

KAUAI ELECTRIC

A DIVISION OF CITIZENS UTILITIES COMPANY
ELECTRIC, TELEPHONE, WATER AND GAS SERVICE TO CUSTOMERS IN OVER 500 COMMUNITIES IN MANY STATES ACROSS THE NATION

Geothermal and undersea cables do not appear to be a viable alternate for Kauai as they may be for the other counties. On the Other hand, the development of hydroelectric power is a very real possibility at a number of sites on the island of Kauai including the Wailua project.

We fully endorse and support this important alternate energy project and trust that we will see it carried forward.

We have one significant reservation which we would like the Corps to consider in their draft.

The Corps has tentatively adopted option 3 which basically calls for state ownership and operation of the proposed plant with power sold to preference customers at preferential rates.

Perference customers would include state and county buildings, military bases and the like. Such an arrangement would not be a benefit to the customers of Kauai Electric insofar as rates are concerned but rather would be a disadvantage.

We support a modification of option 3 in the draft study under which the power generated by the hydroelectric plant would be sold to Kauai Electric for distribution to its customers. Such an arrangement would have a beneficial effect on electric rates to the extent the energy was sold below our avoided cost.

Very truly yours,

Boyd T. Townsley

Boyd T. Townsley
Vice President
Kauai Electric Division

BTT:ey

Amfac

AMFAC, INC.
P.O. BOX 3230
HONOLULU, HAWAII 96801
TELEPHONE: (808) 945-8111

July 28, 1982

Lt. Col. Kenneth E. Sprague, District Engineer
U.S. Army Engineer District, Honolulu
Fort Shafter, Hawaii 96858

Dear Lt. Col. Sprague:

Re: Wailua River Hydropower Report

Thank you for the opportunity to review and comment on this very detailed study; in particular, your Mr. Paul Mizue should be congratulated on the interest and effort he has obviously put into this project.

As a major landowner and State lessee within the project basin, we would like to submit some comments and suggestions for your consideration.

a. While we believe there is no disagreement between us, we would like to reinforce the understanding that none of our existing water diversions for hydroelectric power, irrigation, and factory purposes will be disturbed in order to satisfy this project's stream flow requirements. We are also concerned that our diversions from the North Fork Wailua Stream into our Wailua River system not be affected by the proposed increase in the Stable Storm Ditch diversions to the South Fork.

b. As noted in Table 10, we are planning an upgrading of our hydroelectric system. An essential part of this upgrading will be increased diversions by the Iliiliula-North Wailua Ditch to Waiahi Stream; this change will not in itself alter the combined North and South Fork Wailua River flows available for your proposed project, and would be approximately balanced by a corresponding decrease in our Stable Storm Ditch diversions.

c. As to the status of water rights, we can only say that we necessarily reserve the exercise of all ownership rights over water originating on our fee lands, in accordance to the law at the time of such exercise.

d. Figure 8: We believe the Kauai Island pie chart does not square with the Table 3 values. Kauai Electric does itself not generate any power from bagasse or hydro sources.

e. Table 10: The description of our Lihue Upgrading Project should be revised as follows:

Stage of Investigation Status should be:

"Engineering, Environmental, Economic 75% complete/
POL: post 1984."

Type of Improvement should be:

"Increased ditch/tunnel capacity, second turbogenerator" for Upper Powerplant.

"Increased ditch/tunnel capacity, larger turbine" for Lower Powerplant.

Development Capacities and Energies should be:

"0.8 MW 5.7 million KWH for Upper Powerplant"
"1.0 MW 7.1 million KWH for Lower Powerplant"

f. The Kekaha (Waiawa) Upgrading should be described as

"Rebuild of turbine at existing plant. 0.55 MW, 3.5 million KWH."

g. Last paragraph, page 34: If most of the proposed hydro projects become a reality, we believe their cumulative effect will be significant in Kauai's power resources. Also, hydro power is extremely dependent on the avoided cost principle contained in both the Federal PURPA and State PUC Chapter 74.

h. Page B16: Would mechanical and electrical equipment necessarily come from the West Coast United States?

i. Project Economics: Although the B C ratio is positive for both of the Alternates, the 7-5/8% interest rate used is almost certainly unattractive to private capital investment. We would like to offer three suggestions to Alternative IA that may help to increase economic attractiveness.

1) Relocation of the intake dam further upstream to reduce its height and cost.

2) Substitution of an open channel, possibly unlined, between the diversion dam and the penstock headbox. The berm for this channel could also serve as the falls overlook road and viewing areas. It is true that the greater taking of cane land will increase payments to us, but believe this substitution can be a net benefit.

3) Substitution of a single turbogenerator, the turbine for which is a vertical shaft, multi-jet Pelton or Turgo. Two generators means increased mechanical and electrical cost per kilowatt, and the minimum flow cutoff point inherent in Francis turbines allows substantial flows to escape without energy extraction.

We hope this letter will be of assistance, and we will be glad to respond to your further questions.

Very truly yours,

AMFAC SUGAR COMPANY

E. W. B.

E. W. Broadbent
Director, Energy Resources

GEORGE R. ARIYOSHI
GOVERNOR

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

DIVISIONS:
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FISH AND GAME
FORESTRY
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

April 9, 1980

Colonel B. R. Schlapak
District Engineer
U.S. Army Engineer Dist., Honolulu
Building 230
Fort Shafter, Hawaii 96858

Dear Colonel Schlapak:

Our Nation's overall energy supply and market prices appears to indicate that the development of alternative energy sources is worthy of renewed emphasis. Also, as you know, the people of Hawaii are particularly susceptible to unstable and accelerating petroleum prices. In this regard, our department has spearheaded efforts for hydroelectric power development, initially with the Kokee Water Project and lately with the Waialeale Hydropower Study and with your organization in your study of Hydroelectric Power for the State of Hawaii.

The current energy situation seems to indicate a new effort is in order for small-scaled hydropower in consideration of Hawaii's insular water and land resources. Based upon your traditional role in federal water resource activities and under the authority of Section 209 of Public Law 87-874, we are requesting your assistance in the investigation of small-scaled hydropower facility in the Wailua River basin, Kauai, Hawaii. This particular area appears suitable for a new investigation of hydropower development in view of the favorable physical conditions and high dependence on petroleum-based fuels.

We will be pleased to assist you in your study. The coordination activities should be directed to our Division of Water and Land Development.

Very truly yours,

Susumu Ono
SUSUMU ONO
Chairman of the Board

cc: Dept. of Planning & Economic Development
Mr. E. W. Broadbent, Amfac Communities, Hawaii

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858

PODED-PH

24 June 1980

PUBLIC NOTICE

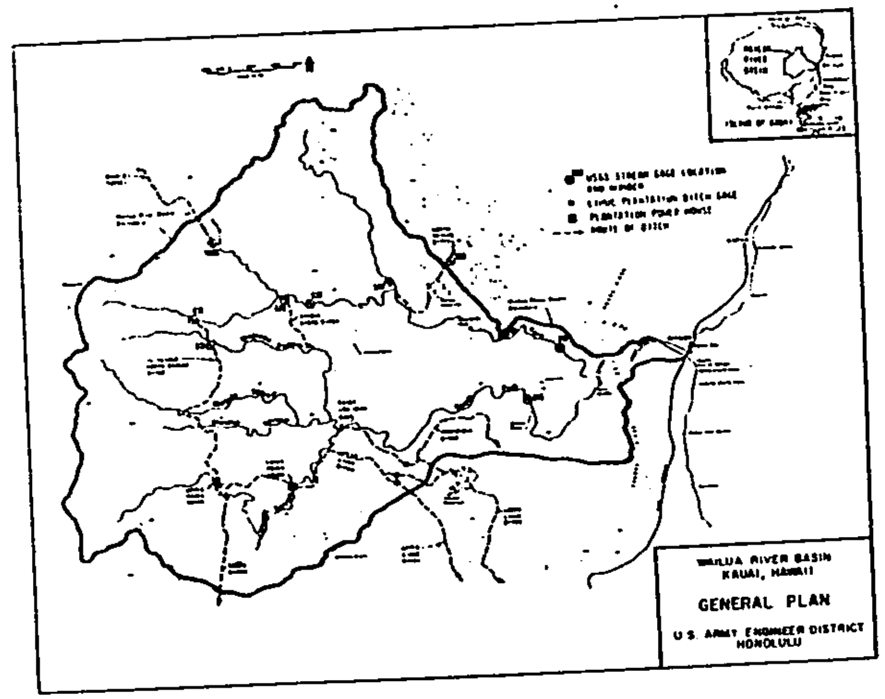
NOTICE OF INITIATION OF STUDY
ON SMALL-SCALE HYDROPOWER DEVELOPMENT FOR
WAILUA RIVER BASIN, KAUAI, HAWAII

The US Army Engineer District, Honolulu has initiated a survey investigation on small-scaled hydropower development for the Wailua River Basin, Kauai, Hawaii (see map on the back). Initiated at the request of the State of Hawaii, the study is authorized by Section 209 of the Flood Control Act of 1962 (Public Law 87-874). This notice is issued to advise all interested parties of the study and to request information pertinent to the study.

The study, to be conducted through fiscal year 1982, will determine the feasibility of a small-scaled, run-of-river hydropower development on the Wailua River Basin and the extent to which the Federal Government should participate in implementation. During the course of the study, a full range of alternative solutions will be developed, evaluated, and, if warranted, a potential plan will be selected. Technical adequacy, economic feasibility, environmental quality impacts, and social acceptability will be addressed in accordance with the US Water Resources Council's "Principles and Standards for Planning Water and Related Land Resources" and regulations of the US Army Corps of Engineers. The final result of the study will be a report on the feasibility of developments including an environmental statement concerning impacts of any proposed solution.

For proper assessment of the problem and formulation of solutions, information will be needed on the past history, present condition, and future plans of the study area. Information concerning marketability of hydroelectricity, condition of natural and man-made features, and potential ecological and social impacts will also be needed. Please advise the Corps, at the address above, of the availability of any information of this nature. Please bring this public notice to the attention of any interested individual or organization.

B. R. Schlapak
B. R. SCHLAPAK
Colonel, Corps of Engineers
District Engineer



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PUBLIC NOTICE INC'OSED

PUBLIC WORKSHOP

WAILUA RIVER HYDROPOWER STUDY KAUAI, HAWAII

PODED-PJ

19 January 1981

THURSDAY, FEBRUARY 12, 1981
7:30 PM
KAPAA NEIGHBORHOOD CENTER
KAPAA, KAUAI

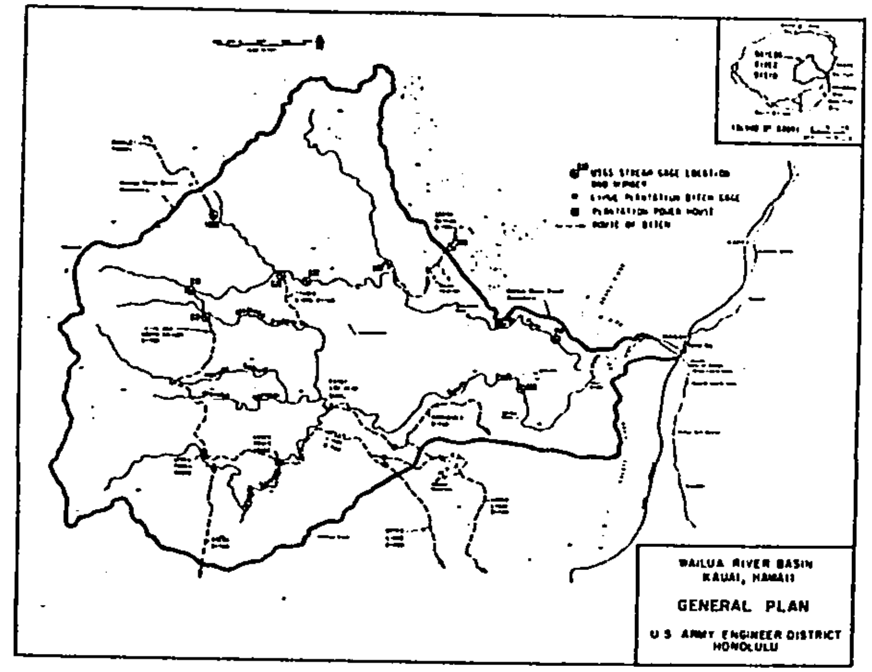
Federal, local, and private interests have expressed the need to develop and use renewable energy resources, particularly hydropower resources. The US Army Corps of Engineers has initiated a feasibility study of hydroelectric development at the Wailua River Basin, island of Kauai.

Your attendance and participation at the workshop will help us in the formulation and evaluation of possible plans to develop the hydropower potential.

If you have any questions concerning the workshop or would like additional information, contact Mr. Harvey Young, telephone 438-1307, or at the address below.

Mr. Harvey Young
US Army Engineer District, Honolulu
ATTN: PODED-PJ
Building 230
Ft Shafter, HI 96858

ALFRED J. THIEDE
Colonel, Corps of Engineers
District Engineer



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U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT SHAFTER, HAWAII 96858

PODED-PJ

30 June 1982

Honorable Daniel K. Inouye
United States Senate
105 Russell Senate Office Bldg
Washington, DC 20510

Dear Senator Inouye:

We are providing for your information a copy of the Draft Interim Survey Report and Environmental Statement for the Wailua River Hydropower Study, island of Kauai, Hawaii. The document has been distributed to public agencies for their review and comment.

Sincerely,

KENNETH E. SPRAGUE
Lt Col, Corps of Engineers
District Engineer

1 Incl
As stated

Copies Furnished:
Honorable Daniel K. Inouye
United States Senator
300 Ala Moana Blvd, Room 6104
Honolulu, HI 96850

Commander
ATTN: DAEN-CWZ-G
Department of the Army
Washington, DC 20314

Identical letters sent to following:
Honorable Cec Heftel, Representative in Congress, 300 Ala Moana Blvd, Room 4104 Honolulu, HI 96850 and House of Representatives, 1030 Longworth House Office Bldg, Washington, DC 20515
Honorable Spark M. Matsunaga, United States Senate, 5121 Dirksen Bldg, Washington, DC 20510, and United States Senator, P.O. Box 50124, Honolulu, HI 96850
Honorable Daniel K. Akaka, House of Representatives, 1510 Longworth House Ofc Bldg, Washington, DC 20515 and Representative in Congress, 300 Ala Moana Blvd, Room 5104, Honolulu, HI 96850
Honorable George R. Ariyoshi, Governor of Hawaii, Honolulu, HI 96813
Honorable Byron Baker, Chairman, Energy, Ecology & Environmental Protection, Hawaii House of Representatives, Honolulu, HI 96813
Honorable Eduardo E. Malapit, Mayor, County of Kauai, Lihue, HI 96766
Mr. Jeremy Harris, Chairman, Kauai County Council, 4396 Rice St., Lihue, HI 96766
Honorable Richard Henderson, Chairman, Economic Development, Hawaii State Senate, Honolulu, HI 96813

PODED-PJ

U.S. ARMY ENGINEER DIVISION, PACIFIC OCEAN
BUILDING 230
FT SHAFTER, HAWAII 96858

30 June 1982

In accordance with the Council on Environmental Quality regulations (40 CFR 1500) for implementing the National Environmental Policy Act (NEPA), we are circulating the Draft Interim Survey Report and Environmental Statement for the Wailua River Hydropower Study, island of Kauai, Hawaii. Comments regarding this project should be submitted to the District Engineer by 16 August 1982 or 45 days following notice of the report in the Federal Register, whichever is later.

Sincerely,

KISUK CHEUNG
Chief, Engineering Division

1 Incl
As stated

Identical letter sent to following:
(see attached mailing list)

PODED-PJ

U.S. ARMY ENGINEER DIVISION, PACIFIC OCEAN
BUILDING 230
FT SHAFTER, HAWAII 96858

30 June 1982

SUBJECT: Wailua River - Draft Interim Survey Report and Environmental Statement

Division Engineer
US Army Engineer Division, North Pacific
ATTN: NPDEN
P.O. Box 2870
Portland, OR 97208

In accordance with the Council on Environmental Quality regulations (40 CFR 1500) for implementing the National Environmental Policy Act (NEPA), we are circulating the Draft Interim Survey Report and Environmental Statement for the Wailua River Hydropower Study, island of Kauai, Hawaii. Comments regarding this project should be submitted to the District Engineer by 16 August 1982 or 45 days following notice of the report in the Federal Register, whichever is later.

FOR THE COMMANDER:

KISUK CHEUNG
Chief, Engineering Division

1 Incl
as

Identical letter sent to:
Commander, Fourteenth Coast Guard District, 300 Ala Moana Blvd, 9th Floor, Honolulu, HI 96850
Commander, Pacific Missile Range Facility, Barking Sands, Kekaha, HI 96752

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

13 JUL 1982

OFFICE OF
THE ADMINISTRATOR

Dear Dr. Maragos:

I am writing to verify the official filing of the EIS entitled:

Draft: Wailua River Hydropower Project, Island and County of Kauai, Hawaii (#820459)

This EIS was received by the Office of Federal Activities on July 8, 1982. It has been determined the above document meets the requirements for filing an EIS as set forth under Section 1506.9 of the CEQ Regulations. Accordingly, EPA has scheduled publication of the Notice of Availability in the Federal Register dated July 16, 1982 and the public review period is scheduled to terminate on August 30, 1982.

If you have any questions or concerns relating to this matter, please do not hesitate to contact me or Ms. Jan Lott of my staff on 245-3006.

Sincerely,

Jan Lott Shaw
for Kathi L. Wilson
Management Analyst
Office of Federal Activities (A-104)

Dr. James E. Maragos
Honolulu District
US Army Corps of Engineers
Building 230
Fort Shafter, Hawaii 96858

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION NINE
Hawaii Division
Box 50206
Honolulu, Hawaii 96850

ARIZONA
CALIFORNIA
NEVADA
HAWAII
GUAM
AMERICAN SAMOA

July 13, 1982

IN REPLY REFER TO
HDA-HI

Mr. Kisuk Cheung, Chief
Engineering Division
U.S. Army Corps of Engineers
Pacific Ocean Division, Bldg. 230
Fort Shafter, Hawaii 96858

Dear Mr. Cheung:

Subject: Wailua River Hydropower, Interim Survey Report and Environmental Statement

We have no comments on the subject EIS circulated by your letter dated 30 June 1982. Thank you for the opportunity to review the report.

Sincerely yours,

H. Kusumoto
Division Administrator

EXECUTIVE CHAMBERS
HONOLULU

GEORGE R. ARIYOSHI
GOVERNOR

July 16, 1982

Lt. Colonel Kenneth E. Sprague
District Engineer
Corps of Engineers
U. S. Army Engineer District, Honolulu
Ft. Shafter, Hawaii 96858

Dear Colonel Sprague:

Thank you for the draft of the interim survey and environmental impact statement for the Wailua River hydropower project.

We, for some time, have been interested in employing steam run-off to generate electricity. This study of the potential of small-scale hydropower on the Wailua River will be of tremendous help in our studies in this area.

With warm personal regards, I remain,

Yours very truly,

George R. Ariyoshi

United States Department of Agriculture — Soil Conservation Service — P.O. Box 50004, Honolulu, Hawaii 96850

July 21, 1982

Mr. Kisuk Cheung
Chief, Engineering Division
U.S. Army Engineer District, Honolulu
Building 230
Ft. Shafter, HI 96858

Dear Mr. Cheung:

Subject: Wailua River Hydropower, Kauai, Hawaii

We have reviewed the Draft Interim Survey Report and Environmental Statement for the subject study and have no comments to make.

Thank you for the opportunity to review this document.

Sincerely,

FRANCIS C. H. LUM
State Conservationist

The Soil Conservation Service is an agency of the Department of Agriculture

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION

RYOKICHI HIGASHIONNA, Ph.D.
DIRECTOR

DEPUTY DIRECTORS
WAYNE J. YAMASAKI
JAMES R. CARRAS
JAMES B. McCORMACK
JONATHAN K. SHIMADA, Ph.D.

IN REPLY REFER TO
STP 8.8439

July 23, 1982

Mr. Kisuk Cheung
Chief, Engineering Division
Department of the Army
U.S. Army Engineer District, Honolulu
Port Shafter, Hawaii 96858

Dear Mr. Cheung:

Draft EIS Waialua River Hydropower Study
Kauai, Hawaii

Thank you for the opportunity to participate in the development of your subject EIS.

We suggest that adequate vehicule turn-around and parking space be provided at the proposed visitor center on Maalo Road.

Very truly yours,

Ryokichi Higashionna
Ryokichi Higashionna
Director of Transportation

University of Hawaii at Manoa

Water Resources Research Center
Holmes Hall 283 • 2540 Dole Street
Honolulu, Hawaii 96822

27 July 1982

Office of Environmental Quality Control
550 Halekauwila Street, Room 301
Honolulu, Hawaii 96813

Gentlemen:

Subject: Wailua River Hydropower, Kauai, Hawaii, Draft Interim Survey Report and Environmental Statement, Corps of Engineers, June 1982

We have reviewed the subject material and have no comment to offer at this time. Thank you for the opportunity to comment. This material was reviewed by WRRC personnel.

Sincerely,

Edwin T. Murabayashi
Edwin T. Murabayashi
EIS Coordinator

ETM:jm

cc: Y.S. Fok
H. Gee
Corps of Engineers

CITIZENS UTILITIES COMPANY

P.O. BOX 278 · ELEELE, KAUAI, HAWAII 96705

July 28, 1982

Mr. Paul Mizue
U.S. Army Engineer District,
Honolulu
Attn: PODED-PJ
Building 230
Fort Shafter, HI 96858

Dear Mr. Mizue:

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KAUAI ELECTRIC

A DIVISION OF CITIZENS UTILITIES COMPANY

ELECTRIC, TELEPHONE, WATER AND GAS SERVICE TO CUSTOMERS IN OVER 500 COMMUNITIES IN MANY STATES ACROSS THE NATION

Geothermal and undersea cables do not appear to be a viable alternate for Kauai as they may be for the other counties. On the Other hand, the development of hydroelectric power is a very real possibility at a number of sites on the island of Kauai including the Wailua project.

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Very truly yours,

Boyd T. Townsley

Boyd T. Townsley
Vice President
Kauai Electric Division

BTT:ey

CITIZENS UTILITIES COMPANY

P.O. BOX 278 · ELEELE, KAUAI, HAWAII 96705

July 28, 1982

Mr. Paul Mizue
US Army Engineer District, Honolulu
Atten: PODED-PJ
Building 230
Fort Shafter, HI 96858

Dear Mr. Mizue:

Attached is a copy of the Draft Wailua Hydropower Study "red-marked" to reflect changes or operations for year 1981.

There have been significant changes in our operations as a result of the Lihue Purchase Power Contract.

Very truly yours,

Boyd T. Townsley
Vice President
Kauai Electric Division

BTT:bt

encls.

KAUAI ELECTRIC

A DIVISION OF CITIZENS UTILITIES COMPANY
ELECTRIC, TELEPHONE, WATER AND GAS SERVICE TO CUSTOMERS IN OVER 500 COMMUNITIES IN MANY STATES ACROSS THE NATION

A-35

SOCIO-ECONOMIC RESOURCES

Institutions. The State of Hawaii is governed by a bicameral legislature, a judiciary and an executive branch where power is vested in a governor. The principal executive department responsible for the management of the State's public lands, water and mineral resources, fish and game resources, forest reserves, and State parks, including historic sites is the Department of Land and Natural Resources (DLNR). The Division of Water and Land Development, within the DLNR, provides for the development of water resources, including hydroelectric power facilities. The DLNR is administered by the Board of Land and Natural Resources, headed by its chairman. As the authorized representative of the Governor, the chairman may execute agreements, within his powers, on behalf of the State.

The promotion of long-range socio-economic development, including general planning, technical analyses, redevelopment, and employment is a function of the Department of Planning and Economic Development. The State Energy Office within the DPED compiles detailed information on energy and fuel consumption, sales, generation, and shipment. In addition, DPED is charged with management of State energy research and development funds and coordination of inter-agency energy developments, including hydroelectric power.

Electric generating companies servicing the public in the State of Hawaii are governed by the rules set forth by the Public Utilities Commission (PUC) of the State of Hawaii under the Department of Budget and Finance. This commission was created and is chartered under Chapter 269, the revised laws of Hawaii 1955, as amended. The Commission examines the propriety of rates, capital expenditures, and regulates standards of electrical service. Companies generating power primarily for their own use, such as sugar companies, are not directly controlled by the PUC.

Local government in the Wailua River basin is vested in the County of Kauai. The County of Kauai includes the island of Kauai and Niihau, adjacent waters and islets within three nautical miles of their shores. The executive power of the County is exercised by the Mayor. The principal local agencies involved with hydroelectric development are the departments of Public Works, Planning and the Office of Economic Development.

The only electric utility on the island of Kauai is the Kauai Electric Division of Citizens Utility Company whose corporate headquarters are located in Stamford, Connecticut. Approximately ~~87~~ 57 percent (as of 198~~0~~1) of the system energy is developed at the Port Allen main thermal plants, the balance being purchased energy from industrial sugar companies.

Unlike the mainland United States there does not exist any National Electric Reliability Council Region (NERC) similar to the Western Systems Coordinating Council (WSCC) for the area west of the Rocky Mountains. There are no Federal projects supplying public power in Hawaii; hence there are no Department of Energy Power Marketing Administrations (PMA's) in the area.

Population. Island population levels on Kauai remained relatively stable during the 1950-1970 period. In the 1970's, however, population growth was somewhat faster than had been anticipated. Hawaii Department of Planning and Economic Development (DPED) projections had predicted growth during the 70's to 36,500 by 1980. Census figures reveal that this estimate has been exceeded, as 1980 population was 39,082, about 7% higher than the forecast.

KAUAI ELECTRICAL UTILITY SYSTEM

System Features. Prior to 1964 the island of Kauai's electrical facilities were under ownership by the sugar plantations. Since 1969 the major electrical features have been owned and operated by the Kauai Electric Division (KED) of Citizens Utilities Company. However, smaller purchased power facilities and associated transmission lines remain under sugar plantation jurisdiction. All the principal KED generation units are petroleum-based fueled plants. Internal combustion diesel units and gas turbine units utilize Number 2 diesel fuel and the steam unit utilizes Number 6 Bunker C fuel oil. There are no nuclear, coal nor hydropower plants operated by KED. A general map of the system is shown on Figure 7.

The transmission lines parallel the road transportation system except for the cross-island connection between Wainiha and Port Allen. The principal transmissin lines are rated at 57.1 kv; secondary lines are at ~~33.0 kv~~, 12.47 kv, 11.5 kv and 6.9 kv. The major 57.1 kv lines total approximately 113 miles in length, ~~approximately 89 miles of the~~ The lines are ~~under~~ leased or owned by Kauai Electric ~~ownership~~, ~~the balance under ownership of McBryde Sugar Company~~.

The island's electrical generation and consumption are restricted to Kauai; electrical inter-ties between the islands do not exist.

Installed Capacity and Energy Production. All energy generation for the utility system's plant is located at Port Allen. The KED system includes a mix of diesel, oil-fired steam, and gas turbine units. The bulk of the capacity (64%) ~~and generation (70%) are~~ is provided by the gas turbine units. A summary of the plant inventory is shown in Table 2. The gas turbine Number 2 unit ~~is~~ also operated in combined cycle with flue gases firing the waste heat boiler of the steam unit.

The mix of electrical utility generation by fuel type for Kauai differs radically from the typical mix in the United States, as a whole. Nationwide oil accounts for roughly 11 percent of utility generation whereas in Kauai it accounts for almost ~~90~~ 57.2 percent of electrical utility energy. Bagasse totals a significant ~~8~~ 42.8 percent of energy in Kauai whereas solid waste and other sources total an insignificant ~~0.3~~ 11.1 percent in the U.S. A graphical display of the relative proportions of fuel types is shown in Figure 8.

Table 2. KAUAI ELECTRIC DIVISION PLANT INVENTORY 1/

Location, Unit Type & Year Installed		Installed Capacity, MW	Generation (Net) 2/ million kwh	Demand On Plant MW 4/
PORT ALLEN				
Diesel				
#1	1964	2.0		
#2	1964	2.0		
#3	1968	2.75		
#4	1968	2.75		
#5	1968	2.75		
		12.25	~~5.3~~ 17.0	~~5.2~~ 7.7
Steam				
	1969	10.0	~~50.5~~ 53.2	~~9.5~~ 7.5
Gas Turbine				
#1	1972 (Hitachi) 3/	17.65	~~12.2~~ 18.6	--
#2	1977 (John Brown) 3/	22.18	~~116.4~~ 35.8	~~19.3~~ 19.5
Lihue Bagasse Plant		12.00		
TOTAL		~~62.08~~ 74.08	~~184.4~~ 124.6	~~34.2~~ 34.7

1/ Year ending 31 December 1980
2/ Inclusive of energy consumed by in-plant use
3/ Operated also in combined cycle mode.
4/ At time of peak

In addition to the Kauai Electric Division owned and operated powerplant and system features, KED maintains separate agreements with the four island sugar plantations for purchased capacity and energy. The four sugar plantations (Lihue, McBryde, Kekaha, and Olokele) use a combination of hydroelectric, diesel, and bagasse steam plants to produce electrical energy for their respective plant operations. As of 1980, approximately 22% of the industrial energy output or 27 million kwh was transferred as nonfirm energy. This total also constituted approximately 13% of the energy output of KED. The distribution of sugar plantation energy generation by fuel type is shown on Table 3.

And [illegible] to 43% in 1981.

Since 1969 the proportion of purchased energy has decreased from approximately 50 percent to 15 percent in 1980. From 1969 to 1976 KED maintained agreements for purchasable capacity; 1977 to 1980 required no purchasable capacity (except for emergencies). In March of 1981 a 20 MW bagasse-fired powerplant became fully operational at Lihue Plantation. In accordance to an agreement with KED, Lihue would furnish 12.0 MW firm capacity and 55.6 million kwh per year. The plant became fully integrated into the KED system and operations are directly controlled from KED's Port Allen headquarters. The relative impact of the purchased and KED plants prior to the 1981 Lihue addition is shown on Table 4.

No Less than

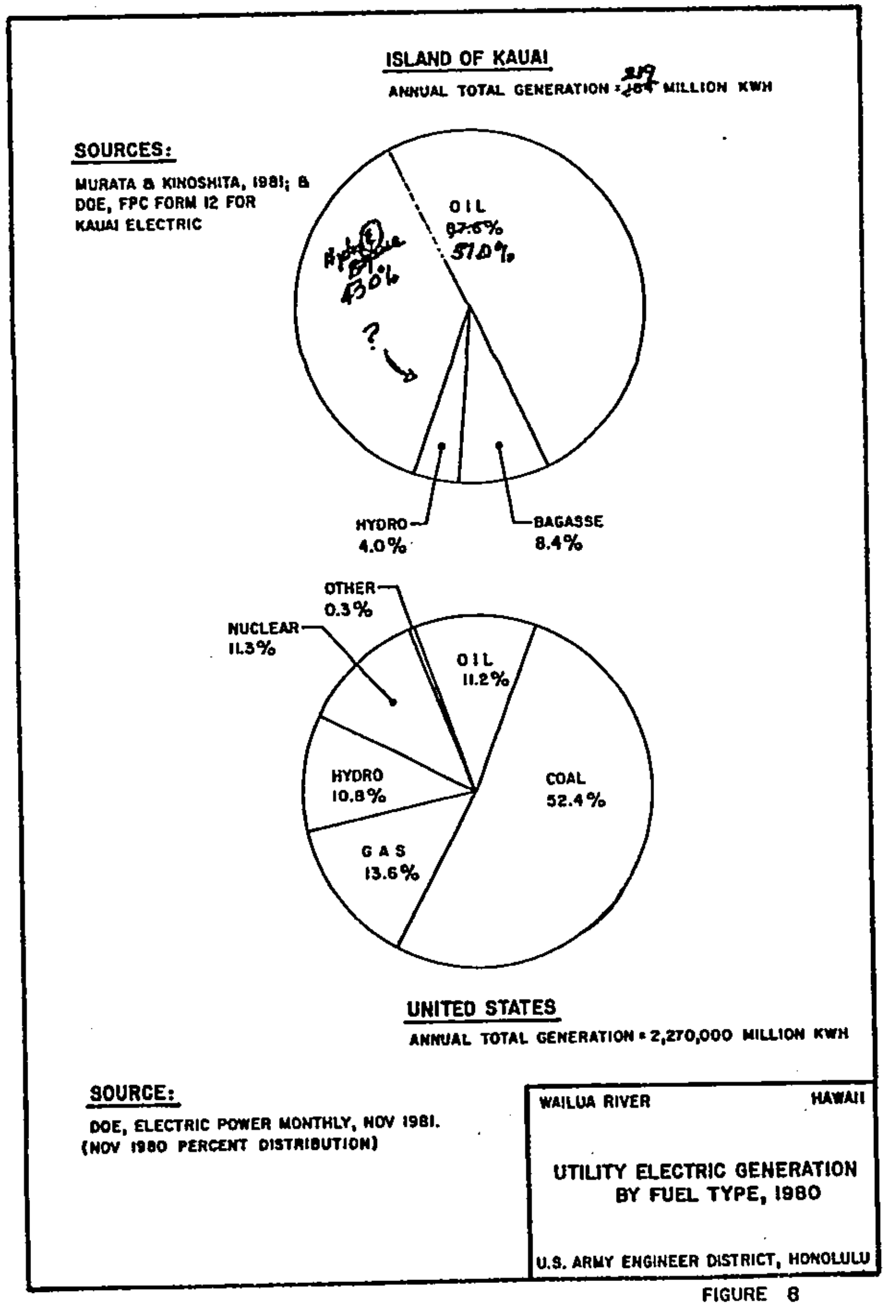


FIGURE 8

Table 3. ELECTRICAL GENERATION ON KAUAI BY FUEL TYPE 1/

	Oil	Bagasse	Hydro	Total
		?	?	
Total Plantation & Utility System				
Plantation Generation, million kwh	~~2.4~~ 2/	~~78.4~~ 3/	~~42.1~~	~~122.9~~
Percent by Fuel Type	~~1.2~~	~~63.6~~	~~34.2~~	~~100.0~~
Utility, Generation, million kwh	124.6 ~~184.4~~	0	0	124.6 ~~184.4~~
Percent by Fuel Type	100.0	--	--	100.0
Total Generation, million kwh	186.8	~~78.4~~	~~42.1~~	307.3
Percent by Fuel Type	60.8	~~25.5~~	~~13.7~~	100.0
Electrical Utility System				
Plantation Generation Sold to Utility, million kwh	~~0.5~~ 4/	~~17.8~~ 4/	~~8.5~~ 4/	94.1 ~~26.8~~
Percent of Total Generation	--	--	--	21.8
Utility Generation, million kwh	124.6 ~~184.4~~	0	0	124.6 ~~184.4~~
Percent by Fuel Type	100.0	--	--	100.0
Total Generation, million kwh	~~184.9~~	~~17.8~~	~~8.5~~	218.7 ~~211.2~~
Percent by Fuel Type	~~87.6~~	~~8.4~~	~~4.0~~	100.0

1/ Sources: Murata, D & C.M. Kinoshita. Energy Inventory for Hawaiian Sugar Factories 1980. Honolulu: 1981. Dept of Energy FPC Form 12, 1980, for Kauai Electric.
2/ Diesel units plus 2.8% of boiler generation based on utilization of boiler fuel oil.
3/ Boiler bagasse generation less fuel oil generation.
4/ Estimated based on generation proportion by fuel type for individual plantation.

Table 4. KAUAI ELECTRIC DIVISION AND SUGAR PLANTATION POWERPLANTS

Summary for Year Ending 31 December 1980 1/

Plant	Capacity, MW: Installed	Capacity, MW: Demand by KED 2/	Energy, Million kwh: Generation by Sugar Companies	Energy, Million kwh: Purchased/Generated by KED
Kauai Electric at Port Allen	62.08	~~34.2~~ 34.7	?	~~184.4~~ 124.6
Lihue Power Plant	12.00		--	
Purchased Energy				
Lihue	31.3	-- ..	39.1	~~11.6~~ 7.7
McBryde	19.6	~~2.4~~ 4.6	48.6	~~9.9~~ 10.4
Kekaha	8.0	~~0.7~~ .6	24.5	~~4.6~~ 5.9
Olokele	4.2	~~.8~~ .1	10.7	~~0.7~~ .6
Total to KED	~~62.08~~ 74.08	~~37.3~~ 38.5	122.9	~~211.2~~ 218.7

1/ U.S. Dept of Energy. "1980 Power System Statement" (covering Kauai Electric Division) FPC Form 12

2/ AT TIME OF PEAK

Distribution and Load Centers. The load or service areas are designated by judicial districts. The largest peak demand and total energy consumption are located in Lihue District. The 1980 FPC data indicates the Lihue District was provided approximately 58.0 million kwh and experienced a peak demand of 12.0 MW. In the Lihue District the largest consumer area is the industrial sector constituting approximately 43 percent of the distribution or 25.1 million kwh. However, on an island-wide basis, the non-farm residential is the largest user category at 66.9 million kwh (39 percent), followed closely by the industrial user category of 64.5 million kwh (34 percent). The summary of the system load and associated population by judicial district is shown in Table 5. The distribution of load and population is illustrated in Figure 9.

FUTURE POWER AND ENERGY REQUIREMENTS

Peak Demand Forecast. The annual rate of increase in the peak demand has gradually decreased since 1969 from an initial 12 percent down to approximately 4 percent per year. However, since 1969 the demand has almost doubled from 19.6 MW to ~~37.3~~ 34.7 MW in 1981. According to officials of KED, the annual increase should remain steady at 3.6 percent compounded per year up to and including 1991 (Figure 10). Historical and projected data on peak demand and related capacities of KED are shown on Table 6.

The monthly peak load distribution has remained relatively constant over time. The highest peak demand occurs in the fall during the months of September to November, corresponding to main sugar plantation operations. The remainder of the year is relatively constant in demand. A distribution of monthly peak load for the years 1970 and 1980 is shown in Table 7. The peak hourly loads occur generally between the hours of 6 p.m. to 9 p.m. The period of low demand occurs in the early morning hours and varies between 45 to 50 percent of the peak hourly load. Typical monthly and hourly system load charts are shown in Figure 11.

System Operational Characteristics. The Kauai Electric Division (KED) power system is operated, similar to normal electrical utilities, by a computer dispatch model. The computer assesses the operational costs of each component of the system and adjusts the power output from both the KED and purchased sources. As a result, depending in the load and time of day, the capacity for each component may vary.

The critical month for operation appears not to be in the period of October through December during periods of peak demand but in the month of January. During this entire month the Lihue 12.0 MW bagasse plant is normally shut down (in accordance to the contract) because of the cessation in sugar mill operations. The actual reserve capacity would decrease from 33.2 MW (for 1982, noted in Table 7) to 21.2 MW which is less than the capacity of the largest gas turbine unit (22.2 MW). The possibility of simultaneous shutdown of both the 12.0 MW Lihue plant and the 22.2 MW gas turbine No. 2, although remote, is of concern to KED officials. Hence, KED ~~desires~~ to maintain at least ~~34.2~~ 22.2 MW reserve capacity in the absence of additional utility or purchasable capacity as required by the PUC.

The combined cycle operation of the gas turbine units is definitely an economic asset for KED. The exhaust gases of the gas turbine units are utilized to charge the waste heat boiler of the 10 MW unit. As a result, the combined cycle operation cannot be operative if both gas turbines and the steam units were on-line simultaneously.

The potential additions to the KED system further considers utilizing the advantages of steam boiler and gas turbine. The 18 MW steam turbine is planned for construction in 1989. However, it will be operated at 8 MW utilizing the steam from the existing steam unit. In 1993 its capability will reach 18 MW when it will be hooked up with the existing gas turbine No. 1, operating in a combined cycle mode.

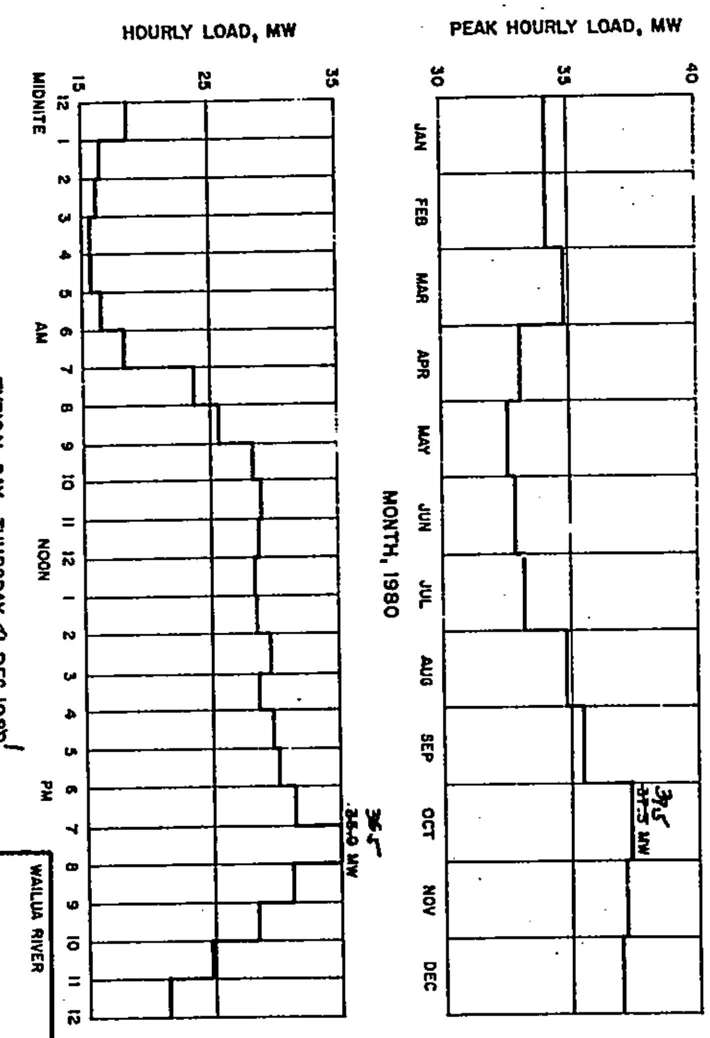
HYDROPOWER RESOURCES

Hydropower Perspective. The basic physical resources required for hydropower energy extraction are differences in elevation or head for the captured water, the rate of water flow, and the stability of flow over a time period (reflecting water storage and/or high perennial flows). The man-made resources required are a structure in the river to impound or capture the waters, a waterway to transport the waters, and electromechanical devices (turbines and generators) to convert the fall of flowing water ultimately to electrical energy.

Existing Hydropower Developments. The island of Kauai, benefitting from topographic and hydrologic conditions combined with historical development, produces more energy from hydropower sources than any of the Hawaiian islands. The existing hydropower facilities were originally installed by the sugar industry in conjunction with their irrigation, pumping, or mill operations. Table 9 shows the characteristics of the existing hydropower facilities.

Conventional hydropower developments are in general categorized in terms of operational type, capacity, and head requirements. The physical operational categories are storage, run-of-the-river, and conduit and are illustrated in Figure 13. All of the existing hydropower facilities in the State of Hawaii

FIGURE 11



SOURCE:
UNITED STATES DEPARTMENT OF ENERGY, ENERGY INFORMATION ADMINISTRATION, 1980 POWER SYSTEM STATEMENT, FPC FORM 12 FOR CITIZENS UTILITIES, KAUAI ELECTRICAL

WAILUA RIVER HAWAII

TYPICAL SYSTEM LOADS

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 11

U.S. ARMY ENGINEER DIVISION, PACIFIC OCEAN
BUILDING 230
FT SHAFTER, HAWAII 96858

5 October 1982

PODED-PJ

Mr. Boyd T. Townsley
General Manager and Vice President
Kauai Electric Division of Citizens
Utilities Company
PO Box 278
Eleele, Kauai, HI 96705

Dear Mr. Townsley:

We appreciate your views presented on 28 July 1982 for the Wailua River hydropower study final public meeting. Members of my staff, as well as the staff of the Western Area Power Administration, also thank you for your continued assistance in providing data and information regarding your utility's system.

As we had discussed with you on 21 September 1982, there is an established legal framework for Federal action in the production and distribution of power from Federal hydropower facilities. In accordance with the intent of the Federal Government for publicly developed power, the beneficiaries receiving priority consideration would be identified as public preference customers. The transmission and sale of power and energy would be provided to encourage the most widespread use consistent with sound business principles as mandated by Congress. These aspects will be explained in detail in the final Power Marketing Study to be completed by the Western Area Power Administration and to be contained in the Corps' final Interim Survey Report.

Again, allow us to express our appreciation for your support of our planning efforts for the Wailua River study. We will continue to keep you informed of developments for this investigation.

Sincerely,

KISUK CHEUNG
Chief, Engineering Division

Copy Furnished:
Mr. David C. Coleman, Area Manager
Western Area Power Administration
Sacramento Area Office
2800 Cottage Way
Sacramento, CA 95825

Amfac AMFAC, INC.
P.O. BOX 3230
HONOLULU, HAWAII 96801
TELEPHONE: (808) 945-8111

July 28, 1982

Lt. Col. Kenneth E. Sprague, District Engineer
U.S. Army Engineer District, Honolulu
Fort Shafter, Hawaii 96858

Dear Lt. Col. Sprague:

Re: Wailua River Hydropower Report

Thank you for the opportunity to review and comment on this very detailed study; in particular, your Mr. Paul Mizue should be congratulated on the interest and effort he has obviously put into this project.

As a major landowner and State lessee within the project basin, we would like to submit some comments and suggestions for your consideration.

a. While we believe there is no disagreement between us, we would like to reinforce the understanding that none of our existing water diversions for hydroelectric power, irrigation, and factory purposes will be disturbed in order to satisfy this project's stream flow requirements. We are also concerned that our diversions from the North Fork Wailua Stream into our Wailua River system not be affected by the proposed increase in the Stable Storm Ditch diversions to the South Fork.

b. As noted in Table 10, we are planning an upgrading of our hydroelectric system. An essential part of this upgrading will be increased diversions by the Iliiliula-North Wailua Ditch to Waiahi Stream; this change will not in itself alter the combined North and South Fork Wailua River flows available for your proposed project, and would be approximately balanced by a corresponding decrease in our Stable Storm Ditch diversions.

c. As to the status of water rights, we can only say that we necessarily reserve the exercise of all ownership rights over water originating on our fee lands, in accordance to the law at the time of such exercise.

d. Figure 8: We believe the Kauai Island pie chart does not square with the Table 3 values. Kauai Electric does itself not generate any power from bagasse or hydro sources.

e. Table 10: The description of our Lihue Upgrading Project should be revised as follows:

Stage of Investigation Status should be:

"Engineering, Environmental, Economic 75% complete/ POL: post 1984."

Type of Improvement should be:

"Increased ditch/tunnel capacity, second turbogenerator" for Upper Powerplant.

"Increased ditch/tunnel capacity, larger turbine" for Lower Powerplant.

Development Capacities and Energies should be:

"0.8 MW 5.7 million KWH for Upper Powerplant"
"1.0 MW 7.1 million KWH for Lower Powerplant"

f. The Kekaha (Waiawa) Upgrading should be described as

"Rebuild of turbine at existing plant. 0.55 MW, 3.5 million KWH."

g. Last paragraph, page 34: If most of the proposed hydro projects become a reality, we believe their cumulative effect will be significant in Kauai's power resources. Also, hydro power is extremely dependent on the avoided cost principle contained in both the Federal PURPA and State PUC Chapter 74.

h. Page B16: Would mechanical and electrical equipment necessarily come from the West Coast United States?

i. Project Economics: Although the B C ratio is positive for both of the Alternates, the 7-5/8% interest rate used is almost certainly unattractive to private capital investment. We would like to offer three suggestions to Alternative IA that may help to increase economic attractiveness.

1) Relocation of the intake dam further upstream to reduce its height and cost.

2) Substitution of an open channel, possibly unlined, between the diversion dam and the penstock headbox. The berm for this channel could also serve as the falls overlook road and viewing areas. It is true that the greater taking of cane land will increase payments to us, but believe this substitution can be a net benefit.

3) Substitution of a single turbogenerator, the turbine for which is a vertical shaft, multi-jet Pelton or Turgo. Two generators means increased mechanical and electrical cost per kilowatt, and the minimum flow cutoff point inherent in Francis turbines allows substantial flows to escape without energy extraction.

We hope this letter will be of assistance, and we will be glad to respond to your further questions.

Very truly yours,

AMFAC SUGAR COMPANY

E. W. B.

E. W. Broadbent
Director, Energy Resources

DEPARTMENT OF THE ARMY
PACIFIC OCEAN DIVISION, CORPS OF ENGINEERS
FT. SHAFTER, HAWAII 96858

PODED-PJ

12 November 1982

Mr. E. W. Broadbent
Director, Energy Resources
Amfac, Inc.
P.O. Box 3230
Honolulu, HI 96801

Dear Mr. Broadbent:

We appreciate your comments provided at the 28 July 1982 public meeting for the Wailua River hydropower study, island of Kauai, Hawaii. Responses to your comments are provided in the inclosure. The information and corrections for the draft report will aid us for the final report preparation.

Your continued support for the development of hydropower on Kauai is appreciated. We will keep you posted on further developments on the Wailua River study.

Sincerely,

KISUK CHEUNG
Chief, Engineering Division

1 Incl
As stated

PODED-PJ 12 November 1982

WAILUA RIVER HYDROPOWER STUDY

RESPONSES TO E. W. BROADBENT'S COMMENTS

Comment a: Diversions. We concur that the proposed Wailua River improvements will not affect existing irrigation diversions for Lihue Plantation. In addition, based upon prior coordination with your staff of Lihue Plantation, we understand that the proposed additional diversion will not significantly impact your irrigation operations dependent on the North Fork River.

Comment b: Lihue Upgrading. We appreciate your verification of our earlier understanding of the operational impact of your Lihue hydropower upgrading project.

Comment c: Water Rights. We affirm that the Wailua project will be consistent with applicable laws.

Comment d: Energy Chart. The pie chart provided in Figure 8 and Table 3 did not specify whether the energy for the electrical utility system originated from Kauai Electric Division or from the plantations. The figures are valid for the year 1980 for energy produced for the total electric utility system.

Comment e: Lihue Upgrading Data. We appreciate the information on your project.

Comment f: Kekaha Upgrading Data. As above.

Comment g: Hydropower Impacts. Concur. However, for Federal hydropower projects, the provisions of PURPA and State PUC Chapter 74 do not necessarily control the negotiated rates for power and energy. The value of the avoided cost will certainly serve as a key benchmark in the establishment of rates.

Comment h: Equipment. This statement will be revised. The equipment may originate at other locations in the United States.

Comment i: Project Economics.

(1) Diversion Dam. The diversion dam may be located further upstream. However, the cost for additional conduit length will be higher. In addition, there may be increased disturbance to the existing cane haul culvert located approximately 600 feet above the proposed diversion site. The tradeoffs of relative location will be investigated in greater detail in the future design efforts.

(2) Open Channel Alternative. The suggestion of an open channel is appreciated. However, the depth of cut will create a very wide open ditch. For example, for Alternative 1A, the maximum depth of cut is approximately 50 feet. Even at a minimal 1H:1V slope, the ditch top width would be at least 110 feet at the midpoint of the conduit. For a permanent cut, it is anticipated at least 2 - 10' wide benches would be incorporated and the side slope would be increased to 1.5H:1V. The resulting permanent maximum top width would be increased to 200 feet. In terms of maintenance, safety, accessibility, aesthetics, and effective utilization of land, a 50-foot deep, 200-foot wide trench would be difficult to recommend.

(3) Single Turbogenerator. For the purposes of feasibility studies, the Corps cannot specify proprietary turbines like the Pelton or Turgo. A single unit was investigated and based on typical performance curves and would not effectively capture as wide a range of flows as the double unit system. In addition, the extraction of energy from the river will be partially dependent upon sustaining flows for aesthetic and ecological considerations. The diversion of all available flow will not be acceptable for these reasons. The turbogenerator requirements will be refined during the plans/specifications stages based on manufacturer's submission of performance/cost data.

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

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

CHARLES G. CLARK
DIRECTOR OF HEALTH

JOHN F. CHALMERS, M.D.
DEPUTY DIRECTOR OF HEALTH

HENRY N. THOMPSON, M.A.
DEPUTY DIRECTOR OF HEALTH

MELVIN K. KOIZUMI
DEPUTY DIRECTOR OF HEALTH

ABELINA MADRID SHAW, M.A., J.D.
DEPUTY DIRECTOR OF HEALTH

In reply, please refer to:
File: EPHSD-SS

August 3, 1982

MEMORANDUM

To: Kisuk Cheung, Chief
Engineering Division
Department of the Army

From: Deputy Director for Environmental Health

Subject: Draft Interim Survey Report and Environmental Impact Statement (EIS) for Wailua River Hydropower, Kauai

Thank you for allowing us to review and comment on the subject EIS. On the basis that the project will comply with all applicable Public Health Regulations, please be informed that we do not have any objections to this project.

We realize that the statements are general in nature due to preliminary plans being the sole source of discussion. We, therefore, reserve the right to impose future environmental restrictions on the project at the time final plans are submitted to this office for review.

Melvin K. Koizumi

MELVIN K. KOIZUMI

BC:jh
cc: Office of Environmental Quality Control

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Washington, D.C. 20230

OFFICE OF THE ADMINISTRATOR

August 9, 1982

Colonel Kenneth E. Sprague
District Engineer
Honolulu District Corps of Engineers
Department of the Army
Fort Shafter, Hawaii 96858

Dear Colonel Sprague:

This is in reference to your draft environmental impact statement and interim survey report entitled "Wailua River Hydropower, Kauai, Hawaii." The enclosed comments from the National Oceanic and Atmospheric Administration are forwarded for your consideration.

Thank you for giving us an opportunity to provide these comments, which we hope will be of assistance to you. We would appreciate receiving four copies of the final environmental impact statement.

Sincerely,

Joyce M. Wood

Joyce M. Wood
Director
Office of Ecology and Conservation

Enclosure: Letter from Doyle E. Gates
National Marine Fisheries Service

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
Western Pacific Program Office
P. O. Box 3830
Honolulu, Hawaii 96812

Rec'd 8/9/82
EC: dw

August 6, 1982

F/SWR1:JJN

Colonel Kenneth E. Sprague
District Engineer
U. S. Army Engineer District,
Honolulu
Fort Shafter, Hawaii 96858

Dear Colonel Sprague:

The National Marine Fisheries Service (NMFS) has received and reviewed the draft environmental impact statement (DEIS) and Interim Survey Report for Wailua River Hydropower, Kauai, Hawaii. The following comments are offered for your consideration.

General Comments

The proposed action described in the subject DEIS should not significantly affect resources for which NMFS has a responsibility. The tentatively selected plan (Plan 1A) will increase sedimentation of stream and possibly estuarine habitat below Wailua Falls during construction. However, these impacts will be temporary and should be relatively insignificant to aquatic resources, particularly with implementation of the mitigation measures outlined on page EIS-17, paragraph b. Aquatic Resources, (1) to (4).

Sincerely yours,

Doyle E. Gates

Doyle E. Gates
Administrator

cc: F/SWR, Terminal Is., CA
F/HP, Washington, D. C.

U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT SHAFTER, HAWAII 96858

PODED-PJ

9 August 1982

Mr. Susumu Ono
Chairman of the Board
Board of Land and Natural Resources
State of Hawaii
1151 Punchbowl Street
Honolulu, HI 96813

Dear Mr. Ono:

We have recently completed the Draft Interim Survey Report and Environmental Statement for the Wailua River Hydropower improvements, island of Kauai, Hawaii. The report was issued to all appropriate public agencies, including your Department of Land and Natural Resources. Favorable comments were received at the public meeting held on Kauai on 28 July 1982.

This study, as you are aware, is being conducted at the request of your agency. The Department of Land and Natural Resources has been designated the State sponsoring agency. The principal responsibility of the local sponsoring agency is to provide at periodic intervals of study and design memoranda completion, letters of intent to comply with statutory provisions of local cooperation requirements. The "letter of intent" serves to assure the Federal Government that local support is provided at each stage of investigation. We are including for your consideration a sample of the required letter (Incl 1).

The specific provisions for which you are requested to provide would be to comply with the following items:

a. Assure sound operation and maintenance of the project in accordance with regulations prescribed by the Secretary of the Army; and

b. Reimburse the Federal Government for all expenditures for the construction of the recommended plan, and all subsequent expenditures.

Members of my staff have discussed the need to provide this letter with your staff of the Division of Water and Land Development on 12 July 1982 and on 28 July 1982. With your assent, we intend to pursue to completion Plan 1A, the alternative plan which would provide 11.28 million kw-hr of average annual energy. The complete plan description is documented in our report.

Please bear in mind that although the initial date of operation of the hydropower plant is in the relatively distant future, and that both Federal and State administrative directions are subject to change, we should pursue the completion of the Federal authorization action. Without suitable local and Federal support, the study may be terminated without receiving its fully deserved evaluation.

We look forward to receiving your letter of intent by 27 August 1982. Your interest and cooperation in the Wailua River Hydropower study are appreciated.

Sincerely,

1 Incl
As stated

KENNETH E. SPRAGUE
Lt Col, Corps of Engineers
District Engineer

D R A F T

LTC Kenneth E. Sprague
District Engineer
US Army Engineer District, Honolulu
Bldg 230, Ft Shafter, HI 96858

Dear Colonel Sprague:

I understand your agency, the US Army Corps of Engineers, has completed the feasibility investigations for the Wailua River Hydropower Project, island of Kauai, Hawaii. Members of my staff have apprised me of the current state of planning and potential future work on this project. Based upon on the current coordination between our agency personnel, the final Corps report will be submitted to appropriate Federal processing channels, and depending upon the merits of the project and relative priorities among Federal projects, Congress may authorize the project for construction. As a result, there appears to be a relatively long leadtime between now and the ultimate completion of a project.

The State of Hawaii is supportive of the Corps' final selected plan for hydropower improvements in the Wailua River basin. We fully intend to cooperate with the Federal Government to continue planning and engineering work. Also, we support your future Federally-funded preauthorization studies which will more fully define the technical and financing details. Finally, with regard to your statutory requirements of Section 221 of the Flood Control Act of 1970 (Public Law 91-611), I declare the intention of the State of Hawaii, by the powers vested in my office, to enter in an agreement with the Secretary of the Army:

a. Assure sound operation and maintenance of the project in accordance with regulations prescribed by the Secretary of the Army; and

b. Reimburse the Federal Government for all expenditures for the construction of the recommended plan, and all subsequent expenditures.

Furthermore, I understand when the formal agreement is acquired prior to the commencement of the construction of the project, that the document will be signed by the authorized representatives of the State of Hawaii and the office of the Secretary of the Army.

Sincerely,

SUSUMU ONO
Chairman of the Board

INCL 1

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

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

SUSUMU ONO, CHAIRMAN
BOARD OF LAND & NATURAL RESOURCES
EDGAR A. HAMASU
DEPUTY TO THE CHAIRMAN
DIVISIONS:
AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

August 12, 1982

Colonel Alfred J. Thiede
Commander and District Engineer
U.S. Army Engineer Division,
Pacific Ocean
Building 230
Fort Shafter, Hawaii 96858

Dear Col. Thiede:

Comments on Draft Interim Survey Report and Environmental Statement, Wailua River Hydropower Project, Kauai

I understand your agency, the U.S. Army Corps of Engineers, has completed the feasibility investigations for the Wailua River Hydropower Project, island of Kauai, Hawaii, and that a public meeting on the project was held on Kauai on July 29, 1982. Members of my staff have apprised me of the current state of planning and potential future work on this project. It is my understanding that the final Corps report will be submitted to appropriate Federal processing channels, and depending upon the merits of the project and relative priorities among Federal projects, Congress may authorize the project for design and construction.

Our department has several concerns regarding the financing of the subject project. We are informed from your recent letter to the Governor that new Federal policy on Corps of Engineers' civil work projects which include hydropower development requires local participation of 50 percent for feasibility studies. Further, the Interim Survey Report on page 30 states, "The current administration position, subject to Executive and Congressional modification, is 100 per cent up-front financing by non-federal interests for hydropower projects." We understand that the referred to non-federal interest for the Wailua River Hydropower project is the State Government of Hawaii.

Though the State is vitally interested in developing alternative power to reduce their dependency on imported oil, any alternative power development project which requires up-front funding of $8.43 million would have to be closely scrutinized and the need, as well as the benefit and cost of the project, would be carefully weighed against other programs and projects.

Colonel Alfred J. Thiede
August 12, 1982
Page 2

In light of the above, I believe it is premature, at this time, to commit the State of Hawaii to any future financial or institutional arrangements for the Wailua River Hydropower Project. As you know, State appropriations for public work measures are highly dependent on legislative action and other priorities.

We do, though, wish to cooperate with the Federal government in continuing the planning and engineering design of the Wailua River Hydropower project. As we have previously informed you, we are interested in pursuing the details of the Federal policy on cost sharing of construction financing of power in order that we may evaluate the desirability of implementing the project.

Aside from these matters, we would also like to express our concerns regarding the potential impact of the hydropower project on our freshwater recreational fishery resource in the subject area. For the past two decades the Wailua River system with its extensive network of tributary streams has provided the freshwater angler with the largest and most productive smallmouth bass fishery in Hawaii. The protection of this sport fishery is therefore paramount among our concerns for any development projects proposed within this area which may threaten the loss of habitat through stream flow alterations. The proposed project poses such a threat. We suggest then that forthcoming studies on the impact of the proposed project on aquatic resources focus on: 1) a comprehensive assessment of the smallmouth bass to include their distribution and abundance in the tributaries to and mainstream of both the North Fork and South Fork, 2) the loss of smallmouth bass habitat downstream of Stable Storm Ditch intake on the North Fort, particularly during minimum flows, 3) the loss of fishing areas through the establishment of prohibited fishing zones and 4) angler access to the stream reaches and use of service roadways created for the proposed project.

Thank you for the opportunity to comment on the Draft Interim Survey Report and Environmental Statement for the Wailua River Hydropower project.

Very truly yours,

SUSUMU ONO, Chairman and Member
Board of Land and Natural Resources

PODED-PJ

U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT SHAFTER, HAWAII 96858

29 October 1982

Mr. Susumu Ono, Chairman
Board of Land & Natural Resources
State of Hawaii
P.O. Box 621
Honolulu, HI 96809

Dear Mr. Ono:

I am responding to your letter dated 12 August 1982 regarding the Wailua River hydropower project, island of Kauai, Hawaii. Mr. Richard Yamamoto and I were pleased to have recently discussed the project with you on 13 October 1982. In conjunction with follow-up informal discussions with your staff, we are hopeful that all remaining concerns related to the Letter of Intent have been resolved to your satisfaction.

Regarding the environmental concerns you had expressed, we concur that additional studies are in order. Preliminary coordination with the U.S. Fish and Wildlife Service personnel did not reveal the extent of this fishery. However, as pointed out by your staff of the Division of Aquatic Resources, there appears to be a small mouth bass sport fishery located on the North Fork Wailua River below the Stable Storm Ditch. Because of the possible loss of habitat resulting from the diversion of flow from the North Fork at the Stable Storm Ditch, further investigation and assessment of potential adverse impacts on the small mouth bass fishery will be conducted during the next phase of investigation. Close coordination with your staff regarding this matter will be maintained. We are also working closely with the U.S. Fish and Wildlife Service and generally agree upon the nature of the problem.

We appreciate your comments on the draft report. The Corps will look forward to continuing our cooperative efforts for further studies on this project as we pursue the route toward implementation.

Sincerely,

ALFRED J. THIEDE
Colonel, Corps of Engineers
District Engineer

United States Department of the Interior

GEOLOGICAL SURVEY
Water Resources Division
P.O. box 50166
Honolulu, Hawaii 96850

August 9, 1982

Kisuk Cheung
Chief, Engineering Division
Department of the Army
U.S. Army Engineer District, Honolulu
Ft. Shafter, Hawaii 96858

Dear Sir:

The U.S. Geological Survey, Water Resources Division, Hawaii District, staff has reviewed the Interim Survey Report and Environmental Statement for the Wailua River Hydropower, Kauai, Hawaii, and have no comments to offer.

We appreciate you allowing us to review the document.

Aloha,

Benjamin L. Jones

Enclosure

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
HONOLULU AREA OFFICE
300 ALA MOANA BLVD., RM. 3318, P.O. BOX 50007
HONOLULU, HAWAII 96850

REGION IX

IN REPLY REFER TO:

August 12, 1982

LTC Kenneth E. Sprague
District Engineer
U. S. Army Engineer District, Honolulu
Building 230
Fort Shafter, Hawaii 96858

Dear LTC Sprague:

SUBJECT: Draft Environmental Impact Statement (DEIS)
Waialua River Hydropower Project
Kauai, Hawaii

The Honolulu Area Office has reviewed the subject DEIS that reviews the potential impact of a small-scaled hydropower development in the Waialua River.

We find that the proposed action does not adversely impact any HUD action in Kauai.

We appreciate the opportunity to comment on this DEIS and look forward to receiving the Final EIS.

Sincerely,

Robert K. Fukuda
Area Manager, 9.1S

cc:
9C James, 8428

FEDERAL ENERGY REGULATORY COMMISSION
333 MARKET STREET, 6th FLOOR
SAN FRANCISCO, CA. 94105

August 13, 1982

Lieutenant Colonel Kenneth E. Sprague
District Engineer
U.S. Army Engineer District,
Honolulu
Building 230
Fort Shafter, Hawaii 96858

Dear Colonel Sprague:

This is in response to your letter of June 30, 1982, requesting our review and comments on the draft Interim Survey Report and Environmental Statement for the Wailua River Hydropower Study, island of Kauai, Hawaii, dated June 1982.

We have reviewed the draft report to determine the effects of the proposal on the Commission's responsibilities under the Federal Power Act, Natural Gas Act, and other authorities. Such responsibilities relate to the licensing of non-Federal hydroelectric power projects, participation in the planning of Federal water and power resources projects, and the regulation of construction and operation of natural gas pipelines.

The Wailua River Hydropower Study was conducted under the authority of the Flood Control Act of 1962 and in response to the specific request of the State of Hawaii. The study provided an analysis of the electrical utility energy needs and the alternatives available to meet the needs for the island of Kauai.

The tentatively selected plan would consist of the basic hydropower features of hydraulic control and conduit structures, powerplant transmission line, and access facilities on the South Fork Wailua River. The powerplant would be sized for 5.0 MW, and would operate in the range of 65 to 390 cfs with a two-turbine system. The design flow was established as equalling the 70 percent value of the flow duration curve and includes additional waters diverted from the North Fork Wailua River via the Stable Storm Ditch to augment flows available for hydropower development and to provide sufficient downstream flows for native fisheries. Electrical transmission lines would connect directly to the existing Kauai Electric Lydgate Substation located near Lydgate State Park.

Average annual energy for the project would be 11,280,000 kWh. Firm capacity would not be available for the hydropower scheme, due to the relatively low plant factor resulting from non-firm flows. Annual costs were based on the current Federal interest rate of 7-5/8 percent interest

and 100-year economic life, excluding construction inflation. Based on the power value data supplied earlier by this office, which assume continued real price escalation for fossil fuel and reflect a system energy displacement effect, the project appears to be economically justified with a benefit to cost ratio of 1.3 for a power-on-line date of 1990. The benefit to cost ratio would be slightly higher with a power-on-line date of 1995. The total project cost rate is shown on the pertinent data tabulation on page iii to be $8,430,000, based on January 1982 price levels, with an annual cost of $691,000. Annualized benefits would be $891,000.

Our analysis of the subject report is based on the premise that the Wailua River Project would be constructed and operated by the Federal Government. An analysis based on State financing, ownership, and operation would give significantly different results.

The draft environmental statement appears to adequately protect the future development of any potential hydroelectric project. The project would not have any impact on natural gas pipeline facilities.

We have appreciated the opportunity of being able to contribute to the evaluation of electric power potential in your study area. If you have any questions, or require any additional information, please notify us.

Sincerely,

W. F. Kopfler, II
Regional Engineer

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
550 HALEKAUWILA ST.
ROOM 301
HONOLULU, HAWAII 96813

Jacqueline Parnell
DIRECTOR

TELEPHONE NO.
548-6915

August 13, 1982

Mr. Kisuk Cheung, Chief
Engineering Division
U.S. Army Engineer District, Honolulu
Building 230, Fort Shafter
Honolulu, Hawaii 96858

SUBJECT: Draft Interim Survey Report and Environmental Statement, Wailua River Hydropower, Kauai

Dear Mr. Cheung:

We have reviewed the subject document and offer the following comment for your consideration:

> Since the study proposes the use of state land and/or funds which initiates the state EIS law, it is suggested that consideration be given to a joint EIS process to reduce duplication.

We would like to have twenty-two copies of the final EIS in order to keep our EIS data base current.

We thank you for the opportunity to review the EIS and survey report. We look forward to the final document.

Sincerely,

Jacqueline Parnell

Jacqueline Parnell
Director

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
DIVISION OF CONSUMER ADVOCACY
DEPARTMENT OF COMMERCE AND CONSUMER AFFAIRS
P. O. BOX 541
HONOLULU, HAWAII 96809

MARY G. F. BITTERMAN
Director of
Commerce and Consumer Affairs

WILLIAM W. MILKS
EXECUTIVE DIRECTOR

August 16, 1982

Mr. Kisuk Cheung
Chief, Engeering Division
Department of the Army
U.S. Army Engineer District, Honolulu
Fort Shafter, Hawaii 96858

Dear Mr. Cheung:

We generally support the idea of a hydropower facility in the Waialua River Basin. We realize that conditions change as time goes by, especially with regards to the economics of the hydropower project. However, we feel that with the uncertain future of the supply and price of fossil fuels, the economics and other benefits will favor this type of project.

We have one other comment to make which concerns the capacity requirements for Kauai Electric. Hawaii's electric utilities do not experience the sharp winter of summer peak loads as do the utilities on the mainland. Consequently, capacity requirements become critical not only during the system peak, but also during the period when the utility has its large units down for overhaul. Many times it is during this period when the large units are down for overhaul that the capacity requirements become most critical.

We appreciate the opportunity to comment on your Waialua River Hydropower draft report.

Very truly yours,

Roy Terada

Roy Terada
Chief Engineer

GEORGE R. ARIYOSHI
GOVERNOR

JACK K. SUWA
CHAIRMAN, BOARD OF AGRICULTURE

SUZANNE D. PETERSON
DEPUTY TO THE CHAIRMAN

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

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

August 16, 1982

MEMORANDUM

To: Mr. Kisuk Cheung, Chief
Engineering Division
Department of the Army

Subject: Draft Interim Survey Report and Environmental Statement for the Wailua River Hydropower Study, Island of Kauai, Hawaii

The Department of Agriculture has reviewed the subject statement and offers the following comment.

We believe that it would be beneficial if the final version contained a discussion of the impacts and/or benefits, if any, of the project related to agricultural irrigation.

Thank you for the opportunity to comment.

Jack K. Suwa
JACK K. SUWA
Chairman, Board of Agriculture

"Support Hawaiian Agricultural Products"

Advisory Council On Historic Preservation

1522 K Street, NW
Washington, DC 20005

Reply to: PLEASE NOTE OUR CHANGE IN ADDRESS" [illegible] Plaza South, Suite 616
[illegible]4 Union Boulevard
Lakewood, CO 80228

730 Simms Street, Room 450
Golden, Colorado 80401

August 24, 1982

Mr. Kisuk Cheung
Chief, Engineering Division
Department of the Army
U.S. Army Engineer District, Honolulu
Fort Shafter, Hawaii 96858

Dear Mr. Cheung:

Thank you for your request received August 9, 1982, for comments on the Draft Interim Report and Environmental Statement for the Wailua River Hydropower Study, Kauai, Hawaii. Pursuant to Section 102(2)(C) of the National Environmental Policy Act of 1969 and the Council's regulation, "Protection of Historic and Cultural Properties" (36 CFR Part 800), we have determined that your draft environmental statement appears adequate concerning our area of interest, and we have no further comments.

Sincerely,

Louis S. Wall
Louis S. Wall
Chief, Western Division
of Project Review

This response does not constitute Council comment pursuant to Section 106 of the National Historic Preservation Act or Section 2(b) of Executive Order 11593.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
215 Fremont Street
San Francisco, Ca. 94105

AUG 30 1982

LTC Kenneth E. Sprague
District Engineer
U.S. Army Engineer District, Honolulu
Building 230
Fort Shafter, Hawaii 96858

Dear Colonel Sprague:

The Environmental Protection Agency (EPA) has received and reviewed the Draft Environmental Impact Statement (DEIS) titled WAILUA RIVER HYDROPOWER PROJECT, ISLAND OF KAUAI, HAWAII.

EPA's comments on the DEIS have been classified as Category LO-2. Definitions of the categories are provided by the enclosure. The classification and the date of the EPA's comments will be published in the Federal Register in accordance with our responsibility to inform the public of our views on proposed federal actions under Section 309 of the Clean Air Act. Our procedure is to categorize our comments on both the environmental consequences of the proposed action and the adequacy of the environmental statement.

EPA appreciates the opportunity to comment on this DEIS and requests three copies of the Final Environmental Impact Statement (FEIS) when available. If you have any questions regarding our comments, please contact Loretta Kahn Barsamian, Chief, EIS Review Section, at (415) 974-8188 or FTS 454-8188.

Sincerely yours,

William Anning

for John Wise, Acting Director
Office of Policy, Technical,
and Resources Management

Enclosures (2)

Water Quality Comments

1. The Final Environmental Impact Statement (FEIS) must assess the potential of Alternatives 1A and 2A to adversely impact the water quality of the South Fork Wailua River both upstream and downstream of the proposed project. An increase in scouring potential and ponding may lead to an increase in erosion; temperature fluctuations may occur upstream of the power plant due to ponding and to the reduction of flows between the diversion structure and the power plant; reduced flows could lead to downstream sedimentation problems and loss of gravels suitable for spawning by native fisheries. Periodic flushing flows may be necessary to maintain a viable fishery downstream of Wailua Falls. We are concened that state-adopted, EPA-approved water quality standards may be impacted and suggest that appropriate mitigation measures be identified to protect beneficial uses.

2. Although a minimum flow of 10 cubic feet per second (cfs) is recommended to mitigate adverse impacts of the diversion structure for both Alternatives 1A and 2A, Tables 18 and 19 indicate that the frequency of flows of 10 cfs or less would increase under both these alternatives. Please address this discrepancy and identify how the 10 cfs will be maintained.

3. The FEIS should discuss the effects of additional North Fork Wailua River flow diversion on the aquatic environment downstream of its confluence with the Stable Storm Ditch. In addition, please indicate whether or not a minimum flow will be maintained for the weir at the U.S. Geological Survey's gaging station 620 on the North Fork Wailua River.

4. Both Alternatives 1A and 2A would require electrical transmission lines crossing through the Kalepa Forest Reserve. The FEIS should address the environmental impact of routing the transmission lines through this reserve.

5. It is unclear how improvements to the visitor parking and viewing area would mitigate impacts from project construction facilities in the vicinity of the Falls (EIS, page 20).

Section 404 Comments

The 404(b)(1) evaluation (Appendix G) should be based on the current Guidelines promulgated on December 24, 1980, rather than the September 5, 1975 version. The evaluations of impacts on water quality, aesthetics, fisheries, and wildlife are not consistent with evaluations of these factors presented elsewhere in the document.

The Guidelines at 40 CFR 230.10(c) state:

> No discharge of dredged or fill material shall be permitted which will cause or contribute to significant degradation of the waters of the United States. Under these Guidelines, effects contributing to significant degradation considered individually or collectively, include... significantly adverse effects of discharge of pollutants on recreational, aesthetic, and economic values.

Please discuss this project's compliance with this section of the Guidelines.

General Comment

We support Alternative 3 as the preferred alternative because it has less potential to adversely impact Water Quality Standards adopted for the South Fork Wailua River.

EIS CATEGORY CODES

Environmental Impact of the Action

LO—Lack of Objections

EPA has no objection to the proposed action as described in the draft impact statement; or suggests only minor changes in the proposed action.

ER—Environmental Reservations

EPA has reservations concerning the environmental effects of certain aspects of the proposed action. EPA believes that further study of suggested alternatives or modifications is required and has asked the originating Federal agency to reassess these aspects.

EU—Environmentally Unsatisfactory

EPA believes that the proposed action is unsatisfactory because of its potentially harmful effect on the environment. Furthermore, the Agency believes that the potential safeguards which might be utilized may not adequately protect the environment from hazards arising from this action. The Agency recommends that alternatives to the action be analyzed further (including the possibility of no action at all).

Adequacy of the Impact Statement

Category 1—Adequate

The draft impact statement adequately sets forth the environmental impact of the proposed project or action as well as alternatives reasonably available to the project or action.

Category 2—Insufficient Information

EPA believes that the draft impact statement does not contain sufficient information to assess fully the environmental impact of the proposed project or action. However, from the information submitted, the Agency is able to make a preliminary determination of the impact on the environment. EPA has requested that the originator provide the information that was not included in the draft statement.

Category 3—Inadequate

EPA believes that the draft impact statement does not adequately assess the environmental impact of the proposed project or action, or that the statement inadequately analyzes reasonably available alternatives. The Agency has requested more information and analysis concerning the potential environmental hazards and has asked that substantial revision be made to the impact statement.

If a draft impact statement is assigned a Category 3, no rating will be made of the project or action, since a basis does not generally exist on which to make such a determination.

DEPARTMENT OF THE ARMY
PACIFIC OCEAN DIVISION, CORPS OF ENGINEERS
FT. SHAFTER, HAWAII 96858

PODED-PV

1 October 1982

Mr. John Wise, Acting Director
Office of Policy, Technical, and
Resources Management
US Environmental Protection Agency
Region IX
215 Fremont Street
San Francisco, CA 94105

Dear Mr. Wise:

Thank you for your 30 August 1982 letter providing comments on our Wailua River Hydropower Draft Interim Survey Report and Environmental Statement. Responses to your comments are provided in the inclosure.

We trust that these responses are satisfactory. Indicated areas of correction will be suitably modified in the Final Environmental Statement.

Sincerely,

KISUK CHEUNG
Chief, Engineering Division

1 Incl
As stated

WAILUA RIVER STUDY
RESPONSES TO EPA COMMENTS FOR
DRAFT EIS

4 October 1982

1. Potential long-term adverse impacts to water quality resulting from implementation of Plan 1A or 2A would be minimal. The pond area created by the diversion structure would be small (approx 4.4 acres with a volume of 23.5 acre-feet). The detention time within the impoundment would be 24 hours for a 12 CFS flow. Normally the rate of turnover in the pond would be many times greater than once per day, hence, increases in water temperature would be negligible. Fluctuations in the water level in the impoundment would normally be small and the banks of the pond are currently heavily vegetated, thus erosion would not be a serious problem. In addition, turbidity levels of stream water under normal conditions are relatively high, due to frequent freshets. A small additional contribution of silt resulting from the project, however unlikely, would have a minimal effect on existing water quality. Plan 1A would not result in downstream sedimentation because the distance between the diversion structure and powerplant is small (approx 800 feet). For Plan 2A some sedimentation within the stream reach between the diversion structure and powerplant (approx 1.7 miles) may be anticipated. However, periodic flushing flows would occur whenever flows exceed the design flow of 390 CFS. This would take place about 8% of the time (see Plate B-5) and occur relatively randomly throughout the year. Such flows, often exceeding 2,000 CFS, would provide sufficient scouring of the stream bed to preclude any long-term or significant deposition of sediment.

2. There is no discrepancy regarding the maintenance of a 10 CFS conservation flow during periods of powerplant operation. The increase in percentage of flows occurring in the 0-10 CFS range under project conditions (Tables 18 and 19) simply reflects the increase in flow of 10 CFS (the recommended conservation flow) being released during powerplant operations where flows under existing conditions would normally range between 65 and 390 CFS. The frequency of flows less than 10 CFS occurring under natural conditions would not be affected by the proposed project. Flows less than 10 CFS occur 32 percent of the time even under natural conditions.

3. Initial Corps of Engineers and subsequent US Fish & Wildlife Service aquatic surveys of the N. Fork Wailua River indicated that this region was depauperate. Hence, it was felt that impacts of the diversion of flow from the N. Fork to S. Fork would result in no significant adverse environmental effects downstream of the diversion at the stable storm ditch. Recently, we have been informed by the State Division of Aquatic Resources that this reach of stream is a significant part of the Wailua River small mouth bass sports fishery. Detailed surveys of the sport fishery populations and their instream flow requirements will be conducted during post-authorization studies. Conservation flow for the N. Fork will be based on the results of these surveys.

4. Concur. A discussion of potential impacts on the Ualepa Forest Reserve will be included in the FEIS.

5. The paragraph on page 20 of the EIS referenced in your letter reads:

> "Proposed improvements to the visitor parking and viewing area, including a visitor information center, would lessen or partially offset impacts in the vicinity of the falls, resulting from project construction activities."

We feel that this statement is valid and requires no further clarification.

Comments

6. A Section 404(b)(1) Evaluation based on the current guidelines will be provided in the FEIS.

The 404 evaluation specifically addresses impacts related to the discharge of fill material on water quality, fisheries, wildlife and other environmental resources. We feel that it is consistent with evaluation of impacts of the fill material where they appear elsewhere in the report.

7. We appreciate your view that Alternative 3 is the preferred action. However, clearly this alternative cannot be implemented by any single agency (including the Corps of Engineers). In addition, the measures may even be implemented without a hydropower project by independent homeowners. Thus although the alternative has been described, the plan is not strictly comparable to the principal structural plans.

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
PACIFIC SOUTHWEST REGION
BOX 36098 • 450 GOLDEN GATE AVENUE
SAN FRANCISCO, CALIFORNIA 94102
(415) 556-8200

August 31, 1982

ER 82/1171

Colonel Alfred J. Thiede
Division Engineer
Pacific Ocean Division
U.S. Army Corps of Engineers
Building 230
Fort Shafter, Hawaii 96858

Dear Colonel Thiede:

The Department of the Interior has reviewed the draft environmental statement and draft Interim Survey Report for Wailua River Hydropower Study, Kauai, Hawaii. Our comments are as follows:

General Comments

The National Park Service (NPS) reports that the statement identifies a direct and adverse impact on the aesthetic quality of Wailua Falls, caused by the proposed upstream diversion and resultant reduction of flows over the falls. Also, the visitor viewing area would be temporarily disrupted. To more adequately understand the magnitude of this potential impact, the following questions should be answered in the impact analysis.

1. What is the significance of Wailua Falls as compared to similar scenic attractions on both the Island of Kauai and other islands in the Hawaiian Chain? For example, the uniqueness of the falls should be discussed along with the relative accessibility as compared to other similar scenic attractions.

2. What reductions in visitor use can be expected from both the temporary disruption of the overlook and the long term reduction in scenic values? Both this and the current estimated visitor use should appear in Section 5, Environmental Effects of the statement.

The Wailua River State Park, in which the falls and proposed project are located, has received acquisition and development grants from the Land and Water Conservation Fund (L&WCF). While both of these grant projects are located in the downstream area of the park, the final statement should be consistent with the terms of the two grants. Mr. Susumu Ono, Chairman of the Board, Department of Land and Natural Resources, the requester of the hydropower study, is the Liaison Officer for the Land and Water Conservation Fund in Hawaii, and would be the appropriate contact on the two grant projects.

Thank you for the opportunity to review and comment on this draft environmental statement and draft Interim Survey Report.

Sincerely,

Patricia S. Port

Patricia Sanderson Port
Regional Environmental Officer

cc: Director, OEPR (w/copy incoming)
Director, Minerals Management Service
Reg. Dir., National Park Service
Reg. Dir., Fish and Wildlife Service
Reg. Dir., Bureau of Land Management
Reg. Dir., Bureau of Mines

U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT SHAFTER, HAWAII 96858

PODED-PV

7 December 1982

Ms. Patricia Sanderson Port
Regional Environmental Officer
Office of the Secretary
US Department of Interior
Pacific Southwest Region
450 Golden Gate Avenue
San Francisco, CA 94102

Dear Ms. Port:

I am responding to your letter commenting on the draft Interim Survey Report and Environmental Statement for Wailua River Hydropower Study, Kauai, Hawaii. We concur that the aesthetic resources and impacts of the project on these resources merit discussion. Question 1 and 2 of your letter will be addressed, as suggested in the final Environmental Impact Statement.

Regarding the consistency of the land grants, the State of Hawaii, Department of Land and Natural Resources (DLNR) indicates that two grants were received from the Federal Land and Water Conservation Fund (LAWCF) in 1967 to assist in the Wailua River State Park development. Both grants were used for land acquisition in the lower reaches of the river. Although portions of the proposed project would be located within or on the periphery of the park, we do not foresee any significant adverse effects resulting from the proposed hydropower improvements, including those lands acquired with Federal grant funds. Mr. Susumu Ono, Chairman of the Board of Land and Natural Resources, is fully supportive of our study.

We appreciate your comment and review of the Wailua River Hydropower study document. Your agency will be informed of the progress of the study during subsequent report processing.

Sincerely,

ALFRED J. THIEDE
Colonel, Corps of Engineers
District Engineer

THERMAL ENGINEERING CORPORATION
3049 UALENA STREET, SUITE 210 • HONOLULU, HAWAII 96819 • PHONE: (808) 836-0182

October 8, 1982

Mr. Paul Mizue
Planning Branch
U.S. Army Corps of Engineers
Building T
Fort Shafter, Hawaii 96858

Dear Paul:

Thank you for sending me a copy of the draft Wailua River Hydropower Study. I would like to compliment you on its thoroughness.

I really do not have any comments of a technical nature. My comment to Boyd Townsley was that the rate of return is too low for private industry to consider building and operating the plant.

Very truly yours,

T.W. Vorfeld
President

TWV:nlv

EDUARDO E. MALAPIT
MAYOR

OFFICE OF THE MAYOR
4396 RICE STREET
LIHUE, KAUAI, HAWAII 96766

JAMES N. KURITA
ADMINISTRATIVE ASST.

October 12, 1982

Colonel Alfred J. Thiede
District Corps of Engineers
Fort Shafter, Hawaii 96858

Dear Colonel Thiede:

One of Kauai's greatest sources of energy is its Hydro-electric potential and probably one of the strongest single locations on the island is on the south fork of the Wailua River. We are very happy that all indicators examined in phase I appear to be for continuance of the study.

Kauai, due to its isolated position in the Hawaiian chain is most vulnerable to energy shortages brought on by oil shortages or embargoes. Should this island's supply of oil be cut off by catastrophe, the only source of electrical power would be that generated by hydro. I think I speak for all of our Kauai residents in urging the U.S. Corps of Engineers to continue to move forward on its evaluation of the Wailua River as a location for a hydro-generator.

Yours very truly,

James N. Kurita
EDUARDO E. MALAPIT
Mayor, County of Kauai

WB/EM/ha

cc: Paul Mizuno
Corp of Engineers
Building 230
Fort Shafter, HI 96858

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

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

SUSUMU ONO, CHAIRMAN
BOARD OF LAND & NATURAL RESOURCES

EDGAR A. HAMASU
DEPUTY TO THE CHAIRMAN

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

November 10, 1982

Colonel Alfred J. Thiede
District Engineer
U.S. Army Engineer District, Honolulu
Bldg. 230, Ft. Shafter, HI 96858

Dear Colonel Thiede:

Reference is made to our meeting on 13 October 1982 with regard to the Wailua River Hydropower Study, Island of Kauai, Hawaii, which helped to clarify questions on the current status and processing of the feasibility report. It is my understanding that the Corps of Engineers has completed its investigations and is finalizing the report and a letter of intent from the local sponsor is required to indicate its support for the project.

The State of Hawaii is supportive of the Corps' selected plan for hydropower improvements in the Wailua River basin. We fully intend to cooperate with the Federal Government to continue planning and engineering work. Also, we support your future Federally-funded post-authorization studies which will more fully define the technical details.

I am providing you this Letter of Intent as evidence of our support for the Wailua River study and to assure you that the Federal Government shall be reimbursed for all expenditures for the construction of the recommended plan to the extent of available revenues generated from the project.

I am confident that the Wailua River project, in conjunction with other alternate energy developments, will enhance energy self-sufficiency for the island of Kauai and lead to the total economic well-being for the State of Hawaii. Working together, I anticipate our planning and engineering efforts will be beneficial to the people of Hawaii.

Very truly yours,

Susumu Ono
SUSUMU ONO
Chairman of the Board

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

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

SUSUMU ONO, CHAIRMAN
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EDGAR A. HAMASU
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CONSERVATION AND RESOURCES ENFORCEMENT
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FISH AND GAME
FORESTRY
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

DEC -7 1982

Mr. Kisuk Cheung, Chief
Engineering Division
Corps of Engineers
Building 230 (PODED-PV)
Fort Shafter, Hawaii 96858

Dear Mr. Cheung:

SUBJECT: Draft EIS and Interim Survey
Wailua River Hydropower Project
Wailua, Kauai, TMK 3-9-01: 1 and
3-9-02: 21, 31, 33

We would like to append the following comments to our response of August 12, 1982, regarding the above subject.

Recreational Concerns:

The recommended project and its hydroelectric generation alternative both have very significant impacts on the upper undeveloped portion of Wailua River State Park. A master plan was developed for the entire park in 1970. This plan has not been updated and there is no implementation scheduled for the upper South Fork area.

The subject study has addressed State Park interests to the extent they are known through the 1970 master plan and the impacts on these known interests have been addressed (see EIS-19, H-6). Unfortunately, the natural features and recreation opportunities of this portion of the park have not been adequately studied so the full impact of the subject proposal cannot be determined. However, it would be very helpful to us if pictures of the falls flowing at 10 cfs could be supplied. Much in their analysis depends upon this as a minimum flow, but we have no way to evaluate it with the information supplied.

Historic Sites Concerns:

Existing cultural resources inventories are inadequate with regard to the study of archival materials and subsurface, buried archaeological sites. Without such additional information, it would be difficult for the SHPO to make an informed decision on the project's impact on cultural resources or proposed project alternatives for mitigation and implementation.

We recommend an archaeological reconnaissance survey be conducted, to include subsurface testing, and a literature search be conducted to include archival material related to former land claims in the area.

Sincerely yours,

Susumu Ono
Chairman and
State Historic Preservation
Officer

DEPARTMENT OF PLANNING AND ECONOMIC DEVELOPMENT

December 16, 1982

Ref. No. 6907

Colonel Alfred J. Thiede
District Engineer
U.S. Army Engineer District Honolulu
Fort Shafter, Hawaii 96858

Dear Colonel Thiede:

Subject: Coastal Zone Management Federal Consistency Review, Wailua River Hydropower Project, Wailua, Kauai

We have reviewed the draft survey report and environmental statement for the proposed activity and offer these comments for your consideration.

The pursuit of energy development projects such as the hydropower facility at Wailua River is strongly supported by the State to lessen Hawaii's dependence on imported fossil fuels and to promote energy self-sufficiency. The Hawaii Coastal Zone Management (CZM) law, Chapter 205A, Hawaii Revised Statutes, likewise supports economic uses such as the subject project provided that the location, design, and construction of facilities will minimize any adverse social, visual and environmental impacts in the area.

In this regard, the primary concern from the CZM standpoint relates to the visual and aesthetic impacts of the hydropower facility's design given its proximity to the scenic Wailua Falls, the recreational impacts to the Wailua State Park, and the ecological impacts from the stream diversion and construction activities.

While the assessment addresses these potential impacts in Alternative 1A, the submission of further design and construction details are needed to assure these CZM concerns will be addressed to the maximum extent practicable. Accordingly, we will await the receipt of more specific design and development plans before determining the consistency for the proposed activity.

Your cooperation in complying with the substantive and procedural requirements of the CZM Program is greatly appreciated.

Sincerely,

Hideto Kono

DEPARTMENT OF THE ARMY
PACIFIC OCEAN DIVISION, CORPS OF ENGINEERS
FT. SHAFTER, HAWAII 96858
December 15, 1982

Mr. Susumu Ono
Chairman, Board of Land and
Natural Resources, and
State Historic Preservation Officer
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

Thank you for your letter of December 7, 1982, which provided supplementary comments on the Draft Interim Survey and Environmental Statement for the Wailua River Hydropower Study, Kauai, Hawaii.

Concerning recreation, we anticipate working closely with your State Parks Division in future engineering and design studies to develop a plan which would attempt to maximize both our objective of hydropower development and your objective of environmental preservation and recreational development.

Under undeveloped conditions, the flow over the falls is less or equal to 10 cfs, approximately 32 percent of the time. The proposed alternative plan would extend the frequency of the minimum 10 cfs flow. Photographs of Wailua Falls flowing at 10 cfs are currently unavailable. As indicated at the final public meeting, the evaluation of aesthetic effect would be completely subjective.

Regarding historic sites concerns, an archaeological reconnaissance has already been conducted for the study. Appendix H (Para. H-2) of the draft survey report summarizes the findings of Francis Ching's "A Cultural Resources Reconnaissance for the Wailua River Hydropower Study" prepared by Archaeological Research Center Hawaii (ARCH) for the Corps in April 1981. A copy of the report is enclosed for your information.

The ARCH report was prepared in the early phases of the study prior to the decision to site the diversion structure at Wailua Falls or to include electric power transmission lines in the project. As a result, the ARCH report does not provide a

detailed description of any historic sites in the immediate vicinity of the falls. We relied on the information contained in an reconnaissance-level investigation performed by Mr. Ching in 1968 for the State to locate cultural resources near the falls. This investigation was supplemented by our own analysis of early maps of the region. For similar reasons, the ARCH survey also does not cover the alternative electrical power transmission routes from the two proposed power generating plants to the grid along Kaumualii Highway. For the purpose of establishing project feasibility, any further detailed subsurface investigations would be beyond the scope of the overall hydropower study.

Additional information and analyses will be prepared during subsequent post-authorization activities. We believe that we have an adequate environmental resource data base for the Wailua Falls area to satisfactorily evaluate the impacts of the alternative plans for the current stage of investigation.

Sincerely,

Kisuk Cheung
Chief, Engineering Division

Enclosure

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
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HONOLULU, HAWAII 96809

SUSUMU ONO, CHAIRMAN
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AQUATIC RESOURCES
CONSERVATION AND RESOURCES ENFORCEMENT
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FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

MAR 7 1983

Mr. Kisuk Cheung, Chief
Engineering Division
Corps of Engineers
Pacific Ocean Division
Department of the Army
Building 230 (PODED-PV)
Fort Shafter, Hawaii 96858

Dear Mr. Cheung:

Thank you for forwarding a copy of "A Cultural Resources Reconnaissance for the Wailua River Hydropower Study" by Francis Ching (1981). The report has been useful in determining the quality and quantity of historic sites in the proposed alternative areas for the Wailua River hydropower project.

We received notification from your office that Alternative 1A was being recommended (Public Notice, December 30, 1982). From the archaeological and Corps project maps, it appears that archaeological area A and F will be affected by the project. There were no sites recorded in Area F. However, located in Area A are four previously recorded sites (Ching, 1968). Although Ching reports that sites #205-208 were located in 1968, we have no record of these sites in our office. Therefore, we would recommend that these sites be thoroughly recorded if they will be impacted or if there is a potential for disturbance or destruction. It is not clear from Ching's report if this was done, except the generalized map (Figure 4, page 21). Our concern for recordation is based on the fact that the information will be lost if the site is not recorded in detail and the site is impacted.

Please keep us informed on the progress of this project such that we can evaluate if this recordation will be needed before any construction.

Sincerely yours,

Susumu Ono
Chairman and
State Historic Preservation
Officer

cc: Robert Chuck, DOWALD

U.S. ARMY ENGINEER DIVISION, PACIFIC OCEAN

March 25, 1983

Mr. Susumu Ono
State Historic Preservation Officer
Department of Land and Natural Resources
State of Hawaii
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

Thank you for your timely response of March 7, 1983 concerning the cultural resources reconnaissance report for the Wailua River Hydropower study, Kauai, Hawaii.

We concur with your recommendation that the archaeological sites in Area "A" which would be affected by construction of Alternative 1A should be recorded prior to their destruction or disturbance. As presently planned, only the auwai, Site #208, would be affected.

The 1981 reconnaissance report prepared for the Corps by Archaeological Research Center Hawaii (ARCH) Inc. concluded (p. 5) that the archaeological remains in Area A were disturbed, unimposing and inappropriate for preservation or research. At that time, we accepted the opinion of the professional investigator that our construction project would not affect any significant archaeological sites. Although, the lack of recordation of that site prevents an independent evaluation of ARCH's opinion, we believe the reconnaissance study is in compliance with the intent of a Corps feasibility study, to assist in alternative plan selection.

Based on the above evaluation, if the Interim Survey Report is approved and funds are made available for further engineering and design studies, we will conduct additional archaeological investigations to determine the significance of the auwai structure. These studies will be conducted at the level of documenting potential National Register eligibility. Complete site recordation, i.e., data

-2-

recovery, can only be undertaken if the site is determined eligible for the National Register and during the construction period. These additional studies would also include a reconnaissance of the undesigned powerline corridor(s) and detailed surveys of any sites recorded in those areas, if recommended by the archaeologist.

In view of the flexibility of the alignment and construction impacts of the powerline, we believe any archaeological site can be either avoided or suitably protected. As a result, the archaeological reconnaissance effort conducted to date is considered adequate for this stage of the project. For Congressionally authorized projects, the authorization process and additional pre-construction planning and engineering will add a minimum of six years prior to initiation of any construction. Hence, there will be ample opportunity to perform any additional documentation of historic and archaeological sites.

We will keep you informed of the progress of the project as it relates to potential impacts on historic sites. Provided our response meets your requirements, we would appreciate a letter of concurrence on this matter.

Sincerely,

Kisuk Cheung
Chief, Engineering Division

Rev. Jun 83

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

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

SUSUMU ONO, CHAIRMAN
BOARD OF LAND & NATURAL RESOURCES

EDGAR A. HAMASU
DEPUTY TO THE CHAIRMAN

DIVISIONS:
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FISH AND GAME
FORESTRY
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

APR 11 1983

Mr. Kisuk Cheung, Chief
Engineering Division
Corps of Engineers
Pacific Ocean Division
Department of the Army
Building 230 (PODED-PV)
Fort Shafter, Hawaii 96858

Dear Mr. Cheung:

Thank you for your letter of March 25, 1983, regarding the Corps of Engineers hydropower project on the Wailua River, Kauai. Your letter clarified the matter of project scheduling and planning.

Our major concern is that the archaeological matters, mostly site recording and possibly testing, be conducted prior to any development. Enough time should be given to the archaeological studies to allow for possible significance and mitigation. We accept your plan of action as outlined in your letter. We were pleased to hear that you will be considering further archaeological studies beyond that conducted by Ching in 1981, now that your alternative and its impact have been narrowed down. This archaeological study, as you mentioned, should be evaluated for impact, mitigation, and possible nomination on the register of historic places.

Please keep our office informed on the progress of this project. We will be interested in evaluating the future archaeological work as it relates to the known cultural sites along the Wailua River.

Sincerely yours,

Susumu Ono
Chairman and
State Historic Preservation
Officer

WAILUA RIVER HYDROPOWER PROJECT

KAUAI, HAWAII

CIVIL ENGINEERING AND COST ESTIMATING INVESTIGATIONS

APPENDIX B

APPENDIX B

CIVIL ENGINEERING
AND
COST ESTIMATING INVESTIGATIONS

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APPENDIX B

CIVIL ENGINEERING
AND
COST ESTIMATING INVESTIGATIONS

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APPENDIX B

CIVIL ENGINEERING
AND
COST ESTIMATING INVESTIGATIONS

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APPENDIX B

CIVIL ENGINEERING
AND
COST ESTIMATING INVESTIGATIONS

TABLE OF CONTENTS

LIST OF PLATES (Cont)

1/ All plates follow page B-29 in numerical order.

HYDROLOGIC INVESTIGATIONS

RAINFALL

1. Average annual rainfall varies from approximately 50 inches near the coastline to over 450 inches on Mount Waialeale. An isohyetal map of the Wailua basin is shown on Plate B-1. Rainfall stations shown on Plate B-1 are listed on Table B-1.

STREAMFLOW

2. Principal watercourses in the Wailua River basin are the North and South Forks of the Wailua River and Opaekaa Stream, with drainage areas of 18.5, 26.0 and 6.4 square miles, respectively. Total drainage area in the Wailua basin is 51.6 square miles. Principal watercourses and tributaries are shown on Plate B-2. Table B-2 lists the stream and ditch-gaging stations operated by the U.S. Geological Survey in the Wailua basin and Table B-3 lists the ditch stations operated by Lihue Plantation.

IRRIGATION DIVERSION

3. The network of streams and irrigation ditches in the Wailua River basin, shown in Plate B-2, create a complex pattern of surface flow. A description of the diversions occurring in the basin follows:

a. The Hanalei Tunnel conveys waters from the Hanalei River basin into the North Fork Wailua River basin from which the water is diverted downstream for irrigation in the vicinity of Lihue and Kapaa.

b. Streamflows from the North Fork are diverted at three locations. The upper two diversions, the Iliiliula - North Wailua Ditch and Stable Storm Ditches, take water to the South Fork basin. The third and lowest diversion, the Wailua Ditch, takes water to Wailua Reservoir and from there for irrigation above Kapaa. The main function of the Iliiliula - North Wailua Ditch is to provide water for hydroelectric generation at Lihue Plantation's Upper Power House. The diverted water via the Stable Storm Ditch is used for irrigation in the vicinity of Lihue.

c. Water comes into the South Fork basin via the two North Fork diversions and is diverted at three locations: The Koloa Ditch transports water south to the McBryde Sugar Co. fields in Koloa, and the Upper Lihue and Hanamaulu Ditches divert water to Lihue and Hanamaulu for Lihue Plantation's use. The Upper Lihue Ditch branches into the Upper Lihue Ditch and the Lower Lihue Ditch about two miles below its intake. The Lower Lihue Ditch conveys water to Kapaia Reservior for mill and irrigation use.

d. In formulating alternatives, it was assumed that the diversions and the external inflows and outflows will continue.

TABLE B-1

RAINFALL STATIONS

State Key Number	Station Name	Elevation Above MSL (Feet)	Latitude Deg-Min-Sec	Longitude Deg-Min-Sec	Period of Record	Frequency of Observations	Observer
1022	Hanamaulu	175	21-59-42	159-21-30	1893-date	Daily	Lihue Plantation
1047	Mt. Waialeale	5,075	22-04-06	159-30-00	1910-date	Continuous	USGS
1050	Iliiliula Intake	1,070	22-02-24	159-28-18	1935-date	Daily	Lihue Plantation
1051	N. Wailua Ditch	1,110	22-03-36	159-27-54	1928-date	Daily	Lihue Plantation
1052	Waiahi Upper	780	22-01-24	159-28-00	1931-date	Daily	Lihue Plantation
1053	Hanalei Tunnel	1,220	22-05-00	159-28-12	1928-date	Monthly	Lihue Plantation
1054	Waiahi Lower	550	22-01-06	159-26-48	1910-date	Daily	Lihue Plantation
1055	N. Wailua River	650	22-03-48	159-26-18	1915-date	Monthly	Lihue Plantation
1056	Wailua River #1	800	22-04-43	159-25-27	1963-date	Continuous	USGS
1056.1	Wailua River #2	1,500	22-05-48	159-26-27	1963-date	Continuous	USGS
1056.2	Wailua River #3	1,970	22-06-18	159-26-54	1963-date	Continuous	USGS
1056.3	Wailua River #4	2,177	22-07-02	159-26-26	1963-date	Continuous	USGS
1057	Hanamaulu 46	570	22-03-48	159-25-24	1935-date	Monthly	Lihue Plantation
1061	EKW 5	475	22-03-36	159-24-12	1932-date	Daily	Lihue Plantation
1062	Wailua Uka	250	22-01-30	159-24-06	1924-date	Daily	Lihue Plantation
1063	Field 619	300	22-04-30	159-21-48	1948-date	After rain	Hawaiian Fruit Packers
1065	Wailua Kai	70	22-02-24	159-20-36	1924-date	Daily	Lihue Plantation

Note: Above data from "Climatologic Stations in Hawaii", Report R42, State of Hawaii.

TABLE B-2

STREAM AND DITCH GAGING STATIONS

USGS STATION NUMBER	USGS STATION NAME	DRAINAGE AREA (SQ. MI)	ELEVATION (FEET)	PERIOD OF RECORD
600	South Fork Wailua River Near Lihue	22.4	240	1911-current
610	North Wailua Ditch Near Lihue	----	1,105	1932-current
612	North Wailua Ditch Below Waikoko Stream	----	1,070	1965-current
620	Stable Storm Ditch Near Lihue	----	710	1936-current
630	North Fork Wailua River at Altitude 650 Ft	5.29	650	1914-current
680	East Branch of North Fork Wailua River	6.27	500	1912-current
690	Wailua Ditch Near Kapaa	----	462	1936-current
710	North Fork Wailua River Near Kapaa	17.9	18	1952-current
715	Left Branch Opaekaa Stream	0.65	458	1960-current
1000	Hanalei Tunnel Outlet Near Lihue	----	1,210	1932-current

TABLE B-3

LIHUE PLANTATION DITCH STATIONS

Station Description	Elevation (Feet)	Period of Record Comments
Hanamaulu Ditch	400	Ditch constructed in 1903; there are 13 years of no record between 1903 and 1926.
Upper Lihue Ditch	520	Ditch constructed in 1903; there are 13 years of no record between 1903 and 1926.
Lower Lihue Ditch	470	Date of ditch construction circa 1903; more than 20 years of no record prior to 1925.
Koloa Ditch	780	Ditch constructed in 1915; first 12 years of diversion not measured.

FLOW DURATION

4. Basic Data. Information from two USGS stream gaging stations were used to construct flow duration information for this study. The two stations were Station 600, South Fork Wailua River near Lihue and Station 630, North Fork Wailua River at altitude 650 feet near Lihue. The respective drainage areas are 22.4 and 5.29 square miles. Station 600 has 63 years of daily flow values available from 1913 to 1980, with missing data for years 1919, 1921, 1925, 1957 and 1958. Station 630 has 64 years of daily flow values available from 1916 to 1980 with missing flow data for year 1919. Flow duration tables were computed from the USGS Watstore computer program. Flow duration curves for Station 600 and 630 are shown on Plates B-3 and B-4.

5. Role in Project Formulation. In the preliminary screening of sites for the relative location of diversion and powerplant, an inspection of the topography, the constructability, and the relationship of discharge and differences in elevation were analyzed. To provide a planning-level assessment of power, a graphical relationship of discharge at 20 percent flow duration exceedance frequency and elevation of the length of the South Fork Wailua River. The discharge along the lower river was determined from the actual records of USGS Gage 600 (Plate B-3) and supplemental analysis from other related studies. The 20 percent flow near Wailua Falls was determined to be 150 cubic feet per second (cfs). From the Belt, Collins and Associate study (p 4, Main Report), approximately 83 percent (or 124 cfs) of the runoff

was generated from areas of higher elevation where there are significant number of tributaries. Finally, from recent US Army Engineer District, Honolulu Study of headwaters for the island of Kauai, the headwater point was determined to be located 17.7 miles above the mouth. The 20 percent discharge at this location would be less than one cfs. The graphical relation between the 20 percent discharge and river mile is shown on Plate B-4A.

6. Superimposed on the same Plate B-4A is shown the streambed elevation. Hence, for purposes of planning and evaluation; an approximation of powerplant capacity may be determined utilizing the relationship of discharge and elevation along the river reach. Utilizing a maximum practical distance of one mile for the waterway length and the standard power equation as shown below, various locations of diversion/powerplant would be located.

$$P = 0.07\ QH$$

in which P = capacity (efficiency at approximately 80 percent), kw.
Q = design discharge (assumed at 20 percent), cfs.
H = net head (elevation difference between the one mile length), feet.

7. The relationship of various locations of powerplant location are shown in Table B-4. The information developed for this table was used in conjunction with the visual evaluation of topography and constructability to derive the suitable alternative location of the hydropower facilities. Further discussion is provided in the Main Report.

TABLE B-4. RELATIVE POWERPLANT CAPACITIES AT LOCATIONS ALONG THE SOUTH FORK WAILUA RIVER[1/]

Location, Mile Above Mouth: Powerplant	Location, Mile Above Mouth: Diversion	Relative Difference in Elevation feet	Approx. Discharge cfs	Capacity kw
2	3	4	154	40
4	5	210	150	2,200
8	9	50	127	440
13	14	60	69	290
16	17	210	15	220

1/ Reference Plate B-4A

8. Project Flow Duration Curves. To derive the total flow available at Station 600 with the additional diverted flow from Station 630 via the Stable Storm Ditch, the following procedure was used with the results tabulated on Table B-5. Flow duration curve flows for Station 630 were read at selected intervals and tabulated. Five cfs was subtracted from the tabulated values to allow for instream use in the North Fork Wailua River. High flows between the 0 to 20% interval were allowed to pass downstream into the North Fork Wailua River and only flows between the 20% to the 100% interval were allowed to be diverted via the Stable Storm Ditch to the South Fork Wailua River. The diverted flows were added to the flows of Station 600 at selected intervals.

9. The combined flows represent the flow available for power near Station 600. Ten cfs was subtracted from the combined flows for instream use in the South Fork Wailua River. The flow duration curve depicting the total flow available near Station 600 is shown on Plate B-5. It is to be noted that the flows diverted at Station 630 were assumed to remain the same when arriving at Station 600. This assumption is valid because losses from the diverted flows are offset by the gaining stream flows of the South Fork Wailua River. Low flow measurements were available for two gages on the South Fork to verify the gaining nature of the river. Table B-6 shows the measurements for the two gages. Station 585 is a low flow partial record station and is located about 3 miles upstream of Station 600.

10. In comparing the natural and project flow conditions, the existing gaged records satisfactorily represent the expected flow conditions at the proposed diversions. Both Station 630 (North Fork Wailua) and Station 600 (South Fork Wailua) are sufficiently close enough to the proposed diversion points to directly utilize the records without adjustment.

11. The impact of the project on the existing streamflow regime were similarly derived. Plates B-5A, B-5B, B-5C, and B-5D illustrate the estimated effects of the project implementation upon the existing flow duration curves at existing USGS gages sites. As shown on Plate B-5A, the natural regime on the South Fork Wailua River is actually enhanced from 50 to 100 percent exceedance points. This increase is due to the added diversion flowing through the Stable Storm Ditch (Plate B-5B). In contrast, there exists an adverse impact on the North Fork Wailua River (Plates B-5C and B-5D). In all cases of these flow duration curves, the discharges were assumed to be directly and linearally added or subtracted at the respected exceedance percentage.

TABLE B-5

FLOW DURATION TABULATION

1	2	3	4	5	6	7
	DISCHARGE IN CUBIC FEET PER SECOND					
PERCENT OF TIME FLOWS ARE EXCEEDED	USGS STATION 630 NORTH FORK, DA-5.29 SQ MI	BALANCE OF STA 630 AFTER SUBTRACTING 5 CFS FOR IN STREAM USE	HIGH FLOWS FROM STA 630 ARE LOST. ONLY FLOWS FROM 20% TO 100% ARE DIVERTED	USGS STATION 600 SOUTH FORK, DA=22.4 SQ MI	BALANCE OF STA 600 FLOW AFTER SUBTRACTING 10 CFS FOR IN STREAM USE	TOTAL FLOW AVAILABLE COLUMNS 4+6
1	475	470	92	1120	1110	1202
2	362	357	92	860	850	942
5	224	219	92	450	440	532
10	151	146	92	275	265	357
20	97	92	92	150	140	232
30	76	71	71	98	88	159
40	60	55	55	62	52	107
50	47	42	42	36	26	68
60	41	36	36	16	6	42
70	33	28	28	10	0	28
80	20	15	15	6	0	11 1/
90	3.5	0	0	4.5	0	0
100	0.2	0	0	1.7	0	0

1/ 15 cfs - 4 cfs = 11 cfs. Four cfs was subtracted from 15 cfs to maintain the 10 cfs for instream use at Sta. 600.

TABLE B-6

LOW FLOW MEASUREMENTS SHOWING THE GAINING NATURE OF SOUTH FORK WAILUA RIVER

Date	Q in cfs Sta. 585 (DA = 20.2 SQ MI)	Q in cfs Sta. 600 (DA = 22.4 SQ MI)
10-1-74	4.8	10.0
6-3-75	2.8	4.8
6-24-75	4.0	8.1
6-27-75	3.2	5.1
7-11-75	2.2	4.0
7-23-75	2.0	4.6
8-26-75	2.1	3.9
9-26-75	1.5	2.5
10-28-75	2.7	5.7
6-3-76	3.4	5.7
9-1-76	2.3	5.1
1-21-77	1.7	4.0
3-25-77	2.9	7.1
7-25-77	2.5	9.3
2-1-78	2.3	4.2
1-3-79	3.2	7.5
4-3-79	3.3	7.7
5-1-79	3.2	6.1
12-5-79	4.1	6.9
2-27-80	6.0	8.2
4-1-80	5.2	10.0
7-1-80	8.5	52.0

Note: Sta. 585 is a low flow partial record station and is located about 3 miles upstream of Sta. 600.

12. The ranges of turbine discharge for each alternative are described in Appendix C. Based on the flow duration curves and the design conditions, specific discharge impacts of Alternatives 1A and 2A for the South Fork Wailua River on the Falls and downstream of the tailrace are shown on Tables B-7 and B-8, respectively. Similarly, the impacts for the North Fork River are provided in Tables B-9 and B-10. To summarize, all flows from the North Fork River between 5 to 92 cfs would be diverted to the South Fork River via the Stable Storm Ditch. On the South Fork, flows would not be diverted unless the project condition discharge exceeds the sum of the minimum turbine discharge plus the conservation flow of 10 cfs. Below this project condition discharge value, the flows will pass unaffected to downstream reaches. The maximum diversion discharge would be the sum of the maximum turbine discharge plus the conservation discharge of 10 cfs.

TABLE B-7. DISCHARGE IMPACT ON FALLS AND ON DOWNSTREAM SOUTH FORK WAILUA RIVER - ALTERNATIVE 1A 1/

Condition	Range of Flows, cfs 0-10	10-75	75-400	400 to peak
Impact on Falls				
Existing Condition, percent	32%	32%	30%	6%
Project Condition, percent	54%	40%	4%	2%
Net, percent	-22%	- 8%	+26%	+ 4%
Time, days/year	80	29	95	14
Impact on Downstream South Fork				
Existing Condition, percent	32%	32%	30%	6%
Project Condition, percent	12%	38%	41%	9%
Net, percent	+20%	+ 6%	-11%	- 3%
Time, days/year	73	22	40	11

1/ Minimum river in flow for diversion - 75 cfs
Range of turbine flows = 65 to 390 cfs

TABLE B-8. DISCHARGE IMPACT ON FALLS AND ON DOWNSTREAM SOUTH FORK WAILUA RIVER - ALTERNATIVE 2A[1/]

Condition	Range of Flows, cfs 0-10	10-68	68-360	360 to peak
Impact on Falls				
Existing Condition, percent	32%	32%	31%	7%
Project Condition, percent	54%	38%	5%	3%
Net, percent	-22%	- 8%	+26%	+ 4%
Time, days/year	80	29	95	14
Impact on Downstream South Fork				
Existing Condition, percent	32%	30%	31%	7%
Project Condition, percent	12%	36%	42%	10%
Net, percent	+20%	- 6%	-11%	- 3%
Time, days/year	73	22	40	11

1/ Minimum river in flow for diversion - 68 cfs
Range of turbine flows = 58 to 350 cfs

TABLE B-9. DISCHARGE IMPACT ON NORTH FORK WAILUA IMMEDIATELY DOWNSTREAM OF STABLE STORM DITCH DIVERSION[1/]

Condition	Range of Flows, cfs 0-10	10-100	100-400	400 to peak
Impact on Falls				
Existing Condition, percent	14%	65%	19%	2%
Project Condition, percent	83%	11%	6%	1%
Net, percent	-69%	+54%	+13%	+ 2%
Time, days/year	252	197	47	7

1/ Based on USGS Gage 630, DA = 5.3 Mi2 (Plate B-5C)

TABLE B-10. DISCHARGE IMPACT ON NORTH FORK WAILUA NEAR WAILUA HOMESTEADS[2/]

Condition	Range of Flows, cfs 0-10	10-100	100-400	400 to peak
Impact on Falls				
Existing Condition, percent	13%	48%	33%	6%
Project Condition, percent	62%	21%	12%	5%
Net, percent	-49%	+27%	+21%	+ 1%
Time, days/year	179	99	77	4

2/ Based on USGS Gage #710, DA = 17.9 Mi2 (Plate B-5D)

LOW FLOW FREQUENCY ANALYSIS

13. Low flow frequency curves for Station 600, South Fork Wailua River near Lihue and Station 630, North Fork Wailua River at altitude 650 feet near Lihue, using duration period of 1, 3, 7, 30, 60, 90 and 183 days were computed using the USGS Watstore computer program. Curves for the 1-day and 7-day duration for both stations are shown on Plates B-6 and B-7. For Station 600, 10 cfs was selected as a minimum flow criterion for instream use. From the curves from Plate B-6, the 1-day and 7-day low flows have a nonexceedance frequency of 93 and 90 percent respectively. This means that 93 and 90 percent of the time, the 1-day and 7-day low flows in any given year will be less than 10 cfs. Therefore, the selection of 10 cfs for instream use represents a sufficient amount of flow at this site. For Station 630, 5 cfs was selected for instream use and the 1-day and 7-day low flows have a nonexceedance frequency of 70 and 60 percent respectively from curves on Plate B-7. This shows that 5 cfs also represents a sufficient amount of flow at Station 630.

FLOOD FREQUENCY

14. The Wailua River basin has several long term gaging stations as listed in Table B-2. Key among these are Station 630, North Fork Wailua, which depicts conditions on the North Fork in the upper region of the basin and Station 600, South Fork Wailua and Station 710, North Fork Wailua, which depict conditions in the lower part of the basin. Floodflow frequency curve for Sta. 630 was calculated based on its own systematic record of 61 years of record and is shown on Plate B-8.

15. Floodflow frequency curves for Stations 600 and 710 were calculated from the respective systematic records and are shown on Plates B-9 and B-10. There is one high flow that plots above the curves shown on Plate B-10. Although it is probably a high outlier, it was included in calculating the curve for Station 710 because curve adjustment information is unavailable on past historical flood peaks. Frequency curves for Stations 600 and 710 depict conditions at their respective sites. Frequency curves were needed on the Wailua River below the confluence of the North and South Forks and below the confluence with Opaekaa Stream.

16. A multiple regression study was conducted for Kauai correlating the geometric mean flood (dependent variable) to the physiographic and meteorological characteristics (independent variables) of each gaging station used in the study. Discharges were calculated for these different concentration points in the lower reaches of the Wailua River. The results do not show reliable and consistent relationships between the discharges below the confluence of the North and South Forks and below the confluence with Opaekaa. As a result, further analysis using this method was not warranted.

17. To provide meaningful relationships of the discharges in the lower Wailua basin, a regional frequency analysis was conducted utilizing the mean annual peak flows from 15 gaging stations on Kauai. Basic data for the 15 gages are listed on Table B-11. Drainage areas vs. mean annual peak flows in cfs/square mile were plotted and are shown on Plate B-11. A graphical best fit curve was drawn through the points and is labeled "base curve." A curve parallel to the "base curve" was then drawn through the plotted point representing the area gaged at Sta. 600. This curve, labeled "Sta. 600," was used to derive the

frequency curve for Sta. 600 on the South Fork. Based on the influence of the Sta. 600 flow from the South Fork on the flows below the confluences in the lower Wailua River basin, another curve was drawn lower than but closer to the "Sta. 600" curve and parallel to the "base curve." This curve was labeled "Wailua River Curves below confluences" and was used for the lower Wailua River basin. Mean annual peak flow values were picked from the drainage area - mean annual peak flow curves for different concentration points such as for Wailua River at the mouth, DA = 51.6 square miles. The mean annual peak flow value was plotted on log probability paper and a curve was drawn parallel to the computed curve for Station 600. The computed curve was adjusted for expected probability using N = 67 years, after Station 600. Plate B-12 shows the expected probability flood frequency curves for the Wailua River at the mouth and at Station 600 and Table B-12 summarizes the peak flows.

TABLE B-11

STATIONS USED IN REGIONAL FREQUENCY ANALYSIS

USGS Station Number	Station Name	Drainage Area (Sq. Miles)	Years Record Years	Mean Annual Peak Discharge (CFS)	Mean Annual Peak Discharge CFS/Sq. Mi.
100	Kawaikoi Stream	3.95	64	3,590	909
160	Waimea River	20.0	43	5,330	267
190	Waialae Stream	1.79	37	2,240	1,251
280	Waimea River	45.0	47	10,200	227
310	Waimea River	57.8	41	13,100	227
360	Makaweli River	26.0	35	7,840	302
490	Hanapepe River	18.5	52	7,380	399
550	Huleia Stream	17.6	15	7,120	405
600	South Fork Wailua River	22.4	67	14,100	629
630	North Fork Wailua River	5.29	61	4,190	792
680	East Branch North Fork Wailua River	6.27	65	2,850	455
710	North Fork Wailua River	17.9	28	6,940	388
800	Kapaa Stream	3.86	40	3,080	798
890	Anahola Stream	4.27	62	2,970	696
1080	Wainiha River	10.2	27	6,870	674

TABLE B-12

SUMMARY OF PEAK FLOWS

Location	Drainage Area (Sq. Miles)	Q-2 (cfs)	Q-10 (cfs)	Q-100 (cfs)	Q-500 (cfs)
Wailua River at Mouth	51.6	17,500	40,500	83,000	124,000
Wailua River Downstream of Confluence of N.F. and S.F.	44.5	16,500	38,500	79,000	115,000
S.F. Wailua River above Confluence with N.F.	26	14,800	34,500	70,000	106,000
S.F. Wailua River at Sta. 600	22.4	14,100	33,700	68,000	103,000

PROBABLE MAXIMUM FLOOD

18. Probable Maximum Flood (PMF) estimates were needed for the design of improvements near Station 600, South Fork Wailua River, and Station 630, North Fork Wailua River. The probable maximum flood estimate of 115,000 cfs for Station 600 was taken directly from the study by the State of Hawaii, Department of Land and Natural Resources, "Waialeale Hydropower Study," 1978, which is a detailed study of hydropower in the Wailua basin. The procedure used in deriving the PMF followed Corps criteria. The 0.15 hour unit hydrograph used is shown on Plate B-13. The probable maximum storm hyetograph and probable maximum flood hydrograph are shown on Plate B-14. A uniform loss rate of 0.3 inch per hour was used.

19. The "Waialeale Hydropower Study" did not have an estimate of the PMF near Station 630; therefore, the following procedure was used in estimating one. Unit hydrograph studies were conducted on Station 680, East Branch of North Fork Wailua River near Lihue, where rainfall runoff data was available. Station 680 is located about 1.4 miles east of Station 630 and has a drainage area of 6.27 square miles compared to 5.29 square miles for Station 630. A unit hydrograph from the storm of October 16, 1966 was selected to represent Station 680 and was transferred to Station 630 using Snyder's synthetic unit hydrograph procedures. (See Plate B-15). The probable maximum storm hyetograph and probable maximum flood hydrograph are shown on Plate B-16. A uniform loss rate of 0.3 inch per hour was used. The peak of the PMF was 26,000 cfs.

HYDRAULIC INVESTIGATIONS

GENERAL

20. Two alternative alignments and locations were considered for the conduit, penstock, and powerplant features. Alternative 1A features would be located near Wailua Falls along the right bank. Alternative 2A features would be located on the left bank and would extend across a plateau before dropping down a bluff to the river. Both alternative plans would divert flow from the North Fork Wailua River to the South Fork Wailua River through the existing Stable Storm Ditch. Pertinent information for the alternatives are shown on Table B-13. The general plan view for the alternative plans are shown on Plate B-17. The plan and profiles for Alternative 1A are shown on Plate B-18; for Alternative 2A on Plate B-19 to Plate B-22.

Table B-13. PERTINENT PROJECT INFORMATION

	Alternative 1A	Alternative 2A
Modified Intake at Stable Storm Ditch	Yes	Yes
Diversion Dam on Wailua River	Yes	Yes
Intake Structure Height at River, feet	13.5	13.5
Ponding Storage		
Elevation, ft msl	255.0	255.0
Flooded Area, Acres	4.4	4.4
Volume, Acre-feet	23.5	23.5
Gatewell	Yes	Yes
Concrete Conduit Length	560" LF, 108" diam	3,100 LF, 108" diam
Head Box between conduit and penstock	Yes	Yes
Steel Penstock (72" diam) Length	282 LF	467 LF
Design Discharge (cfs)	390	350
Gross Head (ft)	187	241
Approximate Net Head (ft)	178	225
Tailrace	30 ft Ditch	500 LF, 72" diam Concrete Conduit

21. Water Surface Profiles. The water surface profile for the 500-year flood was developed for the Wailua River throughout the reaches where the proposed hydropower facilities are impacted or create an impact on the natural flows. The powerplant for Alternative 1A would be sited above the 500-year flood level. The powerplant for Alternative 2A would have a watertight hatch to keep out the 500-year flood levels. Water surface profiles were computed using cross sections derived from aerial surveys dated Dec 1975 at a horizontal scale of 1" = 200' with 5-foot contours. The Corps' HEC-2 water surface profile computer program was used for all of the profile analysis. The limits of the 500-year flood are shown on Plate B-17. Tailwater rating curves are shown on Plates B-29 and B-30.

22. Power Generation Discharges. Instantaneous discharges at two river locations and in the hydropower system are shown on Table B-14. The hydropower system operates only when river flows exceed 75 cfs for Alternative 1A or 68 cfs for Alternative 2A. The minimum discharge released for conservation purposes is 10 cfs and is included in the above flow values. The maximum flow used by the hydropower system is 390 cfs for Alternative 1A or 350 cfs for Alternative 2A. When the river flow exceeds 400 cfs for Alternative 1A or 360 cfs for Alternative 2A, all excess flow is passed over the diversion dam.

Table B-14. INSTANTANEOUS FLOW RANGES FOR POWER DEVELOPMENT AND FOR RELEASE OVER FALLS

Average Yearly Duration (Days)	Percent of Year	River Flow Upstream of Hydropower Intake (cfs)	Hydropower Flow (cfs)	Flow Over Wailua Falls (cfs)
Alternative 1A				
182	50	0 to 75	0	0 to 75
150	41	75 to 400	65 to 390	10
33	9	400 to Peak	390	10 to (Peak-390)
365 Days	100			
Alternative 2A				
175	48	0 to 68	0	0 to 68
150	41	68 to 360	58 to 350	10
40	11	360 to Peak	350	10 to (Peak-350)
365 Days	100			

23. Gross and Net Head. Gross head is the difference in water surface elevation from the headbox to the assumed tailwater elevation. Net head is the gross head less friction and other hydraulic losses. Net head is the head available for power generation.

FLOW REGULATION MEASURES.

24. Stable Storm Ditch Diversion. The Lihue Plantation diverts water from the North Fork Wailua River to the South Fork Wailua River through the Stable Storm Ditch. To divert larger quantities of water to the South Fork, the existing intake would be modified with a new sluice gate and the existing 190-foot conduit would be replaced with a 220-foot 5'H x 4'V box culvert. The box culvert invert would be depressed 1.9 feet below the existing invert to allow the design flow of 100 cfs through the culvert. The weir on USGS gaging station 620, located just downstream from the culvert, would be depressed by 1.35 feet to a crest elevation of 705.17 feet msl. The weir elevation is the hydraulic control on flow into the Stable Storm Ditch. The modified rating curve is shown on Plate B-28. The Stable Storm Ditch, at an average depth of 7 feet, can pass the diverted flow of 100 cfs at a depth of 2.6 ft and a velocity of 3.1 ft/sec with no modifications. The Lihue Plantation would continue using the ditch during dry periods when the hydropower plant would be shut down or running at reduced capacity. During wet periods, the Plantation has no need for the diverted flows. The existing diversion dam in the North Fork Wailua River would have a small notch cut in the stoplogs to pass the conservation flow (Plate B-23). No other modifications to the diversion dam are proposed.

25. Wailua River Diversion Dam. A concrete diversion dam (Plate B-24) would be constructed across the Wailua River to divert flows into the intake structure. The diversion dam would be about 13.5 feet high with a crest elevation at 255 feet msl and would extend about 220 feet across the Wailua River. The diversion structure would pond an area of 4.4 acres with a storage of about 23.5 acre-feet. The area-storage curve is shown on Plate B-31. The diversion dam serves several functions: raises water level and increases head on the turbine, diverts low water flows into the intake structure, and provides minor pondage. The low ogee shaped diversion structure crest was designed for the 100-year water surface elevation, in accordance with EM 1110-2-1603, "Hydraulic Design of Spillways", 3 March 1965. The dam will be designed to be overtopped by the Probable Maximum Flood.

26. Intake Structure. The intake structure consists of a trash rack, sluice gate, 60-inch diameter low level outlet, stop log grooves, and concrete work to divert flows into the conduit (Plate B-25). The intake structure would be inundated by all flows greater than 2-year (15,000 CFS) discharge. A low level sluice gate and outlet in the intake structure would allow conservation flows to bypass the diversion works. The sluice gate would also be capable of draining the ponding area to allow removal of sediment deposits. The stoplogs would be used for temporary dewatering of the low level outlet and trash rack and have no operational function relative to the hydropower facility.

27. Gatewell. A gatewell would serve as a flow control structure between the intake and conduit (Plate B-26). The gatewell consists of concrete work, a sluice gate, and a hatch and ladder for entry into the gatewell and conduit.

28. Conduit. A 108-inch diameter reinforced concrete conduit was selected to convey power flows from the intake structure to the head box. The conduit was designed to flow nine-tenths full and is on a slope based on Kutter's formula with a Kutter's n of 0.015. The conduit size, based on an analysis of material vs friction loss and excavation costs, showed that the largest pipe size is the most economical. The potential use of smaller pipes would result in large friction head losses without appropriate reduction in excavation costs. Manholes would not be required at conduit bends due to the large size of the conduit, available access through the gatewell and head box, and screening of flows at the intake structure.

29. Head Box. The head box would serve as a transition structure between the conduit and the penstock (Plate B-27). The shape of the head box invert was determined using the Corps of Engineers standard downstream spillway quadrant equation for negligible velocity of approach.

$$X^{1.85} = 2H_d^{0.85}Y$$

In which: X = Horizontal Coordinate; distance

Y = Vertical Coordinate; distance

H_d = Design Head

(Reference paragraph 8b of EM 1110-2-1603). The velocity of approach was computed to be 6.1 ft/sec and H_d = 8.5 feet in the 108-inch diameter conduit. To eliminate potential undesirable vortex formation, a vortex suppressor was located in the head box. Submergence on the penstock to further reduce potential vortex formation was based on Gordon's formula:1/

$$S = CVD^{1/2}$$

In which:
- S = required submergence in feet
- C = coefficient (0.35)
- V = velocity in feet/second
- D = penstock diameter in feet

30. Penstock. The penstock was sized based on a design flow of 400 cfs at a velocity of 15 ft/sec. The actual water velocity in the 72-inch diameter steel penstock would be 13.8 feet/sec at a design flow of 390 cfs for Alternative 1A and 12.2 feet/sec at a design flow of 346 cfs for Alternative 2A. The penstock was designed to resist high pressures caused by water hammer effects.

31. Tailrace. The tailrace from the powerhouse for Alternative 1A would be a concrete and riprap lined ditch. The tailrace from the powerhouse for Alternative 2A would consist of a buried 72-inch diameter concrete conduit placed on a one percent slope. The tailrace and river channel confluence was designed for a smooth transition for both alternatives to reduce backwater effects.

32. Structural Analysis. A structural analysis was made of all major structures in accordance with EM 1110-1-2101, "Working Stresses for Structural Design," 1 Nov 63 and EM 1110-2-2502, "Retaining Walls," 29 May 61.

1/ Gordon, J. L. "Vortices at Intakes," Water Power, London, England, Apr 1970; pp 137-138.

CIVIL FEATURES

33. Tramway. Access to the powerplant for Alternative 1A would be by a tramway built on top of the 282-foot penstock. The tramway would be large enough to accommodate six individuals. Heavy machinery such as the turbine/generator would be placed prior to construction of the penstock and tramway. The tramway would also be used to inspect the penstock.

34. Suspension Footbridge. The suspension footbridge would be used for access during high water periods to Alternative 2A facilities. The suspension footbridge is proposed to be built on abandoned railway foundations which are adjacent to the proposed diversion dam.

35. Trashrack. The trashrack on the intake structure must be periodically cleaned to remove accumulated debris. The trashrack was designed for installation of automatic raking equipment with provision for manual cleanout.

36. Ponding Area. The ponding area behind the diversion dam would tend to accumulate sediment deposits. However, much of the bedload would be trapped in a ponding area formed by a cane haul road crossing about 700 ft upstream of the proposed diversion dam. Both areas would need periodic cleanout to keep debris from filling in the area behind the diversion dam.

37. Gatewell and Conduit. The gatewell would have a sluice gate to control and stop discharges into the conduit. The head box would have an access hatch to allow interior inspection of the conduit and penstock during emergency situations. The conduit would normally be inspected during low flow periods when all river flows are discharged through the low level gate in the intake structure. During high river stages, the gatewell sluice gate will limit flows into the conduit to avoid excessive pressures inside the conduit. During extreme flood events, the gatewell sluice gate will close and stop all flows from entering the system until the river returns to "normal" flow conditions.

POWERPLANT FEATURES

38. Information is provided in Appendix C, Hydropower Investigations.

COST ESTIMATES

BASIS FOR COST ESTIMATES

39. Construction Cost. The basic assumptions for the construction cost estimates were as follows:

a. The contractor and labor would be Oahu, Hawaii based. Labor would be performed on 6-8 hours shifts per week.

b. Construction period would be 24 months for Alternatives 1A and 2A.

c. Escalation to mid-point of construction was included. Annual construction inflation would be 9 percent. Contingencies are 25 percent in accordance with EM 1110-2-1301 (31 Jul 80). However, for turbine/generator and related electrical/mechanical items, based on manufacturer's recent or known estimates and bid prices, contingencies are 15 percent.

d. Excavation below elevation 255.0 feet msl would require blasting for rock removal. Material above 255.0 feet msl would be composed of loose soil and cobbles with 15% boulders. Disposal and borrow of material would be within five miles of operations.

e. Mechanical and electrical equipment would be from continental United States. Installation labor from the mainland would be required for turbo-generator features. Itemized costs include delivery costs to site. For Alternative 1A, temporary tracks would be constructed for powerhouse construction material transport. Same tracks would be used for penstock transport.

f. Suitable temporary diversions will be constructed at Stable Storm Ditch and South Fork Wailua for construction.

g. Costs for solar hot water systems were estimated from local contractor prices.

h. Price level for all work is January 1982.

40. Indirect Costs. Indirect costs include technical and administrative costs associated with the design and construction of the project.

a. Engineering and Design (Federal). These indirect costs would be for engineering efforts in the preparation of design memoranda; construction plans and specifications; and engineering during construction. Preauthorization study costs were not included. All associated overhead amounts are included in the Engineering and Design totals.

b. Supervision and Administration (Federal). The construction contract would include contract administration and field inspection provided by the Corps. Associated overhead amounts are included in the total.

c. Rights-of-Way Indirect Costs. Indirect costs included the management of construction rights-of-way, easements and inter-agency coordination during construction.

41. Rights-of-Way. The costs required to acquire construction rights-of-way would be borne by the Federal Government. These costs included purchase of lands in fee and compensation for damages to agricultural lands to private interests. Lands under ownership by the State of Hawaii were considered nominally transferable to the Federal Government.

42. Operation and Maintenance and Replacement Costs. These costs are annual costs required to keep all facilities in good working condition and repair. The annual costs for Alternatives 1A and 2A were determined from the Hydropower Cost Estimating Manual, US Army Corps of Engineers, North Pacific Division, Revised Edition, July 1981. The elements and adjustment method was determined as itemized below:

Element	Reference	Computation
O&M	"Annual Operation and Maintenance Costs": p. 47 Remote Operation Curve July price level, 6-7/8% interest.	(Annual Costs as function of installed capacity) x (adjustment factor for price level and interest rate.) Factor = 1.248 for Jan 82 price level and 7-5/8% interest rate.
Replacement	"Estimating the Annual Cost" p. 46 ff.	(Total initial powerplant costs excluding contingencies) x (1-1/4 percent) x (adjustment factor for contingencies, geography, and interest rate.) Total multiplier of powerplant costs = 0.01455 for contingency, Hawaii, and 7-5/8 % interest rate.

43. Interest During Construction (IDC). Interest during construction accounts for the capital incurred during the construction period. The computed amount is to be included in the total project investment cost and forms a portion of the average annual costs. Although the period of actual construction was determined to be 24 months for the civil and powerplant features, the lead time required for the procurement, manufacture and testing of the turbo-generator will result in a total time of 31 months. The turbo-generator procurement process is normally an independent contract. Hence, construction inflation was computed on the basis of 24 months and IDC was computed on the basis of 31 months. IDC was the first cost times the Federal interest rate (7-5/8 percent) times one-half of the 31-month period (in years).

DETAILED COST ESTIMATE

44. The detailed cost estimate for Plans 1A and 2A are provided in the following tables. Similar estimates, provided in Appendix C, (Hydropower Investigations) were determined primarily to scope the capacity of the powerplant. The total estimates shown in Tables B-15 and B-16 comply with the findings of the Main Report.

Table B-15. DETAILED COST ESTIMATE - ALTERNATIVE 1A

	Quantity	Unit	Unit Cost	Total Cost, $
CONSTRUCTION				
DIRECT CONSTRUCTION COSTS				
Civil Features				
Mobilization & Demobilization	-	LS		$ 150,000
Contingencies 25% ±				38,000
Subtotal				188,000
Stable Storm Ditch Structure				
Dewatering		LS		21,400
Culvert & Structure		LS		90,000
Contingencies 25% ±				27,600
Subtotal				139,000
Diversion Dam				
Dewatering		LS		56,000
Concrete Dam	3,130	CY	262	820,100
Contingencies 25% ±				218,900
Subtotal				1,095,000
Intake Structure				
Excavation & Backfill	70	CY	26	1,800
Structure	58	CY	740	42,900
Trash Rack	116	SF	62	7,200
Sluice Gate	1	EA	10,300	10,300
Contingencies 25% ±				15,800
Subtotal				78,000
Gatewell				
Structure	90	CY	550	49,500
Sluice Gate	1	EA	60,000	60,000
Contingencies 25% ±				27,500
Subtotal				137,000
Conduit				
Loose Excavation	44,600	CY	2.80	124,900
Rock Excavation	2,500	CY	14.10	35,200
RCP 108-inch	560	LF	480	268,800
Backfill	45,500	CY	2.10	95,600
Contingencies 25% ±				131,500
Subtotal				656,000
Headbox				
Excavation & Backfill	20	CY	26	500
Structure	69	CY	540	37,300
Contingencies 25% ±				9,200
Subtotal				47,000
Penstock - 72-inch steel	282	LF	820	231,200
Contingencies 25% ±				58,800
Subtotal				290,000
Tailrace - Open Channel	-	LS		136,000
Contingencies 25% ±				34,000
Subtotal				$ 170,000

Table B-15. DETAILED COST ESTIMATE - ALTERNATIVE 1A (Cont)

	Quantity	Unit	Unit Cost	Total Cost,$
CONSTRUCTION (Cont)				
DIRECT CONSTRUCTION COSTS (Cont)				
Civil Features (Cont)				
Tramway		LS		$ 184,800
Contingencies 25% ±				46,200
Subtotal				231,000
Access Road	700	LF	33	23,100
Contingencies 25% ±				5,900
Subtotal				29,000
TOTAL CIVIL FEATURES				3,060,000
Power Plant Features				
Powerhouse				
Reinforced Concrete				$ 279,700
Misc Building Items				3,000
Bulkhead, Guides & Struct Steel				89,800
Architectural				25,500
Contingencies 25% ±				100,000
Subtotal				498,000
Turbines and Generators				
Turbines & Governors				981,000
Generators & Excitation Equip				558,000
Contingencies 15% ±				231,000
Subtotal				1,770,000
Accessory Electrical Equipment				
Switchgear, Breakers & Buses				245,000
Station Service Unit				20,000
Control System				233,200
Misc Electrical System				50,000
Contingencies 15% ±				82,800
Subtotal				631,000
Auxiliary Systems & Equipment				
Heating & Ventilating				11,000
Station, Brake & Governor Air				8,000
Dewatering & Drainage Systems				11,200
Misc Mechanical Systems				17,000
Contingencies 15% ±				6,800
Subtotal				54,000
Switchgard & Electrical				
Power Transformer				133,000
Disconnects & Elec. Equipment				20,000
Transmission Line 12 kv	3.5	MI	100,000	350,000
Contingencies 15% ±				76,000
Subtotal				579,000
TOTAL POWER PLANT FEATURES				3,532,000
TOTAL DIRECT COSTS				$6,592,000

Table B-15. DETAILED COST ESTIMATE - ALTERNATIVE 1A (Cont)

	Quantity	Unit	Unit Cost	Total Cost
CONSTRUCTION (Cont)				
INDIRECT COSTS				
Engineering & Design				450,000
Supervision and Administration (S&I)				420,000
TOTAL INDIRECT COST				870,000
TOTAL CONSTRUCTION COSTS				$ 7,462,000
LANDS AND DAMAGES				
LANDS, EASEMENTS & RIGHTS-OF-WAY				
Damages to Agricultural Lands	2.7	AC	$ 5,200	14,000
Contingencies 25% ±				6,000
Subtotal				20,000
INDIRECT ACQUISITION COSTS				10,000
TOTAL LAND COSTS				30,000
TOTAL FIRST COSTS				$ 7,492,000

Table B-16. DETAILED COST ESTIMATE - ALTERNATIVE 2A

	Quantity	Unit	Unit Cost	Total Cost,$
CONSTRUCTION				
DIRECT CONSTRUCTION COSTS				
Civil Features				
Mobilization & Demobilization	-	LS		$ 187,400
Contingencies 25% ±				46,000
Subtotal				234,400
Stable Storm Ditch Structure				
Dewatering		LS		20,800
Culvert & Structure		LS		87,000
Contingencies 25% ±				27,200
Subtotal				135,000
Diversion Dam				
Dewatering		LS		54,500
Concrete Dam	3,130	CY	255	798,200
Contingencies				213,300
Subtotal				1,066,000
Intake Structure				
Excavation & Backfill	70	CY	25	1,800
Structure	58	CY	720	41,800
Trash Rack	116	SF	60	7,000
Sluice Gate	1	EA	10,000	10,000
Contingencies 25% ±				15,400
Subtotal				76,000
Gatewell				
Structure	90	CY	530	47,700
Sluice Gate	1	EA	58,400	58,400
Contingencies 25% ±				26,900
Subtotal				133,000
Conduit				
Loose Excavation	386,000	CY	2.70	1,042,200
Rock Excavation	14,500	CY	12.70	184,200
RCP 108-inch	3,040	LF	475	1,444,000
Backfill	390,500	CY	1.90	742,000
Contingencies 25% ±				853,600
Subtotal				4,266,000
Headbox				
Excavation & Backfill	20	CY	25	500
Structure	69	CY	525	36,200
Contingencies 25% ±				9,300
Subtotal				46,000
Penstock 72-inch steel	467	LF	700	326,900
Contingencies 25% ±				81,100
Subtotal				408,000
Tailrace 72-inch RCP	500	LF	250	125,000
Contingencies 25% ±				31,000
Subtotal				$ 156,000

Table B-16. DETAILED COST ESTIMATE - ALTERNATIVE 2A (Cont)

	Quantity	Unit	Unit Cost	Total Cost,$
CONSTRUCTION (Cont)				
DIRECT CONSTRUCTION COSTS (Cont)				
Civil Features (Cont)				
Suspension Footbridge	300	LF	150	$ 45,000
Contingencies 25% ±				11,000
Subtotal				56,000
Access Road	3,200	LF	32	102,400
Contingencies				25,600
Subtotal				128,000
TOTAL CIVIL FEATURES				$6,704,000
Power Plant Features				
Powerhouse				
Reinforced Concrete				210,000
Misc Building Items				3,000
Bulkhead, Guides & Struct Steel				82,200
Architectural				25,500
Contingencies 25% ±				80,300
Subtotal				401,000
Turbines and Generators				
Turbines & Governors				890,000
Generators & Excitation Equipment				605,000
Contingencies 15% ±				225,000
Subtotal				1,720,000
Accessory Electrical Equipment				
Switchgear, Breakers & Buses				215,000
Station Service Unit				20,000
Control System				233,200
Misc Electrical System				45,000
Contingencies 15% ±				76,800
Subtotal				590,000
Auxiliary Systems & Equipment				
Heating & Ventilating				14,000
Station, Brake & Governor Air				8,000
Dewatering & Drainage Systems				8,200
Misc Mechanical Systems				15,500
Contingencies 15% ±				7,300
Subtotal				53,000
Switchyard & Electrical				
Power Transformer				144,000
Disconnects & Electrical Equipment				53,000
Transmission Line 12 kv	2.2	MI	100,000	220,000
Contingencies 15% ±				57,000
Subtotal				441,000
TOTAL POWER PLANT FEATURES				$3,205,000
TOTAL DIRECT CONSTRUCTION COSTS				$9,909,000

Table B-16. DETAILED COST ESTIMATE - ALTERNATIVE 2A (Cont)

	Quantity	Unit	Unit Cost	Total Cost, $
CONSTRUCTION (Cont)				
INDIRECT COSTS				
Engineering & Design				$ 650,000
Supervision and Administration (S&I)				640,000
TOTAL INDIRECT COST				1,290,000
TOTAL CONSTRUCTION COSTS				11,199,000
LANDS AND DAMAGES				
LANDS, EASEMENTS & RIGHTS-OF-WAY				
Damages to Agricultural Lands	9.55	AC	5,200	$ 49,700
Fee Acquisition	0.87	AC	12,000	10,400
Contingencies 25% ±				15,900
Subtotal				76,000
INDIRECT ACQUISITION COSTS				14,000
TOTAL LAND COSTS				$ 90,000
TOTAL FIRST COSTS				$11,289,000

COST APPORTIONMENT AND INITIAL FINANCING

45. The Federal Government is currently considering new legislation and/or new policies governing Corps water resources projects. Under the traditional cost apportionment and financing policies for hydropower, the Federal Government would totally finance the construction of improvements and subsequently recover all financing and operational costs through energy revenues. However, new administration directions indicate that non-Federal interest may be required to finance either a portion or all the initial construction costs. Accordingly, the non-Federal interests would share the income derived from energy revenues with Federal interests for incurred costs. As a result of the unknown status, no cost apportionment or cash contribution requirements have been defined for the alternative plans.

SUMMARY OF PROJECT INVESTMENT COSTS

46. The project first costs for Alternatives 1A and 2A are summarized on Table B-17.

Table B-17. SUMMARY OF PROJECT INVESTMENT COSTS

Item	Alternative 1A	Alternative 2A
CONSTRUCTION		
Direct Construction Costs	$6,592,000	$ 9,909,000
Indirect Costs	870,000	1,290,000
Subtotal	7,462,000	11,199,000
LANDS AND DAMAGES		
Lands, Easements & Rights-of-Way	20,000	76,000
Indirect Costs	10,000	14,000
Subtotal	30,000	90,000
Total First Costs	7,492,000	11,289,000
INTEREST DURING CONSTRUCTION 1/	696,000	1,036,000
TOTAL PROJECT INVESTMENT COST	$8,188,000	$12,325,000

1/ At 31 month, 7-5/8 percent for total first costs, exclusive of inflation during construction.

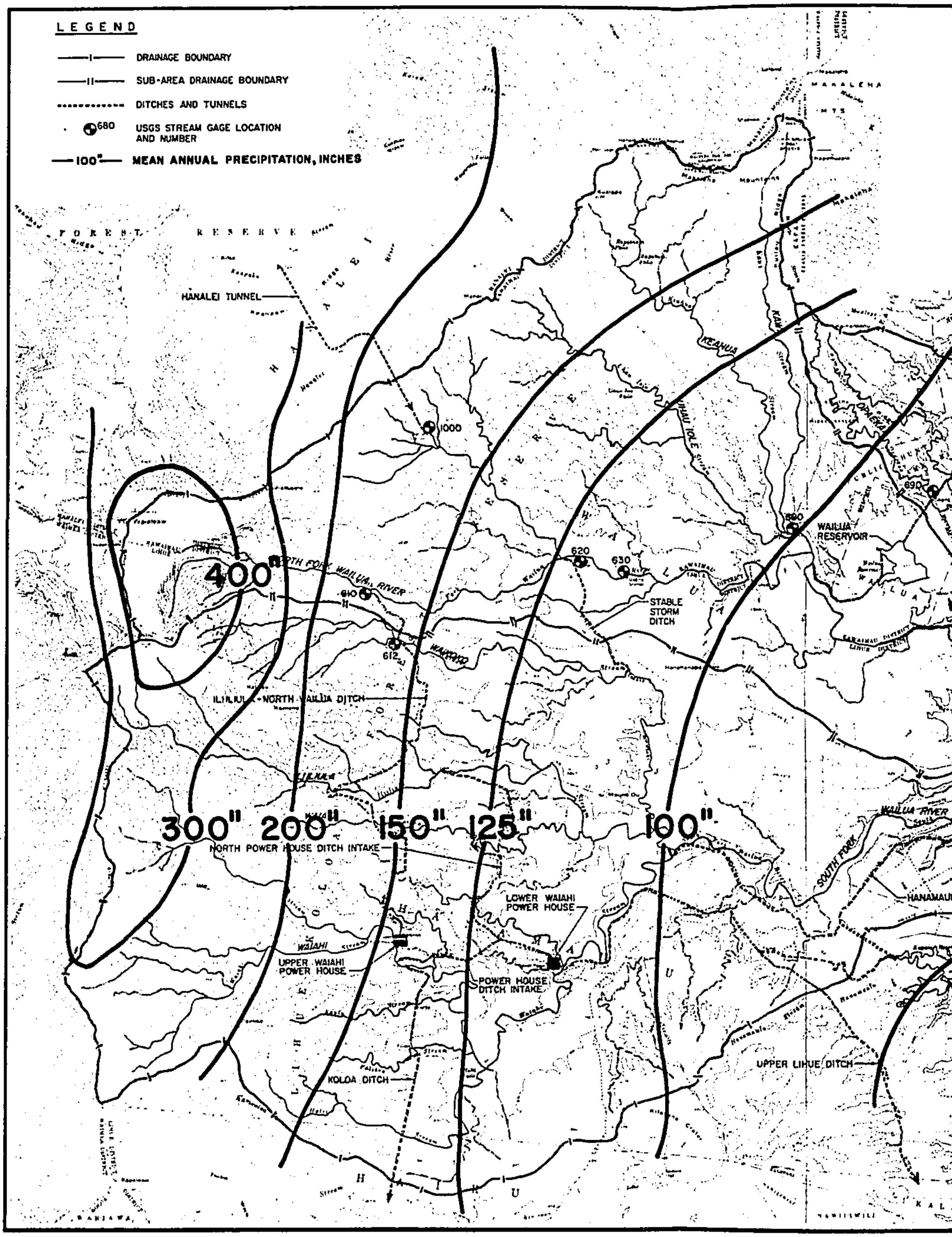
ANNUAL COSTS

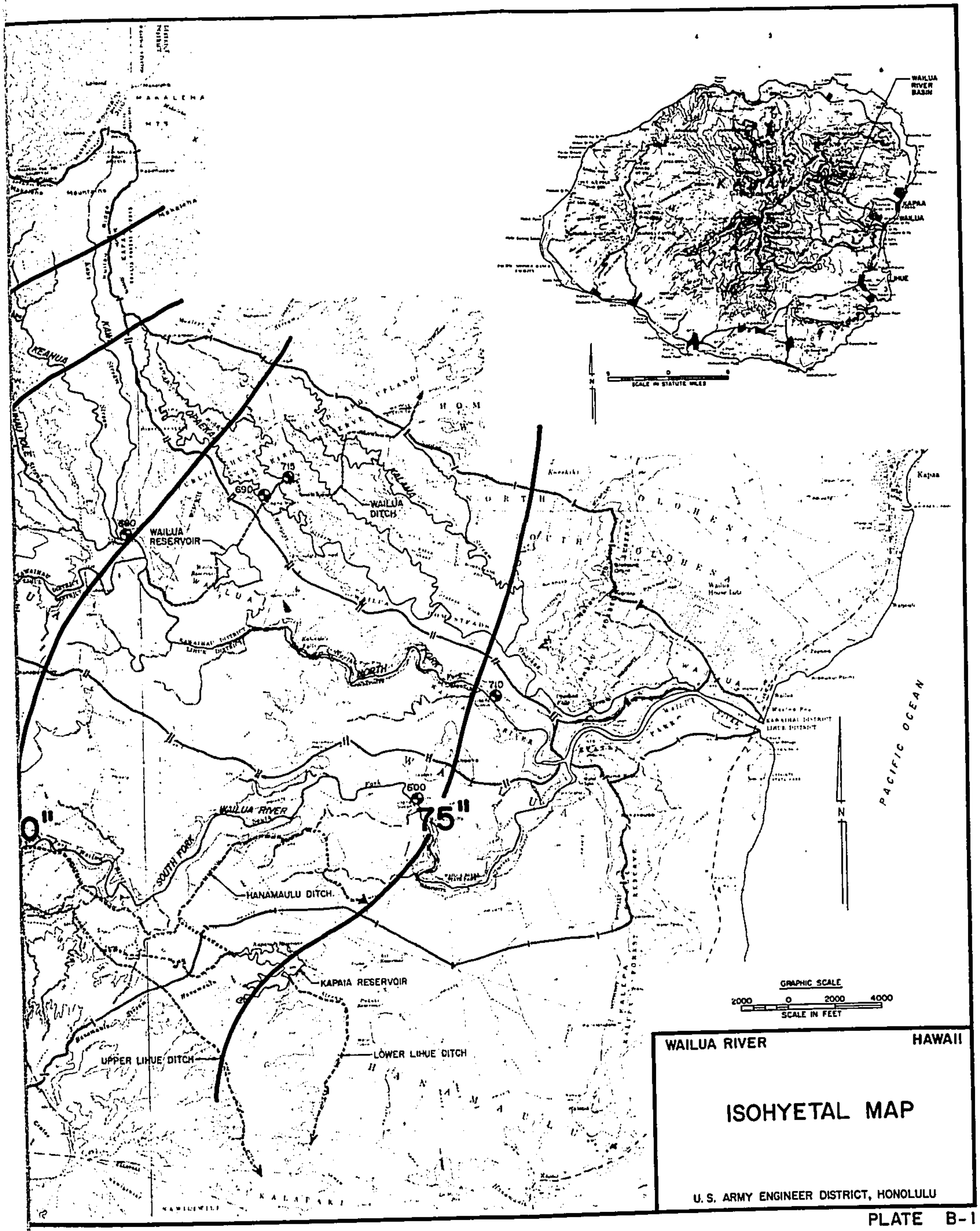
47. The total annual costs are shown in Table B-18. The costs were based on amortization of the NED investment costs at an interest rate of 7-5/8 percent an economic life of 100 years. The operation, maintenance, and replacement costs were determined in accordance with the prior description of basic assumptions.

Table B-18. ANNUAL COST SUMMARY

Item	Alternative 1A	Alternative 2A
Base NED Investment Cost 1/	$ 7,760,000	$ 11,559,000
Average Annual Costs 2/		
Interest & Amortization	592,000	882,000
Operation, Maintenance, & Replacement	85,000	86,000
TOTAL PROJECT ANNUAL COST	$ 677,000	$ 968,000

1/ Excludes construction inflation.
2/ Based on 100-year period, 7-5/8 percent interest (Capital Recovery Factor = 0.07630).


LEGEND
DRAINAGE BOUNDARY
SUB-AREA DRAINAGE BOUNDARY
DITCHES AND TUNNELS
680 USGS STREAM GAGE LOCATION AND NUMBER
100" MEAN ANNUAL PRECIPITATION, INCHES
HANALEI TUNNEL
400"
300"
200"
150"
125"
100"
NORTH FORK WAILUA RIVER
1000
610
612
620
630
680
690
WAILUA RESERVOIR
STABLE STORM DITCH
ILIILIULA-NORTH WAILUA DITCH
NORTH POWER HOUSE DITCH INTAKE
LOWER WAIAHI POWER HOUSE
UPPER WAIAHI POWER HOUSE
POWER HOUSE DITCH INTAKE
KOLOA DITCH
UPPER LIHUE DITCH
WAILUA RIVER
SOUTH FORK
KEAHUA
WAIAHI

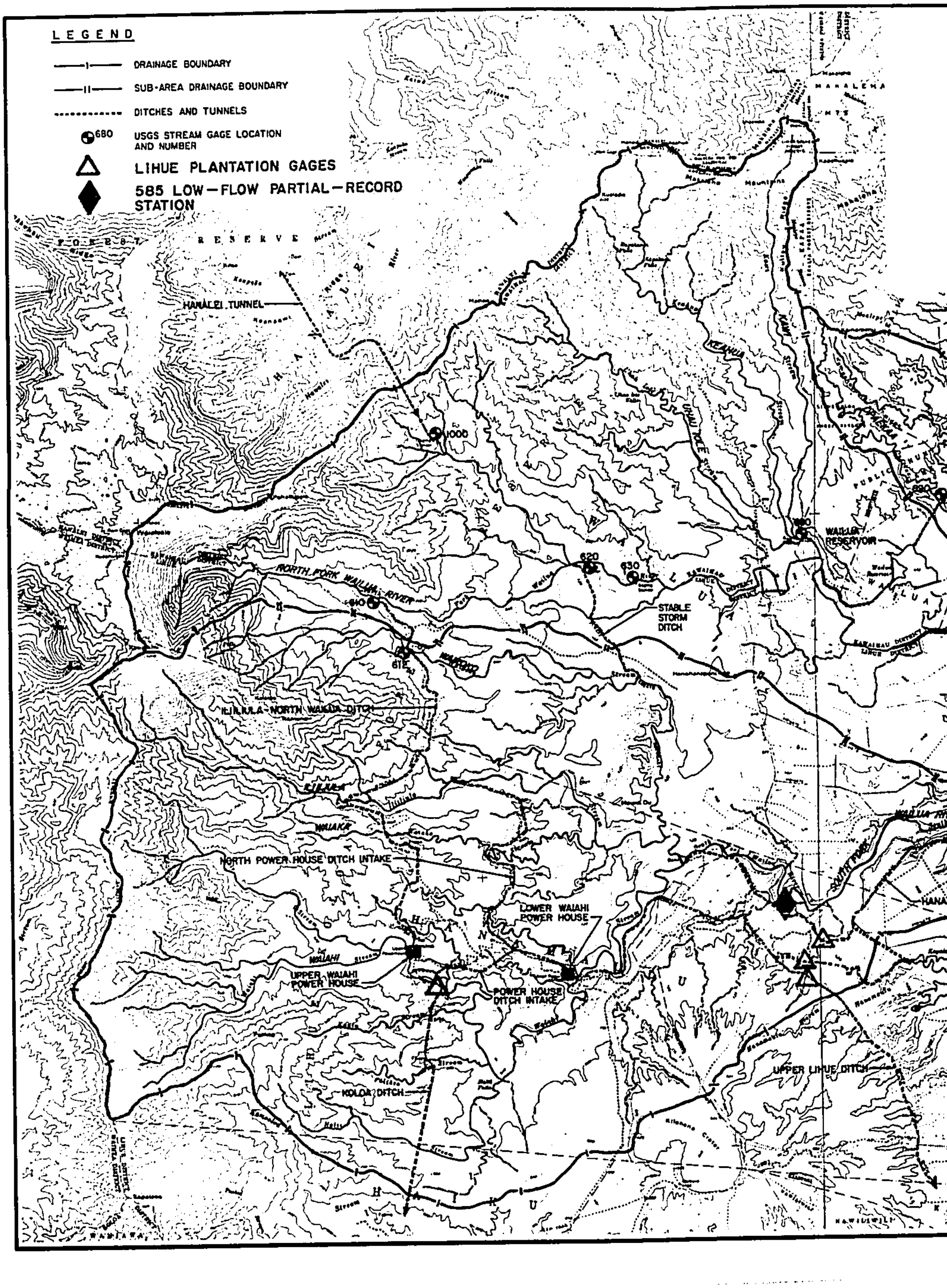


WAILUA RIVER HAWAII

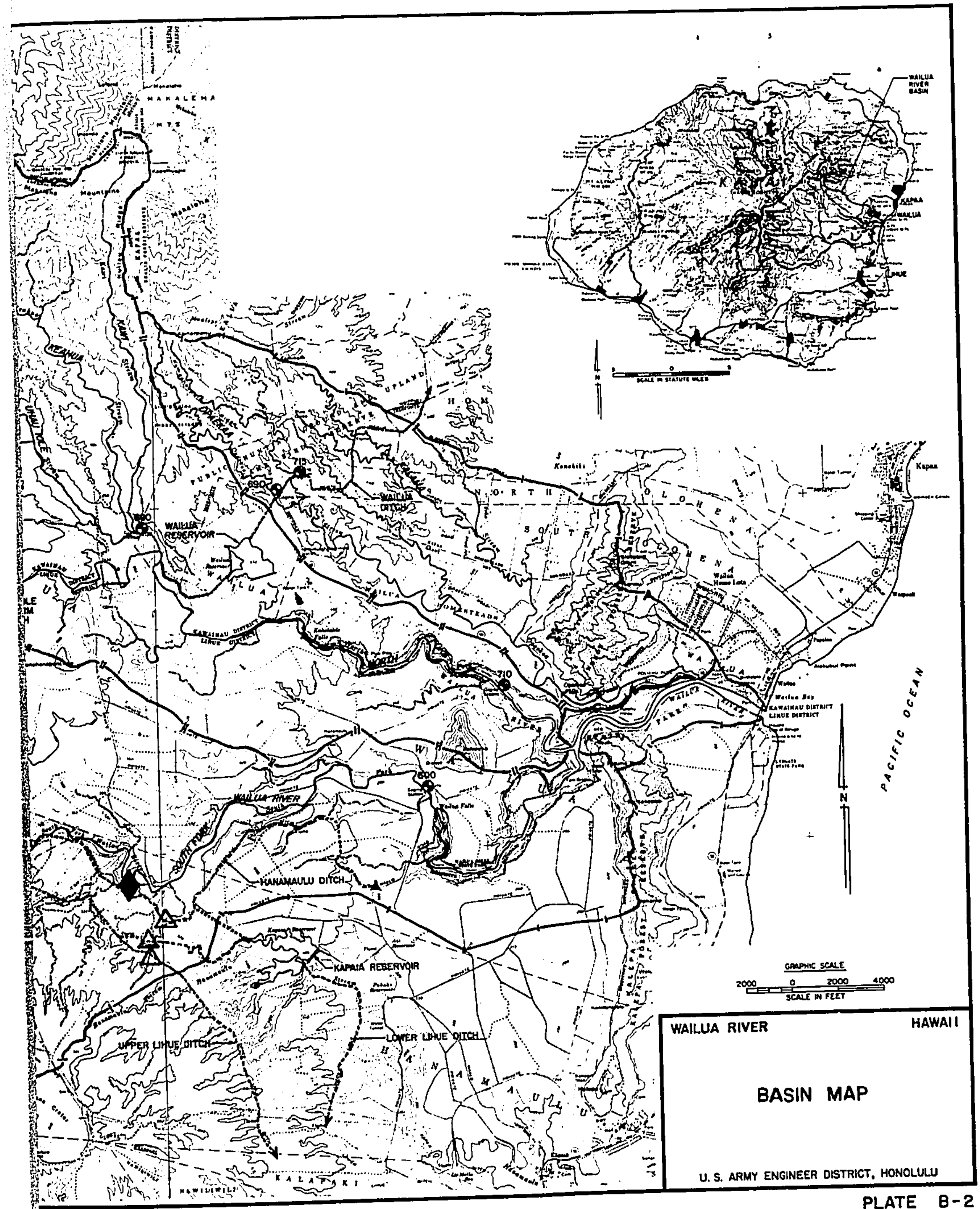
ISOHYETAL MAP

U. S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE B-1



LEGEND
DRAINAGE BOUNDARY
SUB-AREA DRAINAGE BOUNDARY
DITCHES AND TUNNELS
680 USGS STREAM GAGE LOCATION AND NUMBER
LIHUE PLANTATION GAGES
585 LOW—FLOW PARTIAL—RECORD STATION
HANALEI TUNNEL
NORTH FORK WAILUA RIVER
WAILUA RESERVOIR
STABLE STORM DITCH
IIILIULA-NORTH WAIAKA DITCH
NORTH POWER HOUSE DITCH INTAKE
LOWER WAIAHI POWER HOUSE
UPPER WAIAHI POWER HOUSE
POWER HOUSE DITCH INTAKE
KOLOA DITCH
UPPER LIHUE DITCH
1000
620
630
640
611

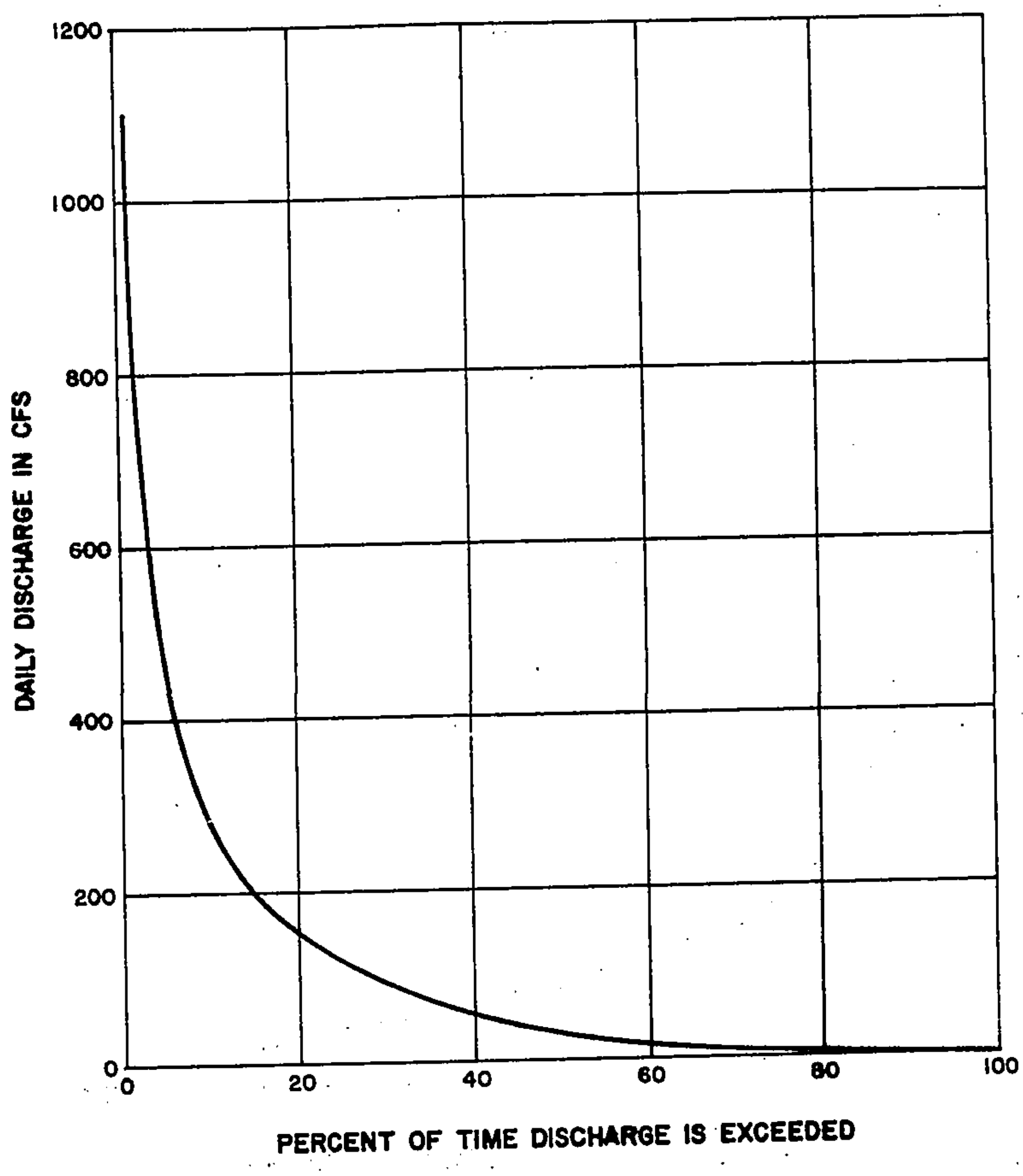


WAILUA RIVER HAWAII

BASIN MAP

U. S. ARMY ENGINEER DISTRICT, HONOLULU

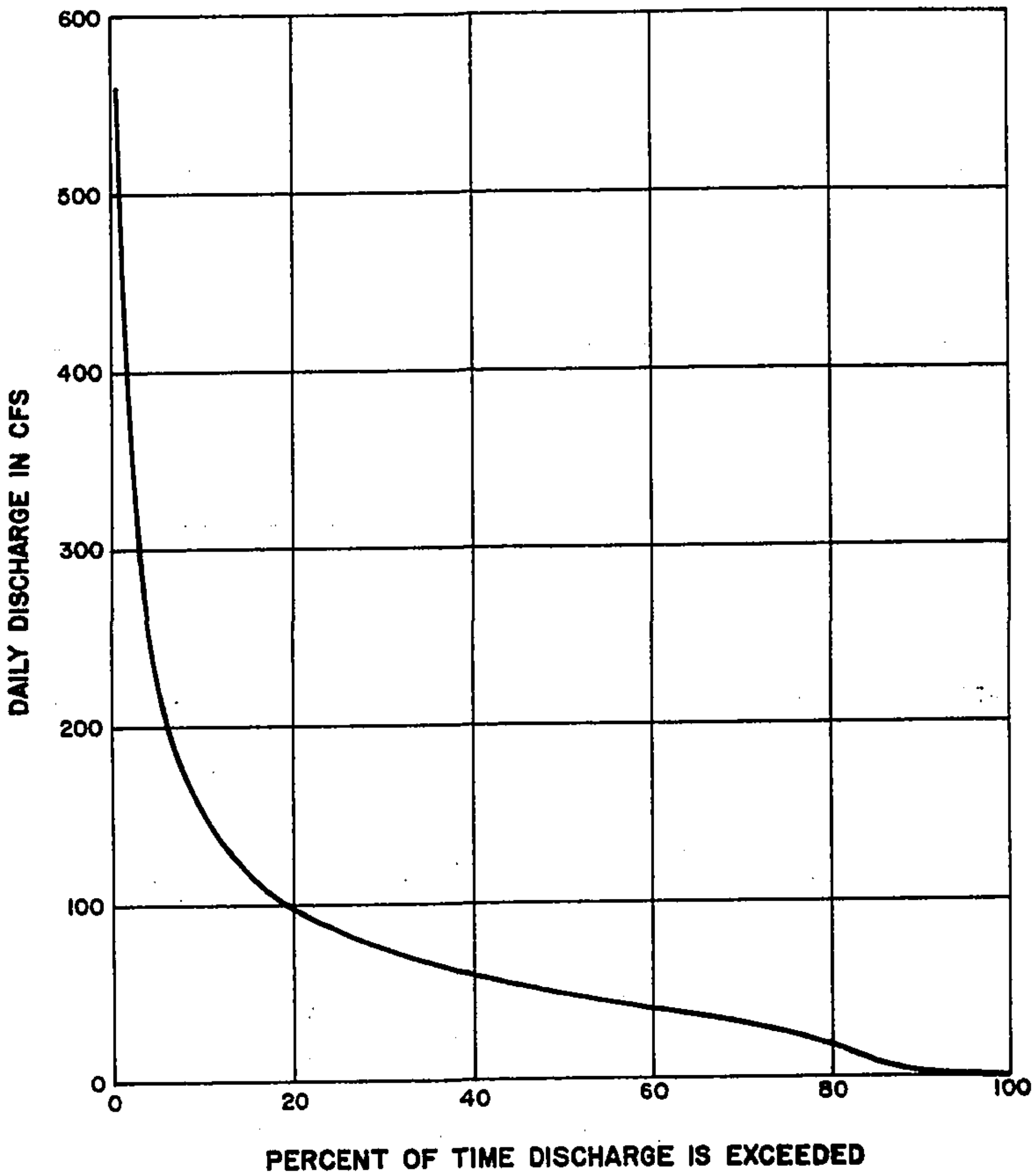
PLATE B-2



WAILUA RIVER HAWAII

FLOW DURATION CURVE
SOUTH FORK WAILUA RIVER
(STATION 600)
DA=22.4 SQ MI

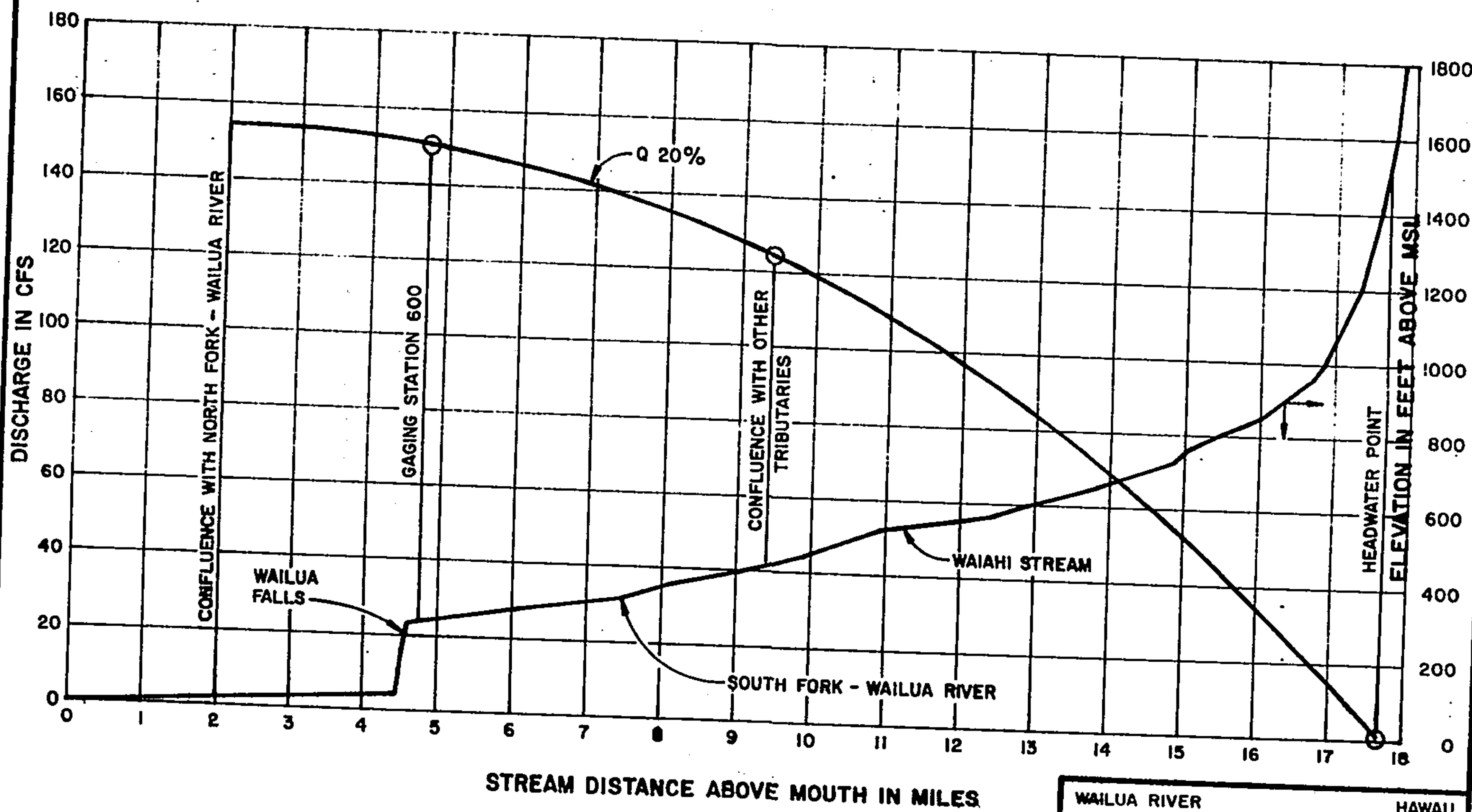
U.S. ARMY ENGINEER DISTRICT, HONOLULU



WAILUA RIVER HAWAII

FLOW DURATION CURVE
NORTH FORK WAILUA RIVER
STATION 630
DA=5.29 SQ MI

U.S. ARMY ENGINEER DISTRICT, HONOLULU

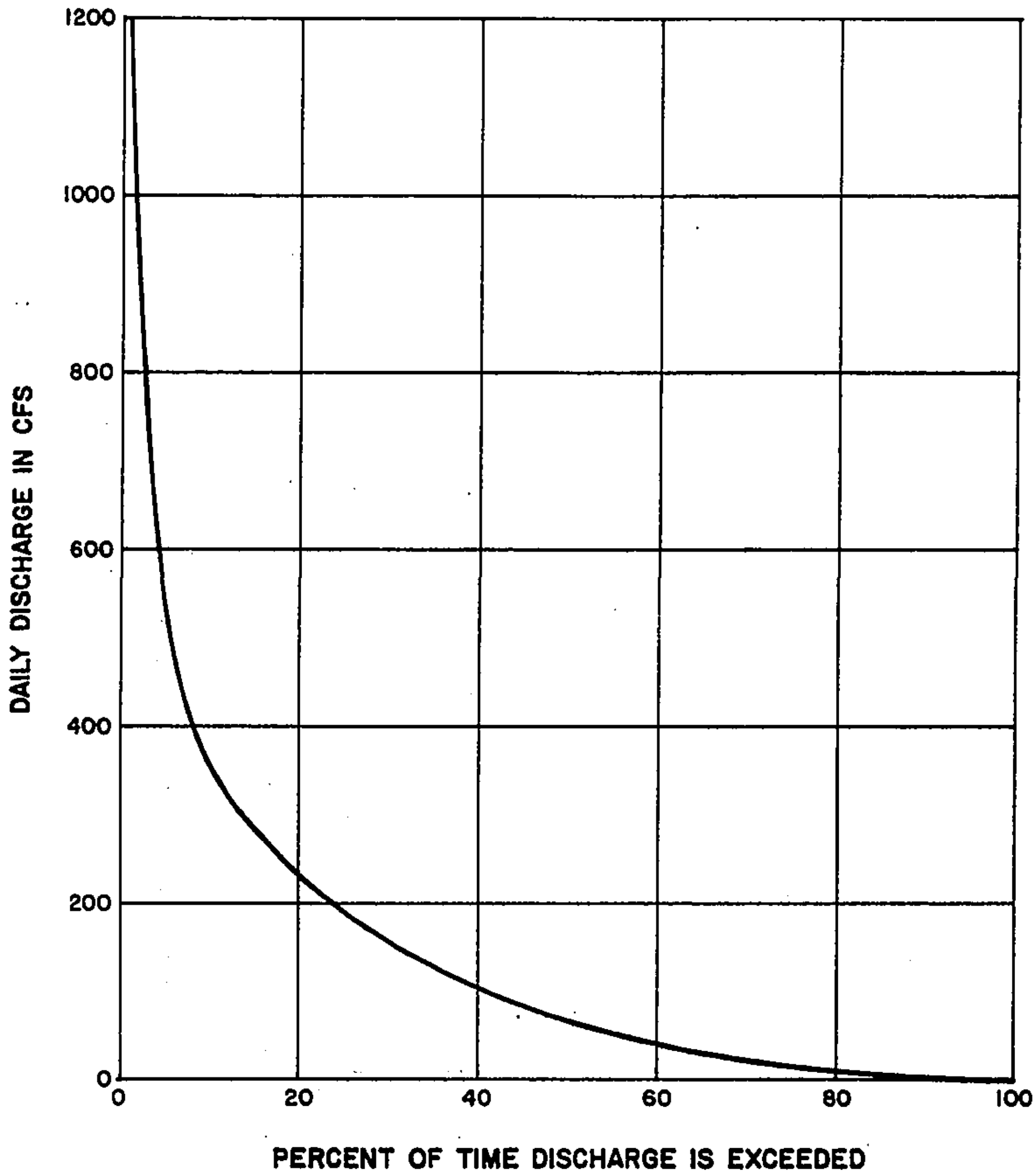


WAILUA RIVER | HAWAII

STREAM PROFILE AND RELATIONSHIP BETWEEN 20% DISCHARGE VS STREAM DISTANCE

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE B-4A

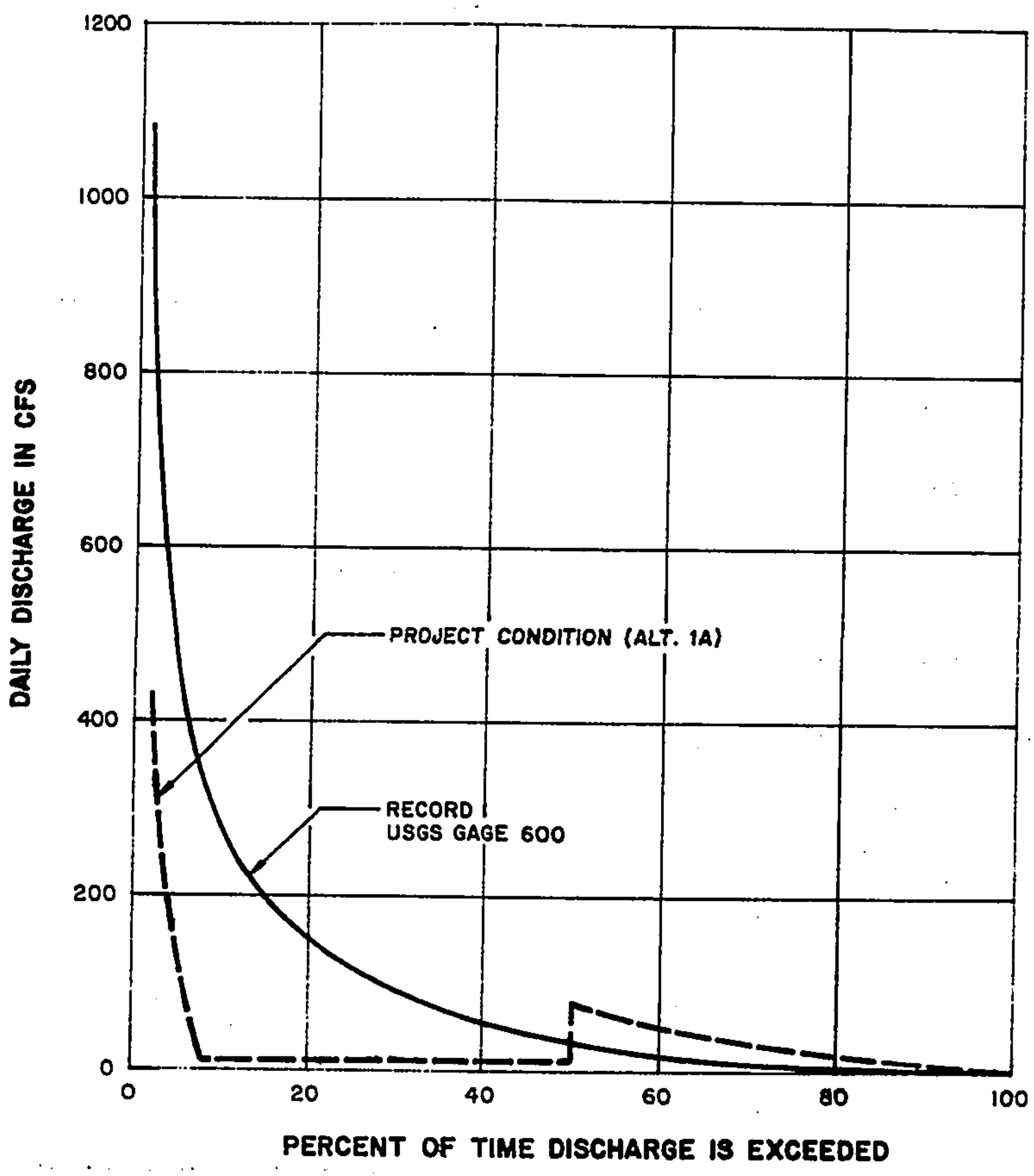


WAILUA RIVER HAWAII

FLOW DURATION CURVE
TOTAL FLOW AVAILABLE
NEAR STATION 600

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE B-5

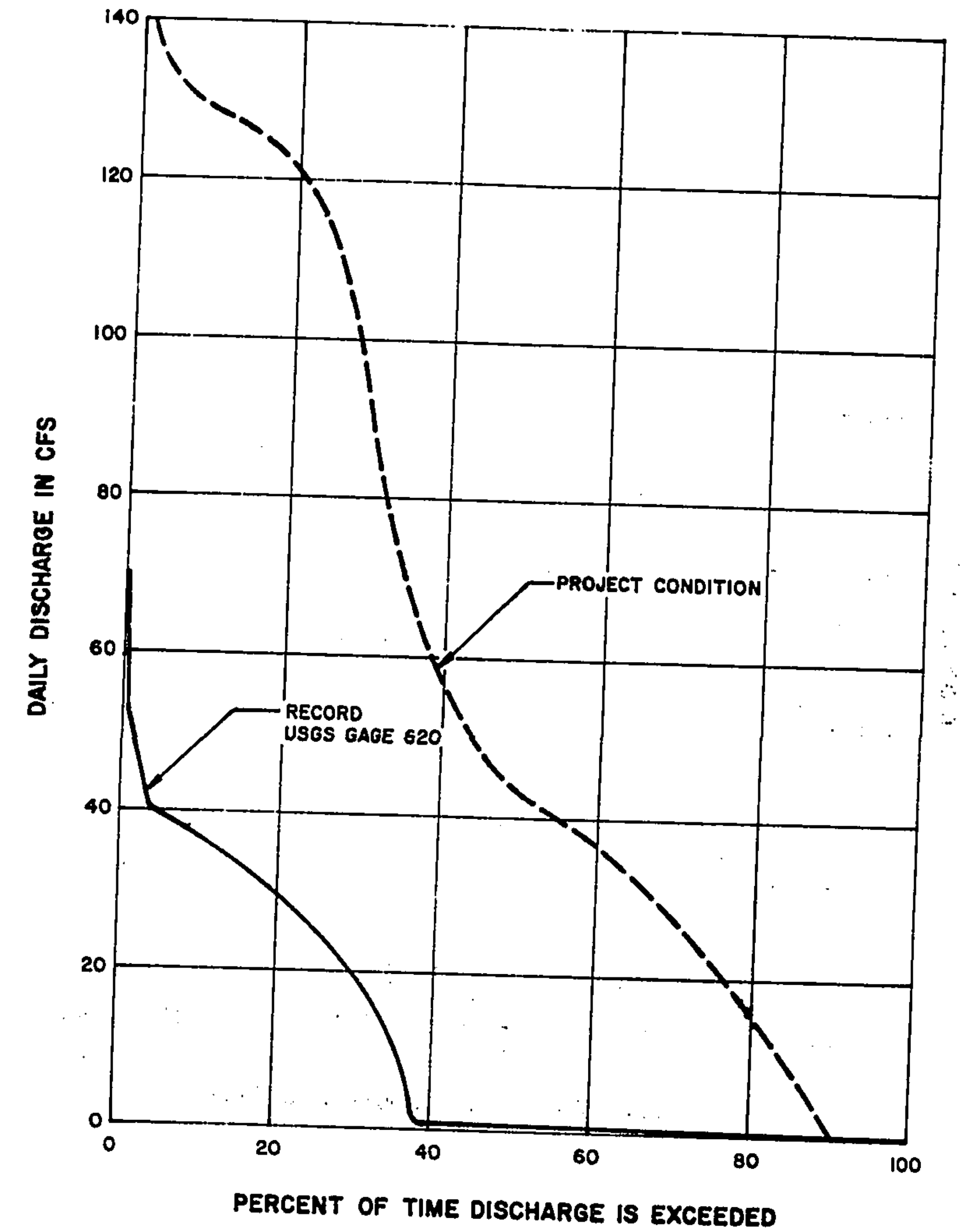


WAILUA RIVER HAWAII

FLOW DURATION CURVES
SOUTH FORK - WAILUA RIVER
EXISTING & PROJECT CONDITIONS

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE B-5A

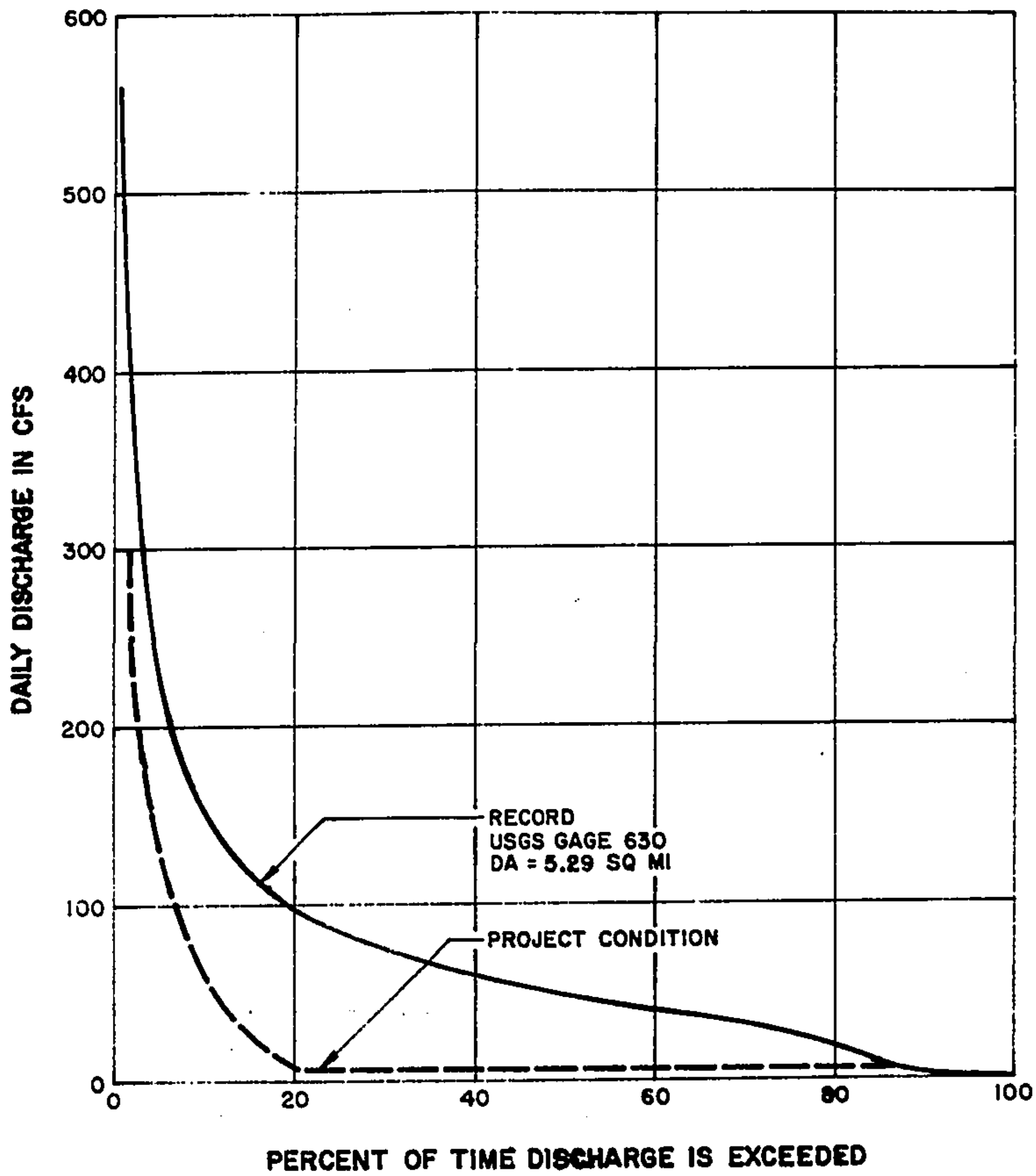


WAILUA RIVER HAWAII

FLOW DURATION CURVES

STABLE STORM DITCH
EXISTING & PROJECT CONDITIONS

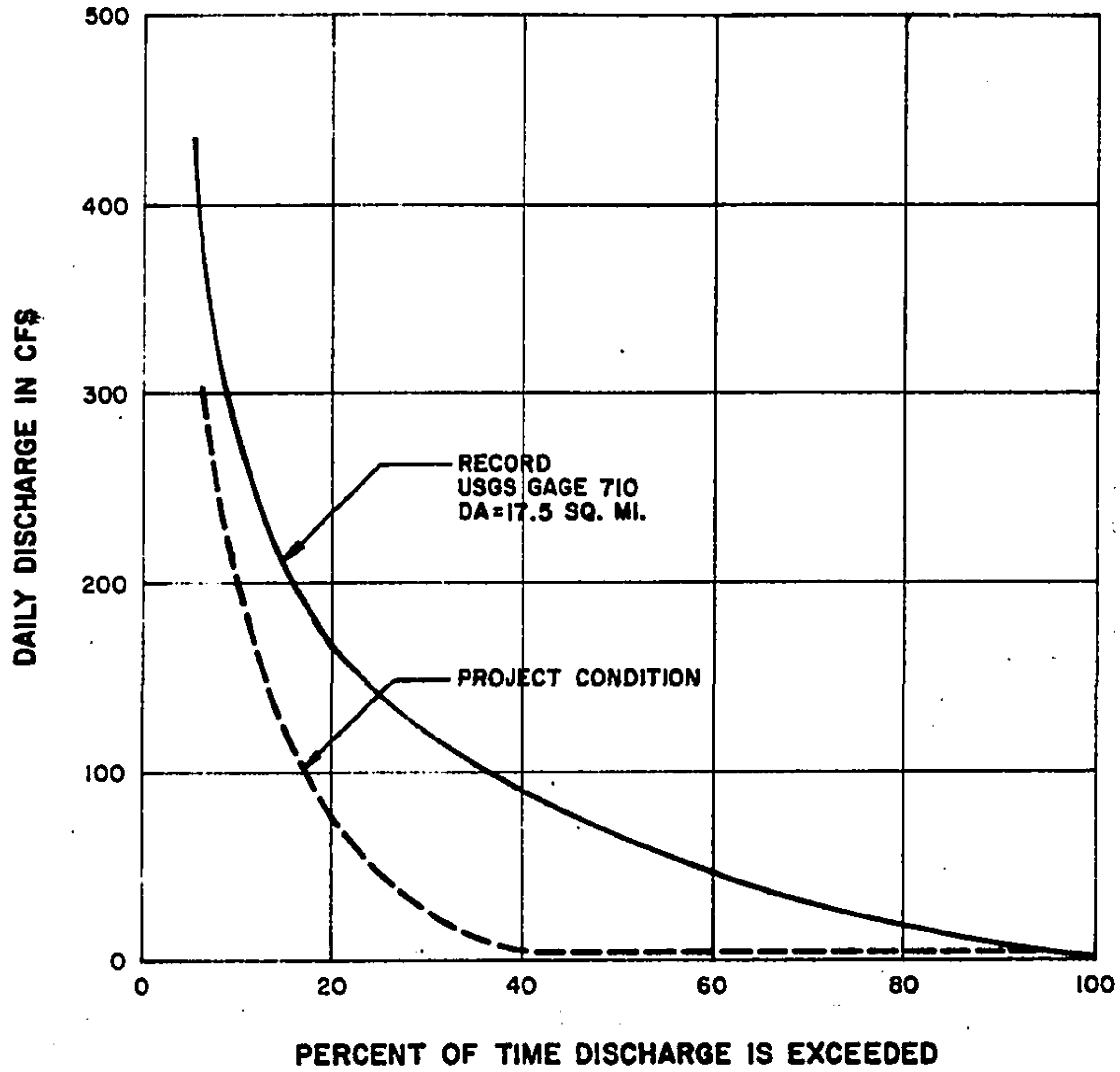
U.S. ARMY ENGINEER DISTRICT, HONOLULU



WAILUA RIVER HAWAII

FLOW DURATION CURVES
NORTH FORK-WAILUA RIVER
UPSTREAM – EXISTING
& PROJECT CONDITIONS

U.S. ARMY ENGINEER DISTRICT, HONOLULU

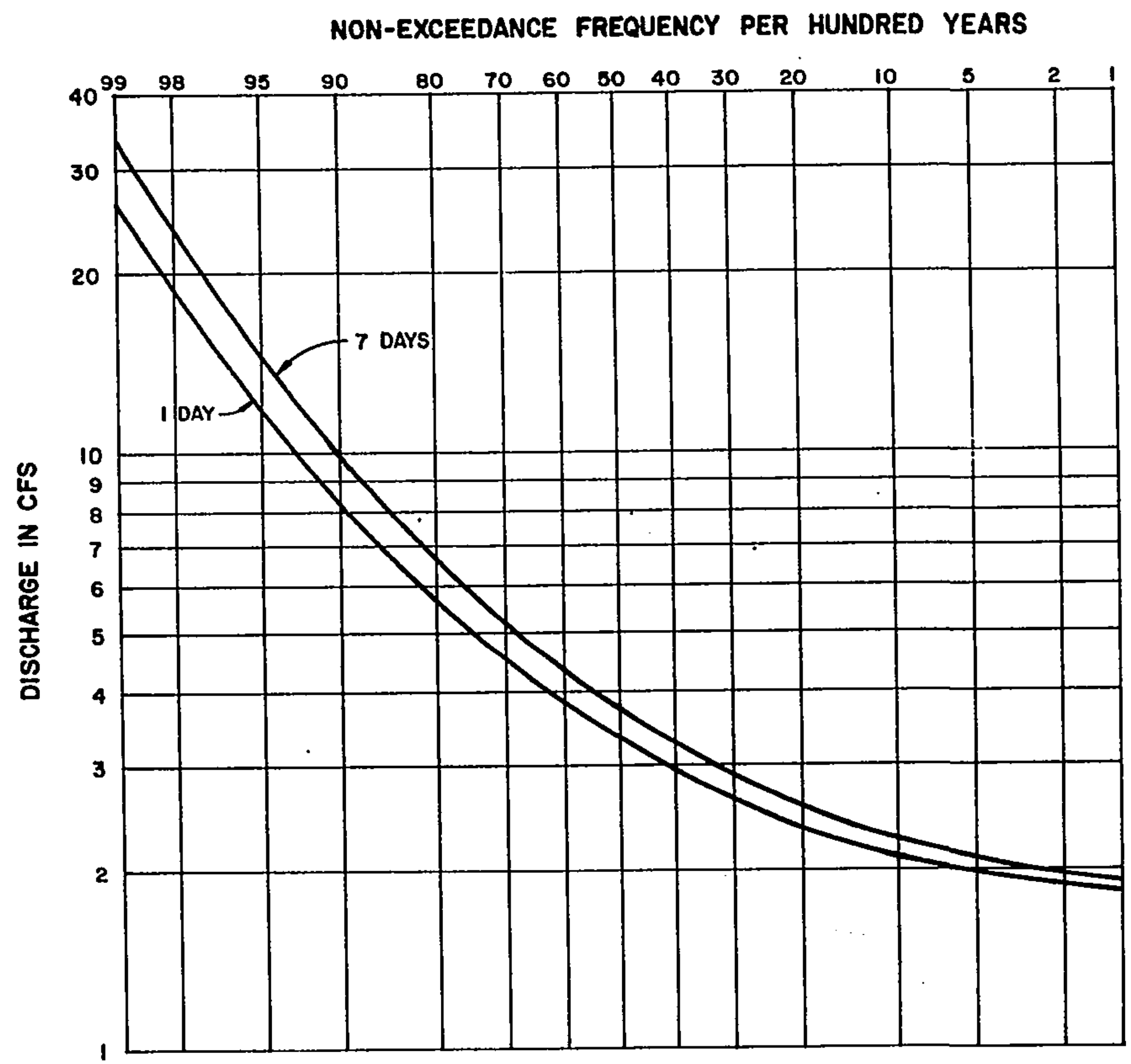


WAILUA RIVER HAWAII

FLOW DURATION CURVES
NORTH FORK - WAILUA RIVER
DOWNSTREAM – EXISTING
& PROJECT CONDITIONS

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE B-5D



WAILUA RIVER HAWAII

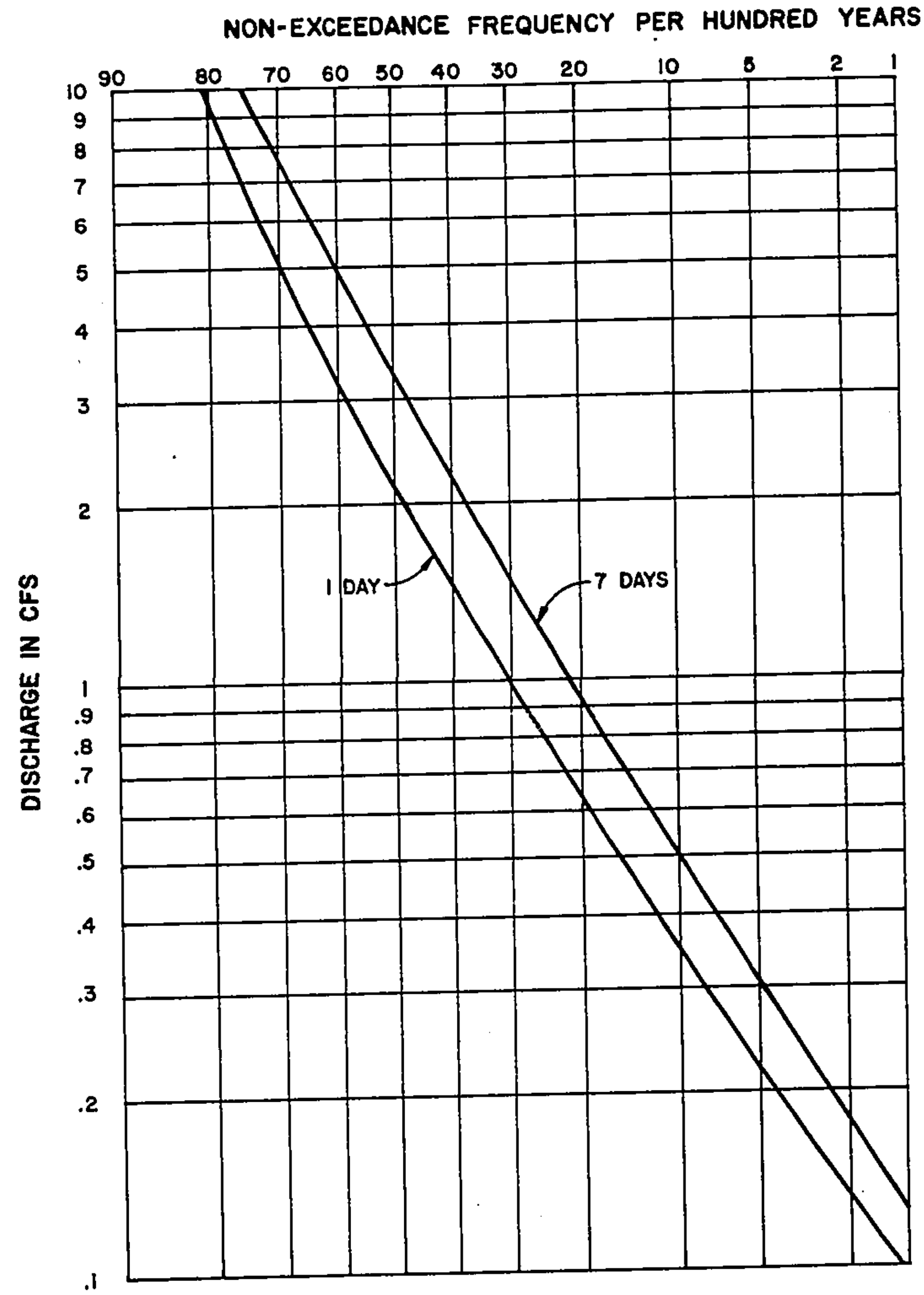
LOW FLOW FREQUENCY CURVE

SOUTH FORK WAILUA RIVER

(STATION 600)

U.S. ARMY ENGINEER DISTRICT, HONOLULU

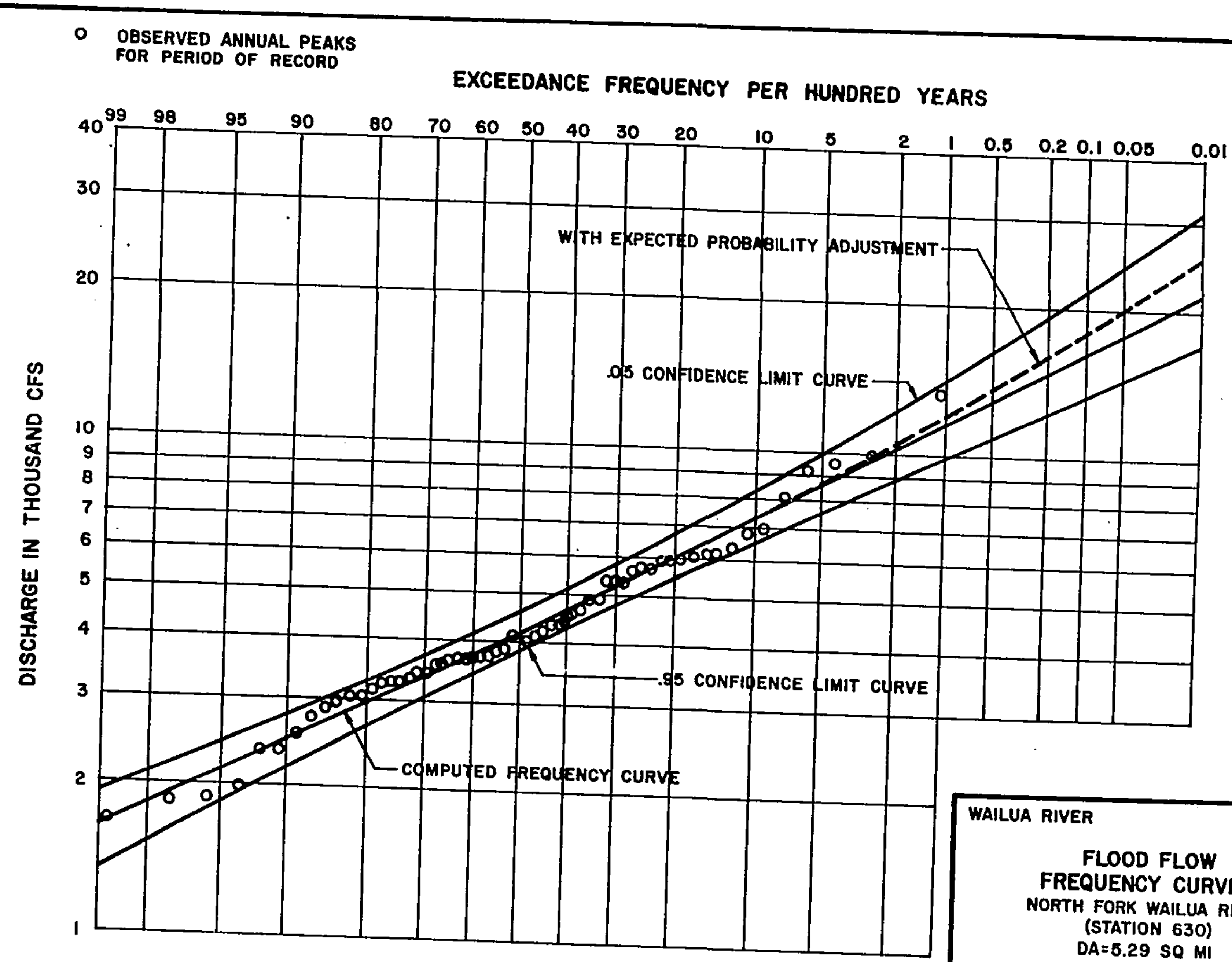
PLATE B-6



WAILUA RIVER HAWAII

LOW FLOW
FREQUENCY CURVE
NORTH FORK WAILUA RIVER
(STATION 630)

U.S. ARMY ENGINEER DISTRICT, HONOLULU



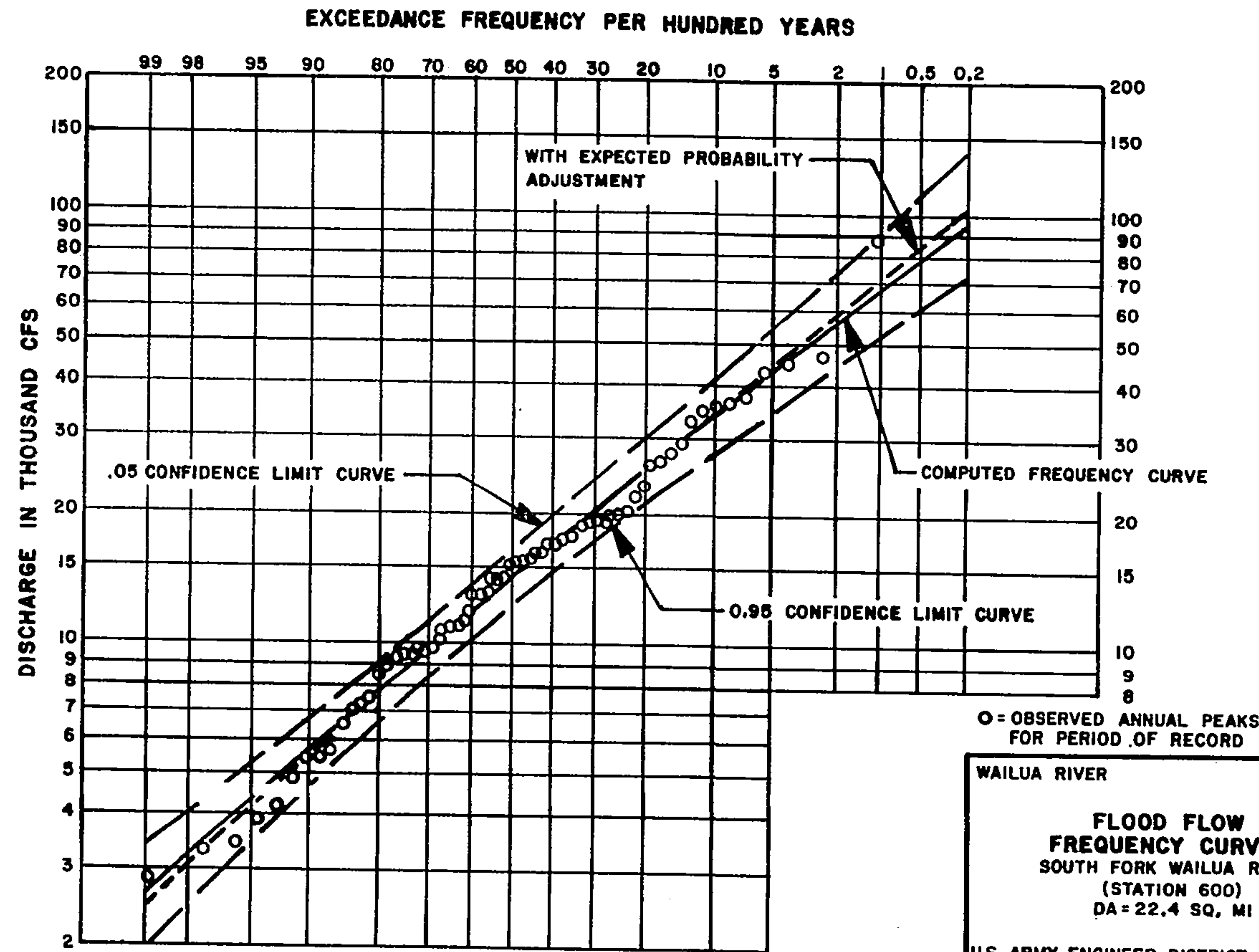
WAILUA RIVER	HAWAII

FLOOD FLOW FREQUENCY CURVES

NORTH FORK WAILUA RIVER
(STATION 630)
DA=5.29 SQ MI

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE B-8



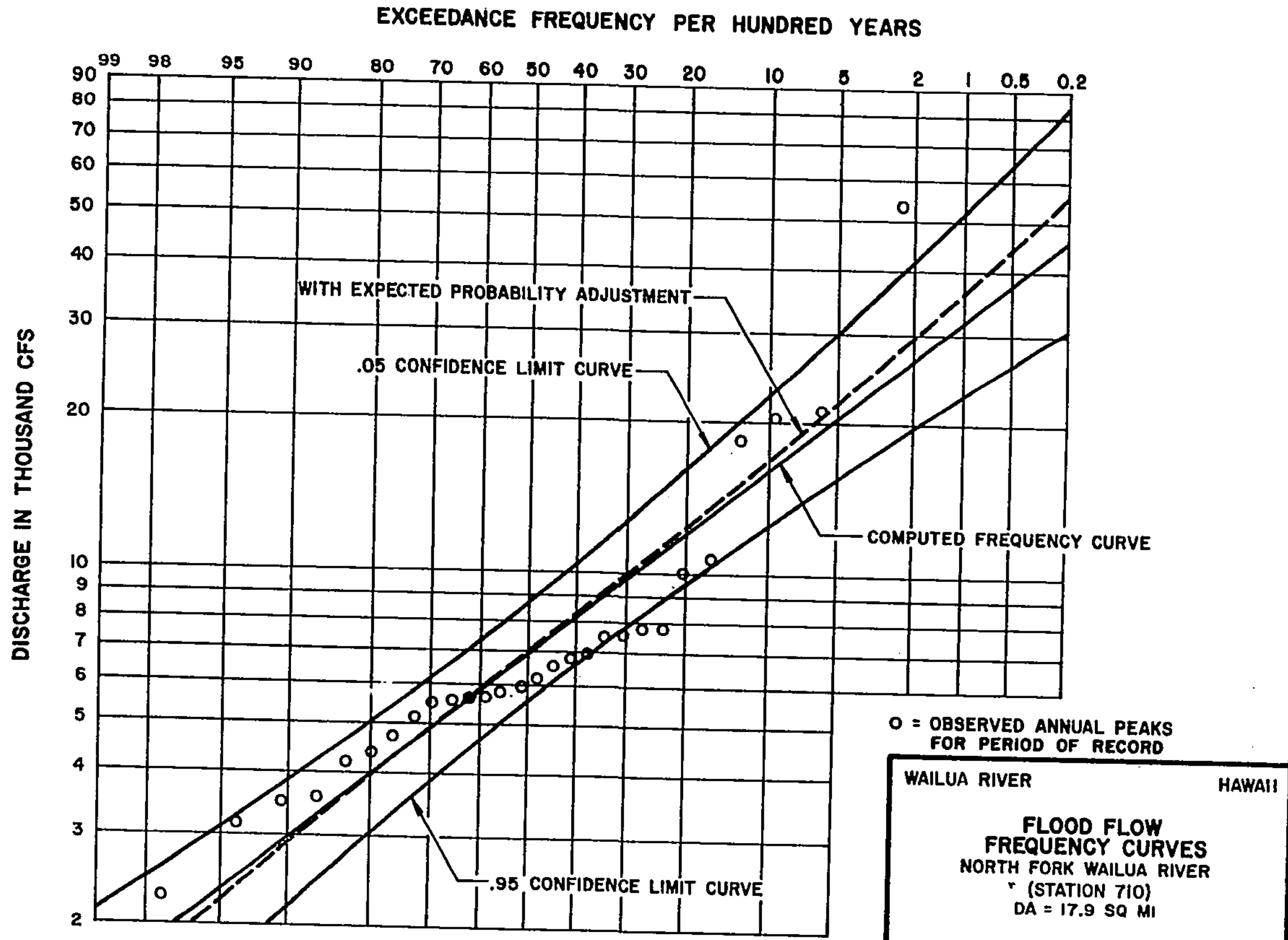
WAILUA RIVER HAWAII

FLOOD FLOW FREQUENCY CURVES

SOUTH FORK WAILUA RIVER
(STATION 600)
DA = 22.4 SQ. MI

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE B-9

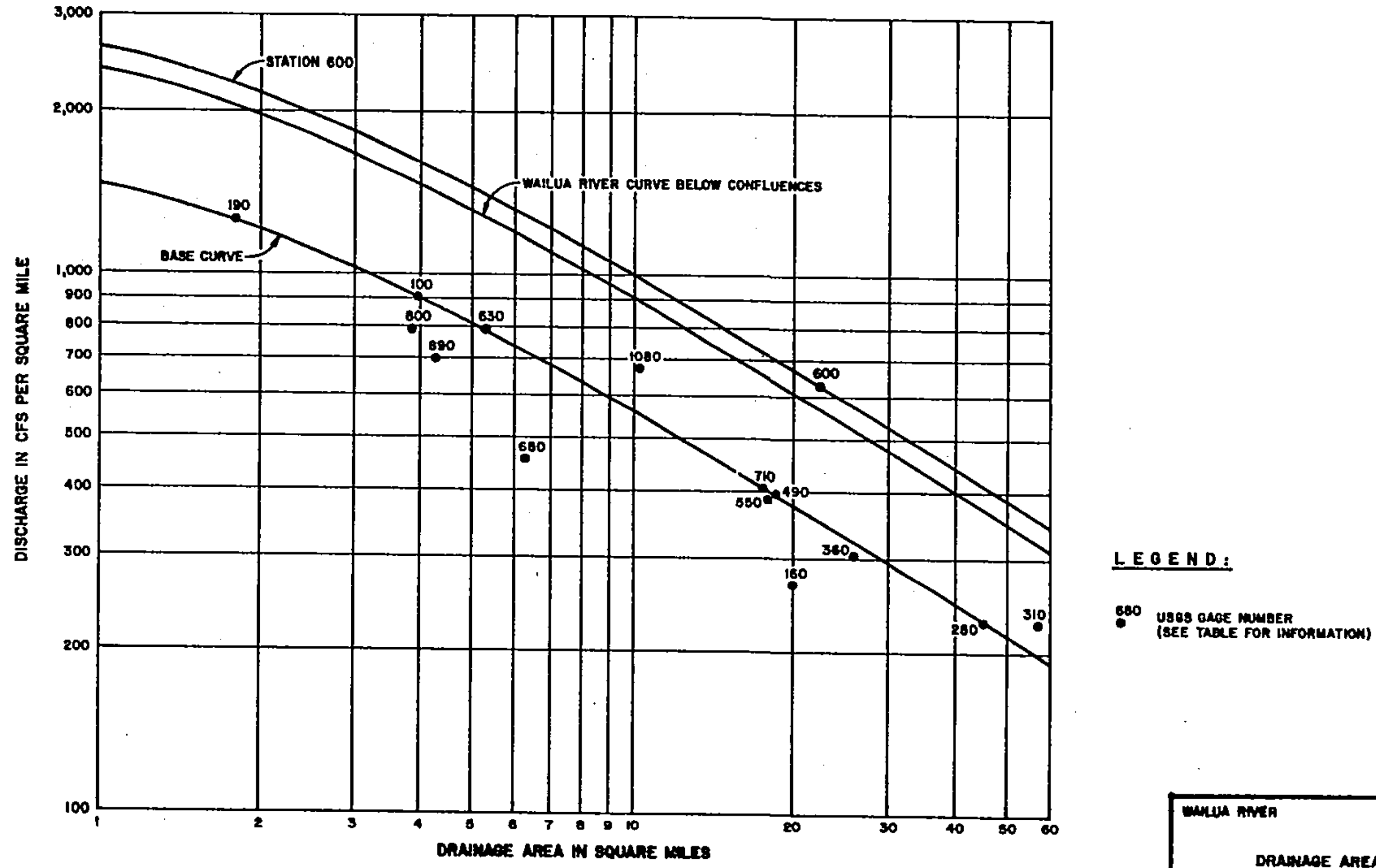


WAILUA RIVER HAWAII

FLOOD FLOW FREQUENCY CURVES
NORTH FORK WAILUA RIVER
(STATION 710)
DA = 17.9 SQ MI

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE B-10

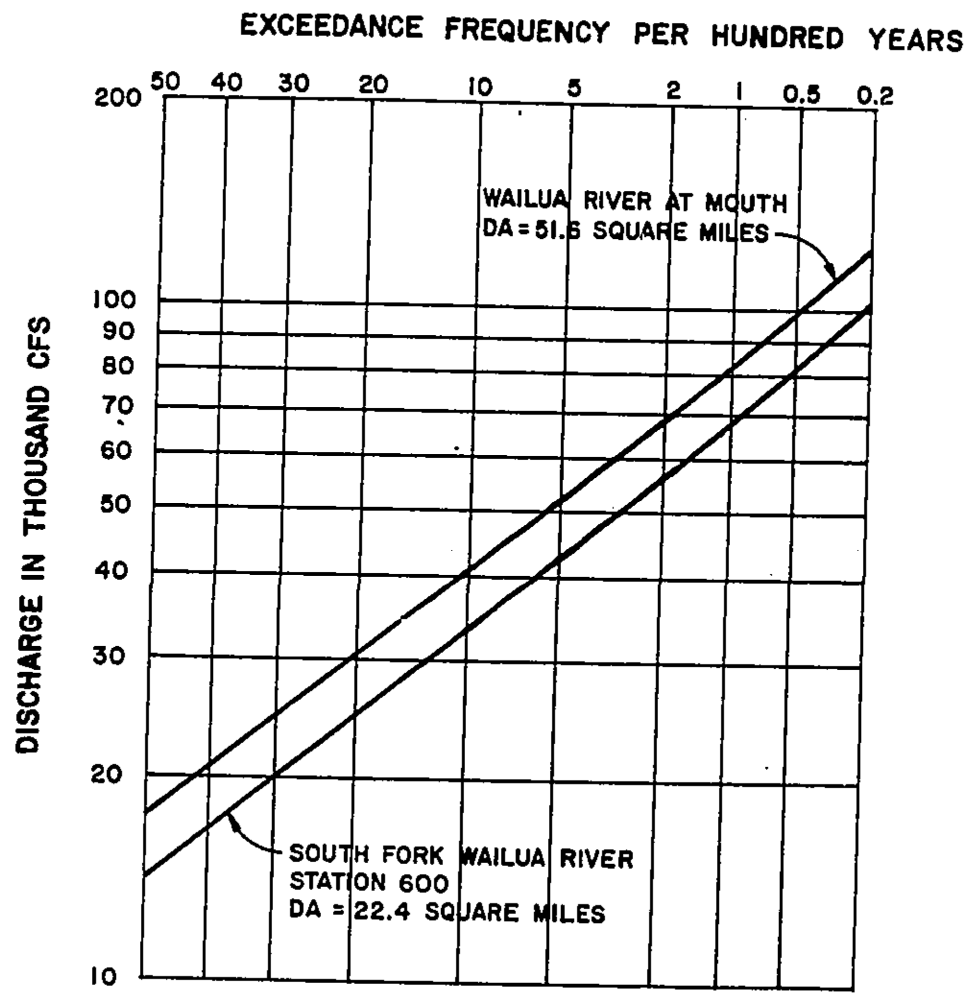


WAILUA RIVER HAWAII

DRAINAGE AREA
MEAN ANNUAL PEAK FLOW
RELATIONSHIP

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE B-11

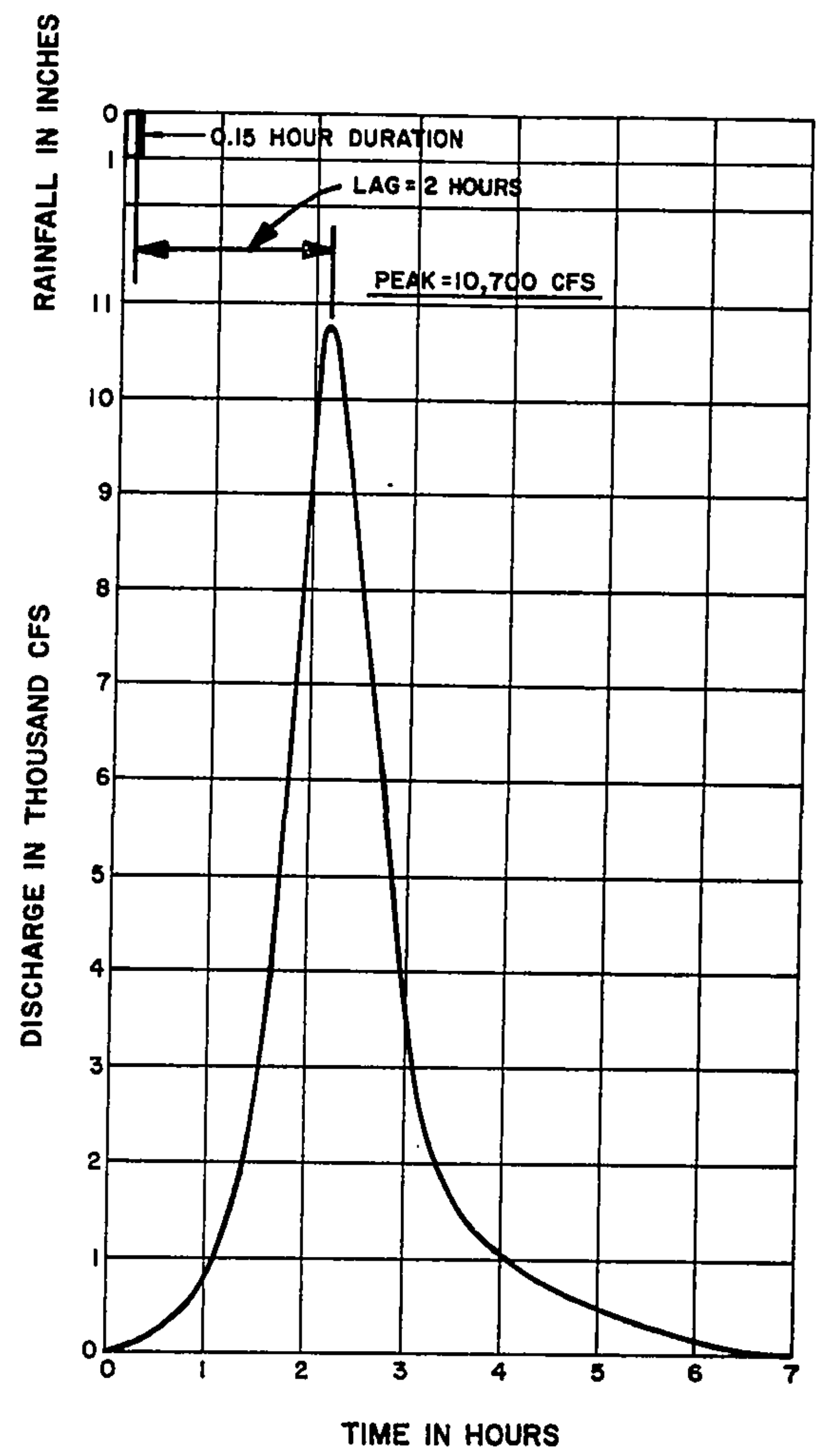


NOTE: THESE CURVES ARE WITH EXPECTED PROBABILITY ADJUSTMENT.

WAILUA RIVER HAWAII

FLOOD FLOW FREQUENCY CURVES
WAILUA RIVER

U.S. ARMY ENGINEER DISTRICT, HONOLULU

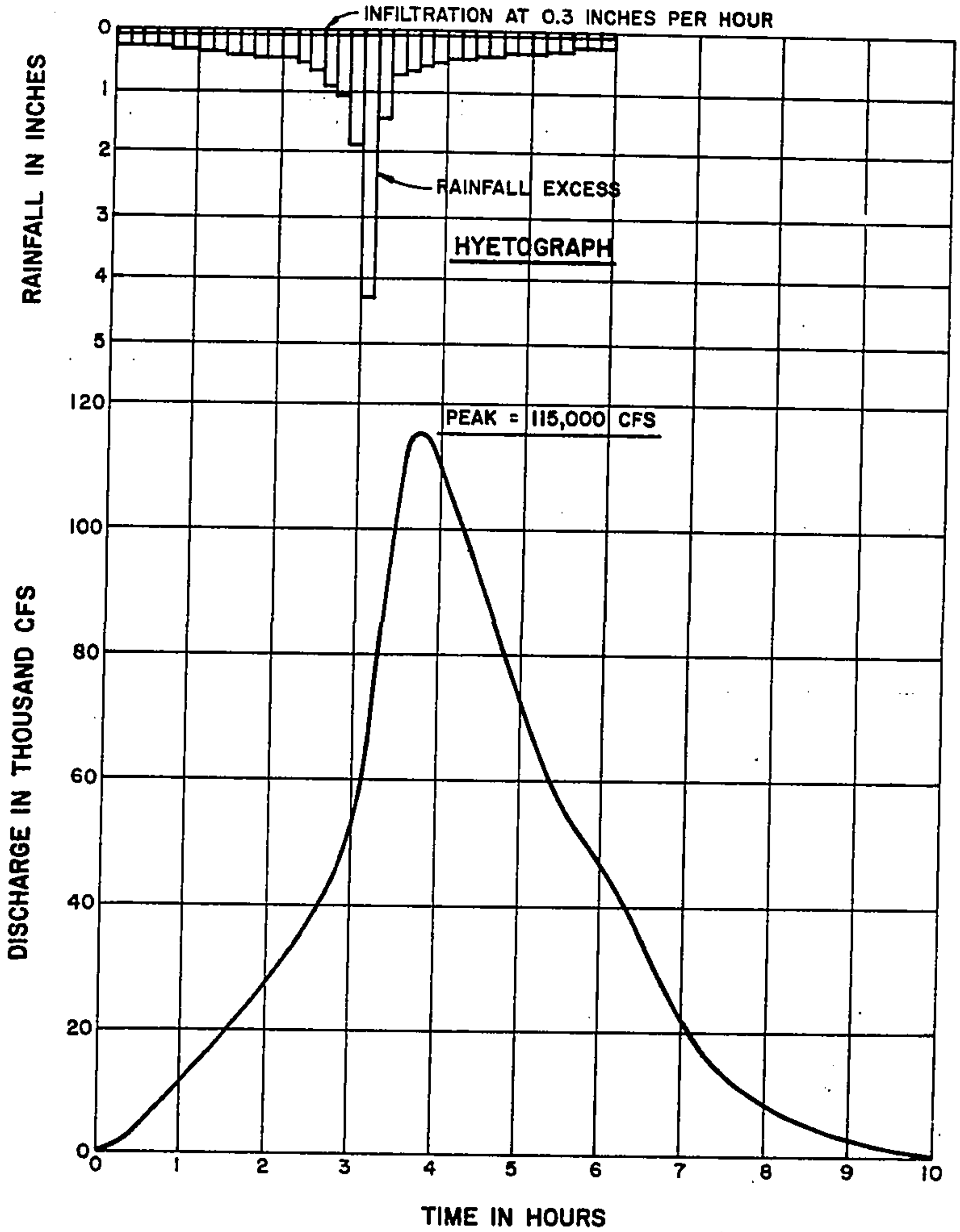


NOTE: THIS PLATE WAS TAKEN FROM THE "WAIALEALE HYDROPOWER STUDY."

WAILUA RIVER HAWAII

UNIT HYDROGRAPH
SOUTH FORK WAILUA RIVER
(STATION 600)
DA = 22.4 SQ. MI.

U.S. ARMY ENGINEER DISTRICT, HONOLULU

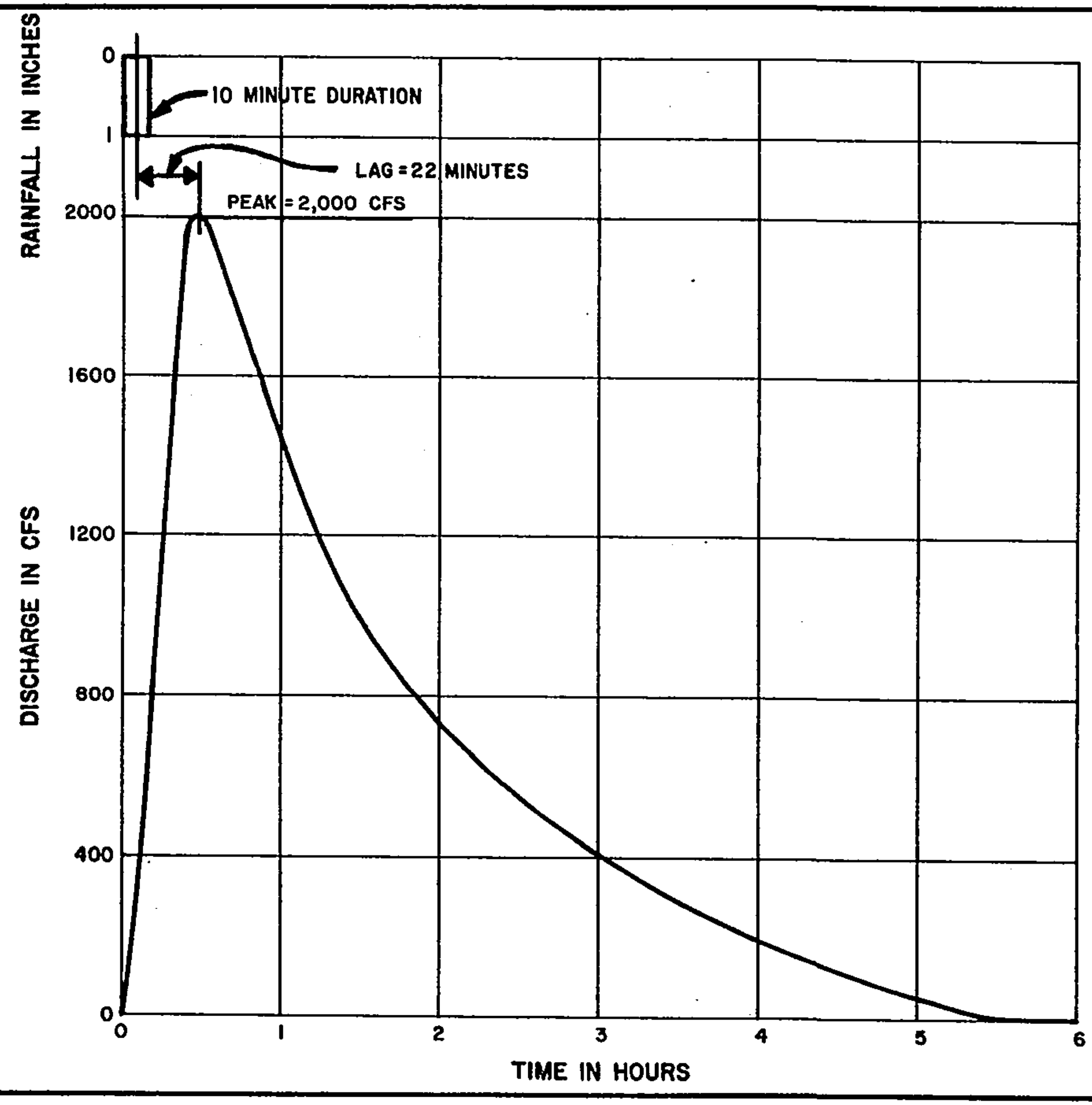


NOTE: THIS PLATE WAS TAKEN FROM THE "WAIALEALE HYDROPOWER STUDY."

WAILUA RIVER HAWAII

PROBABLE MAXIMUM FLOOD
SOUTH FORK WAILUA RIVER
(STATION 600)
DA = 22.4 SQ.MI.

U.S. ARMY ENGINEER DISTRICT, HONOLULU

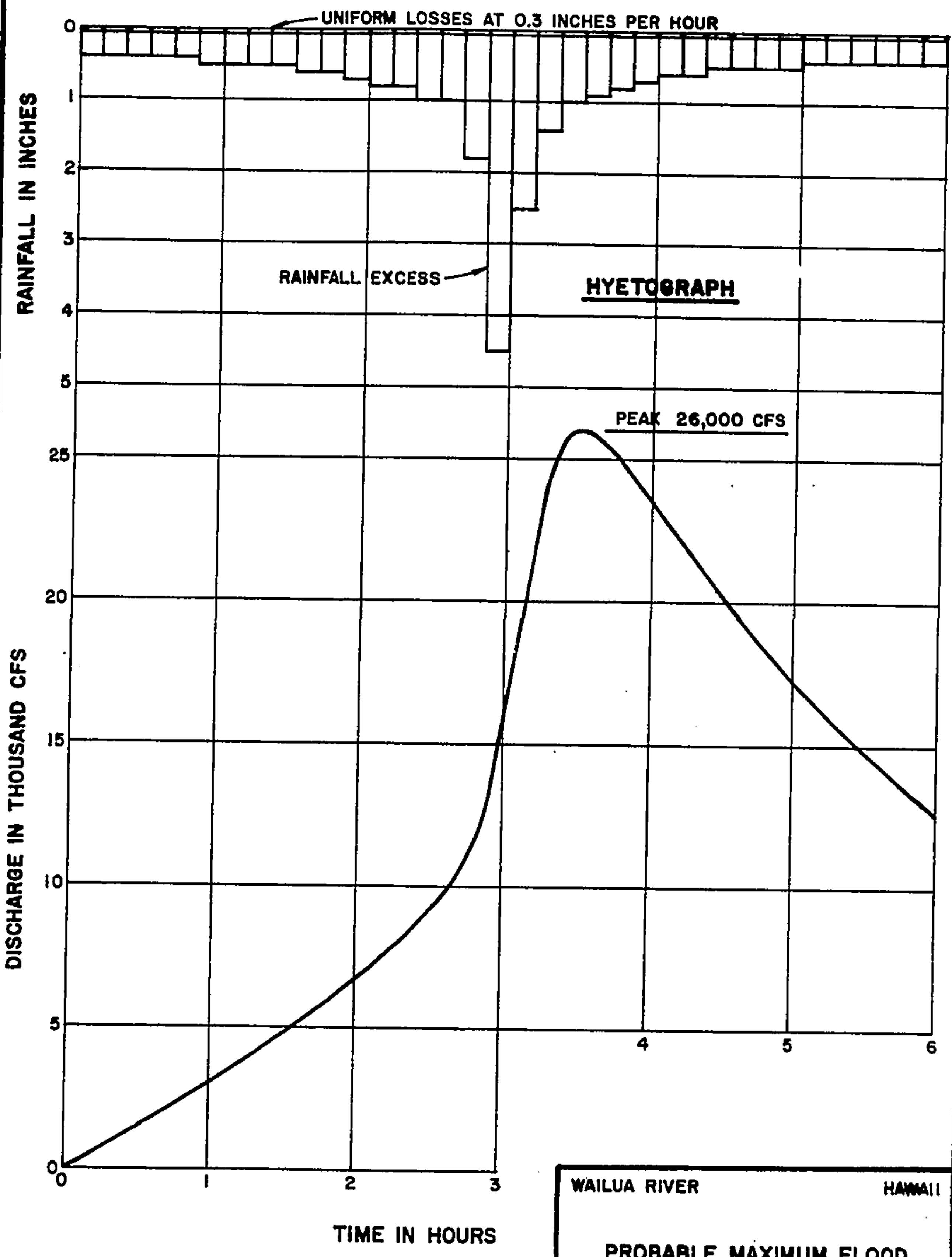


WAILUA RIVER HAWAII

UNIT HYDROGRAPH
NORTH FORK WAILUA RIVER
(STATION 630)
DA = 5.29 SQ. MI.

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE B-15



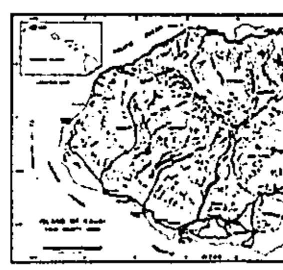
WAILUA RIVER HAWAII

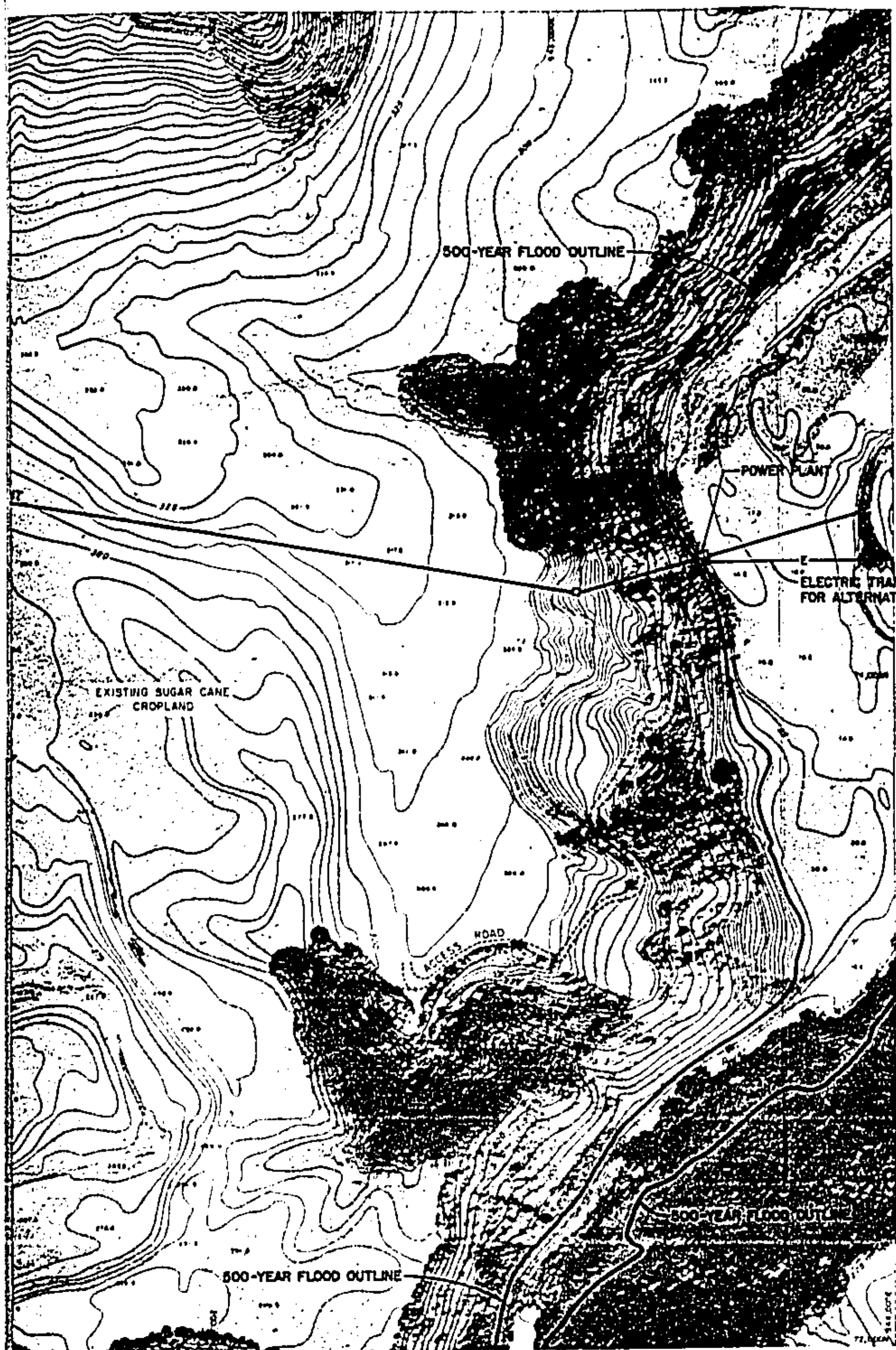
PROBABLE MAXIMUM FLOOD
NORTH FORK WAILUA RIVER
(STATION 630)
DA = 5.29 SQ. MI.

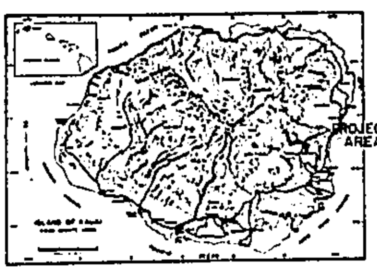
U.S. ARMY ENGINEER DISTRICT, HONOLULU

NOTES:

1. SCALE: 1"=200'
2. CONTOUR INTERVAL: 5'
3. VERTICAL DATUM: MEAN SEA LEVEL
4. ORIGIN OF COORDINATES: HAWAIIAN PLANE COORDINATE SYSTEM, ZONE 4
5. COMPILED BY PHOTOGRAMMETRIC METHODS FROM PHOTOGRAPHY TAKEN DECEMBER 21,1975 AT AN ALTITUDE OF 6600' ABOVE MEAN TERRAIN.
6. ALL CONTOURS IN AREAS WHERE THE HEIGHT OF THE VEGETATION EXCEEDS FIVE FEET ARE TO BE INTERPRETED AS FORM LINES ONLY AND AS SUCH MAY BE SUBSTANDARD.







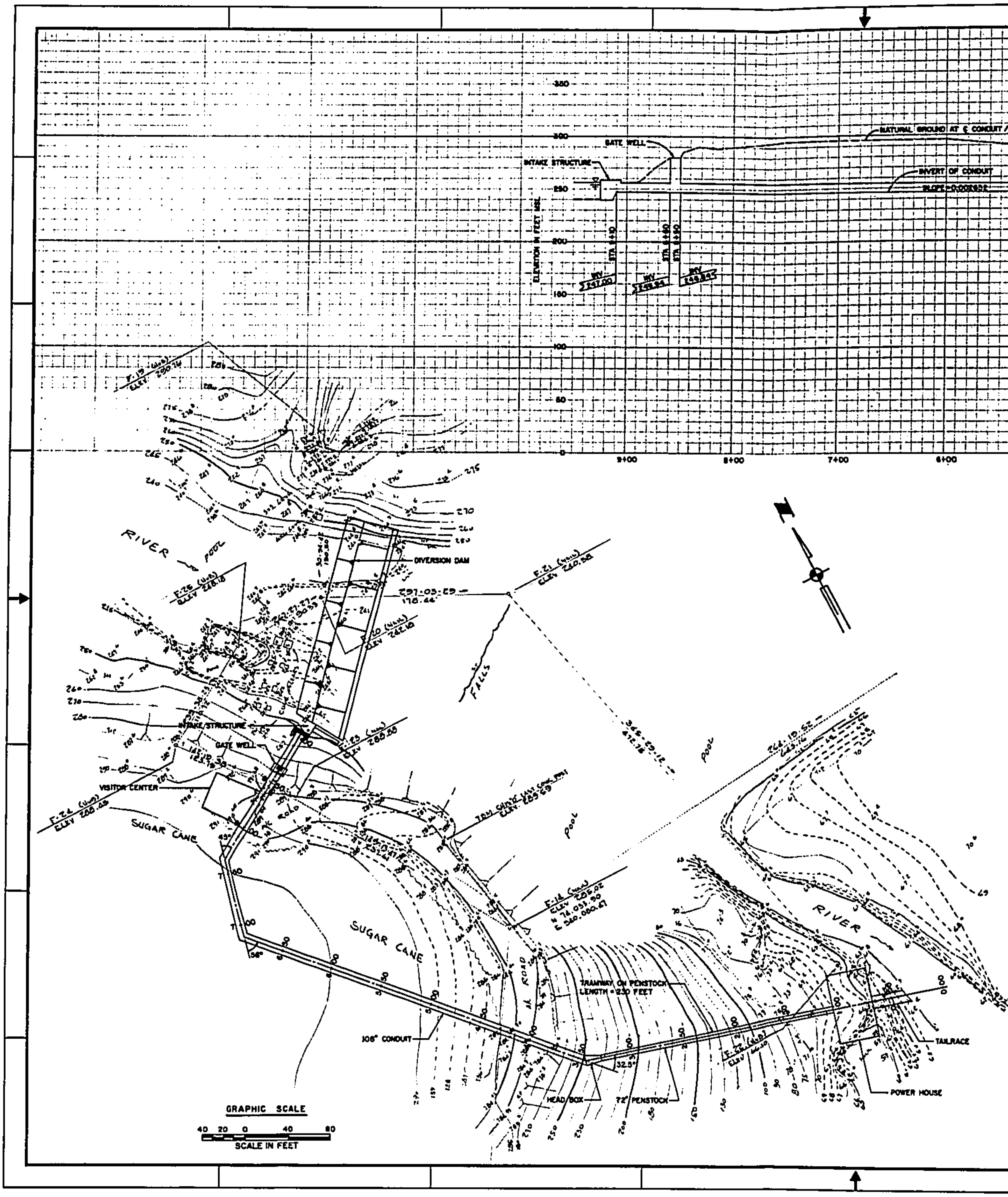
WAILUA RIVER HAWAII

GENERAL PLAN

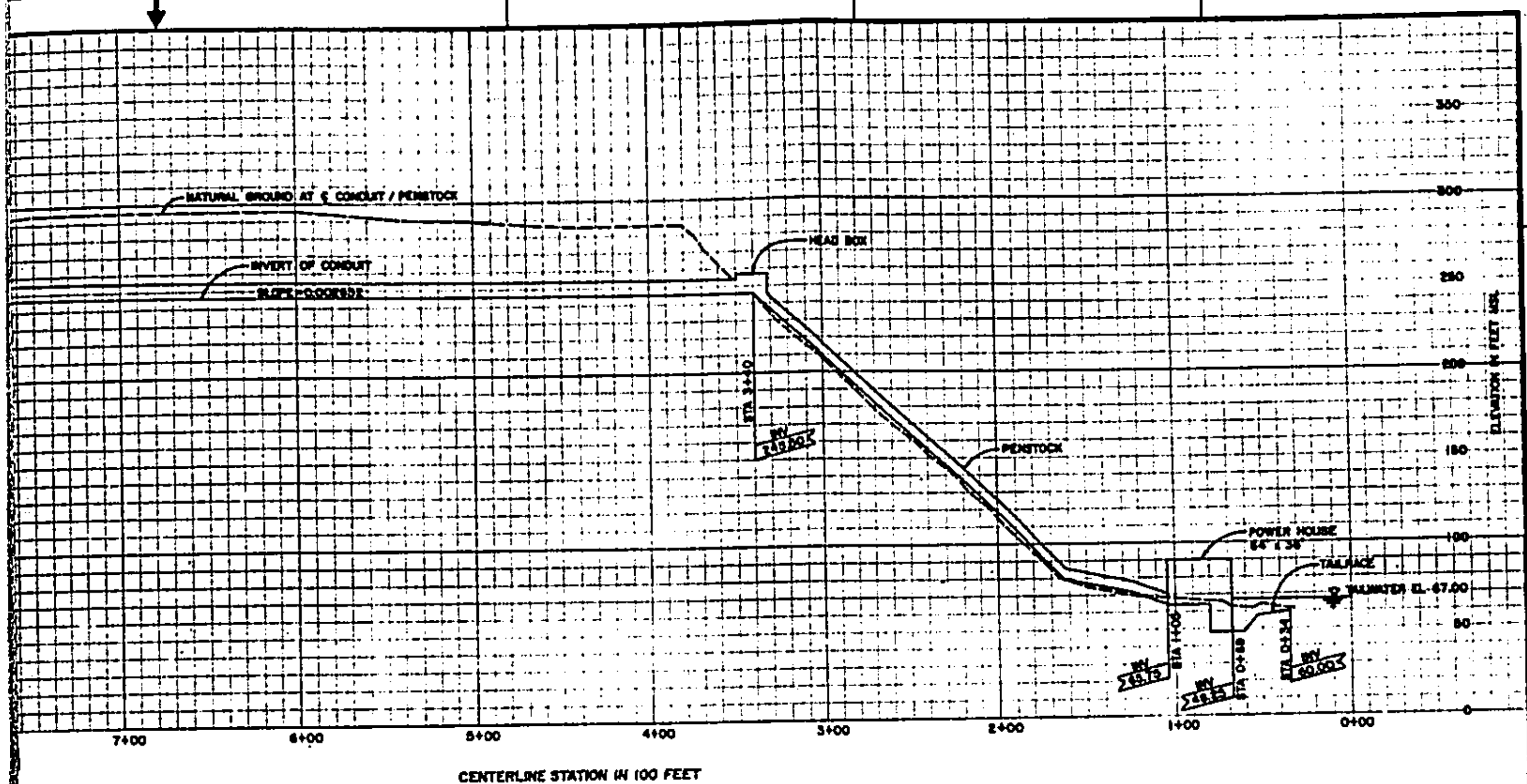
ALTERNATIVES 1A & 2A

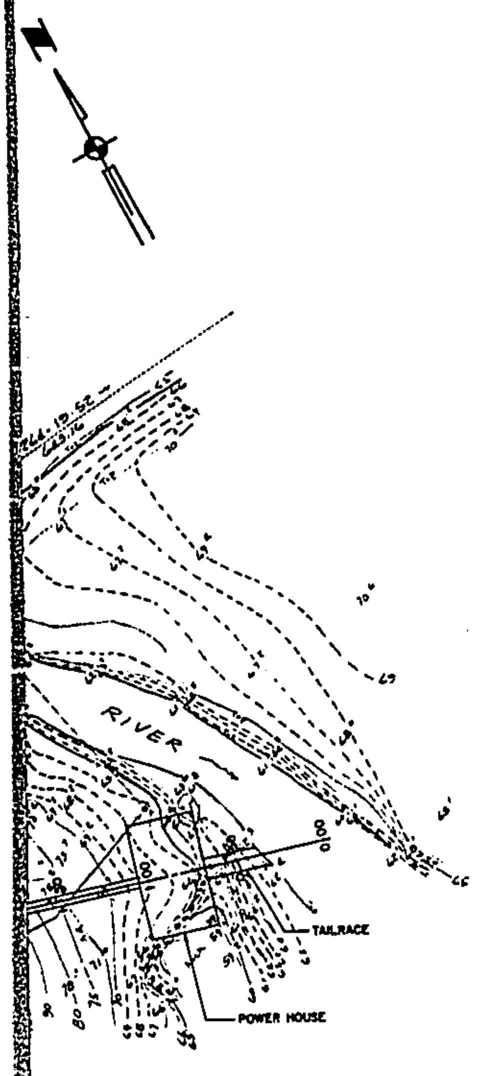
U. S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE B-17



ELEVATION IN FEET MSL
GATE WELL
INTAKE STRUCTURE
INVERT OF CONDUIT
9+00
8+00
7+00
6+00
RIVER
POOL
DIVERSION DAM
FALLS
INTAKE/STRUCTURE
GATE WELL
VISITOR CENTER
SUGAR CANE
ROAD
108" CONDUIT
TRAMWAY ON PENSTOCK
LENGTH = 230 FEET
HEAD BOX
72" PENSTOCK
TAILRACE
POWER HOUSE
GRAPHIC SCALE
40 20 0 40 80
SCALE IN FEET





SURVEY NOTES:

1. COORDINATES BASED ON HAWAII STATE PLANE COORDINATE SYSTEM, ZONE 3.
2. ALL ELEVATIONS BASED ON MEAN SEA LEVEL.
3. NORTH ARROW IS TRUE NORTH
4. TRAVERSE DONE BY TURNING ANGLES AND TAPING. THIRD ORDER SURVEY.
5. BENCHMARK IS STATE BENCHMARK # 20. RAILROAD SPIKE LOCATED IN CENTERLINE MAALO ROAD AND HAUL CANE ROAD NEAR EXPERIMENT STATION. EL 383.22 FT MSL.
6. DATE OF SURVEY: OCT - NOV 1981.

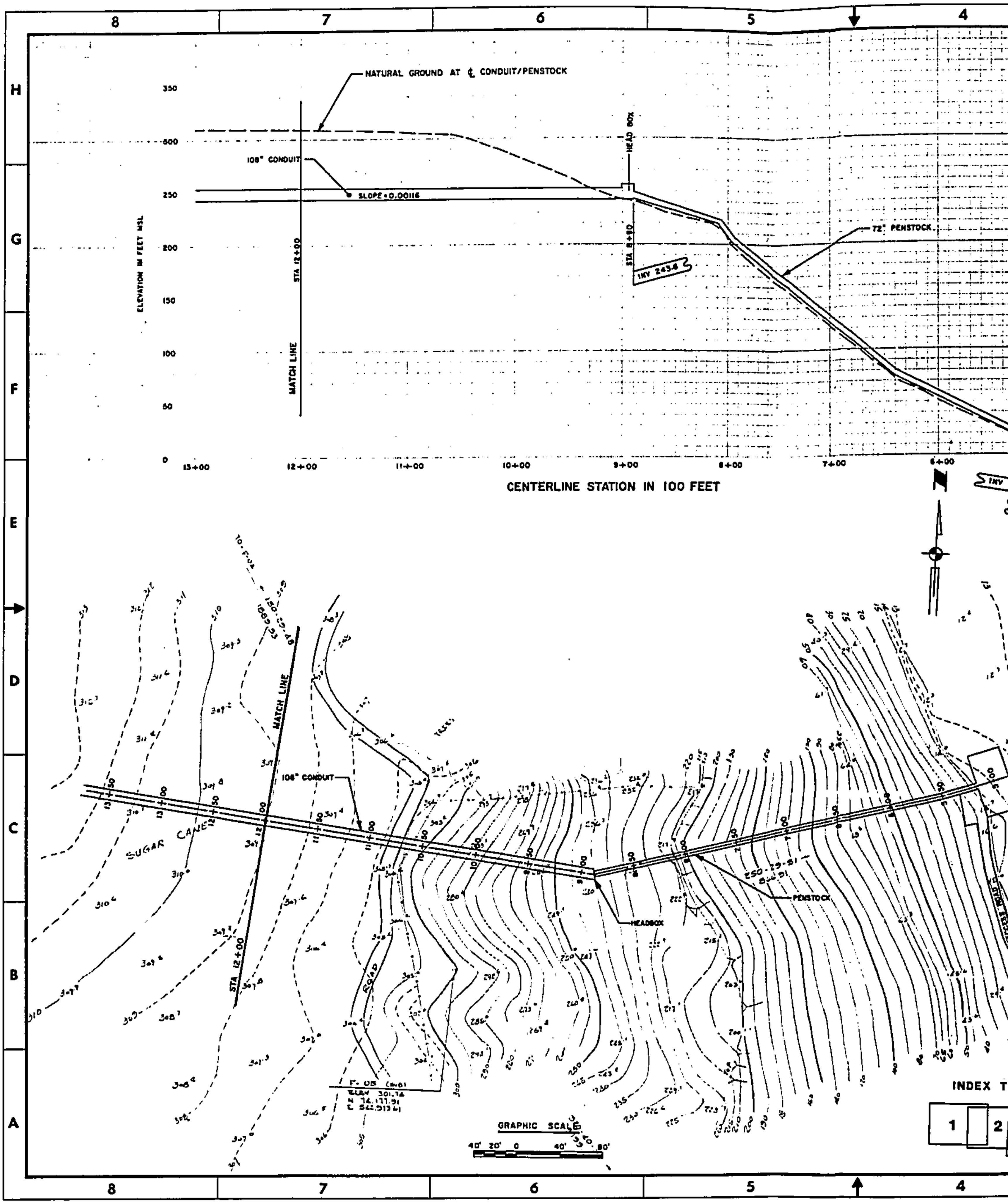
WAILUA RIVER — HAWAII

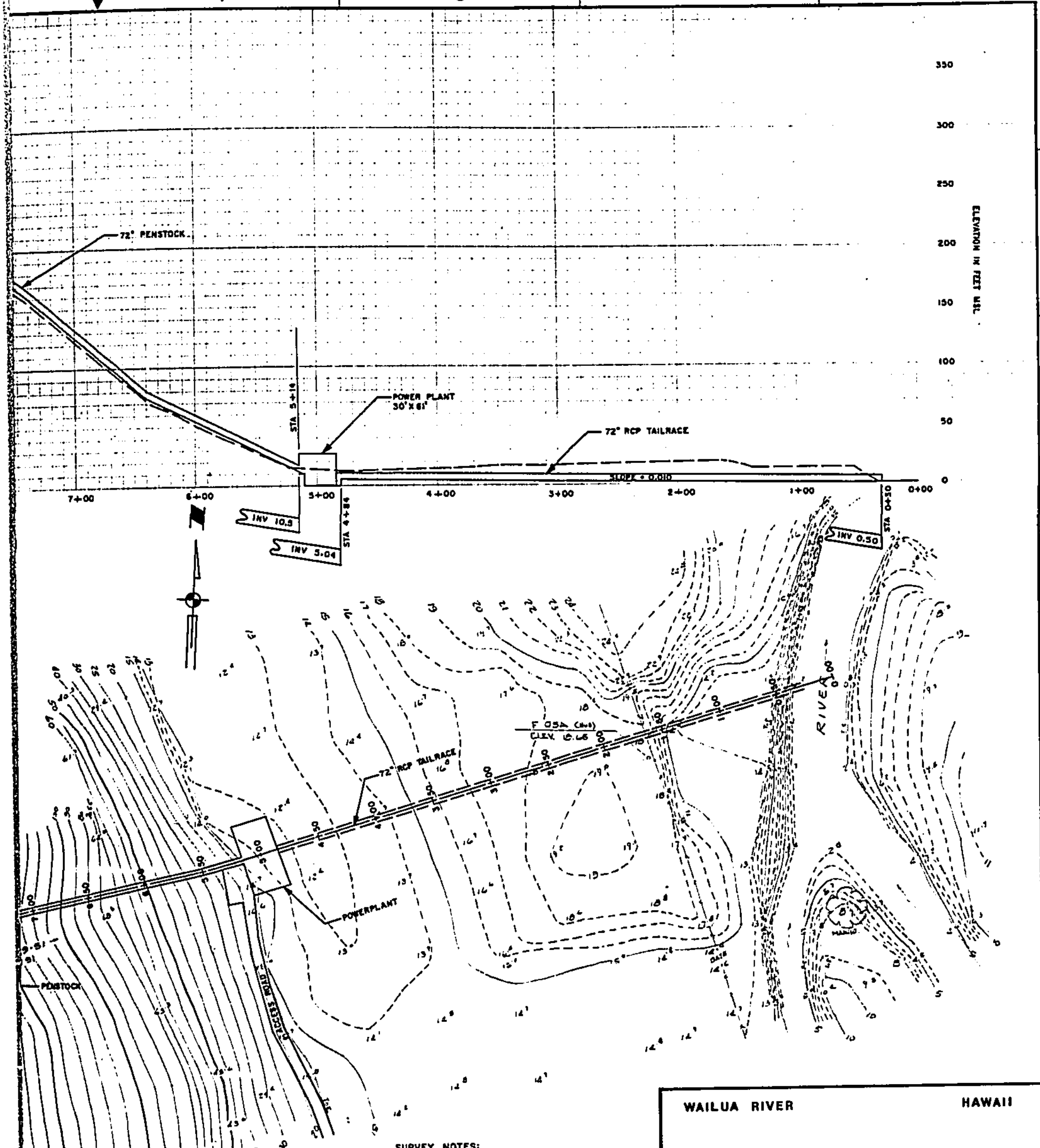
ALTERNATIVE 1A

PLAN AND PROFILE

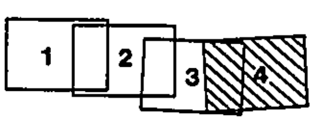
U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE B-18


8
7
6
5
4
H
G
F
E
D
C
B
A
NATURAL GROUND AT ℄ CONDUIT/PENSTOCK
108" CONDUIT
SLOPE = 0.00116
HEAD BOX
STA 8+90
INV 243.4
72" PENSTOCK
ELEVATION IN FEET MSL
350
300
250
200
150
100
50
0
STA 12+00
MATCH LINE
13+00
12+00
11+00
10+00
9+00
8+00
7+00
6+00
CENTERLINE STATION IN 100 FEET
SUGAR CANE
MATCH LINE
108" CONDUIT
ROAD
HEADBOX
PENSTOCK
STA 12+00
GRAPHIC SCALE
40' 20' 0 40' 80'
INDEX T



INDEX TO SHEETS



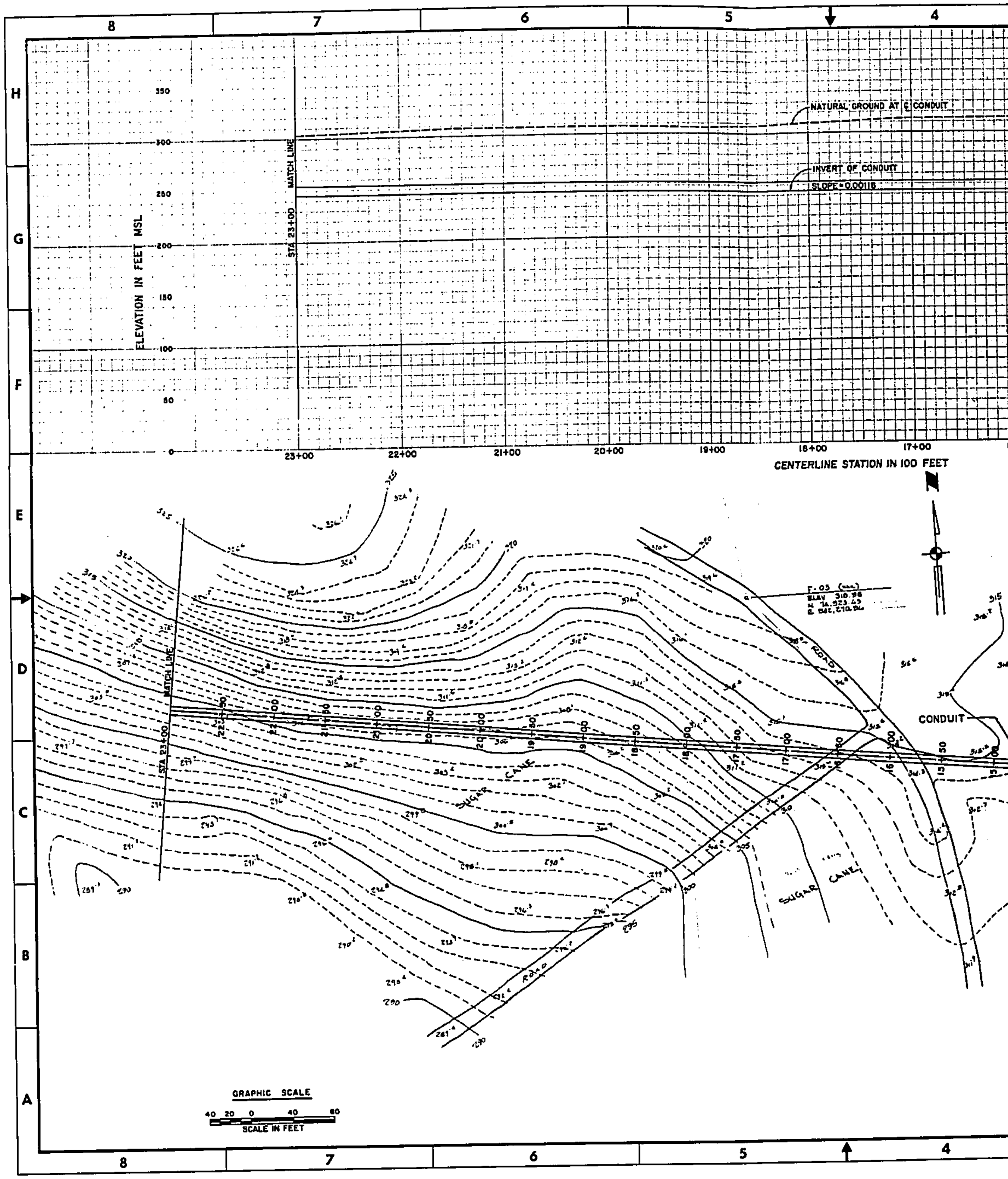
SURVEY NOTES:

1. COORDINATES BASED ON HAWAII STATE PLANE COORDINATE SYSTEM, ZONE 3.
2. ALL ELEVATIONS BASED ON MEAN SEA LEVEL.
3. NORTH ARROW IS TRUE NORTH
4. TRAVERSE DONE BY TURNING ANGLES AND TAPING. THIRD ORDER SURVEY.
5. BENCHMARK IS STATE BENCHMARK # 20. RAILROAD SPIKE LOCATED IN CENTERLINE MAALO ROAD AND HAUL CANE ROAD NEAR EXPERIMENT STATION. EL 383.22 FT MSL.
6. DATE OF SURVEY: OCT - NOV 1981.

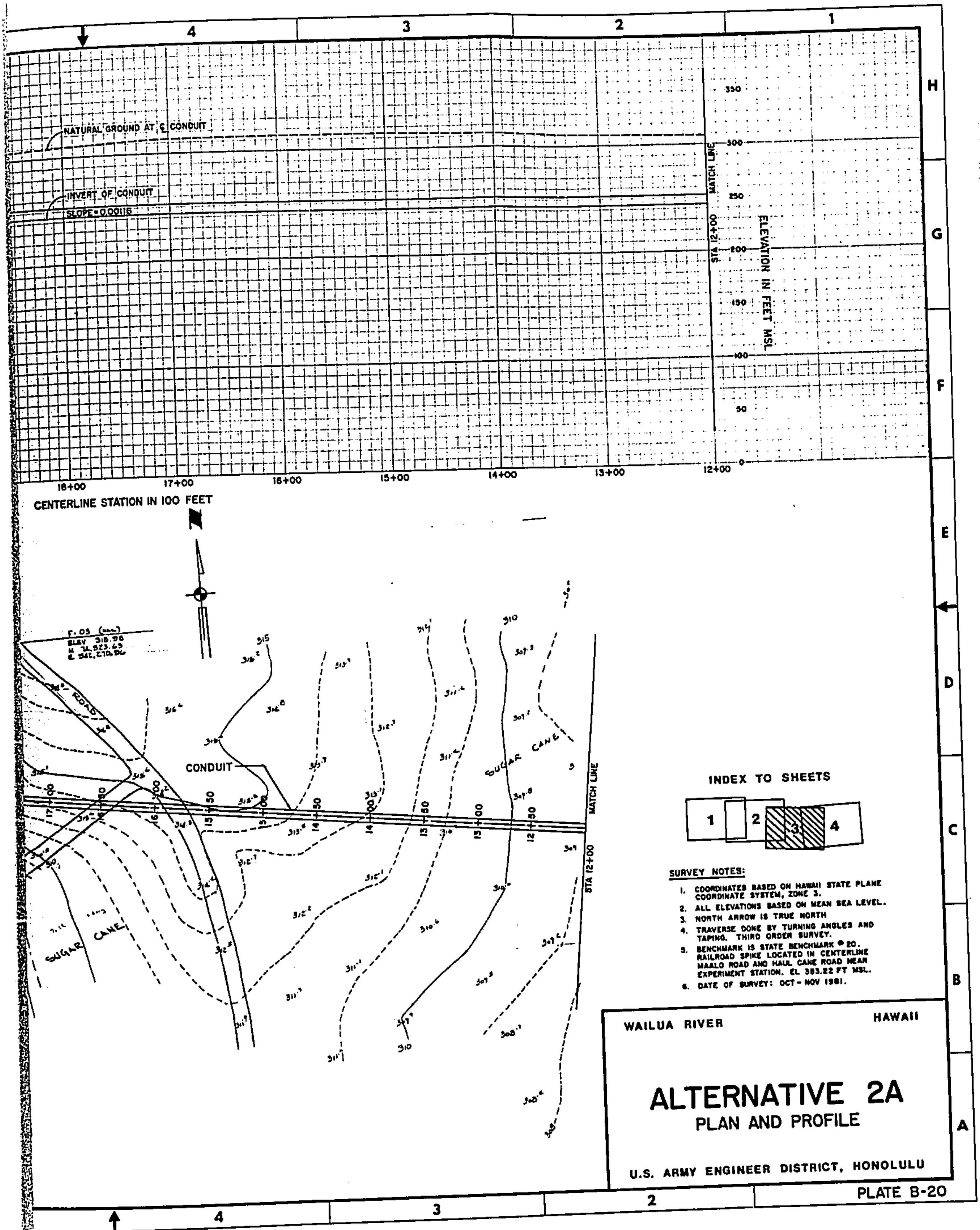
WAILUA RIVER HAWAII

ALTERNATIVE 2A
PLAN AND PROFILE

U.S. ARMY ENGINEER DISTRICT, HONOLULU



NATURAL GROUND AT ℄ CONDUIT
INVERT OF CONDUIT
SLOPE=0.00118
ELEVATION IN FEET MSL
MATCH LINE
STA 23+00
CENTERLINE STATION IN 100 FEET
23+00
22+00
21+00
20+00
19+00
18+00
17+00
CONDUIT
SUGAR CANE
ROAD
GRAPHIC SCALE
SCALE IN FEET


NATURAL GROUND AT ℄ CONDUIT
INVERT OF CONDUIT
SLOPE=0.00116
MATCH LINE
STA 12+00
ELEVATION IN FEET MSL
350
300
250
200
150
100
50
0
18+00
17+00
16+00
15+00
14+00
13+00
12+00
CENTERLINE STATION IN 100 FEET
F. 03
ELEV 310.98
ROAD
CONDUIT
SUGAR CANE
SUGAR CANE
MATCH LINE
STA 12+00
INDEX TO SHEETS
1
2
3
4
SURVEY NOTES:
1. COORDINATES BASED ON HAWAII STATE PLANE COORDINATE SYSTEM, ZONE 3.
2. ALL ELEVATIONS BASED ON MEAN SEA LEVEL.
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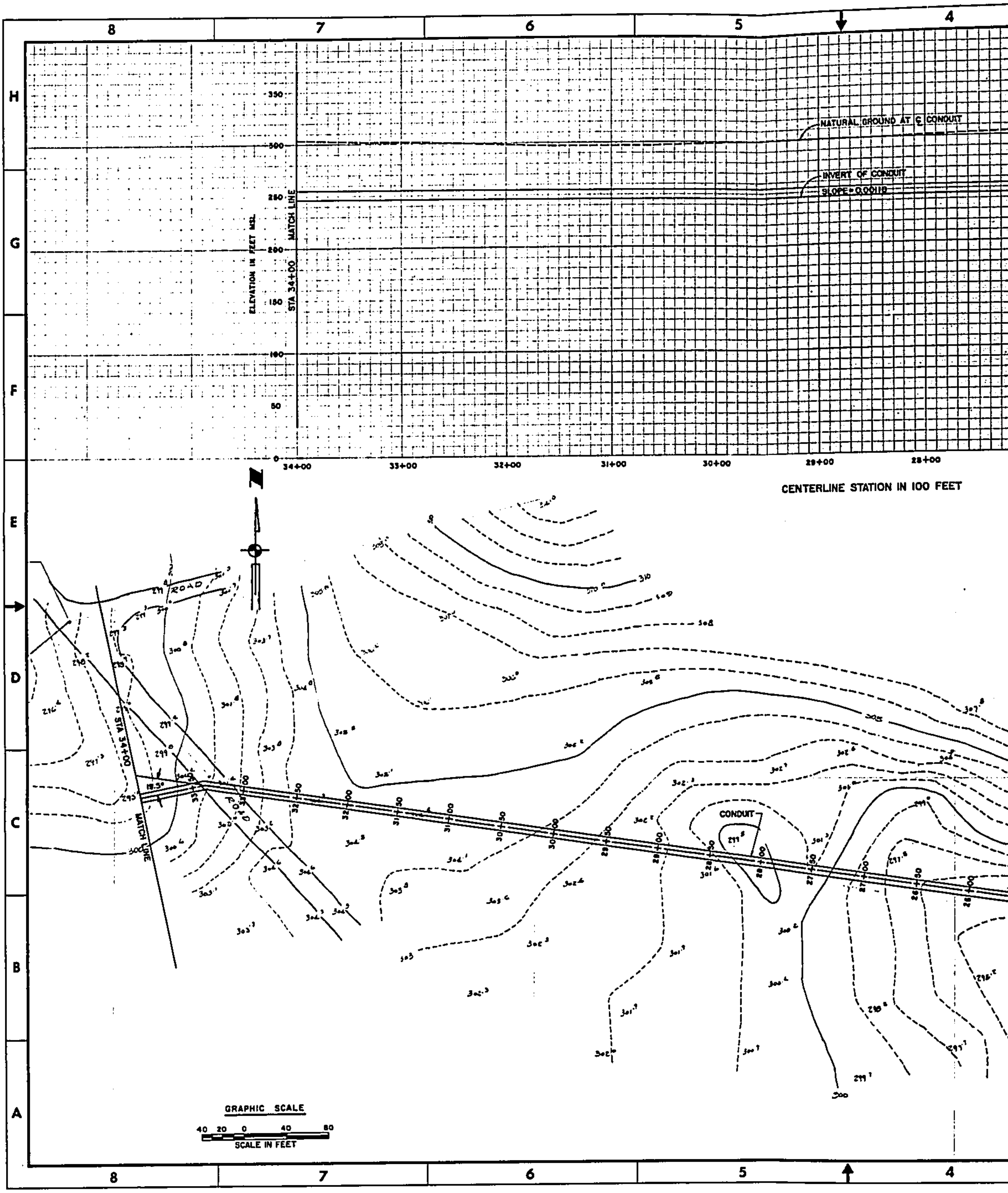
6. DATE OF SURVEY: OCT - NOV 1961.
WAILUA RIVER
HAWAII
ALTERNATIVE 2A
PLAN AND PROFILE
U.S. ARMY ENGINEER DISTRICT, HONOLULU
PLATE B-20



8
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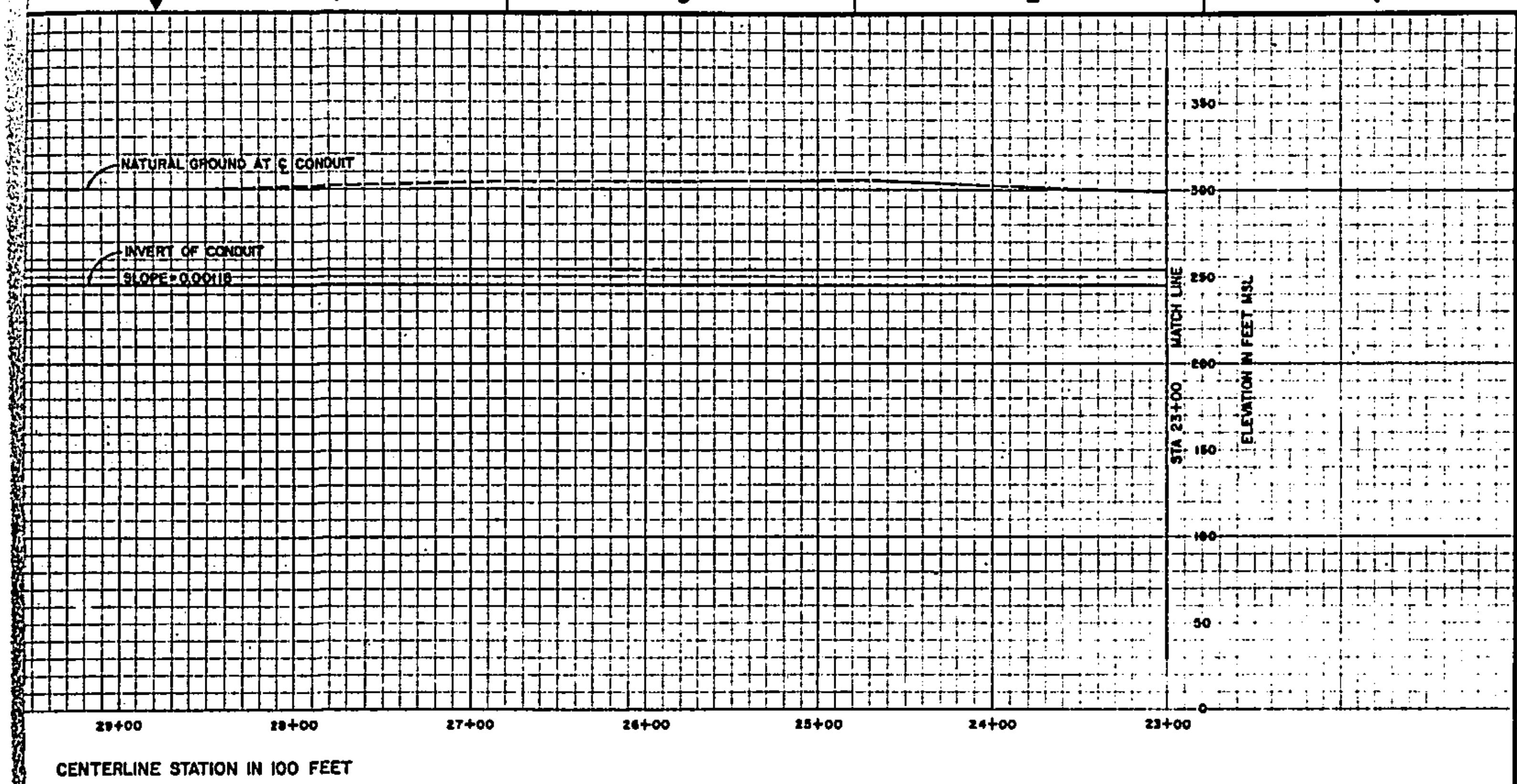
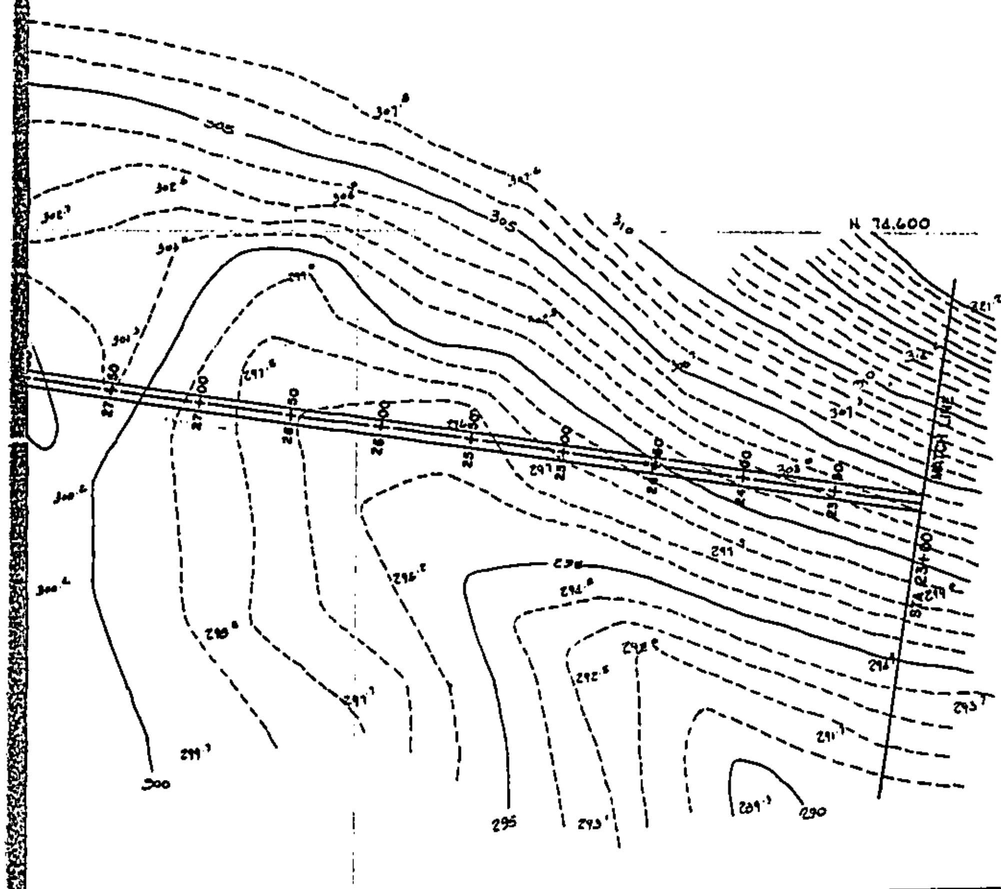
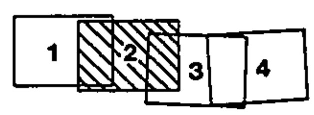
F
E
D
C
B
A
NATURAL GROUND AT ℄ CONDUIT
INVERT OF CONDUIT
SLOPE=0.00110
ELEVATION IN FEET MSL
MATCH LINE
STA 34+00
350
300
250
200
150
100
50
0
34+00
33+00
32+00
31+00
30+00
29+00
28+00
CENTERLINE STATION IN 100 FEET
ROAD
STA 34+00
MATCH LINE
CONDUIT
GRAPHIC SCALE
40 20 0 40 80
SCALE IN FEET





INDEX TO SHEETS



SURVEY NOTES:

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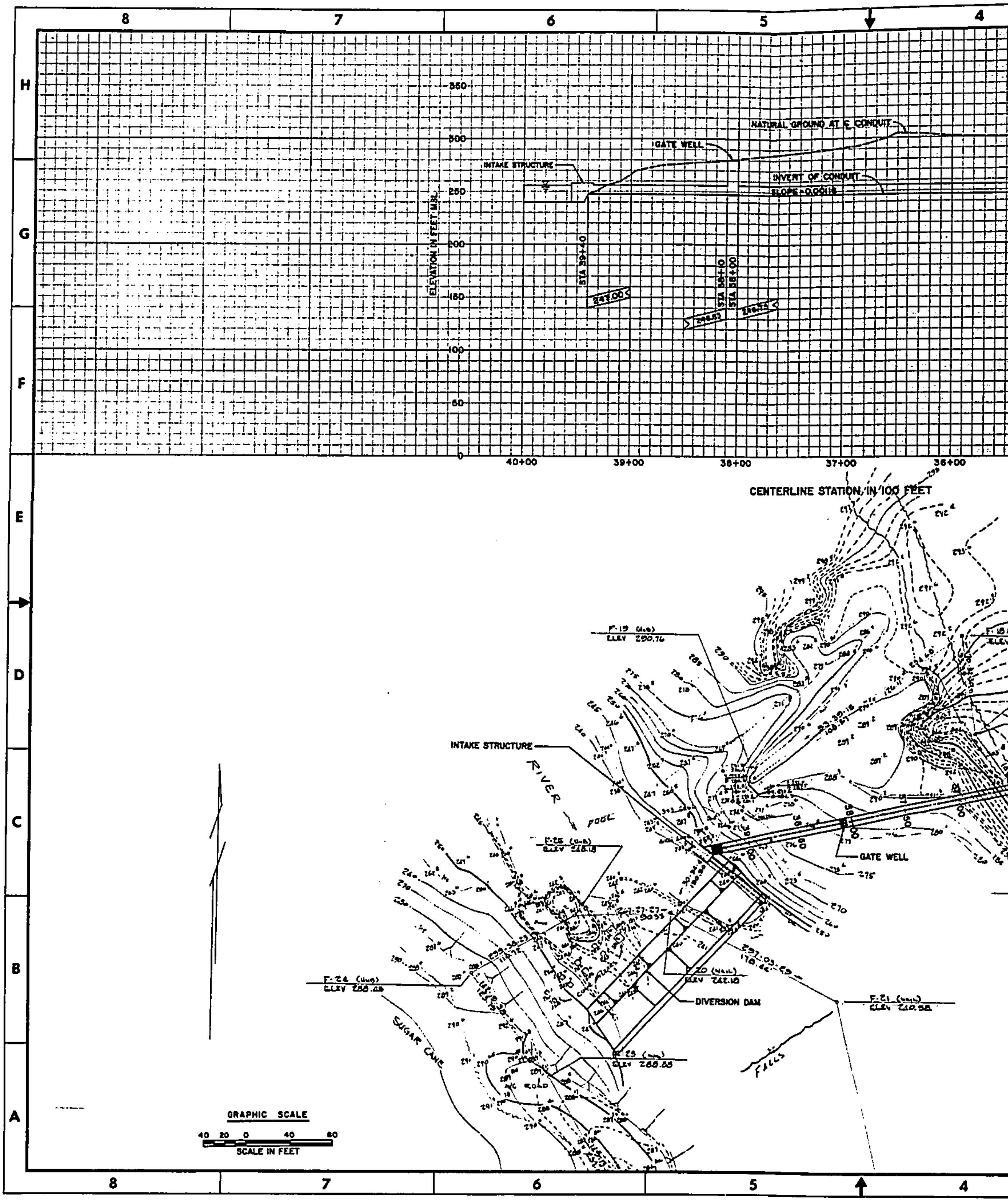
WAILUA RIVER HAWAII

ALTERNATIVE 2A

PLAN AND PROFILE

U.S. ARMY ENGINEER DISTRICT, HONOLULU



8
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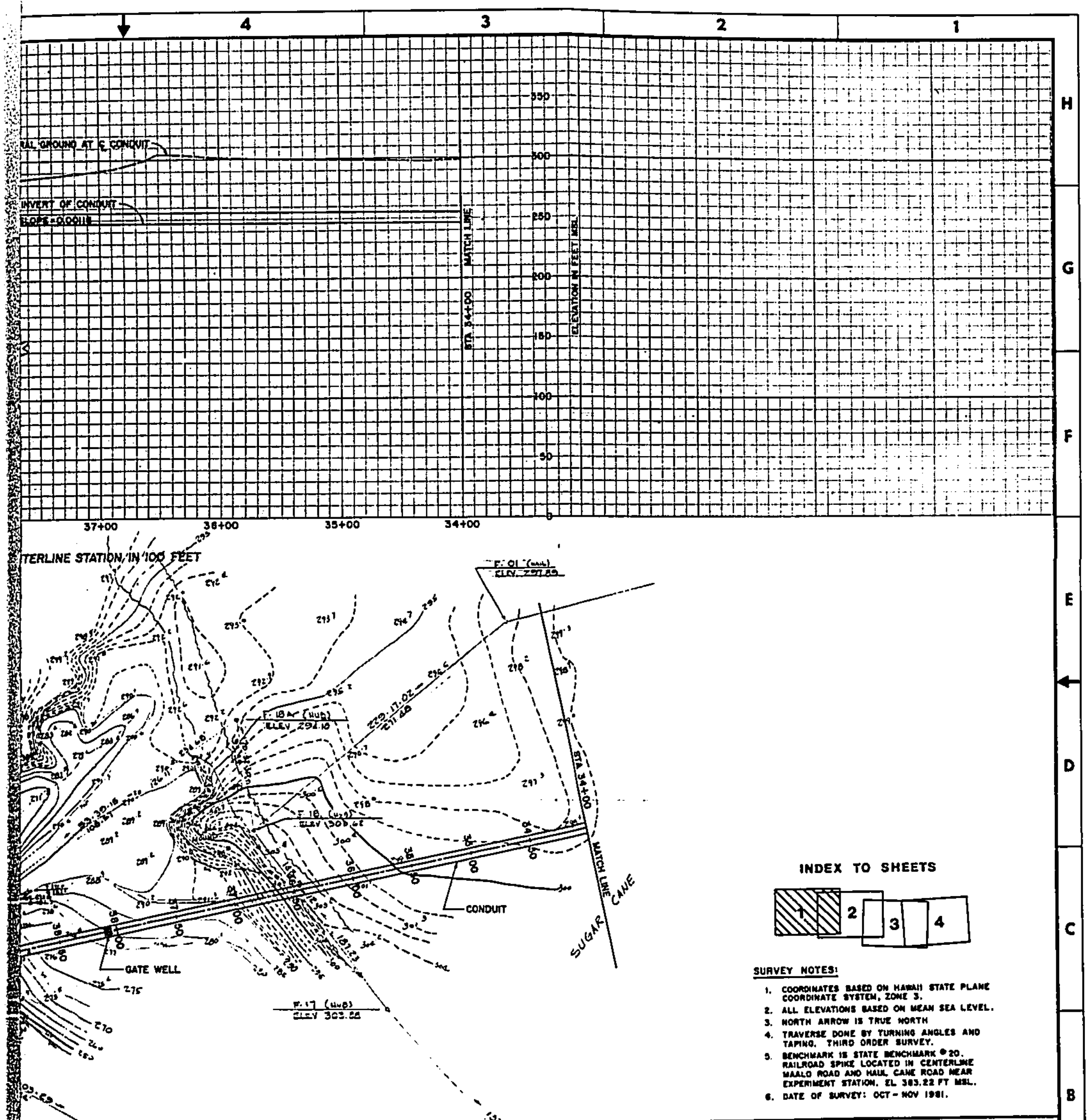
G
F
E
D
C
B
A
NATURAL GROUND AT ℄ CONDUIT
GATE WELL
INTAKE STRUCTURE
INVERT OF CONDUIT
ELEVATION IN FEET MSL
350
300
250
200
150
100
50
0
40+00
39+00
38+00
37+00
36+00
CENTERLINE STATION IN 100 FEET
INTAKE STRUCTURE
RIVER
POOL
GATE WELL
DIVERSION DAM
SUGAR CANE
FALLS
GRAPHIC SCALE
40 20 0 40 80
SCALE IN FEET

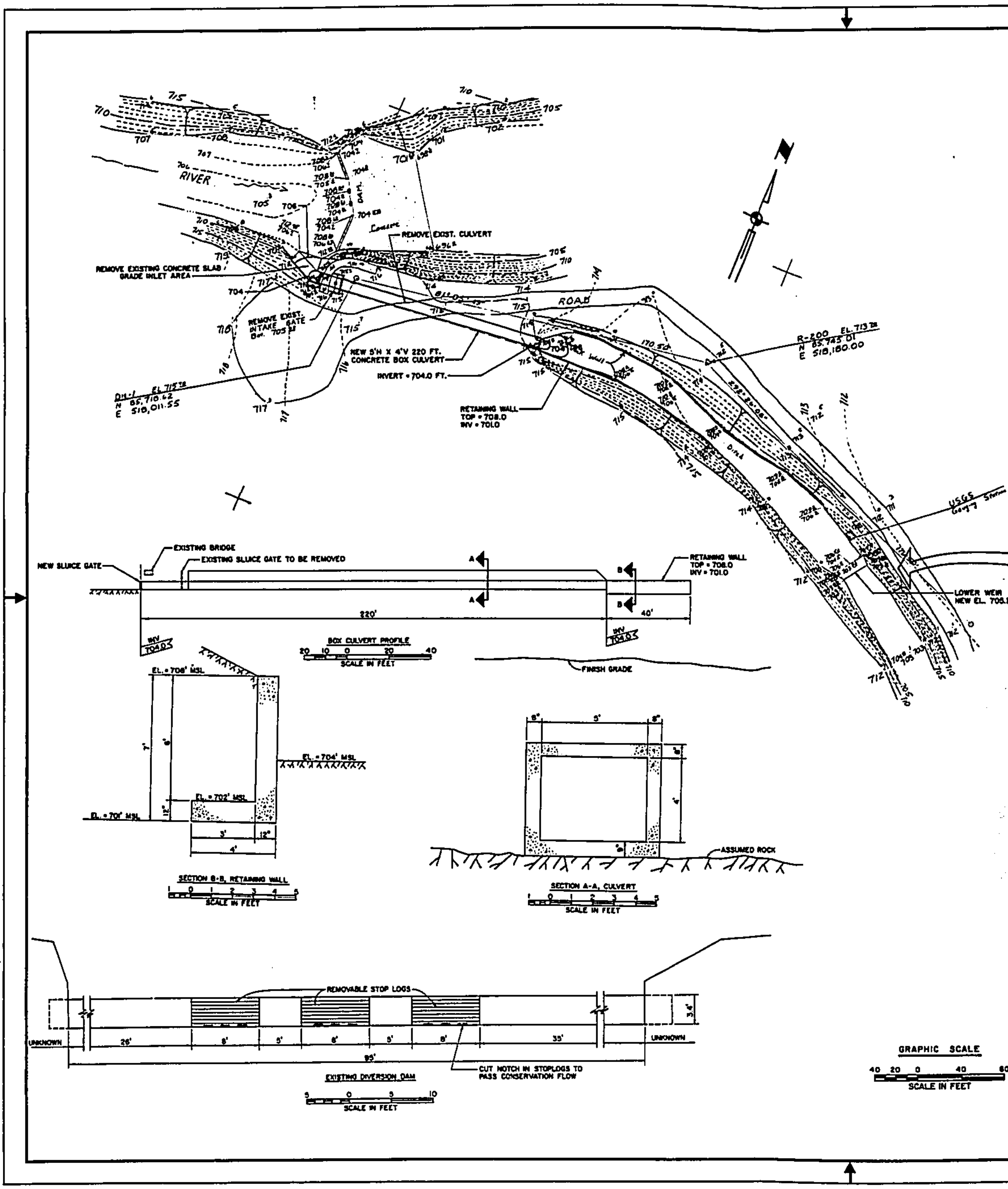


WAILUA RIVER HAWAII

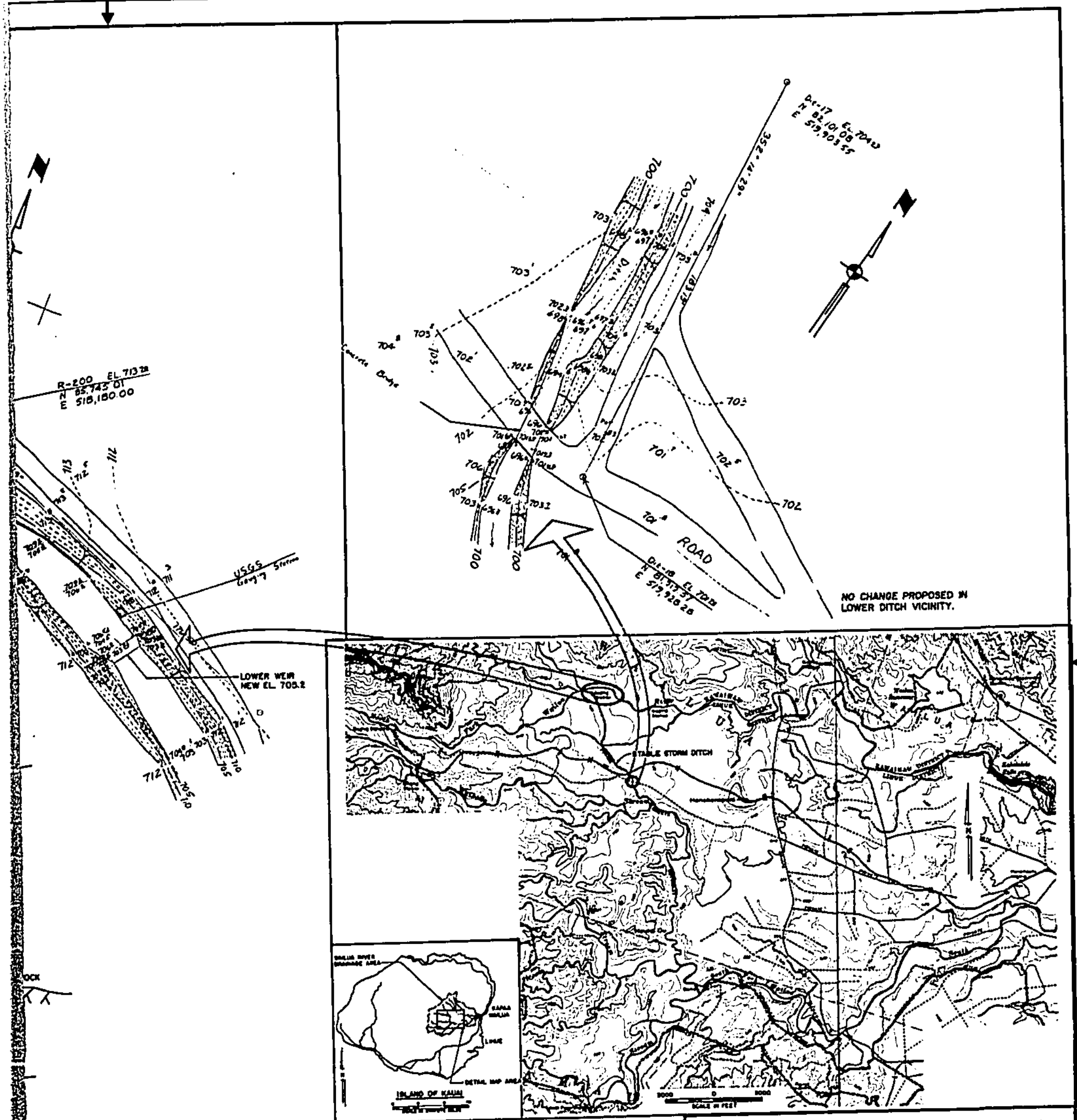
ALTERNATIVE 2A

PLAN AND PROFILE

U.S. ARMY ENGINEER DISTRICT, HONOLULU



RIVER
ROAD
REMOVE EXIST. CULVERT
REMOVE EXISTING CONCRETE SLAB / GRADE INLET AREA
REMOVE EXIST. INTAKE GATE
NEW 5'H X 4'V 220 FT. CONCRETE BOX CULVERT
INVERT = 704.0 FT.
RETAINING WALL TOP = 708.0 INV = 701.0
DH-1 EL. 715.78 N 85,710.62 E 518,011.55
R-200 EL. 713.78 N 85,745.01 E 518,180.00
USGS
LOWER WEIR NEW EL.
EXISTING BRIDGE
NEW SLUICE GATE
EXISTING SLUICE GATE TO BE REMOVED
RETAINING WALL TOP = 708.0 INV = 701.0
220'
40'
INV 704.0
BOX CULVERT PROFILE
SCALE IN FEET
FINISH GRADE
EL. = 708' MSL
EL. = 704' MSL
EL. = 702' MSL
EL. = 701' MSL
SECTION B-B, RETAINING WALL
SCALE IN FEET
ASSUMED ROCK
SECTION A-A, CULVERT
SCALE IN FEET
REMOVABLE STOP LOGS
UNKNOWN
26'
8'
5'
8'
5'
8'
35'
95'
CUT NOTCH IN STOPLOGS TO PASS CONSERVATION FLOW
EXISTING DIVERSION DAM
SCALE IN FEET
GRAPHIC SCALE
SCALE IN FEET



GRAPHIC SCALE

40 20 0 40 80

SCALE IN FEET

SURVEY NOTES:

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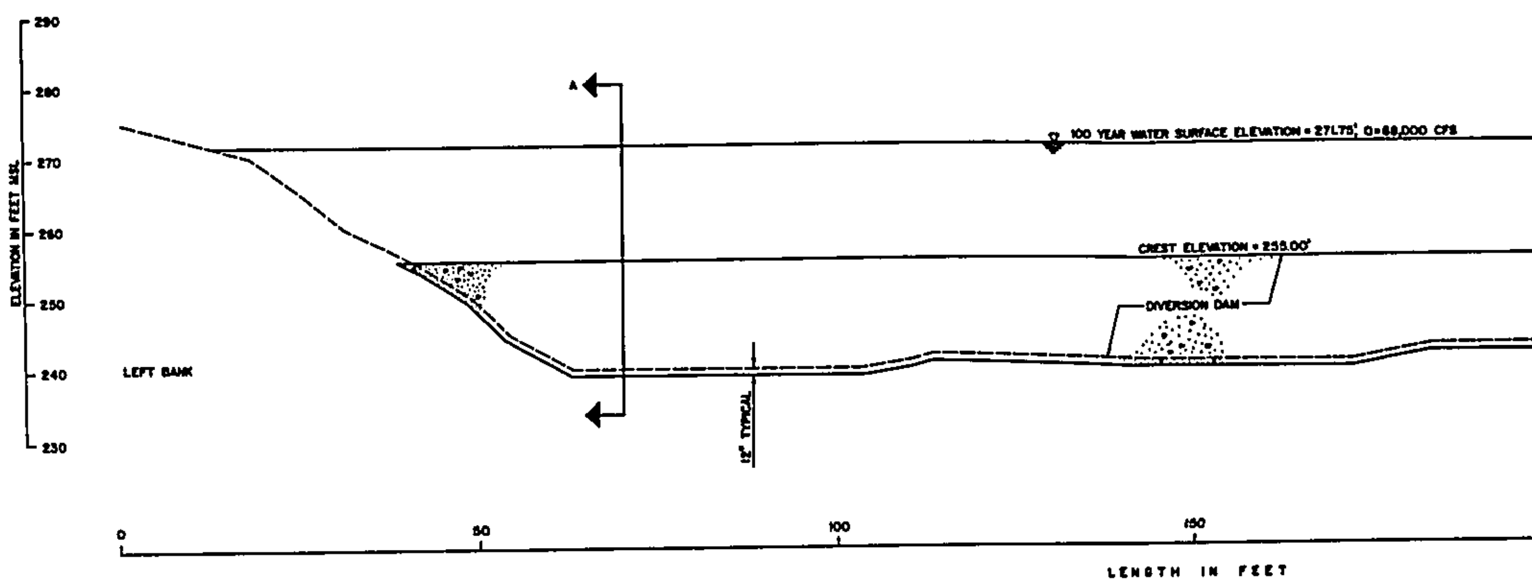
WAILUA RIVER HAWAII

DIVERSION FEATURES STABLE STORM DITCH

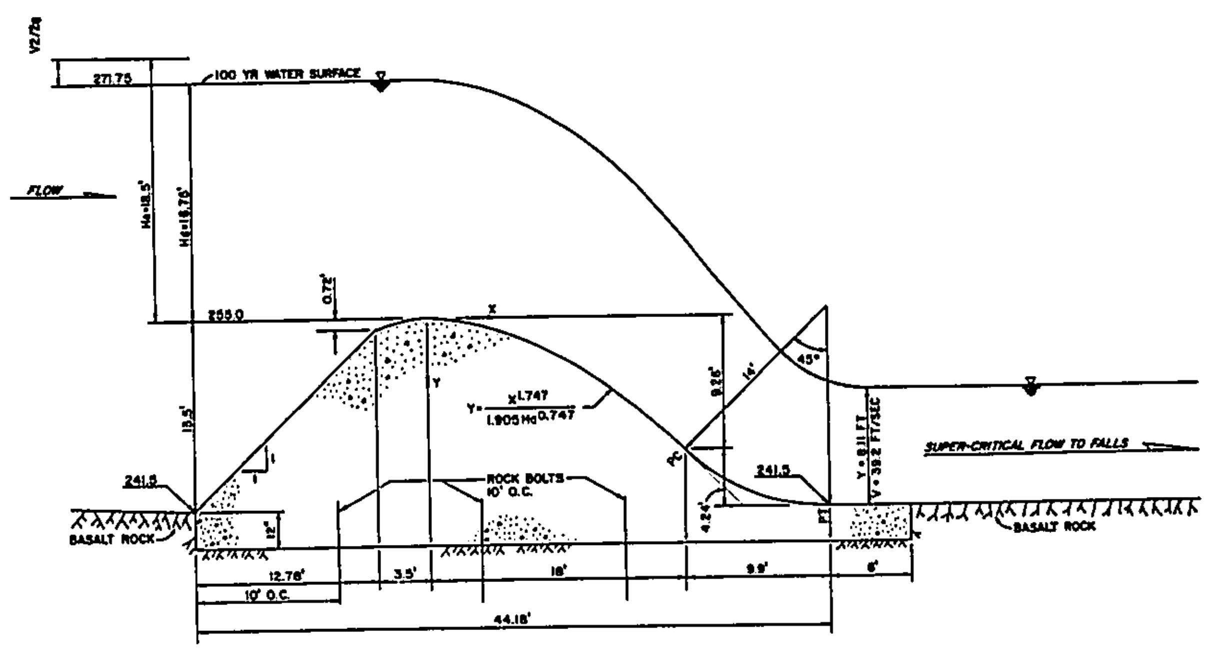
U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE B-23



ELEVATION VIEW AT CREST

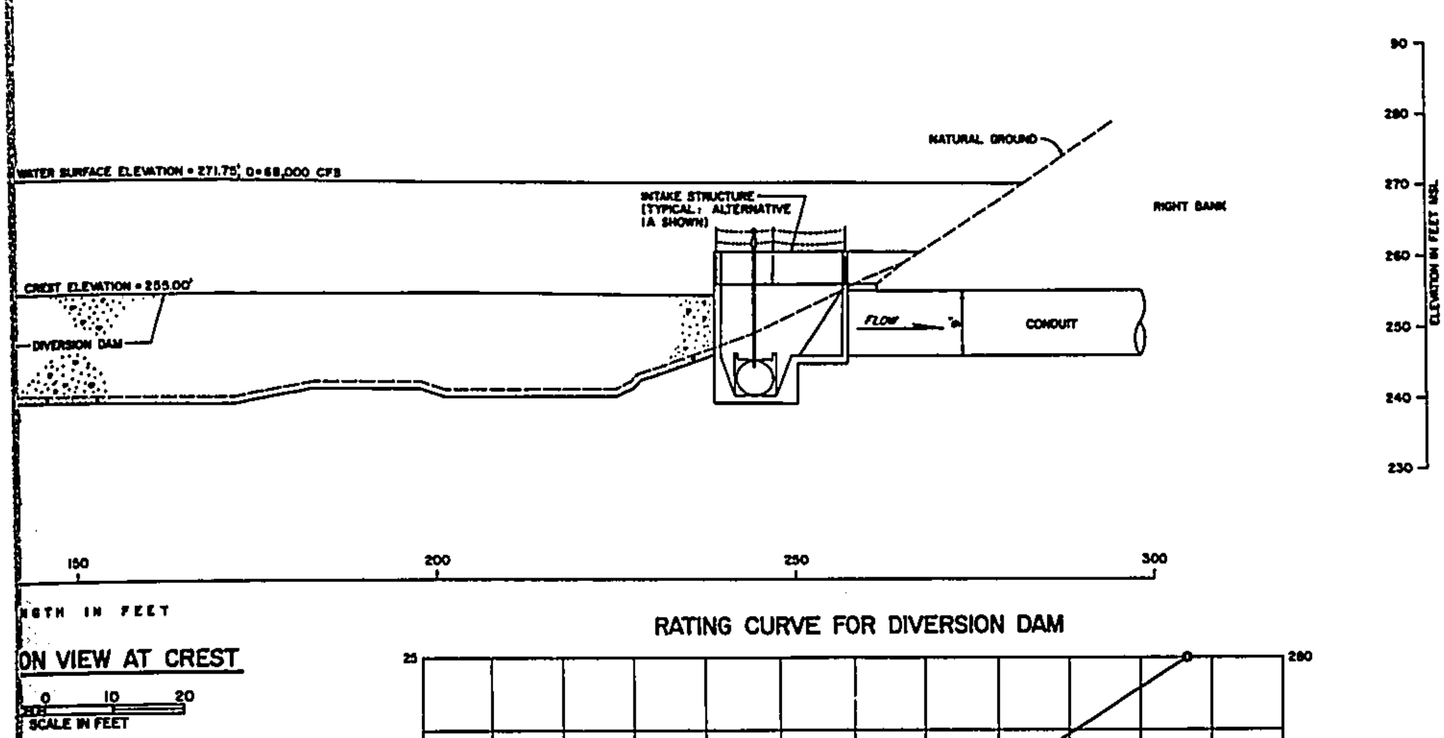
10 0 10 20
SCALE IN FEET

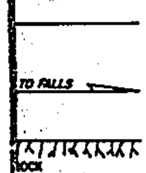


NOTE: CREST DESIGN BASED ON 100 YEAR WATER SURFACE ELEVATION

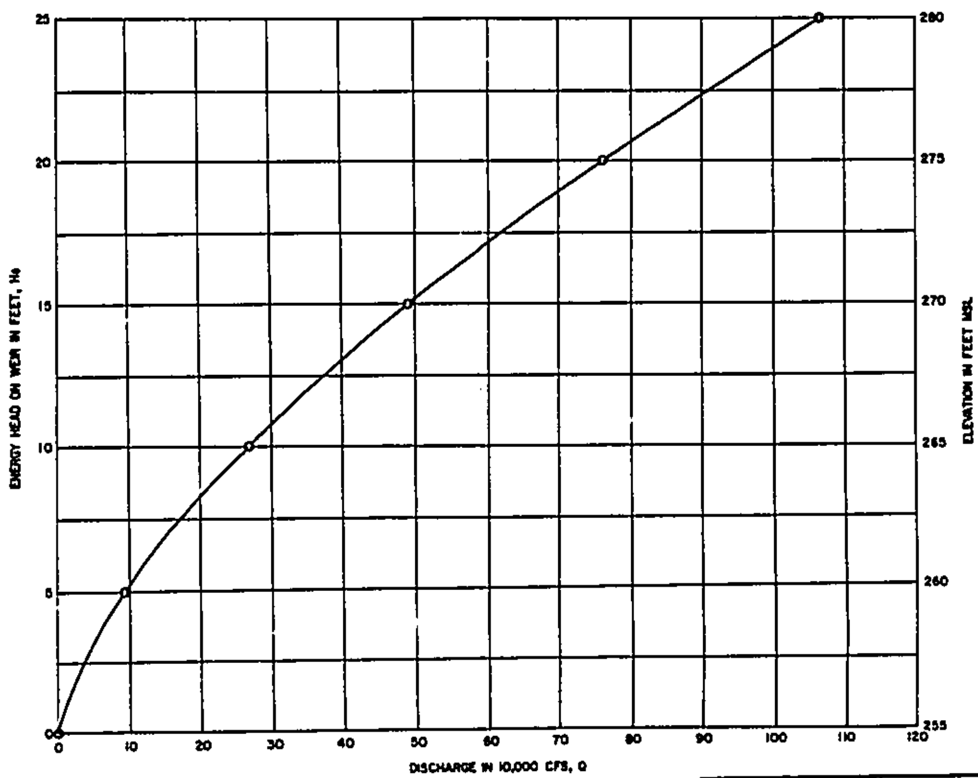
SECTION A-A

5 0 5 10
SCALE IN FEET





RATING CURVE FOR DIVERSION DAM



$Q = CLH_e^{3/2}$ $\quad H_e = H_d + \frac{V^2}{2g}$

WHERE

- Q = DISCHARGE IN CFS
- C = DISCHARGE COEFFICIENT, 3.99
- L = WEIR LENGTH, 212 FEET
- H_e = ENERGY HEAD, FEET
- H_d = HEAD, FEET
- V = WATER VELOCITY UPSTREAM OF WEIR, FT/SEC
- g = ACCELERATION OF GRAVITY, 32.2 FT/SEC^2

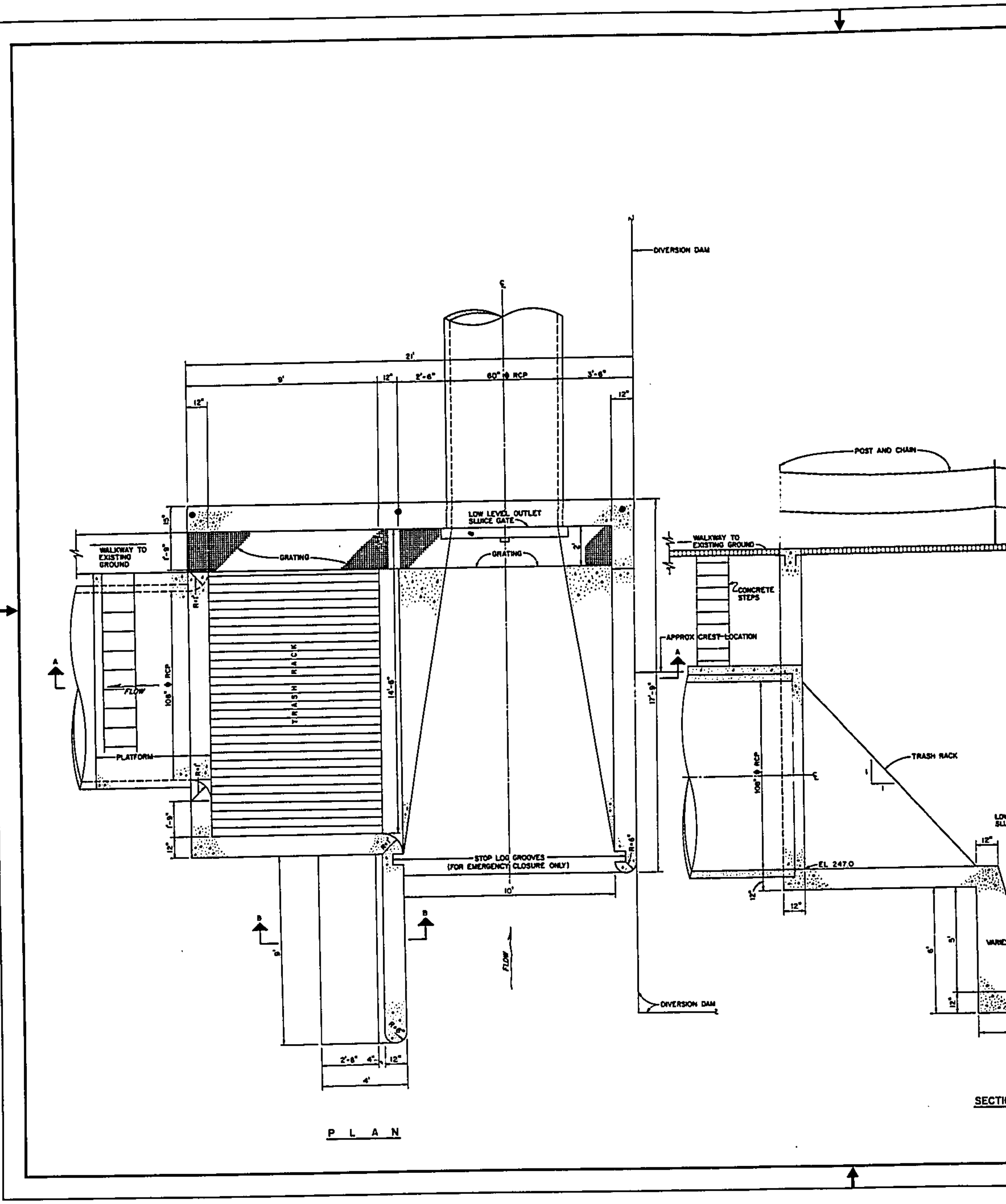
WAILUA RIVER HAWAII

DIVERSION DAM

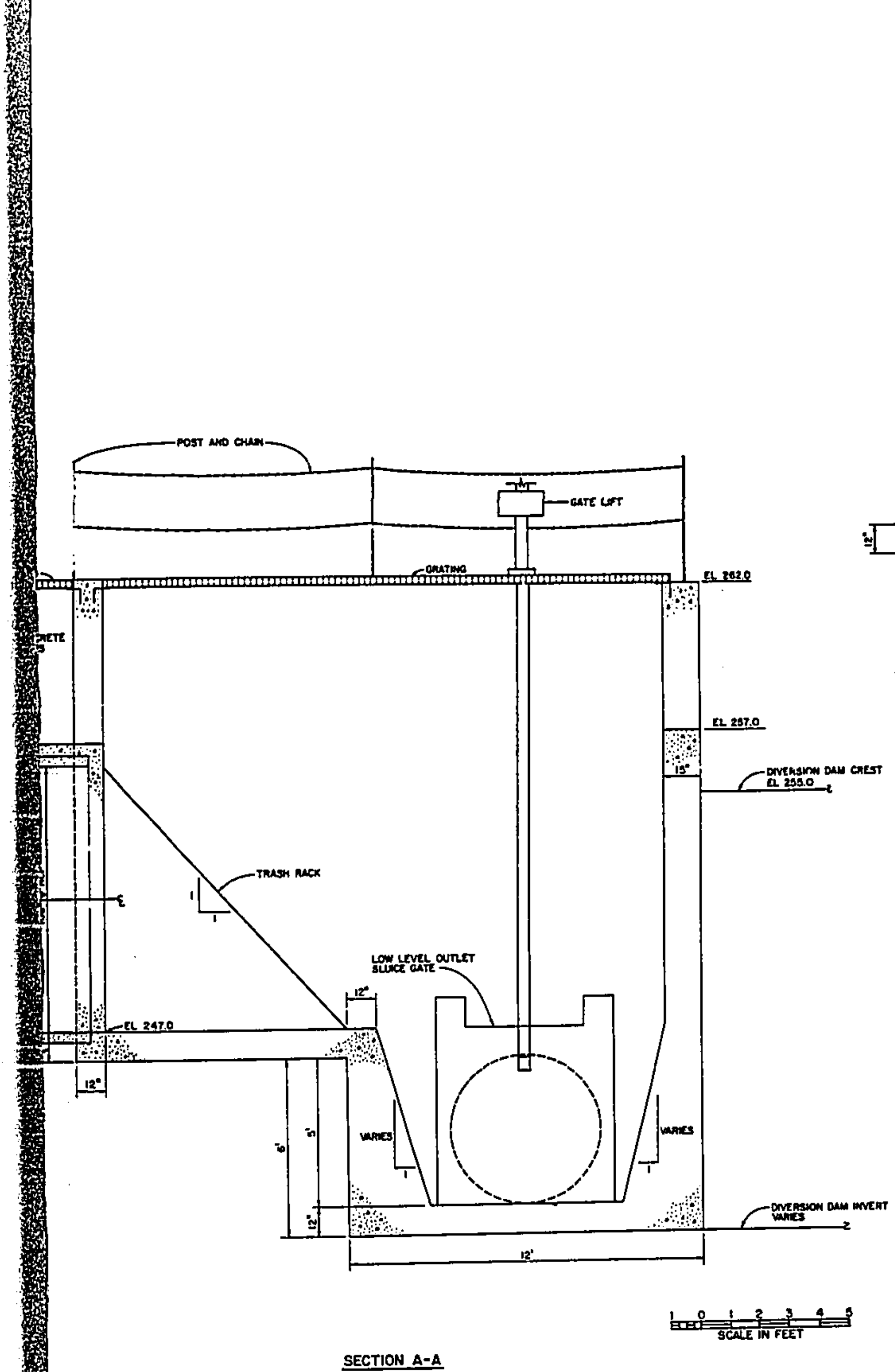
MAIN STEM, WAILUA RIVER

U. S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE B-24


DIVERSION DAM
21'
9'
12"
2'-6"
60" Ø RCP
3'-6"
LOW LEVEL OUTLET SLUICE GATE
GRATING
WALKWAY TO EXISTING GROUND
TRASH RACK
108" Ø RCP
FLOW
PLATFORM
14'-6"
17'-9"
STOP LOG GROOVES (FOR EMERGENCY CLOSURE ONLY)
10'
2'-6"
4'
12"
POST AND CHAIN
CONCRETE STEPS
APPROX CREST LOCATION
EL 247.0

PLAN



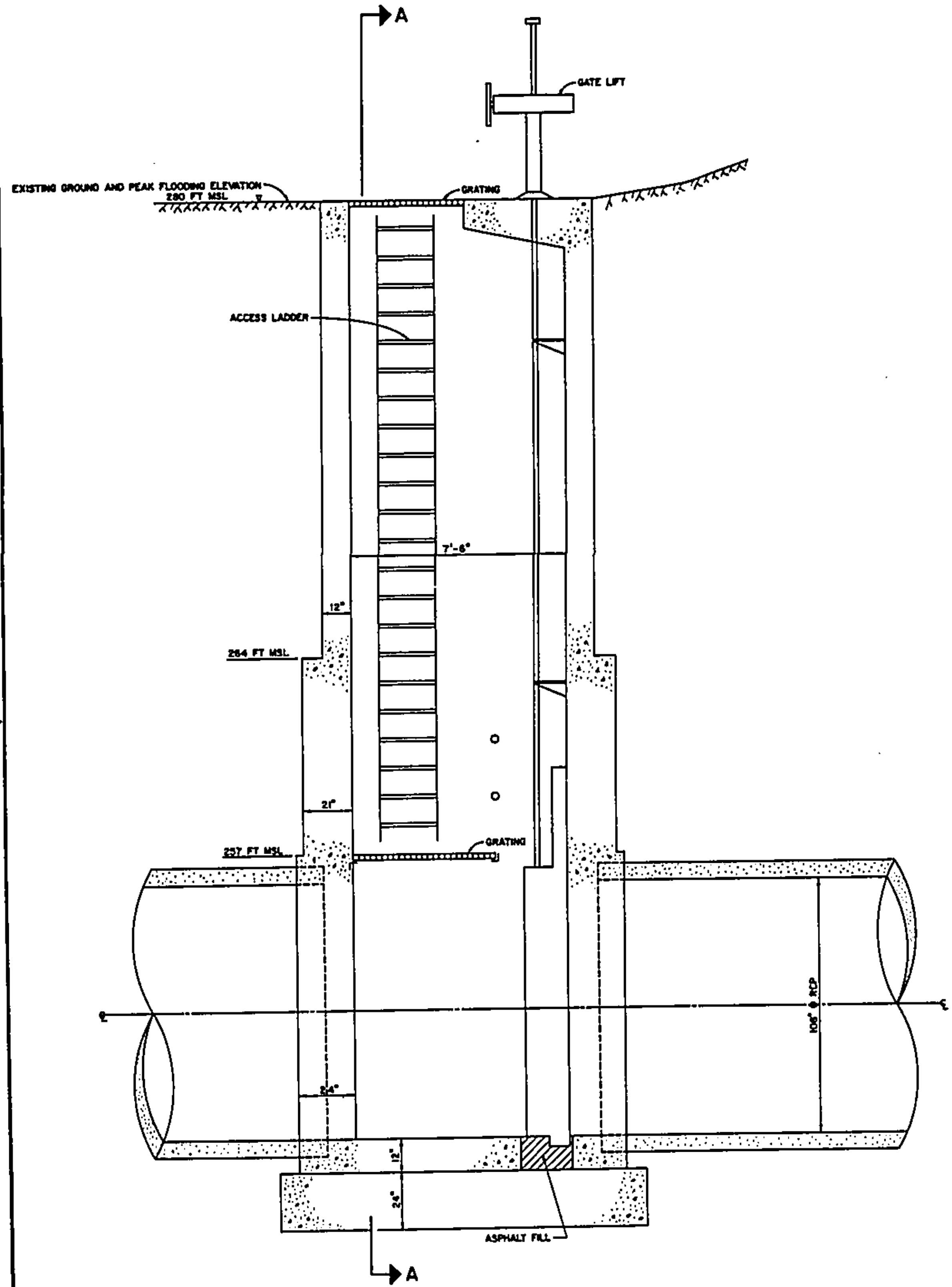
NOTE:
PLAN AND SECTIONS APPLY TO ALTERNATIVE 1B.

WAILUA RIVER HAWAII

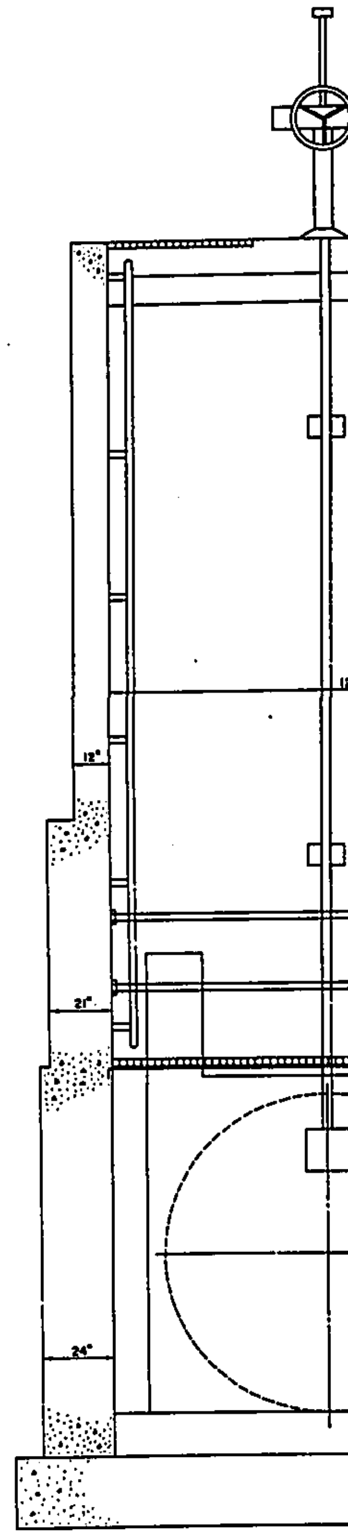
TYPICAL INTAKE STRUCTURE
PLAN AND SECTIONS

U.S. ARMY ENGINEER DISTRICT, HONOLULU

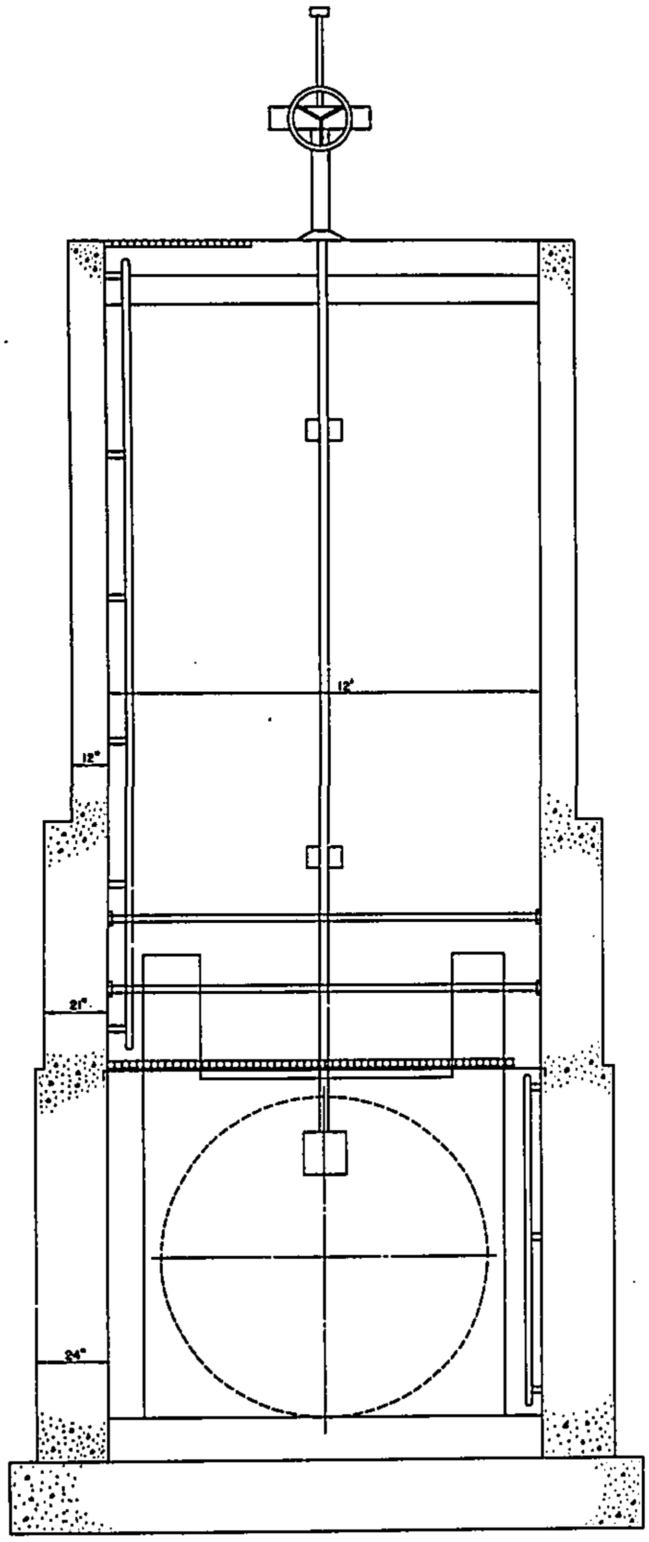
PLATE B-25



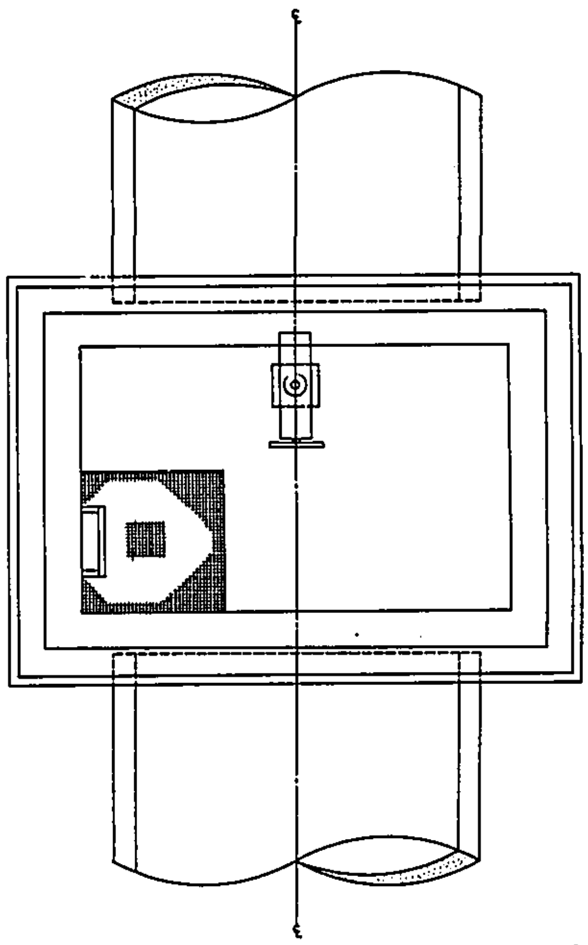
ELEVATION VIEW AT ℄ CONDUIT



SECTION



SECTION A-A



PLAN VIEW

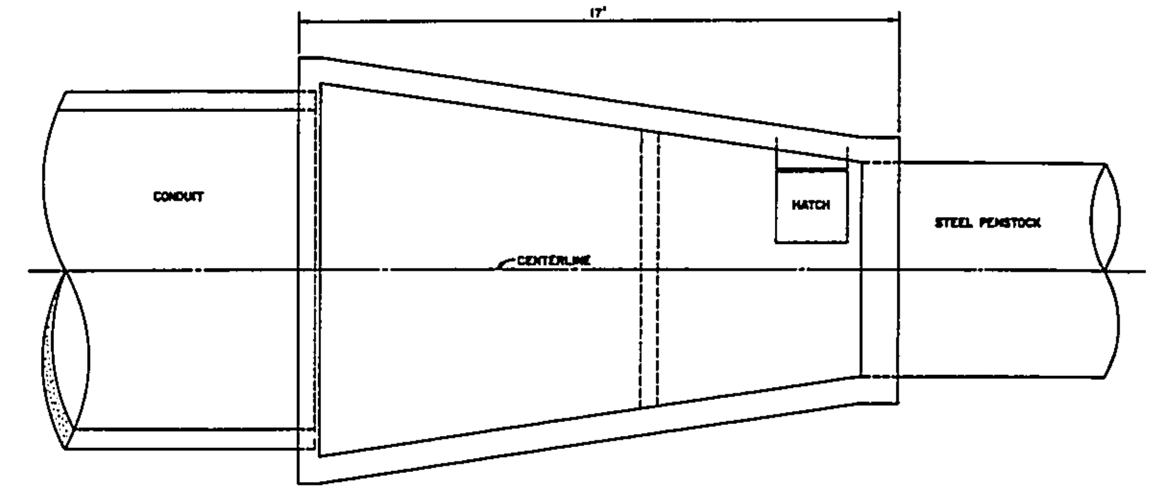
1 0 2 3 4 5 6
SCALE IN FEET

WAILUA RIVER HAWAII

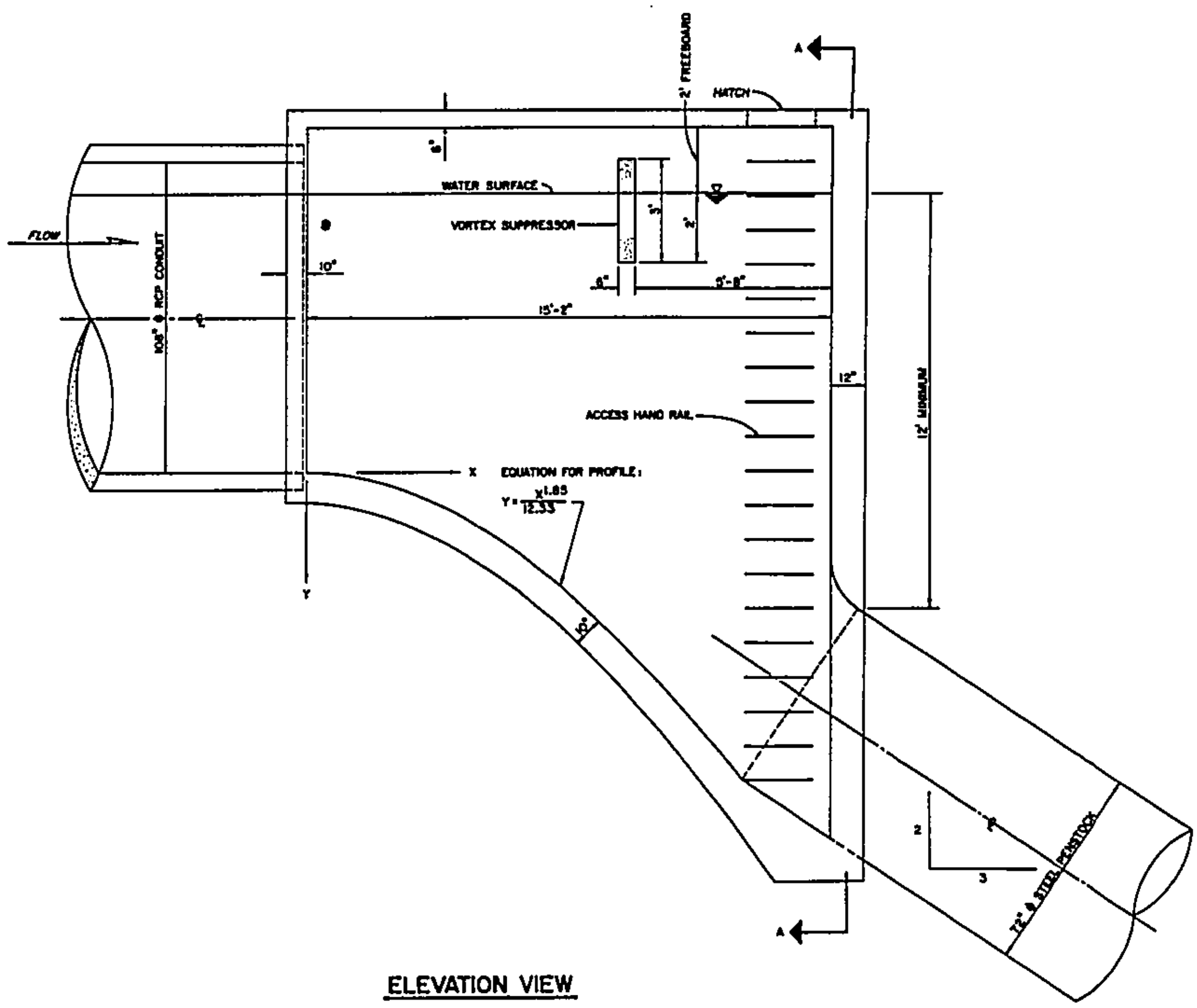
GATE WELL

U. S. ARMY ENGINEER DISTRICT, HONOLULU

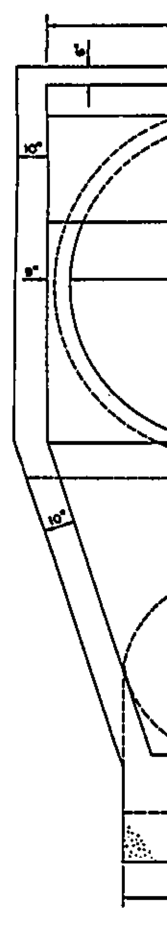
PLATE B-26



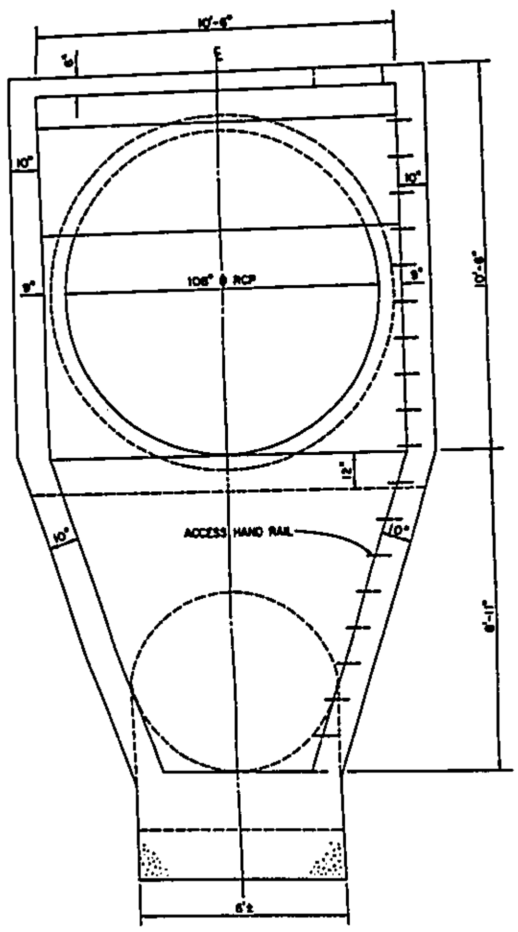
PLAN VIEW



ELEVATION VIEW

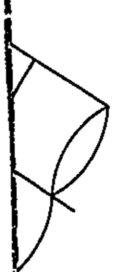


TYPICAL HEAD BOX



SECTION A-A

1 0 1 2 3 4 5
SCALE IN FEET



D BOX

WAILUA RIVER HAWAII

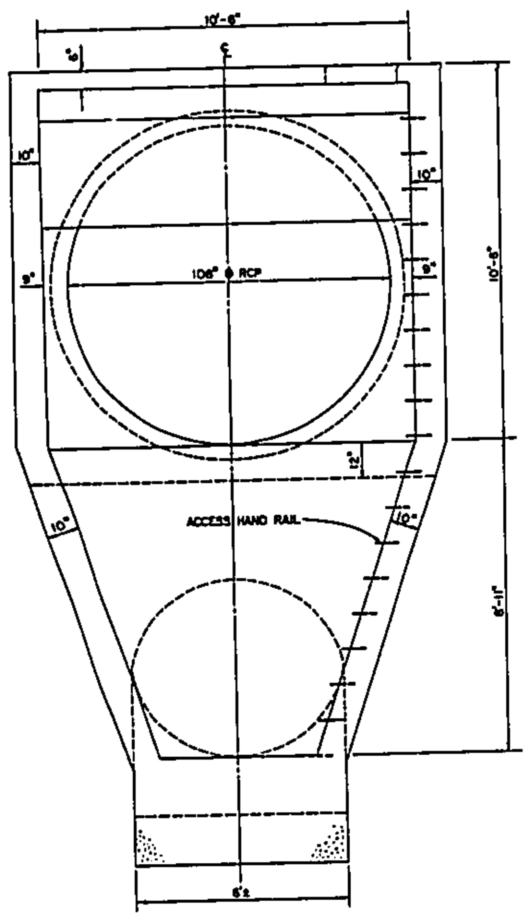
HEAD BOX

U. S. ARMY ENGINEER DISTRICT, HONOLULU

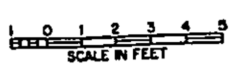
PLATE B-27

CORRECTION

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



SECTION A-A



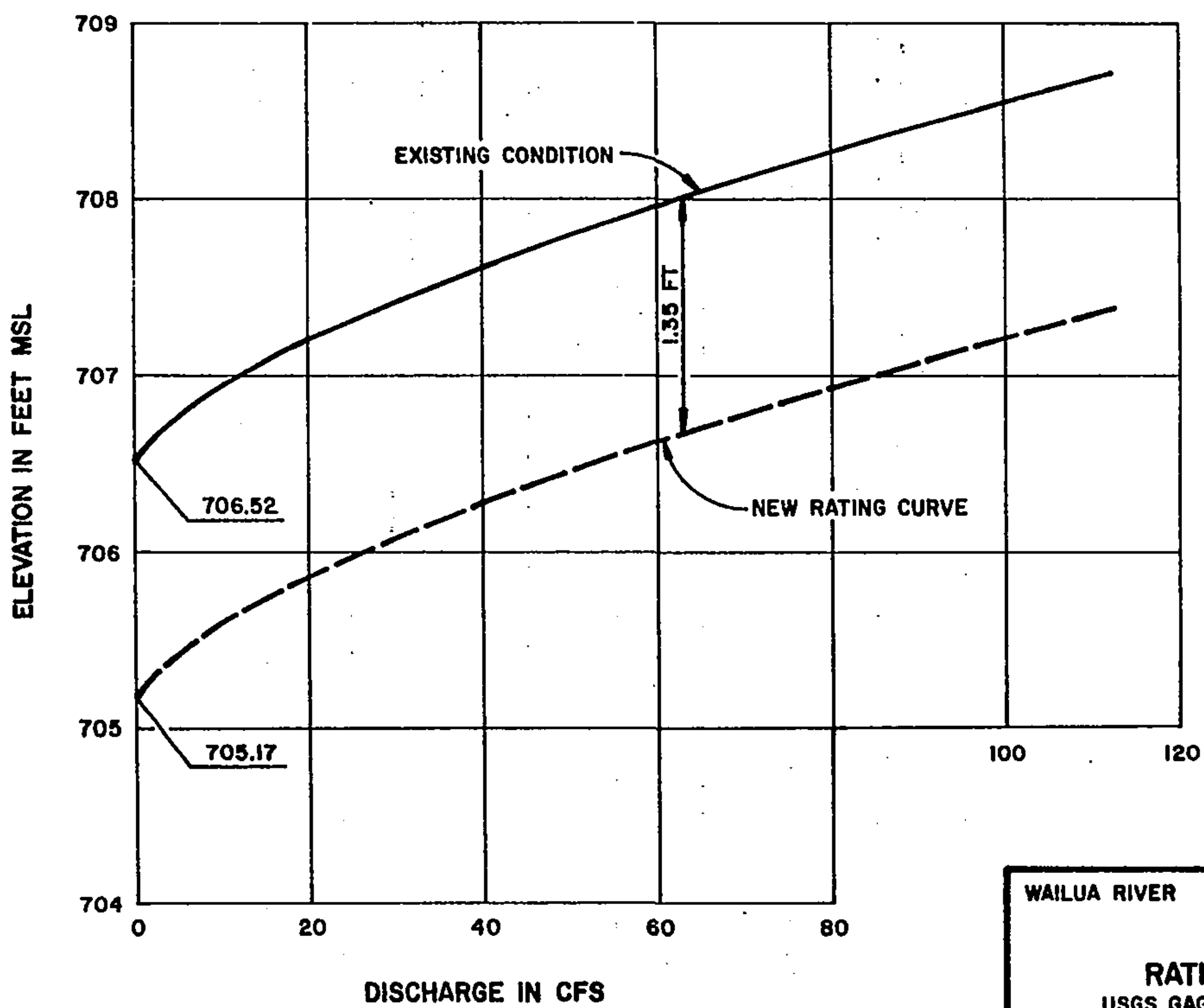
D BOX

WAILUA RIVER	HAWAII

HEAD BOX

U. S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE B-27

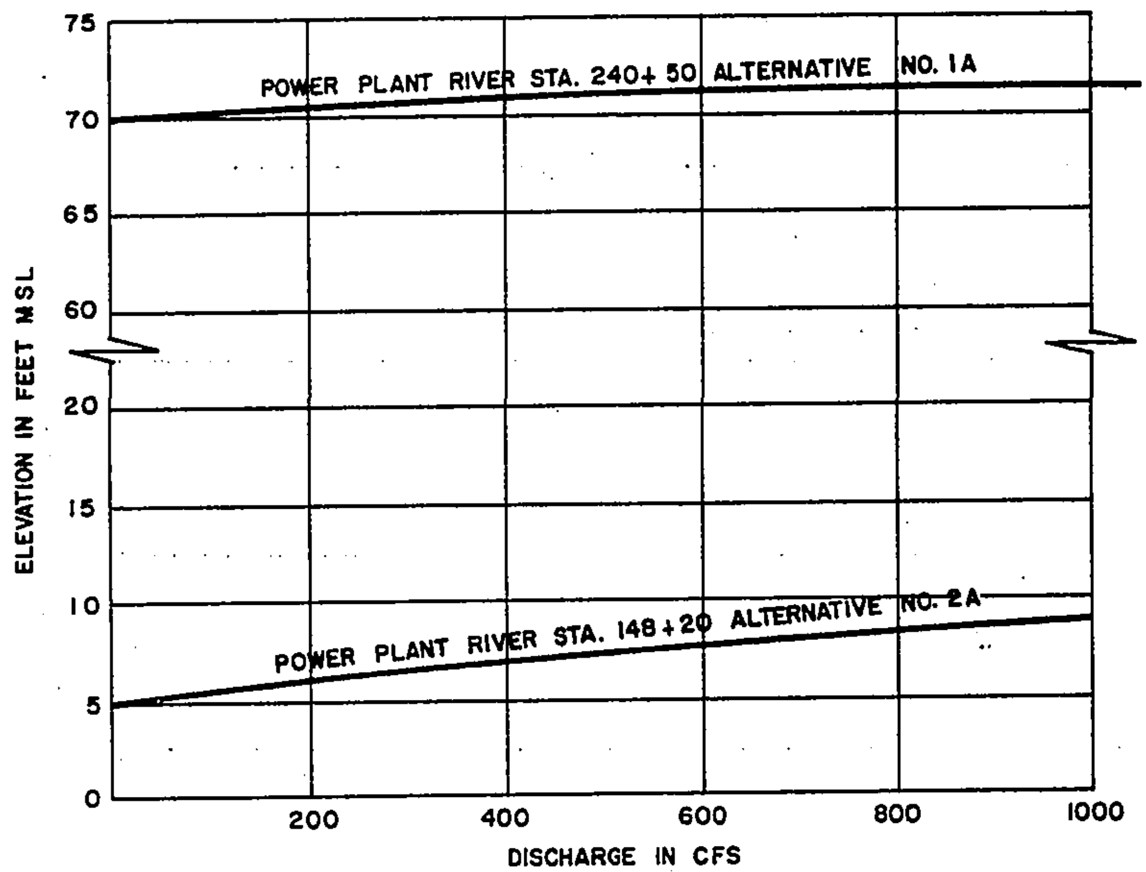


WAILUA RIVER HAWAII

RATING CURVE
USGS GAGING STATION 620
STABLE STORM DITCH

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE B-28

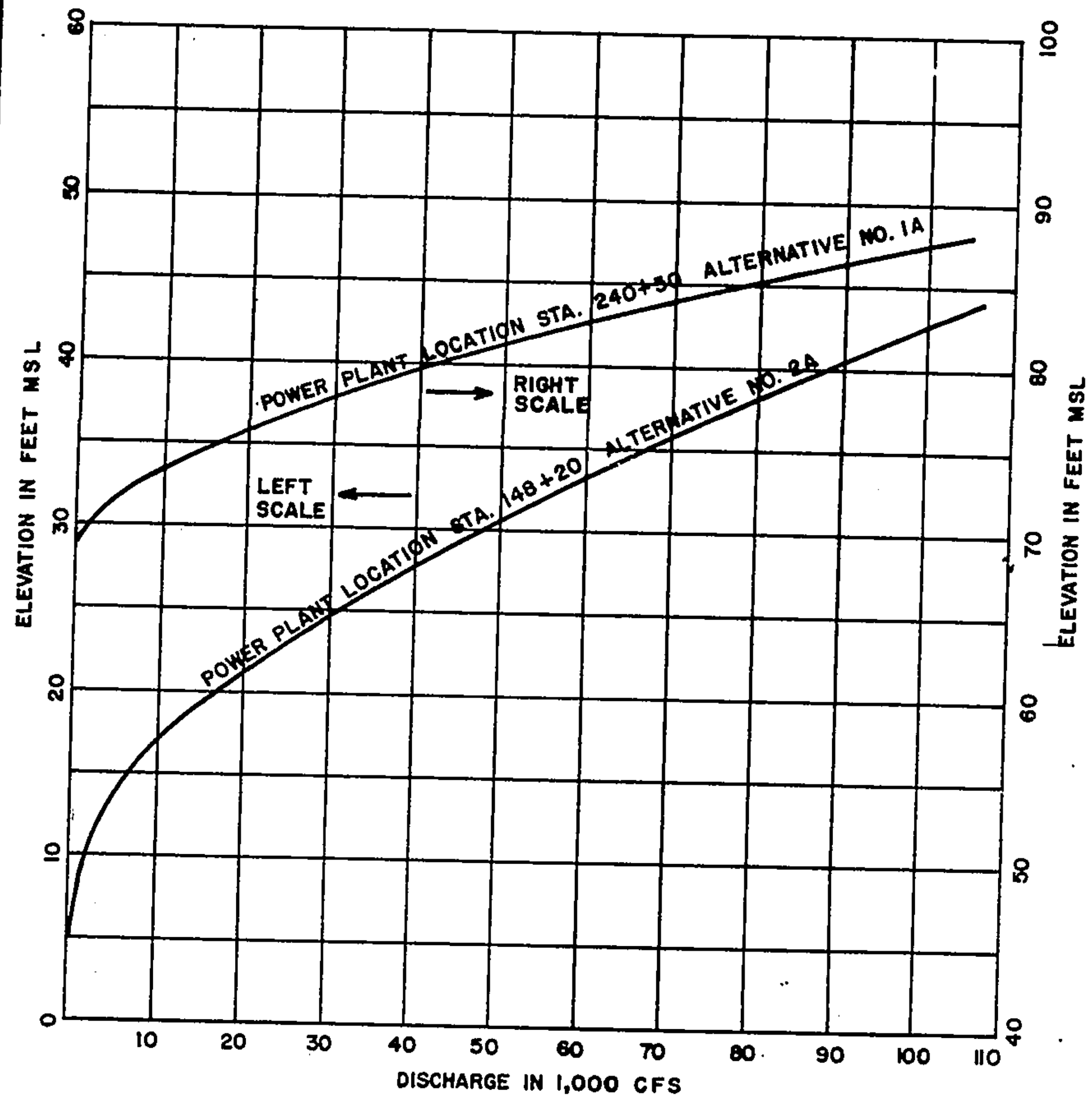


WAILUA RIVER HAWAII

TAILWATER RATING CURVES 0-1000 CFS

US ARMY ENGINEER DISTRICT, HONOLULU

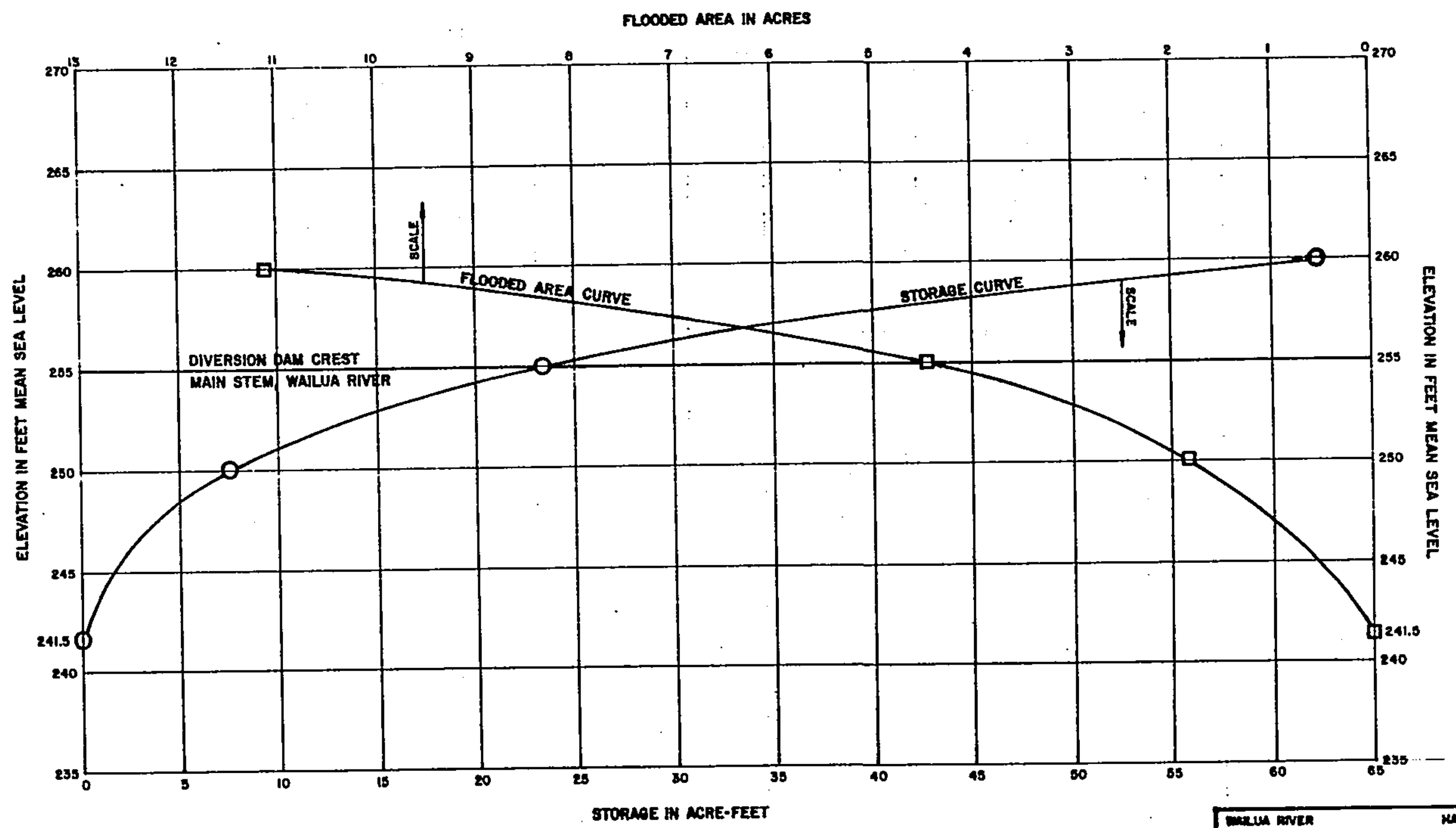
PLATE B-29



WAILUA RIVER HAWAII

TAILWATER RATING CURVES OVER 1000 CFS

U S ARMY ENGINEER DISTRICT, HONOLULU



WAILUA RIVER HAWAII

AREA-STORAGE CURVE

U.S. ARMY ENGINEER DISTRICT, HONOLULU

WAILUA RIVER HYDROPOWER PROJECT
KAUAI, HAWAII

HYDROPOWER INVESTIGATIONS

APPENDIX C

APPENDIX C
HYDROPOWER INVESTIGATION

TABLE OF CONTENTS

LIST OF TABLES

LIST OF PLATES

EXHIBITS

GENERAL

1. Purpose and Authority. The purpose of this appendix is to present a technical report to determine the feasibility of developing hydropower generation at two proposed sites on the Wailua River, Island of Kauai, Hawaii. The Honolulu District, U.S Army Corps of Engineers, is conducting the study under the authority of Section 209 of the River and Harbor and Flood Control Act of 1962 (Public Law 87-874). The Pacific Ocean Division requested North Pacific Division, Corps of Engineers to prepare this hydropower feasibility level documentation.

2. Scope of Study. Initially, two alternative site locations, each with two different flow schemes were considered for development. These alternatives were evaluated as run-of-river (conduit) hydropower developments. Available historical hydrologic data was used to determine the plant sizes. These four basic configurations were first analyzed; the study was then reduced to only two alternative site locations (one located at the falls and the other located some 9,000 feet downstream of the falls), both using a single streamflow scheme (including upstream diversion). See paragraph 8 for further explanation. Selected plant sizes for these two alternatives were then developed and are described in this report.

3. Preliminary design and construction schedules and drawings of the alternatives are presented. Each alternative was studied in sufficient detail to assess the feasibility of the hydrologic development and to determine, if further study is warranted. This appendix does not include environmental considerations as they are addressed in the Main Report and Environmental Statement.

4. Sources of Information. Data used in preparing this study was obtained by North Pacific Division engineering personnel from the U.S. Geological Survey records and from technical information furnished by the Honolulu District, Corps of Engineers. The analysis was completed with information provided by representatives of turbine manufacturers, Department of Energy, Federal Energy Regulatory Commission and Honolulu District.

5. Proposed Project Sites. The proposed sites for the Wailua hydropower development are located in the Wailua River Basin on the Wailua River. The first alternative would be located on the South Fork, directly below Wailua Falls at river station 239+00. The second alternative would be located further downstream on the South Fork at river station 148+20.

6. Proposed Plant Operations and Power Utilization. It is assumed for this report that the Wailua project would be maintained and remotely operated in accordance with the Department of the Army regulations, and that the power would be marketed to the local utility and/or public preferance customers.

HYDROLOGY AND POWER CAPABILITY

7. Hydrologic Analysis. The hydrologic analysis of the Wailua project was made using flows developed from U.S. Geological Survey gaging station 16060000, located on the South Fork of Wailua River just upstream of Wailua Falls, and station 16063000, located on the North Fork of Wailua River at elevation 650 feet. A 60 year period of streamflow record was available. Monthly and annual flow-duration curves were prepared based on daily mean flows. Because the computer program used in the analysis had a maximum capability of only 50 years, tests were made for the total period and the 50-year period was determined to be suitable since the average flows for the last 50 years were nearly the same as the average flows for the total 60 year period.

8. Initially two flow schemes were studied. Scheme B would utilize all available daily flows on the South Fork, while Scheme A would utilize all flows on the South Fork together with diverted flows from the North Fork. A maximum diversion from the North Fork of 92 cfs was used to supplement the South Fork natural flows. After initial studies and comparisons of Schemes A and B, scheme B was deleted and the remaining studies were completed for the diverted flows in scheme A. Scheme B was deleted because of the obvious greater incremental economic benefits of scheme A. The value of the additional energy in scheme A would far exceed the costs of the diversion improvements from the North Fork River. Plates C-1 and C-2 show the average annual flow duration curve for the South Fork with diverted flows from the North Fork. For comparision Plate C-3 shows only flows of the South Fork. Exhibit B contains power duration curves for all months using the diverted flow scheme. The minimum conservation flows were deleated from all flow duration data prior to determining available power production.

9. Power Potential. The power potential of each site was estimated using the Power-Duration Plot Program developed by North Pacific Division. This computer program utilizes input data such as average daily or monthly flows, forebay and tailwater elevation data, constraints associated with the power installation, and streamflow and drainage area adjustment factors. The program calculates monthly and annual flow duration curves and the corresponding power duration curves. The Power-Duration Plot Program developed average annual and monthly power based on the following power equation:

$$\text{Average Power (kW)} = \frac{Q \times H \times e}{11.8}$$

where Q = average daily flow in cubic feet per second at the proposed project site
H = average daily net generating head in feet
e = efficiency, assumed constant at 85 percent

Several sizes of power installations were investigated as well as different combinations of generating units. This output information was then used to prepare the benefit curves used for scoping and economic analysis.

10. The Wailua project would be operated as a run-of-river power plant. A 13.5 - foot high diversion structure would be constructed immediately upstream of Wailua Falls to divert flow to the powerhouse. For each alternative, an average forebay elevation was selected at 250 feet msl. For Alternative 1A, the tailwater elevation was established at 60 feet msl; for Alternative 2A the tailwater elevation was 10 feet msl. Head losses of 5 feet and 15 feet were considered for Alternatives 1A and 2A, respectively. The larger head loss was to account for the longer penstock in Alternative 2A. The net generating head for each alternative was computed as follows:

Alternative 1A:

Net Generating Head = 250 ft - 67 ft - 5 ft = 178 ft

Alternative 2A:

Net Generating Head = 250 ft - 10 ft - 15 ft = 225 ft

11. Annual and monthly power-duration curves were developed to illustrate the total potential energy available for development for each alternative. A conservation flow of 10 cfs was deducted from all flows and is accounted for graphically in all duration curves. This potential is represented by the total area under the power duration curve. The actual amount of energy that could be developed using specified plant sizes is also shown as a shaded area on the same power duration curve. Plates C-4 and C-5 show annual power duration curves, while Exhibit A contains examples of the power duration curves by months for the selected plant size of each alternativs. These figures represent the actual amount of energy that can be developed in each month as compared to the total amount of energy potential that would be available at each site.

12. For each alternative, the total project annual energy was obtained. To optimize each plant size, the annual energy production was computed for a series of plant sizes. In the initial scoping phase a single unit plant was compared with a two-unit plant. It was determined that a two-unit (one large, one small) plant developed the most energy and was most cost effective. See paragraphs 20-30 for additional discussion on plant scoping. Tables C-5 and C-6 shows the range of plant sizes considered for each alternative along with estimated annual benefits and costs used in the final plant selection.

13. Table C-1 summarizes the different generating plant sizes for each alternative and their respective average annual energy outputs and plant factors.

TABLE C-1
SUMMARY OF PLANT SIZES AND GENERATION
FOR ALTERNATIVES 1A AND 2A

	Gross Hydraulic Capacity (cfs)	Plant Size (MW)	Average Annual Energy (Mwh)	Plant Factor 1/ (%)
Alternative 1A				
	210	2.7	9,560	40
	300	3.8	10,640	32
	345	4.4	10,950	28
	390	5.0	11,277	26
	450	5.6	11,355	23
Alternative 2A				
	210	3.4	12,100	41
	300	4.9	13,450	31
	350	5.6	13,840	28
	390	6.3	14,133	26
	450	7.3	14,440	23

1/ Plant Factor = $\frac{\text{Average Annual Energy}}{\text{Plant Size x (8760 hr/yr)}}$

ECONOMIC SCOPING ANALYSIS

14. General. The purpose of this section is to estimate the economic value of the Wailua project; the optimum size of the powerplant will also be determined. Annual project costs will be derived using Federal Energy Regulatory Commission's (FERC) power values based on energy costs for fuel displacement.

15. Cost Estimates. Cost estimates were prepared for several sizes of generating plants for each alternative site location. For scoping it was determined that construction and related costs would vary nearly linearly with the installed capacity. Annual costs for the range of plant sizes were then compared with the annual benefits, thus completing the project scoping phase (also see Scoping paragraphs 27-29).

16. After the initial plant sizes were developed for the selected installations. All costs for the power plant are shown herein, while other project costs (diversion channel and dam, intake structure, and penstock) are shown in Appendix B.

17. The basic construction costs for the various installations are summarized in Tables C-2 and C-3. Engineering and design (E & D) costs of 6 percent were then included. Also, supervision and administration (S & A) costs of 8 percent were included. Because a large portion of the costs of the powerhouse represents electrical and mechanical equipment purchased under supply contracts, E & D and S & A costs represent a smaller portion of total project costs than for most other construction projects. To obtain the total investment cost, interest during construction was added based on a construction period of 31 months for each alternative. This period includes the fabrication and installation of the turbine/generators.

18. Cost Adjustment for Inflationa During Construction. Constrction cost estimates for feasibility level reports are based largely on bids made by contractors on similar projects. Since contractors must cover all costs over the entire construction period, their bid estimates include an allowance for increases in the period. Water Resources Council (WRC), NED 1/ Benefits Manual, states that a project's NED benefits and costs must be compared at a common point in time. The NED benefits for this report are presented at the January 1982 price level; therefore, an adjustmet was made to the project cost estimate to arrive at NED costs of a comparable price level. Making an allowance in the cost estimate for inflation is explicity recognized in Engineering Manual 1110-2-1301, dated 15 April 1982. Based on experience from similar projects in the North Pacific Division, a 6.1 percent total inflation rate adjustment was made to the powerhouse portion of the project cost estimate. This inflation rate was computed for several completed powerhouses using an average length of construction time of 24

1/ National Economic Development

months. Construction cost items exclusive of the powerhouse as shown in Appendix B required a larger percent adjustment for infaltion. The actual length of project construction time for the Wailua project would be 23 months, exclusive of the supply contract items (see para. 19.a below). Thus a total weighted cost adjustment rate of 9 percent was used for both alternative site locations in preparing the total project cost estimate.

19. The process for making the appropriate inflation cost adjustment involves the following steps:

a. From the total project cost, deduct the cost of the turbines and generators and their contingencies. Cost estimates for supply contract items (i.e., turbines and generators) are point estimates with inflation during construction provided for escalating the contract payment at the time of delivery or partial payment.

b. An inflation adjustment factor is computed by multiplying the reduced project cost (described above) times the inflation rate (Reduced project cost x 9%).

c. The inflation adjustment factor is then subtracted from the total project cost. From this subtotal, interest during construction is added, to derive the total investment cost (NED). This NED investment cost is then annualized to produce an annual cost used in economic analysis.

20. Annual Costs. The period of analysis for the project was 100 years. Interest and amortization was computed at 7-5/8 percent, the FY 1982 Federal interest rate. Operation, maintnance, and replacement costs were derived from curves and procedures published in the Corps of Engineers 1979 Hydropower Cost Estimating Manual; all costs were updated to January 1982 price levels. It was assumed that operation of the powerplant would be remote.

21. Table C-2 summarizes the annual costs for Alternative 1A while table C-3 summarizes annual costs for Alernative 2A. The costs presented in these tables, along with the corresponding annual benefits, are shown graphically in Plates C-6 and C-7 (See Appendix B for final adjusted cost.)

TABLE C-2
ANNUAL COSTS OF ALTERNATIVE 1A
(January 1982 Price Levels, $1,000)

Investment Costs		2.7 Mw	3.8 Mw	4.4 Mw	5.0 Mw	5.6 Mw
Powerhouse		2,172	2,835	3,183	3,532	3,890
Items Exclusive of Powerhouse	1/	2,800	2,900	3,000	3,060	3,120
Total Construction Costs	2/	4,972	5,735	6,183	6,592	7,010
Inflation Adjustment Factor	3/	- 356	- 377	- 387	- 398	- 410
Subtotal		4,616	5,358	5,796	6,194	6,600
E & D, S & A @ 14%	4/	650	750	810	870	920
Total First Cost		5,266	6,108	6,606	7,064	7,520
IDC 31 months @ 7 5/8%	5/	518	602	651	695	741
Total Investment Cost (NED)	6/	5,784	6,710	7,257	7,760	8,261
Annual Cost						
Interest & Amortization	7/	441	512	554	592	630
O & M	8/	30	36	39	42	44
Replacement	9/	27	35	40	43	47
Total Annual Cost		498	583	633	677	721

1/ Provided in Appendix B and file data
2/ Includes powerhouse costs and contingencies (From table C-7) plus other items exclusive of powerhouse, adjusted to January 82 price levels (see main report)
3/ Adjustment for Inflation during constructin (see para. 18)
4/ Engineering, Design, Supervision, and Administration 14% (see page para. 17)
5/ Interest during construction: 7-5/8 % average interest @ 31 months
6/ Adjusted for inflation (see para. 19)
7/ 7-5/8 percent @ 100 years (k = 0.076299)
8/ See para. 20 (from cost curve, Hydropower Cost Estimating Manual)
9/ See para. 20

TABLE C-3
ANNUAL COSTS OF ALTERNATIVE
(January 1982 Price levels, $1,000)

Investment Costs		3.4 Mw	4.9 Mw	5.6 Mw	6.3 Mw	7.3 Mw
Powerhouse		2,150	2,880	3,205	3,560	4,030
Items Exclusive of Powerhouse	1/	6,300	6,600	6,704	6,800	7,000
Total Construction Costs	2/	8,450	9,480	9,909	10,360	11,030
Inflation Adjustment Factor	3/	- 650	- 668	- 676	- 685	- 697
Subtotal		7,800	8,812	9,233	9,675	10,333
E & D, S & A @ 14%	4/	1,090	1,230	1,290	1,350	1,450
Total First Cost		8,890	10,042	10,523	11,025	11,783
IDC 31 months @ 7 5/8%	5/	876	989	1,036	1,086	1,161
Total Investment Cost (NED)	6/	9,766	11,031	11,559	12,111	12,944
Annual Cost						
Interest & Amortization	7/	745	842	882	924	988
O & M	8/	33	43	45	48	51
Replacement	9/	27	36	41	46	52
Total Annual Cost		805	921	968	1,018	1,091

1/ Provided in Appendix B and file data
2/ Includes powerhouse costs and contingencies (From table C-7) plus other items exclusive of powerhouse, adjusted to January 82 price levels (see main report)
3/ Adjustment for Inflation during constructin (see para. 18)
4/ Engineering, Design, Supervision, and Administration 14% (see page para. 17)
5/ Interest during construction: 7-5/8 % average interest @ 31 months
6/ Adjusted for inflation (see para. 19)
7/ 7-5/8 percent @ 100 years (k = 0.076299)
8/ See para. 20 (from cost curve, Hydropower Cost Estimating Manual)
9/ See para. 20

22. Power Values Power benefits are based on the costs that would be incurred if the hydro project were not constructed. Hydro project benefits are represented by the costs of the most likely alternative, which would usually be thermal generation. Hydro generation can displace thermal generation in two ways: (1) by displacing an increment of new generating plant, or (2) by displacing the operation of existing power plants. Normally, power benefits are based on the cost of an increment of new generation, which on the island of Kauai, Hawaii would be the cost of constructing and operating an increment of oil-fired steam generation. While the system load area is served by some hydropower generation and some steam generation produced from bagasse (wasted product from sugarcane), the existing generating system does include a high proportion of expensive oil-fired generation. New hydro generation would therefore, be expected to displace some of this existing expensive oil-fired generation. This is particularly appropriate for small run-of-river hydro projects such as Wailua because they have a relatively small dependable capacity due to the wide variations in streamflow.

23. At present, oil-fired generation meets a large portion of the island's energy need. While this proportion may decrese in the future, oil-fired generation will continue to be the marginal source of generation for some time. Therefore, it was considered that the best use of the Wailua project would be to displace existing oil-fired generation.

24. The value of displaced generation would be a composite value, based on the sum of the unit fuel costs and variable O & M costs for a mix of existing thermal plants. Some of these plants would be oil-fired peaking plants and some oil-fired steam plants. This mix may change in the future, as oil-fired generation becomes more expensive, and the unit energy costs of all types of thermal generation increase in real terms in the future.

25. The actual value of the displayed energy would be weighted average of incremental energy costs to the system. The Federal Energy Regualtory Commission (FERC) prepared power values based on system energy displacement, including projected real fuel costs. Listed below are these values recieved from FERC (see letter FERC, 1 May 1982 in Exhibit B):

FERC POWER VALUES
(January 1982 price levels)

Energy value	79 mills/kwh	87 mills/kwh
Power on-line date	1990	1995

26. The above values may be used for either 7-5/8 percent or 7-7/8 percent discounted rates, because only a slight difference will occur and it will be lost in rounding.

27. Scoping Both Alternatives were scoped using a net benefit analysis procedure. For project scoping a market value of 90 mills per kilowatt-hour was used to compute the benefits. This value was estimated at the beginning of the study based on an average cost of production for generation in the area. Later, updated estimated power values were recieved from FERC. These final power values were somewhat less than the 90 mills per kilowatt-hour value; however; it was decided that no change be made in the project scoping, because the difference in the selected plant size would not change significantly.

28. Tables C-5 and C-6 list the annual costs and the annual benefits for the range of plant sizes used for each alternative. The net benefits derived for the project scoping are also listed. Plate C-9 shows graphically representation of these net benefits. For alternative 1A it can be seen that a plant size of about 4 Mw would produce the maximum net benefit. For this study it was decided to use a larger plant size of 5.0 Mw as the selected plant. By selecting the larger plant an additional 640,000 Kwh of energy would developed at only a slight loss in net benefits. For the same reason the selected plant for alternative 2A was 5.6 Mw. For Alternative 2A an additional 390,000 Kwh of energy would be developed by selecting the larger plant size.

29. For both alternatives a slightly larger plant size was selected over the plant size that would be determined using only a maximized net benefit procedure. Sensitivity analysis performed by North Pacific Division Office on similar hydro projects using an inflation-free discount rate have shown that the optimum plant size would be somewhat larger than that shown in the standard net benefit procedure. A recent Federal Task Force Report 1/ suggests that a 3 percent discount rate can be used in the economic analysis. The Task Force Report discusses the implications of not utilizing an inflation free discount rate. The following is an excerpt from the report:

> "Federal evaluation procedures exclude general price inflation from future costs of both a hydropower plant and its most likely alternative. There is a good reason to believe, however, that the Federal discount rate does include an element of inflation to the extent that the Federal descount rate does include an element of inflation, current Federal economic evaluation procedures bias the analysis against hydropower projects. The bias occurs because hydropower benefits are usually measured by the costs of the most likely thermal alternatives, which have relatively higher variable costs and lower capital costs. Using a discount rate which includes an element of inflation increases the hydropower project's annualized capital cost more than those of its thermal alternative and under values the thermal alternative's variable costs. Inclusion of an element of inflation in the discount rate can thus result in a distorted benefit/cost ratio that overstates the real resource costs and understated the benefits. It can also lead to selection of an inefficient hydropower plant size."

1/ Evaluating Hydropower Benefits , December 1981, U.S. Water Resources Council Water and Energy Task Force, chapter 10.

A slightly larger plant was therefore selected as the optimum plant size for each alternative.

30. Annual Benefits. As discussed above, power benefits for project scoping were developed based upon an estimate energy value of 90 mills per kwh. All subsequent benefits were derived by multiplying the annual energy output of the plant by unit energy values of 90 and 79 mills per Kwh. Tables C-5 and C-6 summarizes the energy output, annual costs, production costs, annual benefits, and net benefits for each plant size used in scoping Alternatives 1A and 2A, respectively.

31. These tables include the estimated benefits used for scoping and the benefits derived from the FERC estimated power value of 79 mills per Kwh. Included also are benefit-to-cost ratios. From an economic standpoint Alternative 1A is clearly the best site for development; however, other factors could influence the final recommended site plan.

32. Marketability. Because of the relatively small size of the project, it is unnecessary to conduct a thorough marketing analysis. Appendix F and the main report describes in greater detail the power market and exsting power system.

33. Generally, the existing electrical system is owned and operated by the Kauai Electric Division (KED) of Citizens Utilities Company. Several sugar plantations also share in the system. Existing transmission lines connect the island electrical grid.

34. Since 1969, power demand has almost doubled from 19.6 Mw to 37.3 Mw in 1980. According to officials of KED, the annual increase should remain a steady 3.6 percent compounded per year up to and including 1991. The Wailua project could satisfy a protion of the future energy needs of the island as well as displacement of existing more expensive generation.

35. Table C-4 shows the monthly generation for the selected plant sizes of each alternative. The table shows the seasonal variation of energy resulting from the variation of streamflows. While the winter months of November through April have the highest energy potential, the summer months do provide a significant amount of energy and, therefore, should help in establishing a market for the generaton. Plate C-8 describes this variation graphically.

TABLE C-4
AVERAGE MONTHLY GENERATION, MWH

Month	Alt.1A (5.0 MW)	Alt.2A (5.6 MW)
Jan	1,280	1,580
Feb	960	1,180
Mar	1,230	1,510
Apr	1,080	1,330
May	910	1,130
Jun	490	630
Jul	650	830
Aug	730	930
Sep	530	680
Oct	740	930
Nov	1,250	1,540
Dec	1,340	1,640
Annual	11,300	13,890

TABLE C-5
ESTIMATED ANNUAL COSTS AND BENEFITS
(January 1982 Price levels, $1,000)

Alternative 1A

	Installed Capacity				
	2.7 Mw	3.8 Mw	4.4 Mw	5.0 Mw	5.6 Mw
Annual Energy, Mwh	9,560	10,640	10,950	11,277	11,355
Plant Factor	0.40	0.32	0.28	0.26	0.23
Costs:					
Annual Cost	498	583	633	677	721
Production Cost (mills/kwh)	56	57	59	60	64
Benefits @ 90 mills/kwh					
Annual Benefit	860	957	987	1,015	1,022
Net Benefit	362	374	354	338	301
B/C Ratio	1.7	1.6	1.6	1.5	1.4
Benefits @ 79 mills/kwh					
Annual Benefit	755	841	865	891	897
Net Benefit	257	258	232	214	176
B/C Ratio	1.5	1.4	1.4	1.3	1.2

TABLE C-6
ESTIMATED ANNUAL COSTS AND BENEFITS
(January 1982 Price levels, $1,000)

Alternative 2A

	Installed Capacity				
	3.4 Mw	4.9 Mw	5.6 Mw	6.3 Mw	7.3 Mw
Annual Energy, Mwh	12,100	13,450	13,840	14,133	14,440
Plant Factor	0.41	0.31	0.28	0.26	0.23
Costs:					
Annual Cost	805	921	968	1,018	1,091
Production Cost (mills/kwh)	79	77	78	79	81
Benefits @ 90 mills/kwh					
Annual Benefit	1,089	1,210	1,245	1,272	1,300
Net Benefit	284	289	277	254	209
B/C Ratio	1.4	1.3	1.3	1.2	1.2
Benefits @ 79 mills/kwh					
Annual Benefit	956	1,063	1,093	1,116	1,140
Net Benefit	151	142	125	98	49
B/C Ratio	1.2	1.2	1.1	1.1	1.04

MECHANICAL AND ELECTRICAL

36. General. The powerhouse, in both alternatives considered, would be a conventional indoor plant constructed of reinforced concrete, housing two generating units with adequate space for maintenance and auxiliary equipment. Removal and servicing of powerplant equipment would be through hatches located in the powerhouse roof utilizing a mobile crane.

37. For Alternative 1A the main power equipment would consist of two horizontal shaft synchronous generators, one rated 3700 kva, 0.90 P.F., 3 - phase, 600 RPM, and the second rated 1855 kva, 0.90 P.F., 3 - phase, 720 RPM. The turbines would be horizontal Francis type, the larger unit rated to discharge 260 cfs and the smaller 130 cfs both at a net head of 178 feet.

38. For Alternative 2A the main power equipment would consist of two horizontal shaft synchronous generators, one rated 4222 kva, 0.90 P.F., 3 - phase, 514.3 RPM, and the second rated 2056 kva, 0.90 P.F., 3 - phase, 720 RPM. The turbines would be horizontal Francis type, the larger unit rated to discharge 235 cfs and the smaller 116 cfs both at a net head of 225 feet.

39. Control facilities in both alternatives would be for an unmanned plant, and protective devices would operate automatically to protect equipment without the need for operator assistance.

40. Mechanical Equipment. For both powerhouse alternatives, station, brake and governor air would be provided by a single air compressor. Draft tube unwatering and drainage would be through a common sump using an automatic duplex pump system. Miscellaneous raw water systems would be supplied via a tap from the intake and boosted by pumps as necessary. Oil would be stored in barrels and transported on a cart mounted with pump and filter. Potable water and rest rooms would not be provided.

41. Powerhouse and generators, in Alternatives 1A & 2A, would be cooled by using outside air. Generators would be cooled by drawing powerhouse air through the generator housing and discharging it directly outside. Powerhouse heating would not be required. Dehumidification would not be provided.

42. Bulkheads and Valves. The flow of water to the units would be through intake pipes fitted with hydraulically operated butterfly valves. Draft tube bulkhead installation and removal would be accomplished by a mobile crane.

43. Turbines and Governors. The installation of the "Standardized" horizontal single-runner, Francis type turbines with wicket gates and butterfly valves would match the site's hydraulic conditions. The individual turbines selected for each site would be of differing size and capacity. This would allow operation over a wide variation of flow conditions. For the purpose of this study, the following turbines were selected: For Alternative 1A two turbines would be provided. One turbine would be rated to discharge 260 cfs at 178 feet net head. At this condition, the generator output would be approximately 3.33 MW, at a speed of 600 RPM. The other turbine would be rated to discharge 130 cfs at 178 feet net head. The generator output would be approximately 1.67 MW at a speed of 720 RPM. The operating range for this installation would be based upon flows of approximately 65 cfs to 390 cfs at a net head of 178 ft.

44. For Alternative 2A two turbines would be provided. One turbine would be rated to discharge 234 cfs at 225 feet net head. At this condition, the generator output would be approximately 3.8 MW at a speed of 514.31. The other turbine would be rated to discharge 116 cfs at 225 feet net head. The generator output would be approximately 1.85 MW at a speed of 720 RPM. The operating range for this site would be for flows of approximately 58 cfs to 350 cfs and at a net head of 225 ft.

45. "Standardized" units were selected because of the economic advantages of using pre-engineered and manufactured equipment. Future evaluations may show that other cost effective turbines for these installations (e.g., crossflow or pumps operated as turbines can be utilized.) All appropriate turbine types would be considered in Advance Engineering and Design studies.

46. The governors would be of the oil pressure, relay valve, actuator type with mechanically driven, speed responsive elements designed for regulating the speed. Speed responsive elements would be controlled by a speed signal generator which is directly connected to the turbine generator shaft. Each governor unit would consist of actuator, restoring mechanism, motor driven pumping units, pressure tanks, sump tank, oil piping, and accessories. The "Standardized" turbines described above have their governor as part of the package unit. Specific characteristics of the governor, therefore, will vary between manufacturers.

47. Generators and Excitation Systems. For Alternative 1A the generators would be of the horizontal shaft, synchronous type, with shaft directly connected to the turbine. The generators would be 3 - phase, 60 Hz, 2400 V, the large unit rated at 3330 kW (3700 kVA at 0.9 PF) 600 RPM, and the small unit rated at 1670 kW (1855 kVA at 0.9 PF) 720 RPM.

48. For Alternative 2A the generators would be of the horizontal shaft, synchronous type, with shaft directly connected to the turbine. The generators will be 3 - phase, 60 Hz, 2400 V, the large unit rated at 3800 kW (4222 kVA at 0.9 PF) 514.3 RPM, and the small rated at 1850 kW (2056 kVA at 0.9 PF) 720 RPM.

49. For both alternatives drip proof housings would be provided. The generators would be open ventilated with an 80° C rise, Class B insulation system without provisions for overload. The generators would have full run-away speed capability. The excitation systems would be specified to be the manufacturer's standard type. This can be either a direct connected brushless exciter or a bus-fed power potential source static exciation system. Solid-state continously acting dynamic type voltage regulators would be used and would be incorporated in the unit switchgear.

50. Generator Voltage System. The connection between the generator and breaker would be with non segregated bus. The generator and station service breakers would be metal clad drawout type rated 250 MVA (nominal), 5 kV 1200 amps continuous. The breakers would be combined in a common switchgear lineup along with generator surge protection and instrument transformers. The lineup for Alternative 1A would be housed in an outdoor, protected aisle assembly. The lineup for Alternative 2A would be a standard indoor assembly.

51. Station Service. The station service power would be obtained via a tap between the generator breaker and main power transformer. The station service transformer would be adjacent to the generator switchgear lineup. Station service power distribution would be at 480 volts 3 - phase and 120/240 volts single phase.

52. Connection to Load. For Alternative 1A one power transformer would be provided. This would be a 2.4/12 kV, delta-grounded wye, 3 - phase transformer, AA/FA Class, 4166/5555 kVA, with the minimum non-premium impedance specified.

53. For Alternative 2A one power transformer would be provided. This would be a 2.4/12 kV, delta-grounded wye, 3 - phase transformer, AA/FA Class, 4709/6278 kVA, with the minimum non-premium impedance specified.

54. In both alternatives a 3 - phase 12 kV overhead electrical transmission line would tie the power plant to the existing Lydgate substation. For Alternative 1A the transmission line would be approximately 3.5 miles long. For Alternative 2A the transmission line would be approximately 2.2 miles long. The line would be connected to the powerhouse through a disconnect switch shown on the one line diagram. (Plate C-10).

55. Unit Control and Protective Equipment. A complete complement of control and protective equipment would be provided on the Switchgear cubicles. Controls will provide for generator starting, stopping, and circuit breaker operation, including automatic synchronizing. Start and stop functions would be performed automatically as result of water level and frequency changes. The diesel generators in the existing electrical

utility system will also be started and stopped automatically to allow optimum utilization of the hydro units. Generator protection would include differential, ground, overvoltage, overcurrent, loss of excitation, negative sequence overcurrent, out of step, and field ground relays. Transformer protection would include differential, ground, and temperature relays and other standard devices. Line protection and transfer tripping would be coordinated with the Kauai Electric, the local electric utility.

56. Power Plant Costs. The total estimated project construction cost for the proposed powerplants is summarized below based on 1 Jan 82 price levels.

TABLE C-7
POWERHOUSE COSTS

Feature	ALTERNATIVE 1A 5.0 MW	ALTERNATIVE 2A 5.6 MW
1. POWERHOUSE		
1.1 Excavation, P.H., Channels	App B	App B
1.2 Penstock	App B	App B
1.3 Tailrace	App B	App B
1.4 Reinforced Concrete	279,700.	210,000
1.5 Misc. Building Items	3,000.	3,000.
1.6 Bulkhead, Guides & Struct Steel	89,800.	82,200.
1.7 Architectural	25,500.	25,500.
2. TURBINES AND GENERATORS		
2.1 Turbines & Governors	981,000.	890,000
2.2 Generators & Excitation Equip.	558,000.	605,000.
2.3 Cooling Systems	Included	Included
3. ACCESSORY ELECTRICAL EQUIP.		
3.1 Switchgear, Breakers & Buses	245,000.	215,000
3.2 Station Service Unit	20,000.	20,000.
3.3 Control System	233,200.	233,200.
3.4 Misc. Electrical Systems	50,000.	45,000.
4. AUXILIARY SYSTEMS & EQUIP.		
4.1 Heating and Ventilating	11,000.	14,000.
4.2 Station, Brake & Governor Air	8,000.	8,000.
4.3 Unwatering & Drainage Systems	11,200.	8,200.
4.4 Misc. Mechanical Systems	17,000.	15,500.
5. SWITCHYARD		
5.1 Power Transformer	133,000.	144,000.
5.2 Disconnects & Elec. Equip	20,000.	20,000.
5.3 Transmission Line	350,000.	220,000.
6. SITE PREPARATION		
6.1 Mobilization	App B	App B
Sub-Total	3,035,400.	2,758,600.
Contingency @ 16% ± 1/	496,600.	446,400.
POWERHOUSE CONSTRUCTION COST	3,532,000.	3,205,000.

1/ Weighted contingency. All major features (2,3,4,5) include 15% contingency except for the powerhouse feature (1) which includes 25% contingency.

CIVIL AND CONSTRUCTION REQUIREMENT

57. Powerhouse. The Powerhouse Design and Construction schedules for both alternatives are shown on Figure C-6.

58. For both alternatives the total elapsed time from authorization to proceed with plans and specification to P.O.L. (Power On Line) would be 45 months. Power on line is the date on which uninterrupted marketable power is available from the project. The estimated length of time required from award of turbine contract to P.O.L. would be 27 months and 30 months for the first and second units respectively. This construction schedule assumes that studies such as D.A.R. (Design Analysis Report) or any other study documents required have been completed prior to the start of plans and specifications.

59. Civil Features.
(The descriptions of the civil features, including diversion dam, intake structure, penstock, tailrace and acess road shown in Appendices B and D)

OPERATION AND MAINTENANCE

60. During normal operation the Powerhouse would be unmanned. The plant output would be monitored by the local utility and distributed through the existing power system. A visual inspection and check of the plant, turbines, mechanical and electrical equipment would be required a minimum of 2 or 3 times a week. Maintenance of equipment would be performed on a scheduled basis and in accordance with Dept. of Army and manufacturers specifications.

CONCLUSION

61. The hydropower potential of the two alternative site locations on the South Fork of the Wailua River, below the falls, appears to be economically feasible for development. The Alternative 1A powerhouse would be located directly below the falls and would consist of a two-unit, 5.0 megawatt powerplant. The Alternative 2A powerhouse would be located approximately 1-1/2 miles further downstream and would consist of a two-unit, 5.6 megawatt powerplant.

62. The total investment cost for Alternative 1A would be approximately 7.8 million dollars, while the annual cost of production would be 60 mills per kwh. The total investment cost for Alternative 2A would be approximately 11.6 million dollars, while the annual cost of production would be 78 mills per kwh. Both site alternatives would be economically feasible; however, the site near the falls would be a better selection based on the the net benefits developed. Other factors could also influence the final site recommendations.

63. The project would operate as a run-of-river (conduit) powerplant and would be remotely controlled. Average annual energy production would be either 11.3 million Kwh or 13.8 Kwh, depending on the alternative site location. Corresponding annual plant factors would be 26 or 28 percent.

64. The energy produced at the project would most likely displace more expensive oil-fired system generation. System load projections indicate a need for additional energy. The projected market price for system energy would be in the 80 to 100 mill per Kwh range, thus a market is readily available for the energy generated at the Wailua project.

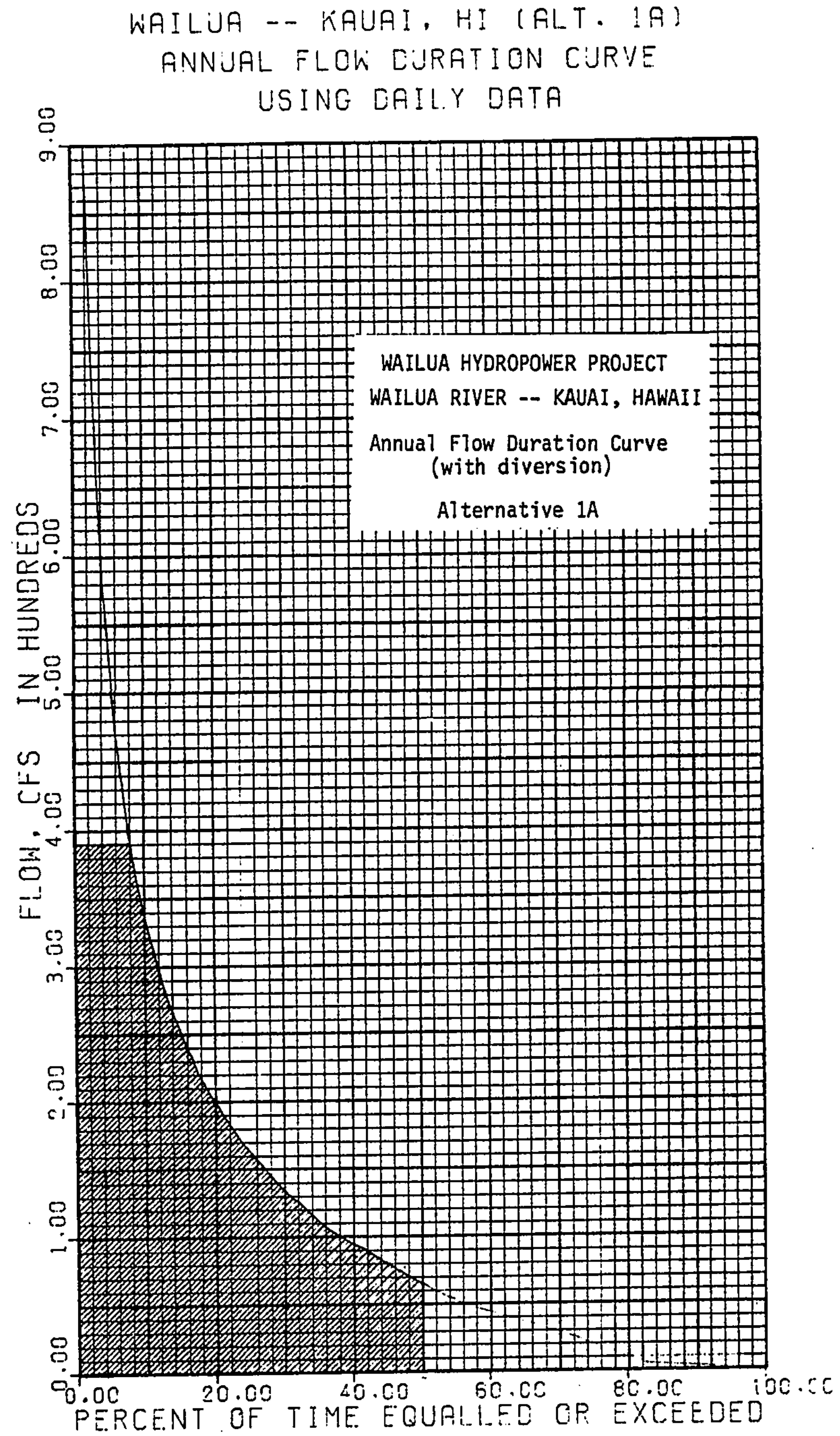

WAILUA -- KAUAI, HI (ALT. 1A)
ANNUAL FLOW DURATION CURVE
USING DAILY DATA
WAILUA HYDROPOWER PROJECT
WAILUA RIVER -- KAUAI, HAWAII
Annual Flow Duration Curve
(with diversion)
Alternative 1A
FLOW, CFS IN HUNDREDS
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
0.00
20.00
40.00
60.00
80.00
100.00
PERCENT OF TIME EQUALLED OR EXCEEDED

PLATE C-1

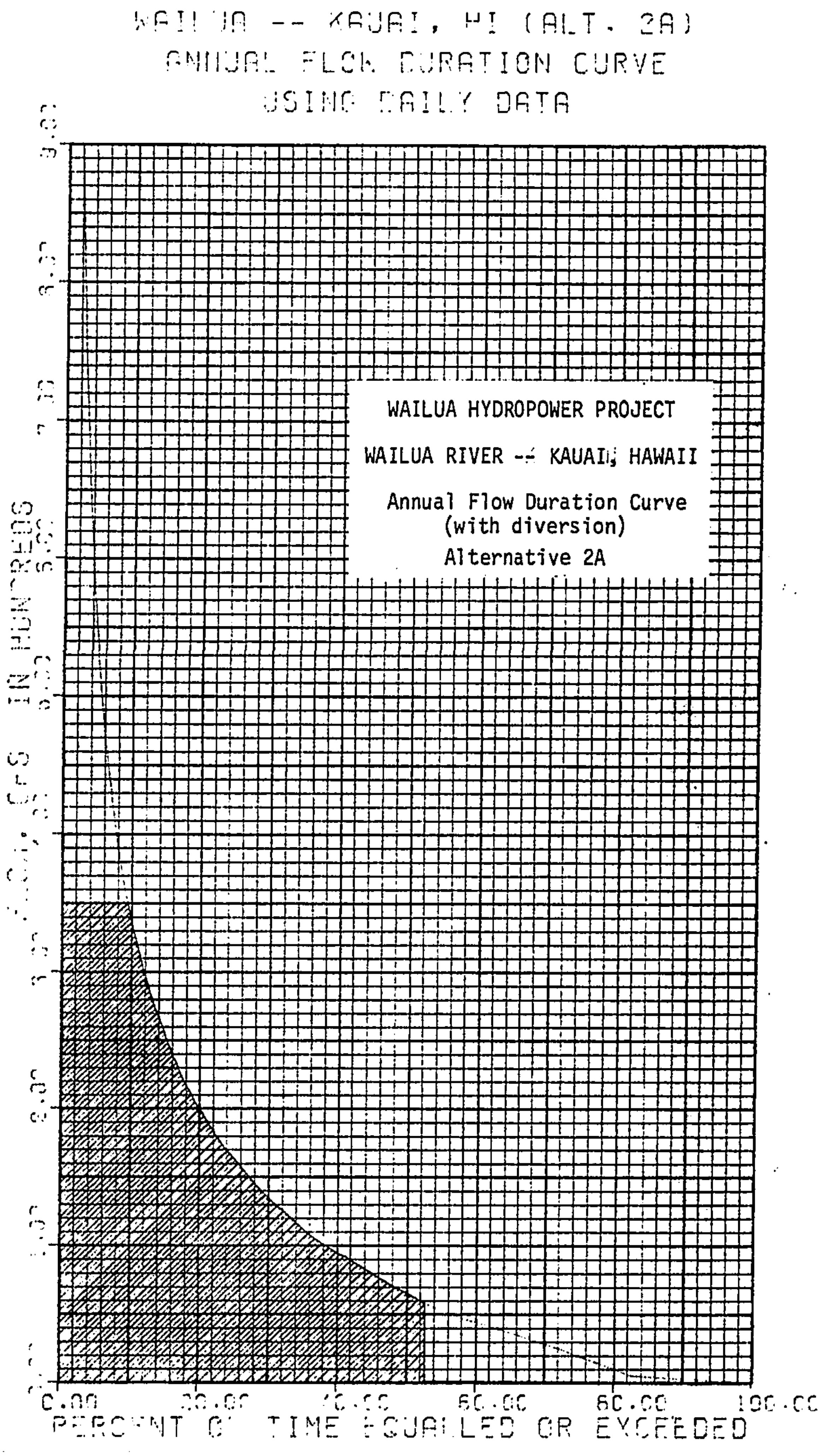

WAILUA HYDROPOWER PROJECT
WAILUA RIVER -- KAUAI, HAWAII
Annual Flow Duration Curve
(with diversion)
Alternative 2A

PLATE C-2

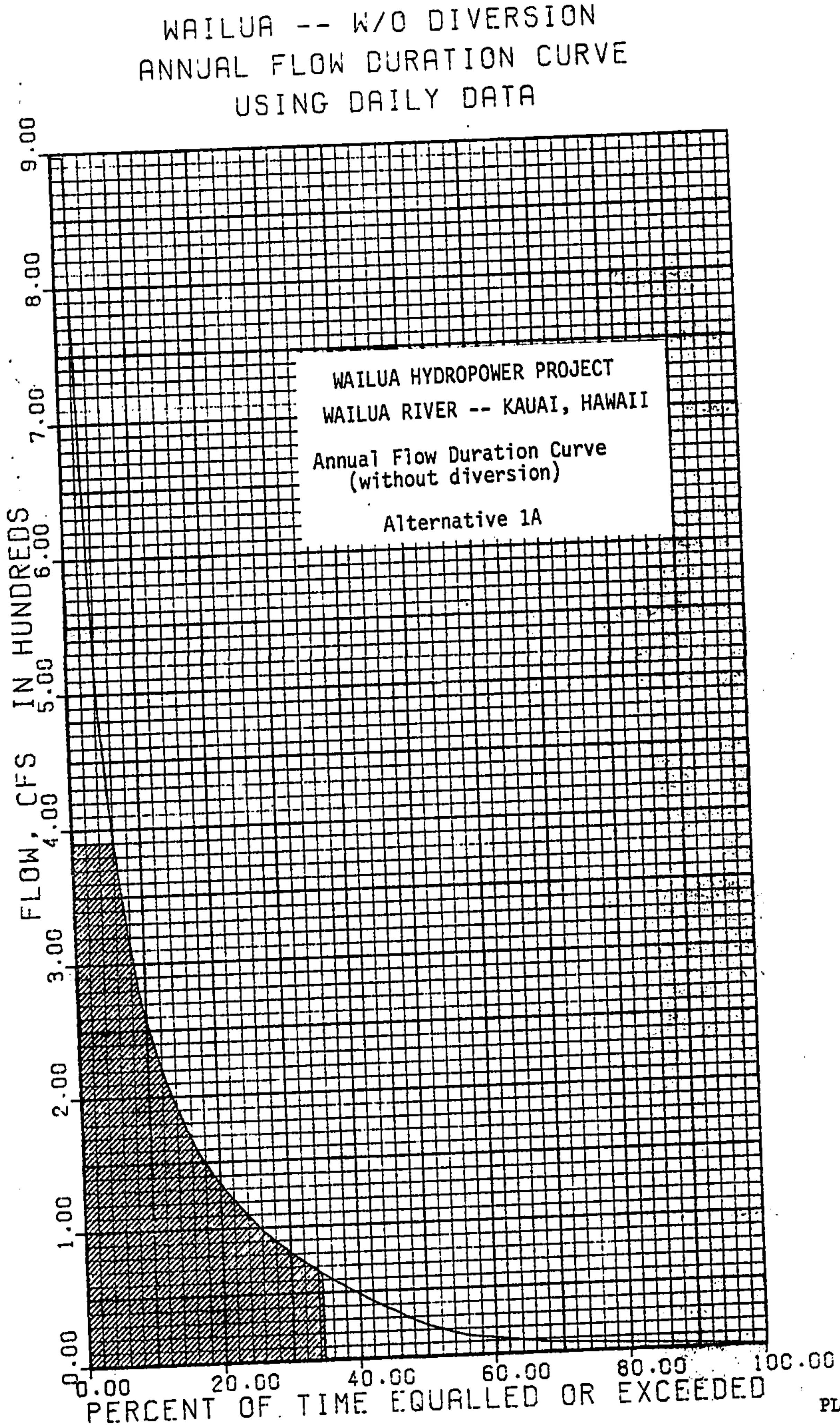

WAILUA -- W/O DIVERSION
ANNUAL FLOW DURATION CURVE
USING DAILY DATA
WAILUA HYDROPOWER PROJECT
WAILUA RIVER -- KAUAI, HAWAII
Annual Flow Duration Curve
(without diversion)
Alternative 1A
FLOW, CFS IN HUNDREDS
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
0.00
20.00
40.00
60.00
80.00
100.00
PERCENT OF TIME EQUALLED OR EXCEEDED

PLATE C-3

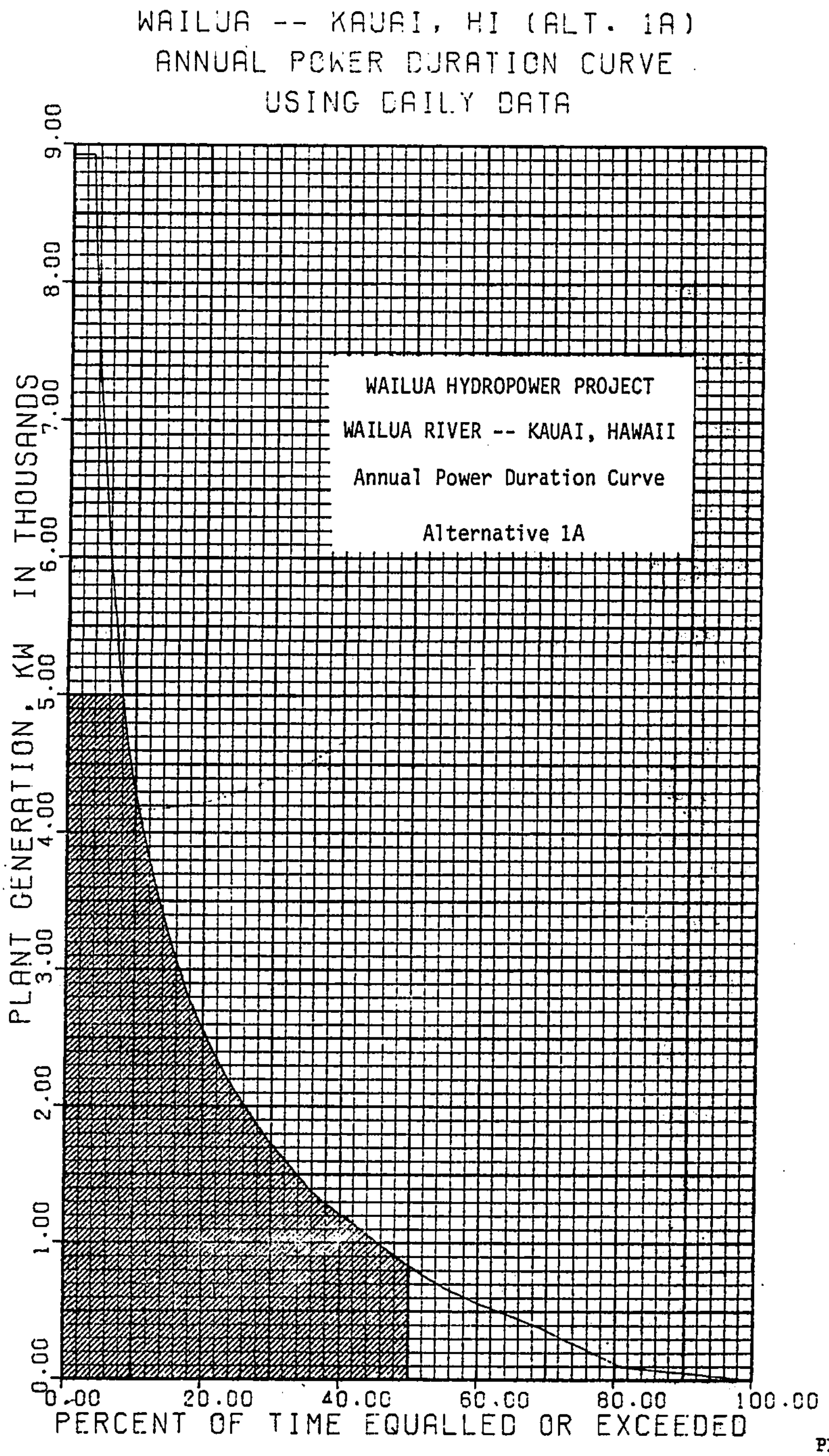

WAILUA -- KAUAI, HI (ALT. 1A)
ANNUAL POWER DURATION CURVE
USING DAILY DATA
WAILUA HYDROPOWER PROJECT
WAILUA RIVER -- KAUAI, HAWAII
Annual Power Duration Curve
Alternative 1A
PLANT GENERATION, KW IN THOUSANDS
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
0.00
20.00
40.00
60.00
80.00
100.00
PERCENT OF TIME EQUALLED OR EXCEEDED

PLATE C-4

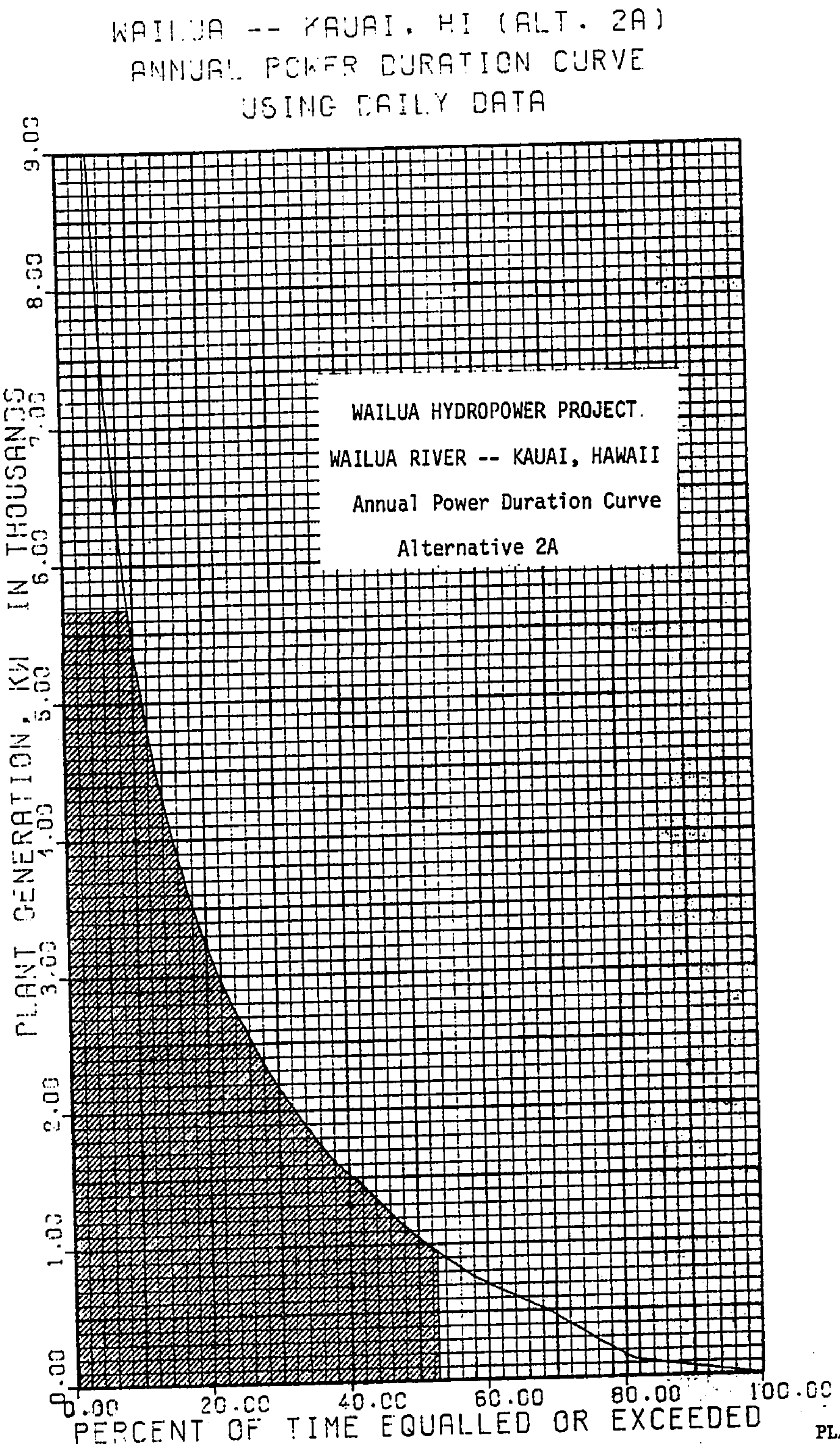
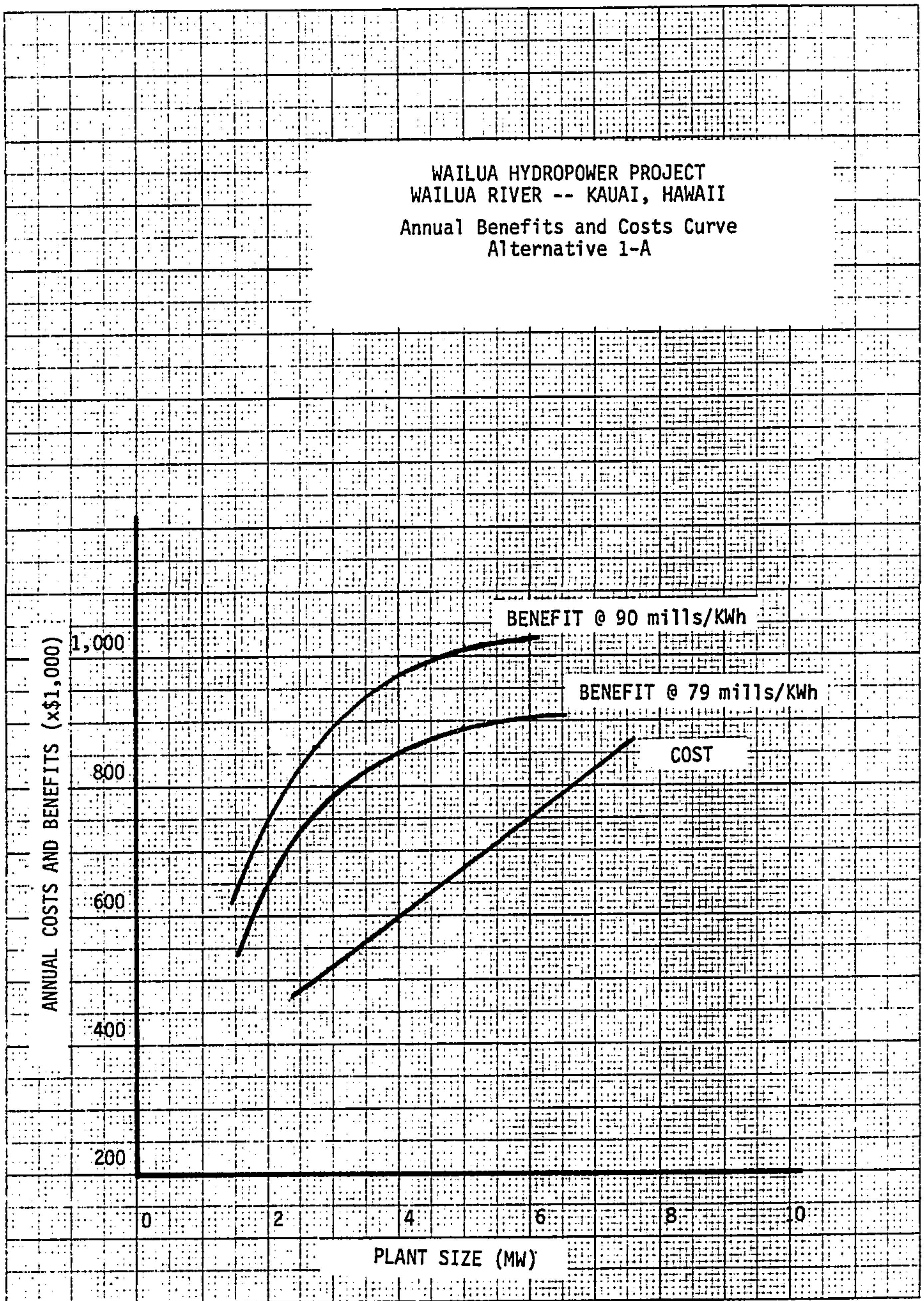
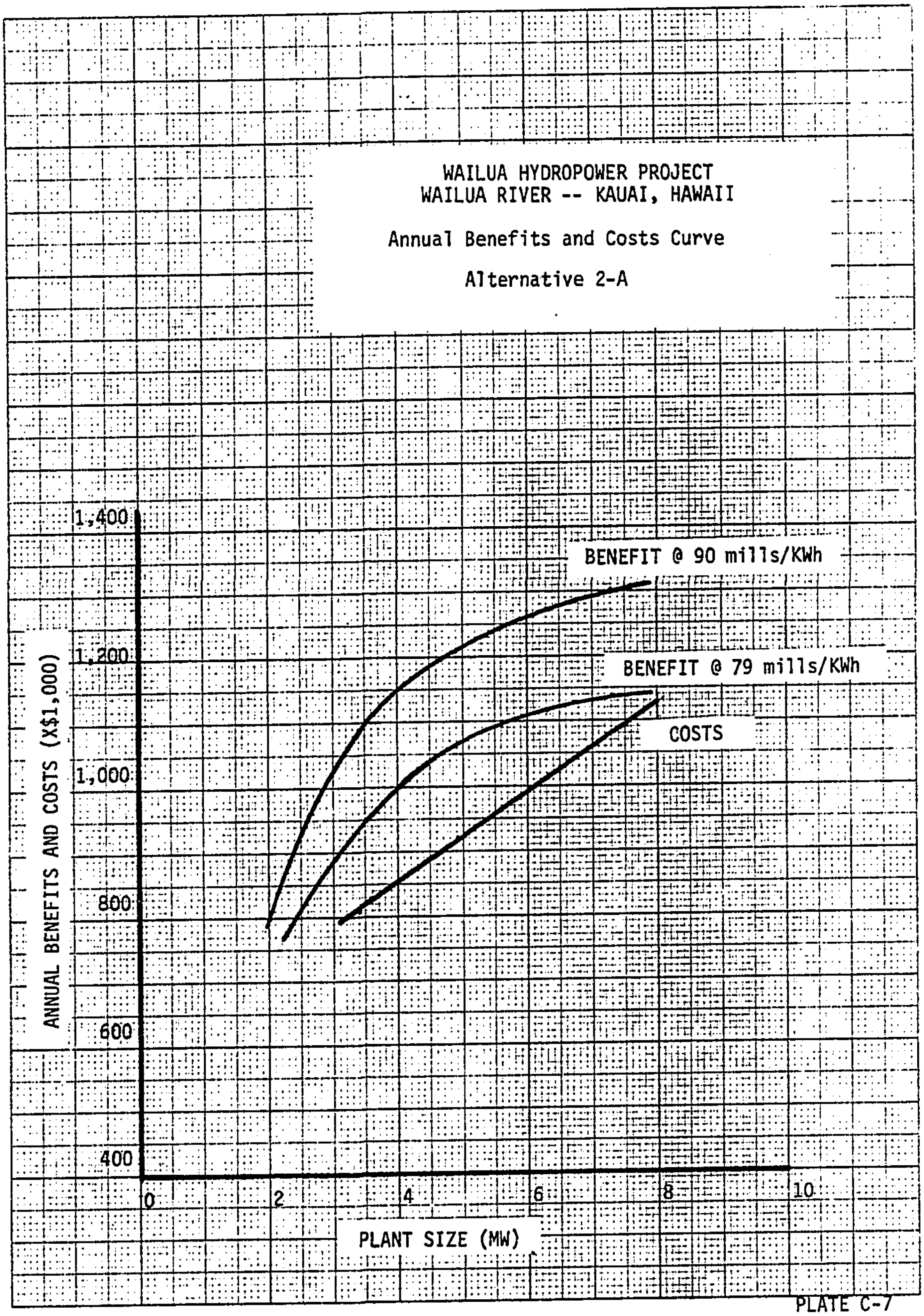

WAILUA -- KAUAI, HI (ALT. 2A)
ANNUAL POWER DURATION CURVE
USING DAILY DATA
WAILUA HYDROPOWER PROJECT
WAILUA RIVER -- KAUAI, HAWAII
Annual Power Duration Curve
Alternative 2A
PLANT GENERATION, KW IN THOUSANDS
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
0.00
20.00
40.00
60.00
80.00
100.00
PERCENT OF TIME EQUALLED OR EXCEEDED

PLATE C-5



WAILUA HYDROPOWER PROJECT
WAILUA RIVER -- KAUAI, HAWAII
Annual Benefits and Costs Curve
Alternative 1-A
BENEFIT @ 90 mills/KWh
BENEFIT @ 79 mills/KWh
COST
ANNUAL COSTS AND BENEFITS (x$1,000)
1,000
800
600
400
200
0
2
4
6
8
10
PLANT SIZE (MW)


WAILUA HYDROPOWER PROJECT
WAILUA RIVER -- KAUAI, HAWAII
Annual Benefits and Costs Curve
Alternative 2-A
BENEFIT @ 90 mills/KWh
BENEFIT @ 79 mills/KWh
COSTS
ANNUAL BENEFITS AND COSTS (X$1,000)
1,400
1,200
1,000
800
600
400
0
2
4
6
8
10
PLANT SIZE (MW)

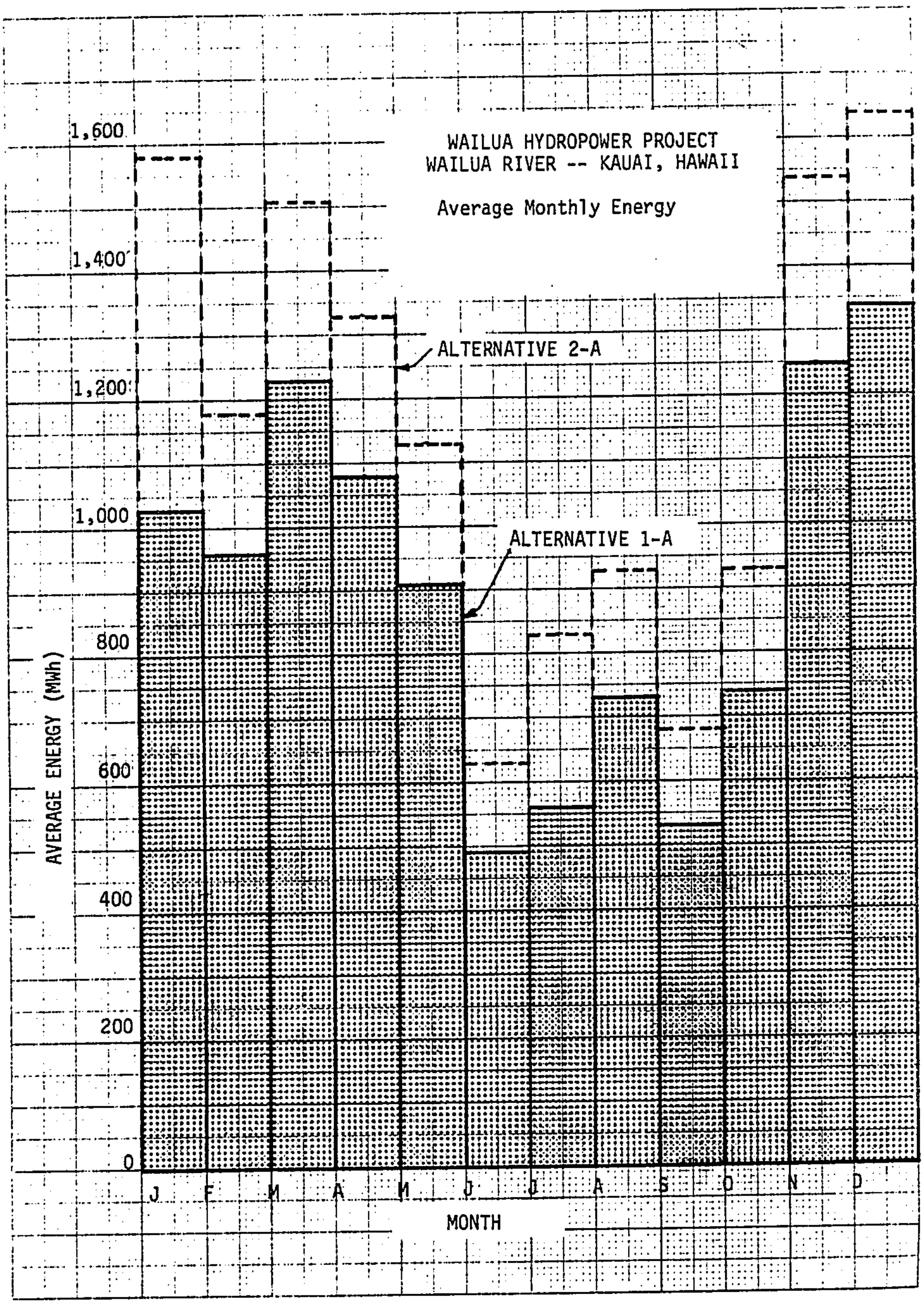

WAILUA HYDROPOWER PROJECT
WAILUA RIVER -- KAUAI, HAWAII
Average Monthly Energy
ALTERNATIVE 2-A
ALTERNATIVE 1-A
AVERAGE ENERGY (MWh)
1,600
1,400
1,200
1,000
800
600
400
200
0
J F M A M J J A S O N D
MONTH

PLATE C-8

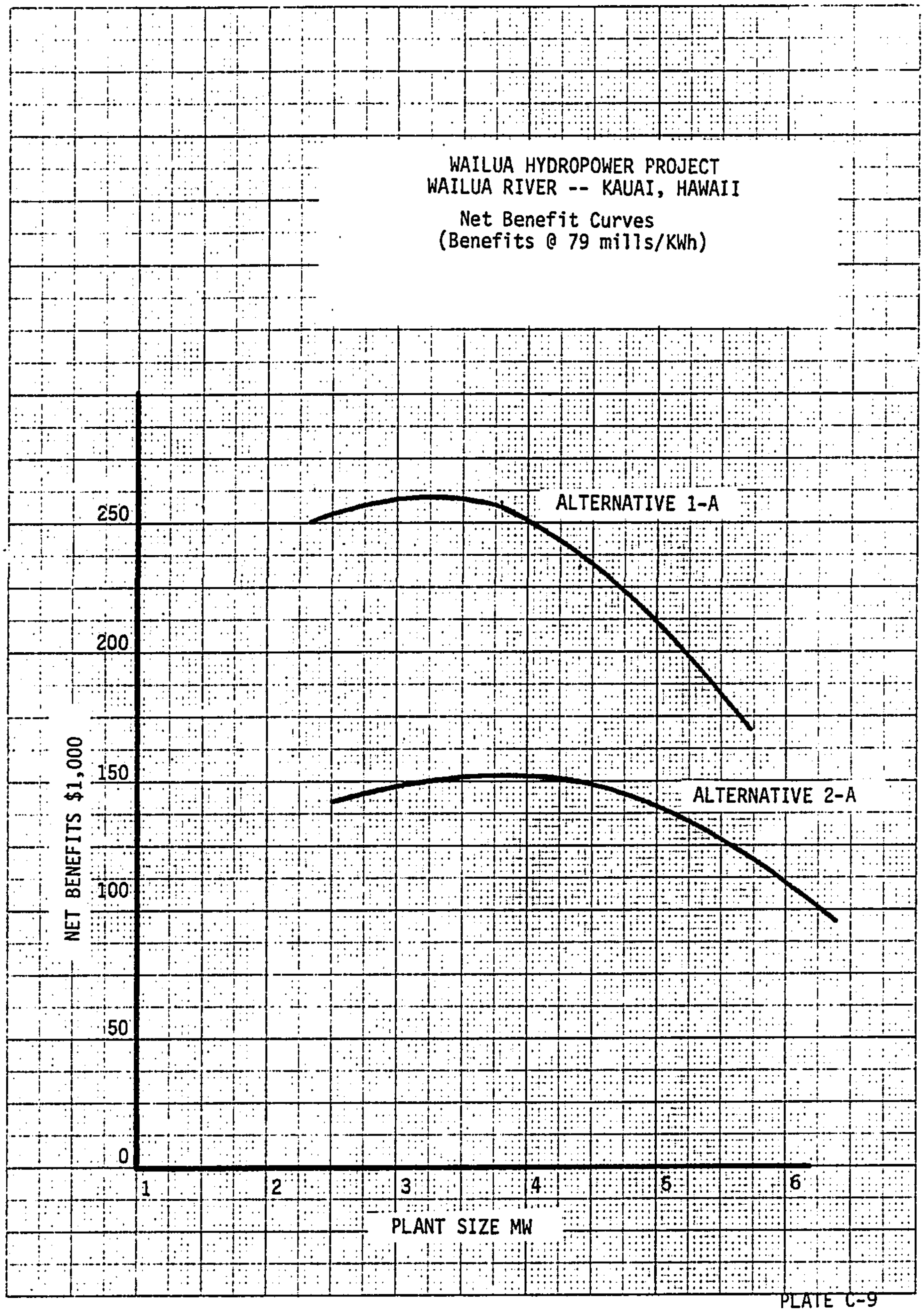

WAILUA HYDROPOWER PROJECT
WAILUA RIVER -- KAUAI, HAWAII
Net Benefit Curves
(Benefits @ 79 mills/KWh)
ALTERNATIVE 1-A
ALTERNATIVE 2-A
NET BENEFITS $1,000
250
200
150
100
50
0
1
2
3
4
5
6
PLANT SIZE MW

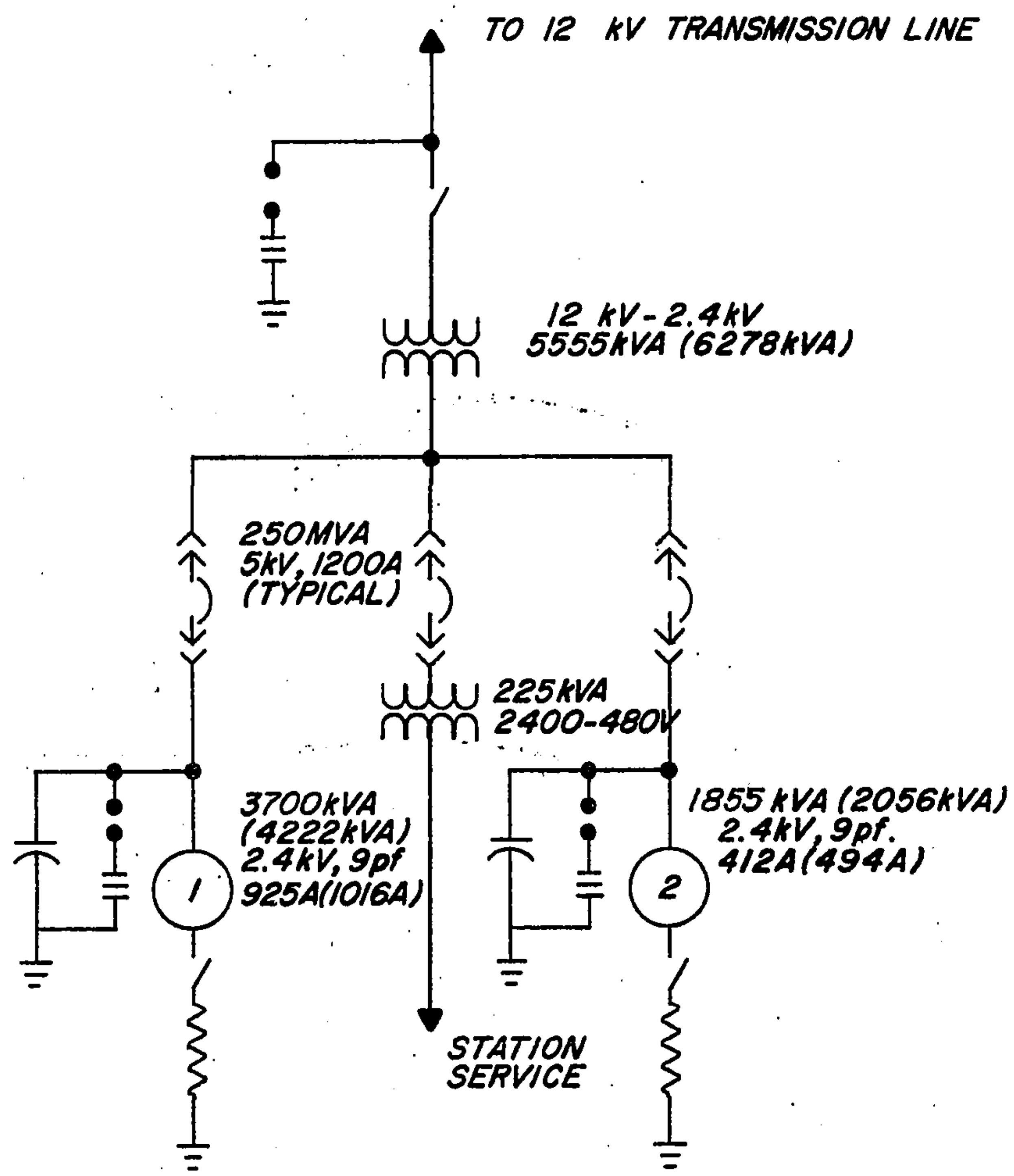
PLATE C-9

U. S. ARMY ENGINEER DIVISION, NORTH PACIFIC HYDRO-ELECTRIC DESIGN BRANCH

PROJECT WAILUA P.H.

SUBJECT ONE LINE DIAGRAM ALTERNATIVES 1A & 2A

BY GKW DATE 12 MAY 82 CHECKED ______ PART ______ PAGE ______ OF ______



NOTE:

ALTERNATIVE 2A VALUES SHOWN IN PARENTHESIS.

NPD Form June 1962 7A

Clearprint 10th Grid - RP Translucent Grid

PLATE C-10

DESIGN AND CONSTRUCTION SCHEDULE
WAILUA PROJECT ALTERNATIVES IA & 2A

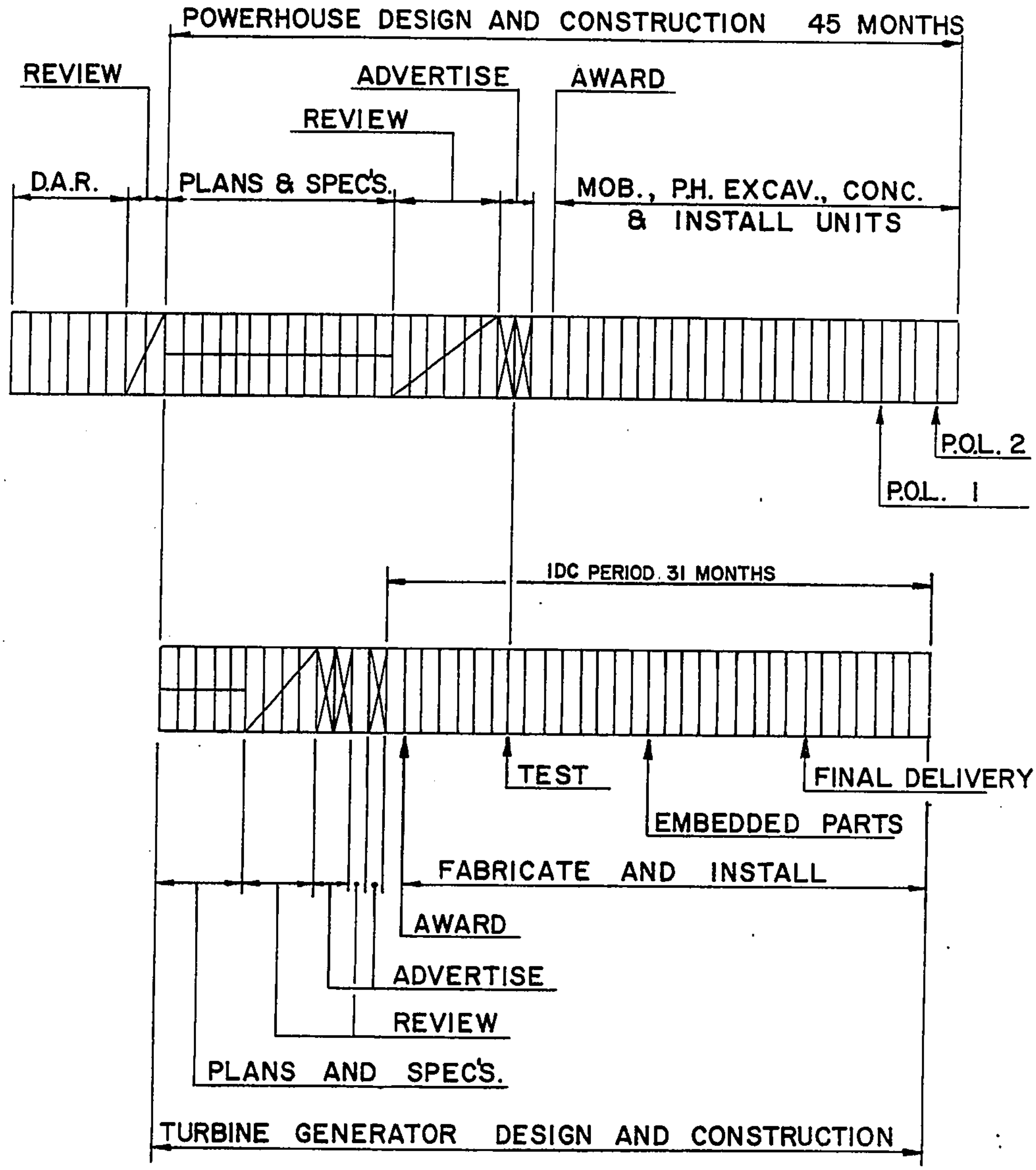
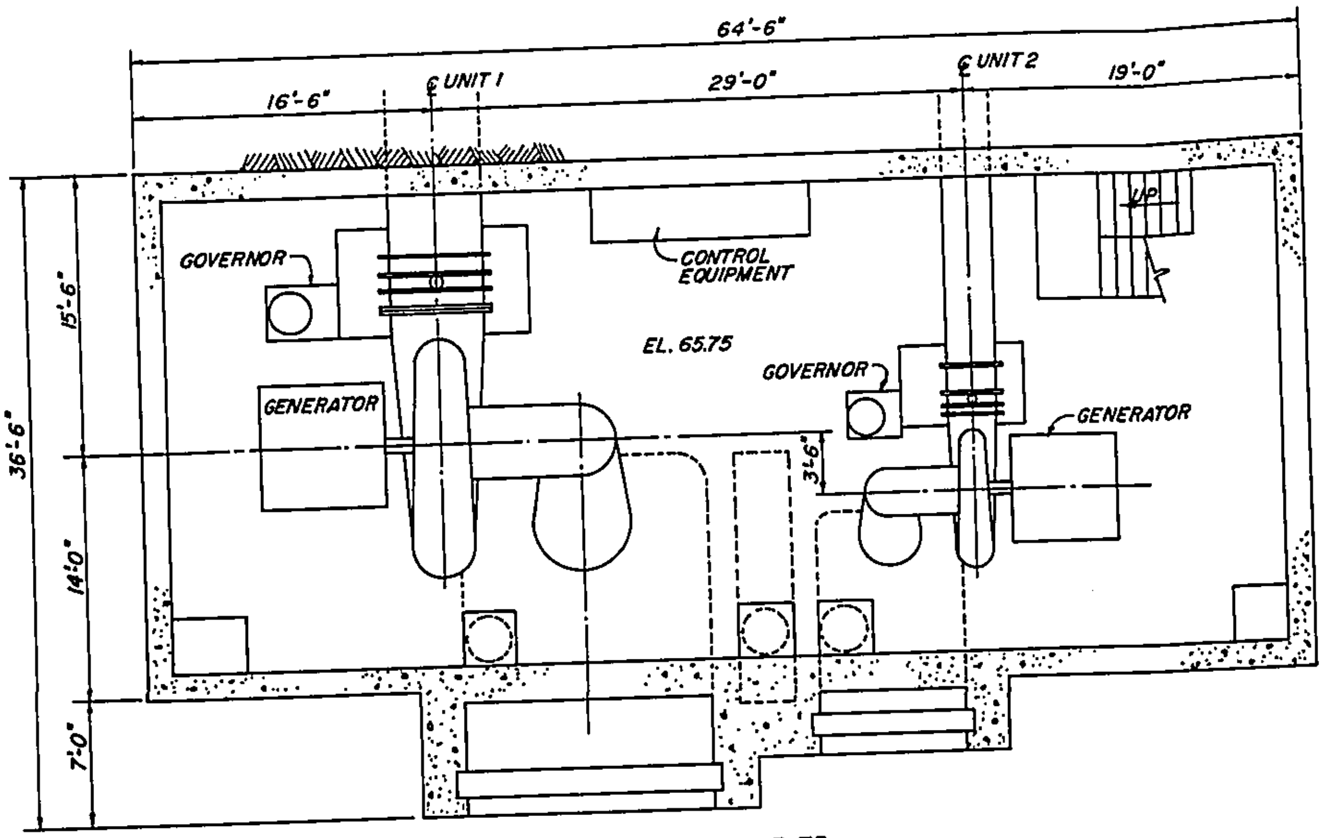
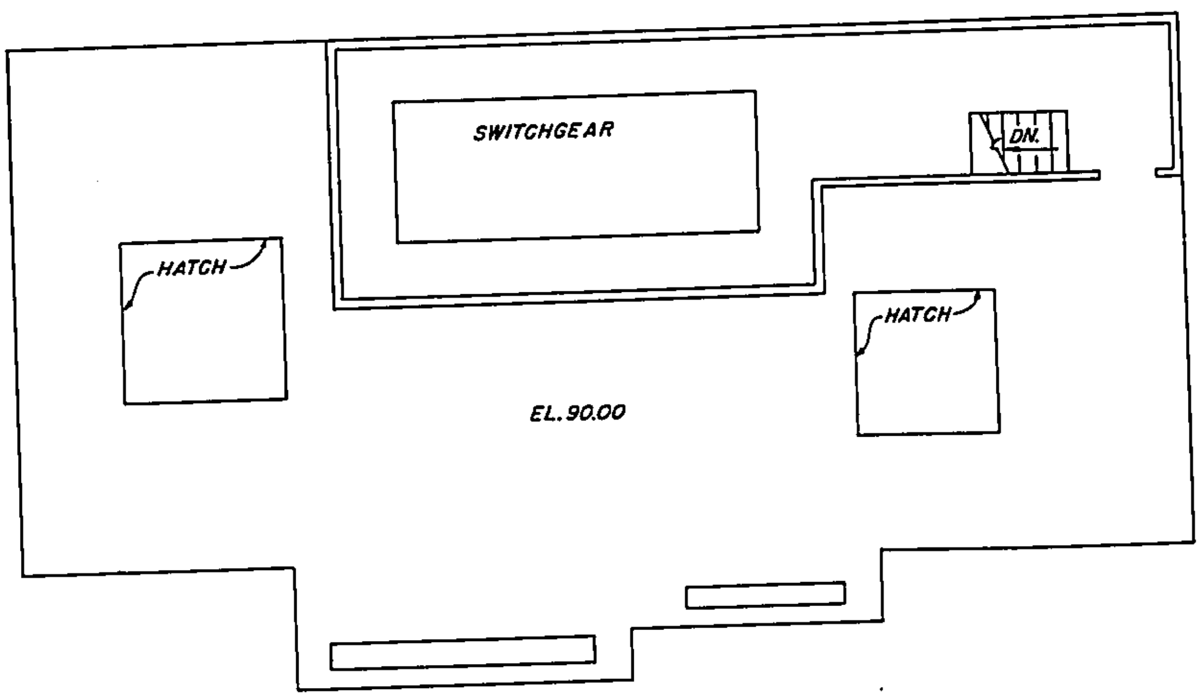


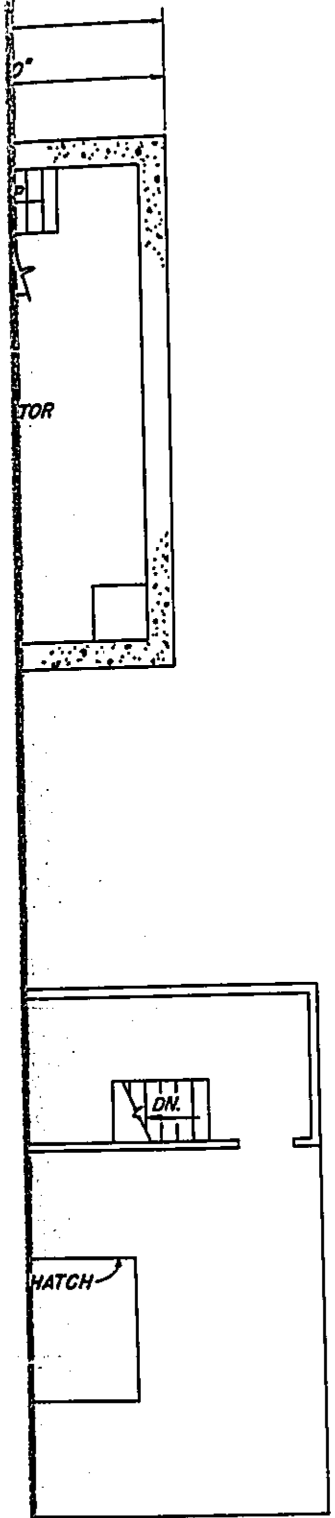
PLATE C-11

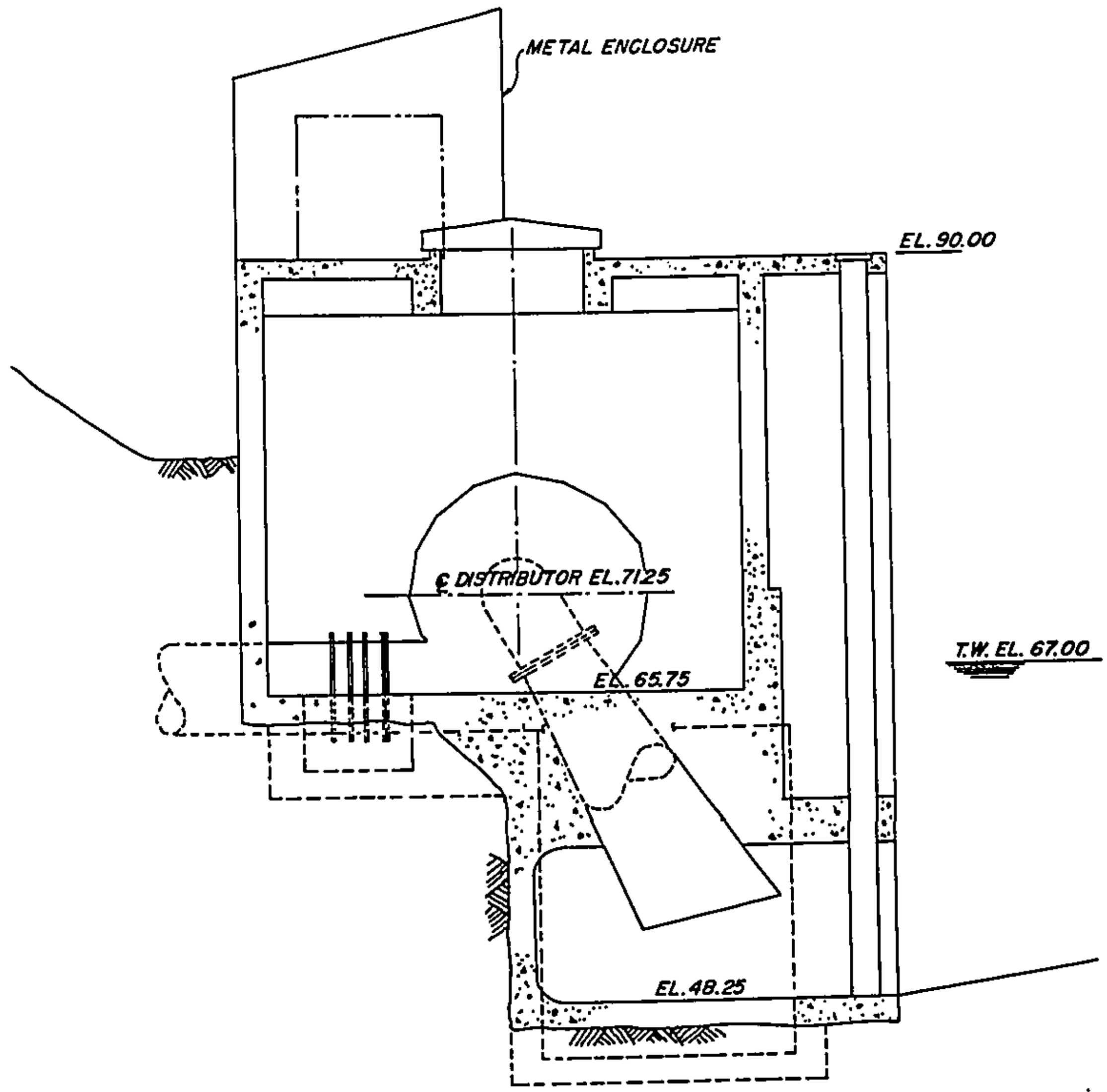


PLAN EL. 65.75



PLAN EL. 90.00





SECTION

PERTINENT DATA

	UNIT I	UNIT 2
GENERATOR RATING KVA @ .90 P.F.	3700	1855
NET HEAD FEET	178	178
SYNCHRONOUS SPEED R.P.M.	600	720
RUNNER THROAT DIA. mm	1200	700
FLOW CFS	130 - 260	65 - 130

SCALE 1/4" = 1'-0"

4' 0 4' 8' 12'
GRAPHIC SCALE

U. S. ARMY ENGINEER DIVISION, N. P.
PORTLAND, OREGON

DESIGNED BY V.R.
DRAWN BY 82-20
CHECKED BY K.J.L.
PREPARED:

WAILUA HYDROPOWER STUDY
WAILUA RIVER KAUAI, HAWAII
ALTERNATIVE I A
PLANS AND SECTION

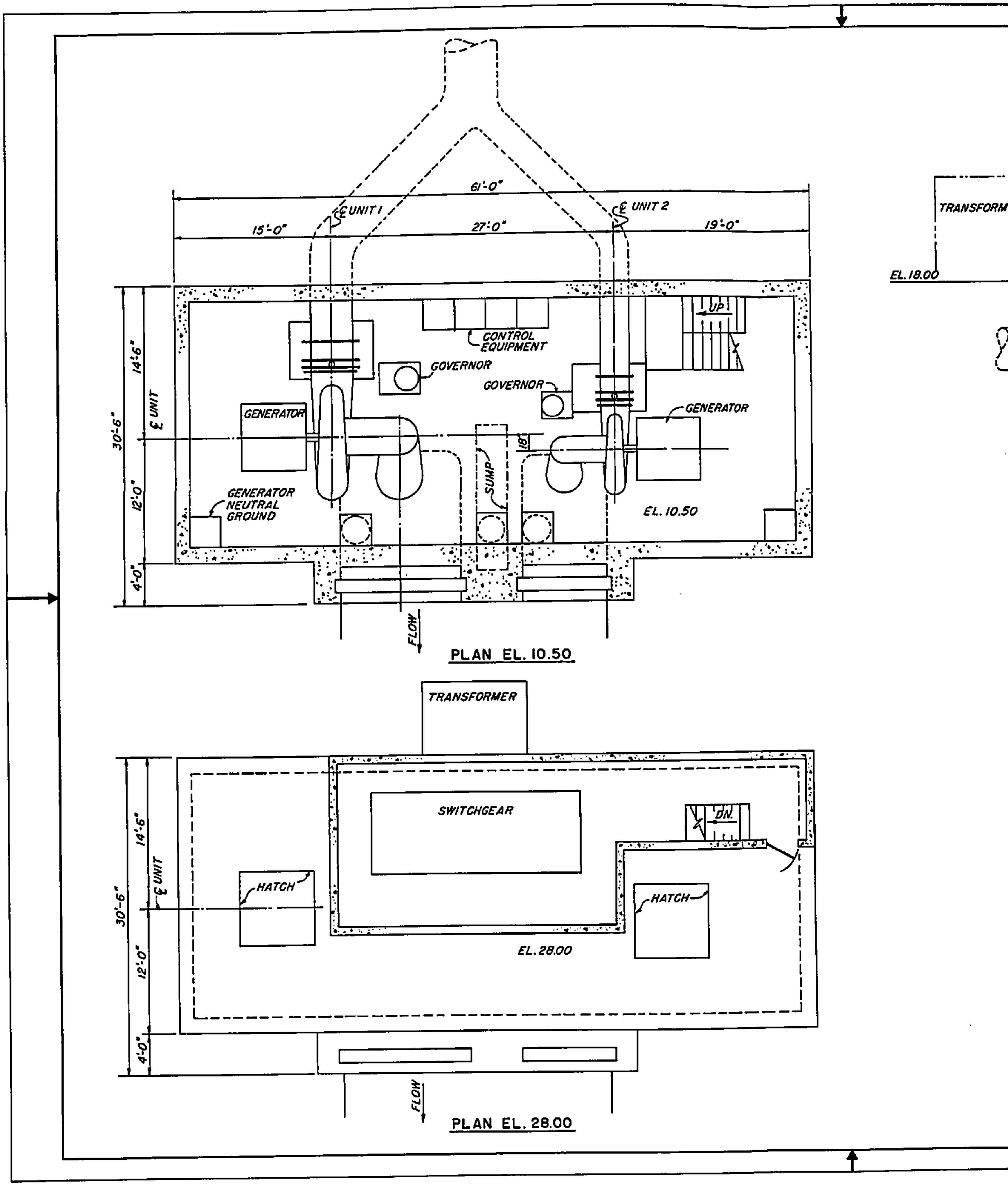
SUBMITTED:

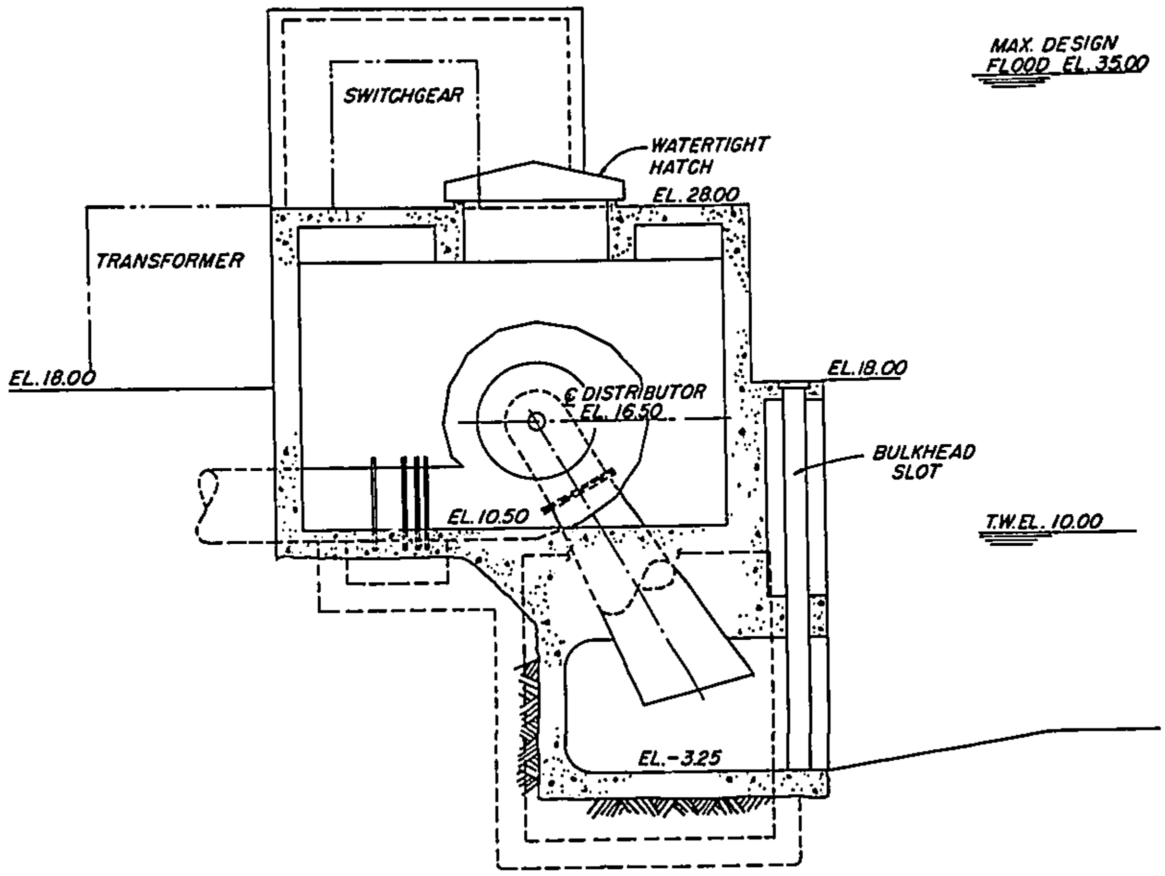
APPROVED: FOR DIV. ENGINEER DATE

SCALE AS SHOWN

SHEET

PLATE C-12


61'-0"
℄ UNIT 1
℄ UNIT 2
15'-0"
27'-0"
19'-0"
CONTROL EQUIPMENT
UP
GOVERNOR
GOVERNOR
GENERATOR
GENERATOR
SUMP
18"
GENERATOR NEUTRAL GROUND
EL. 10.50
30'-6"
14'-6"
℄ UNIT
12'-0"
4'-0"
FLOW
PLAN EL. 10.50
EL. 18.00
TRANSFORMER
SWITCHGEAR
DN.
HATCH
HATCH
EL. 28.00
30'-6"
14'-6"
℄ UNIT
12'-0"
4'-0"
FLOW
PLAN EL. 28.00



SECTION

PERTINENT DATA

	UNIT I	UNIT 2
GENERATOR RATING KVA @.90 P.F.	4222.	2056.
NET HEAD FEET	225.	225.
SYNCHRONOUS SPEED R.P.M.	514.3	720
RUNNER THROAT DIA. mm	1000	700
FLOW CFS	116-235	58 - 116

SCALE 1/4" = 1'-0"

4' 0 4' 8' 12'
GRAPHIC SCALE

U. S. ARMY ENGINEER DIVISION, N. P.
PORTLAND, OREGON

DESIGNED BY V.R.
DRAWN BY 82-20
CHECKED BY K.J.L.

WAILUA HYDROPOWER STUDY
WAILUA RIVER KAUAI, HAWAII
ALTERNATIVE 2A
PLANS AND SECTION

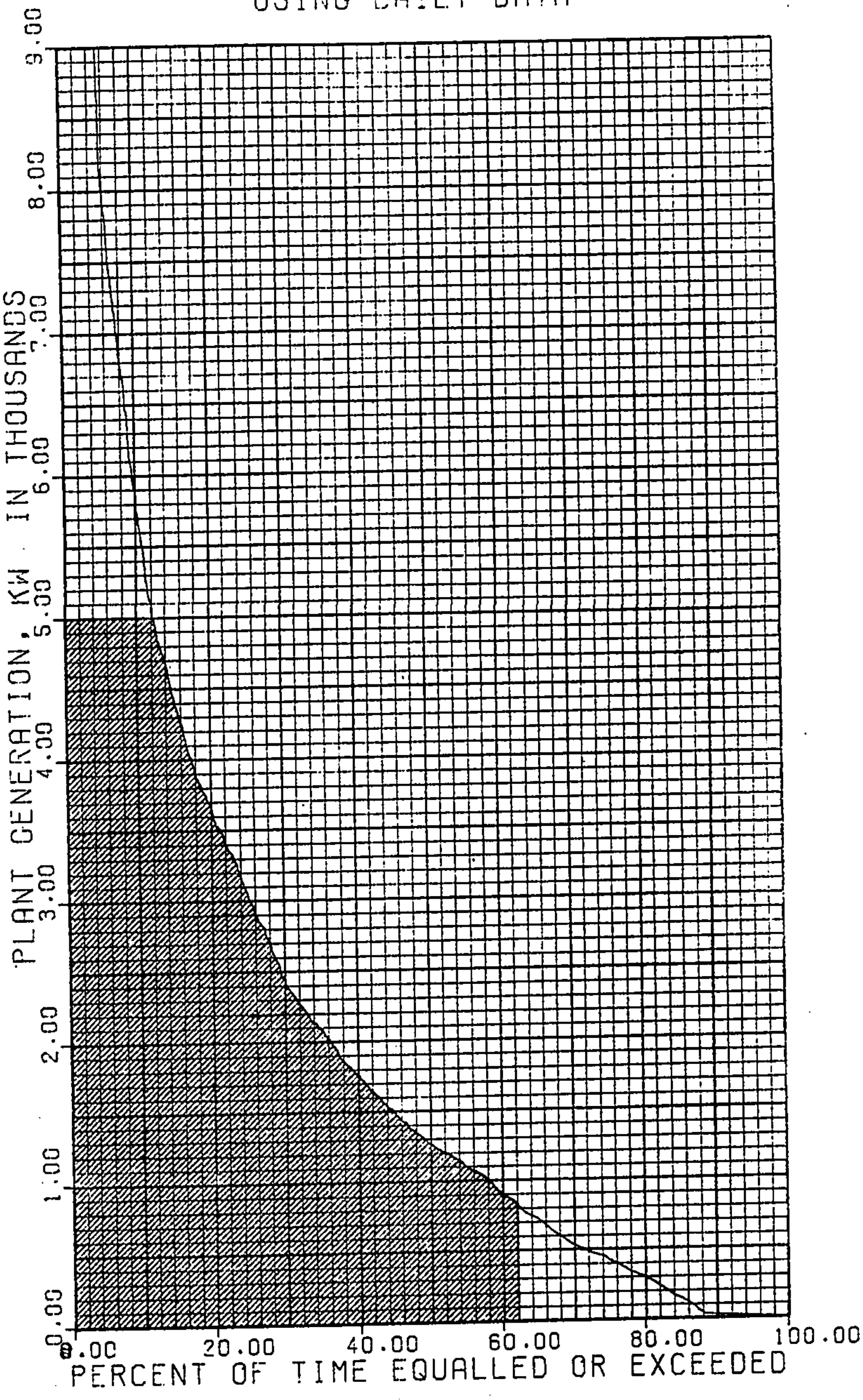
SCALE AS SHOWN

PLATE C-13

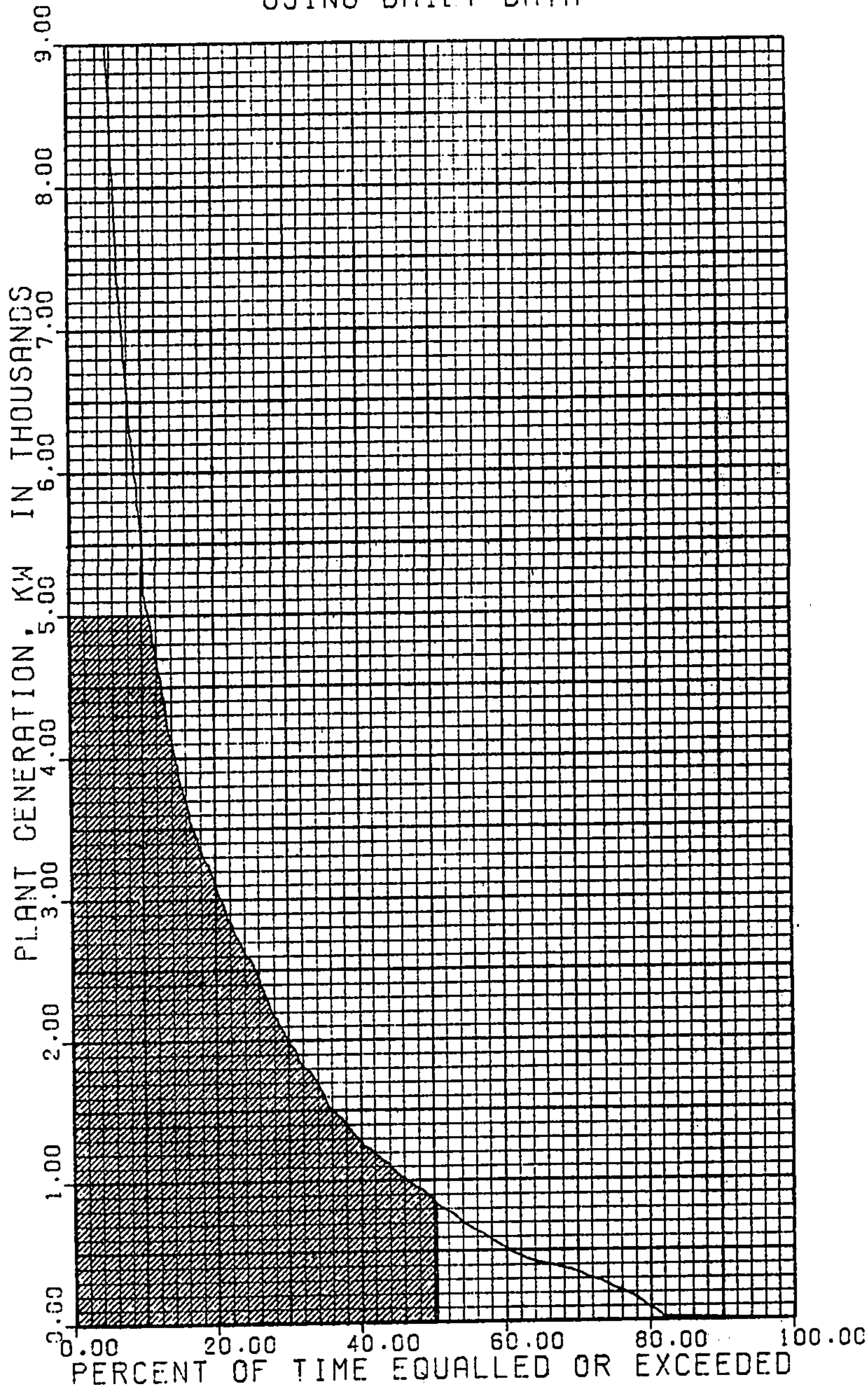
EXHIBIT A

POWER DURATION CURVES

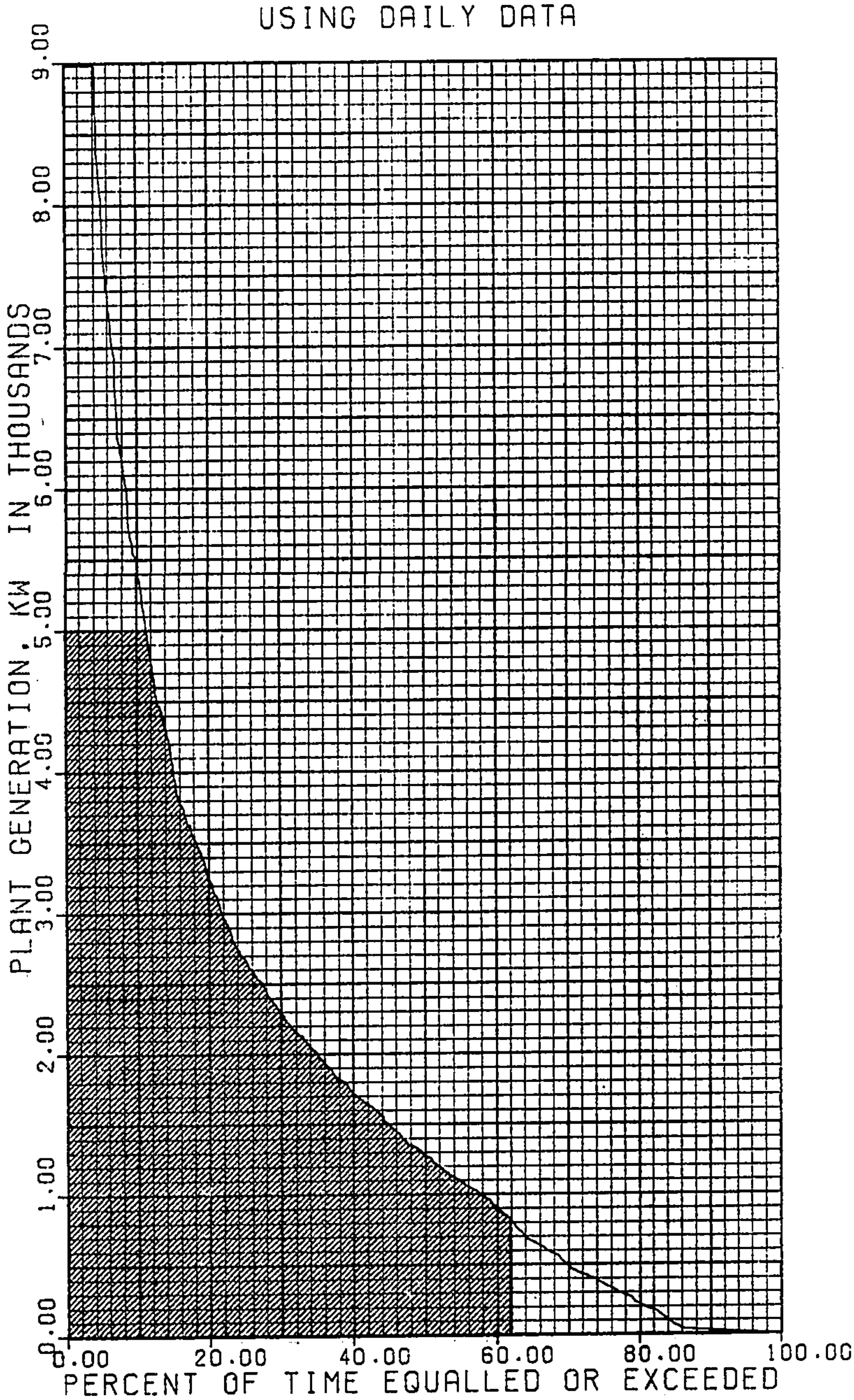
WAILUA -- KAUAI, HI (ALT. 1A)
POWER DURATION CURVE FOR JAN
USING DAILY DATA



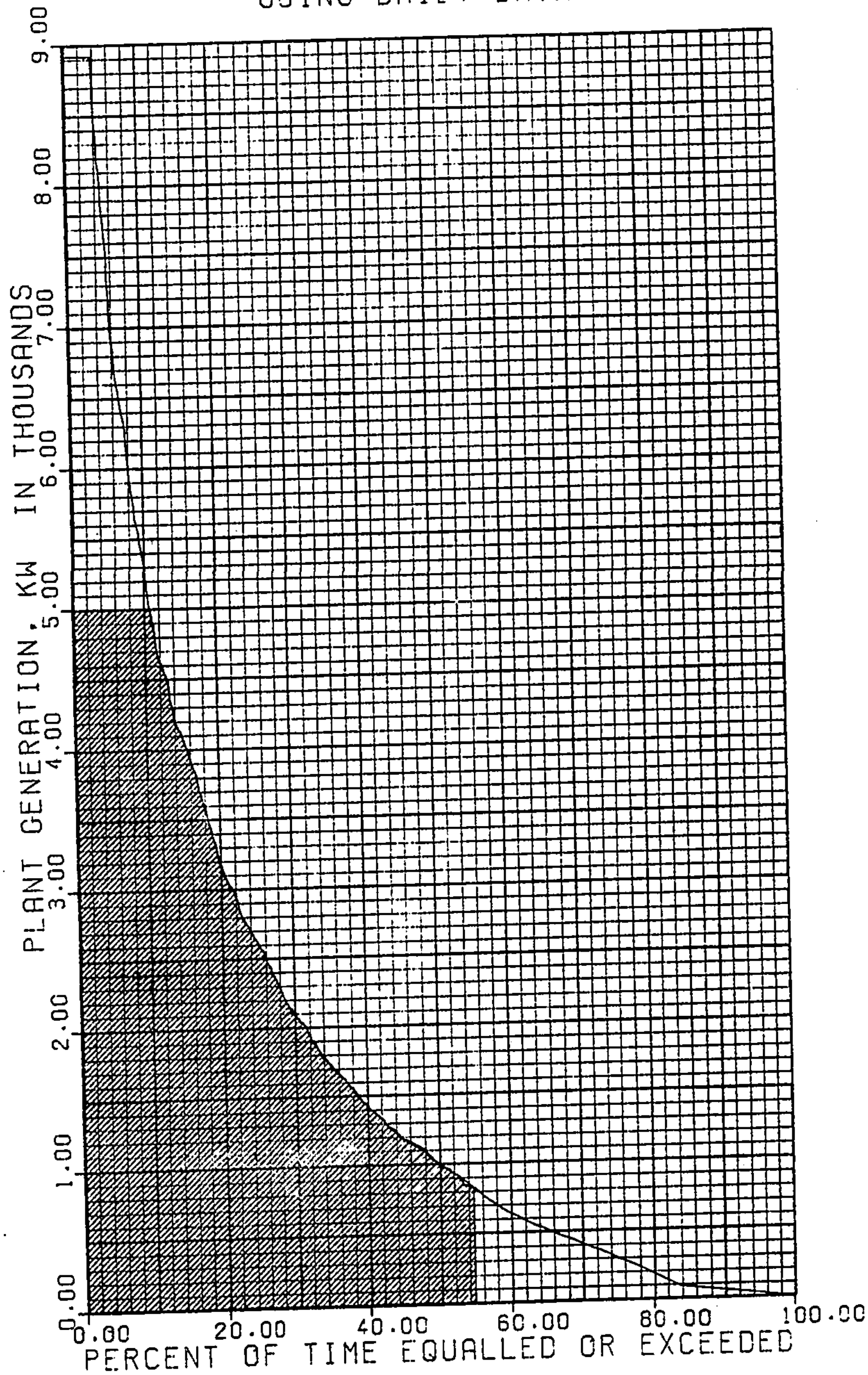
WAILUA -- KAUAI, HI (ALT. 1A)
POWER DURATION CURVE FOR FEB
USING DAILY DATA



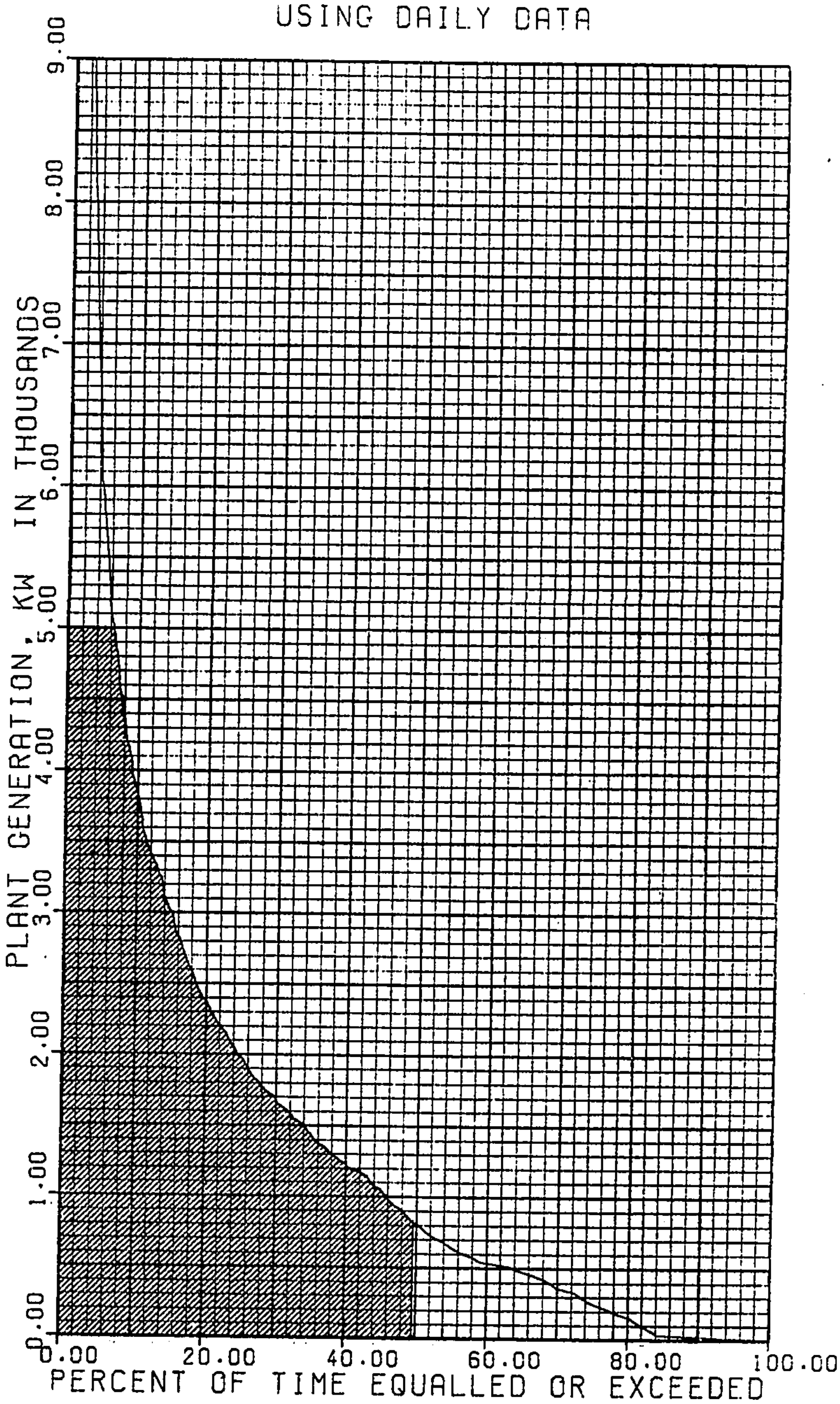
WAILUA -- KAUAI, HI (ALT. 1A)
POWER DURATION CURVE FOR MAR
USING DAILY DATA



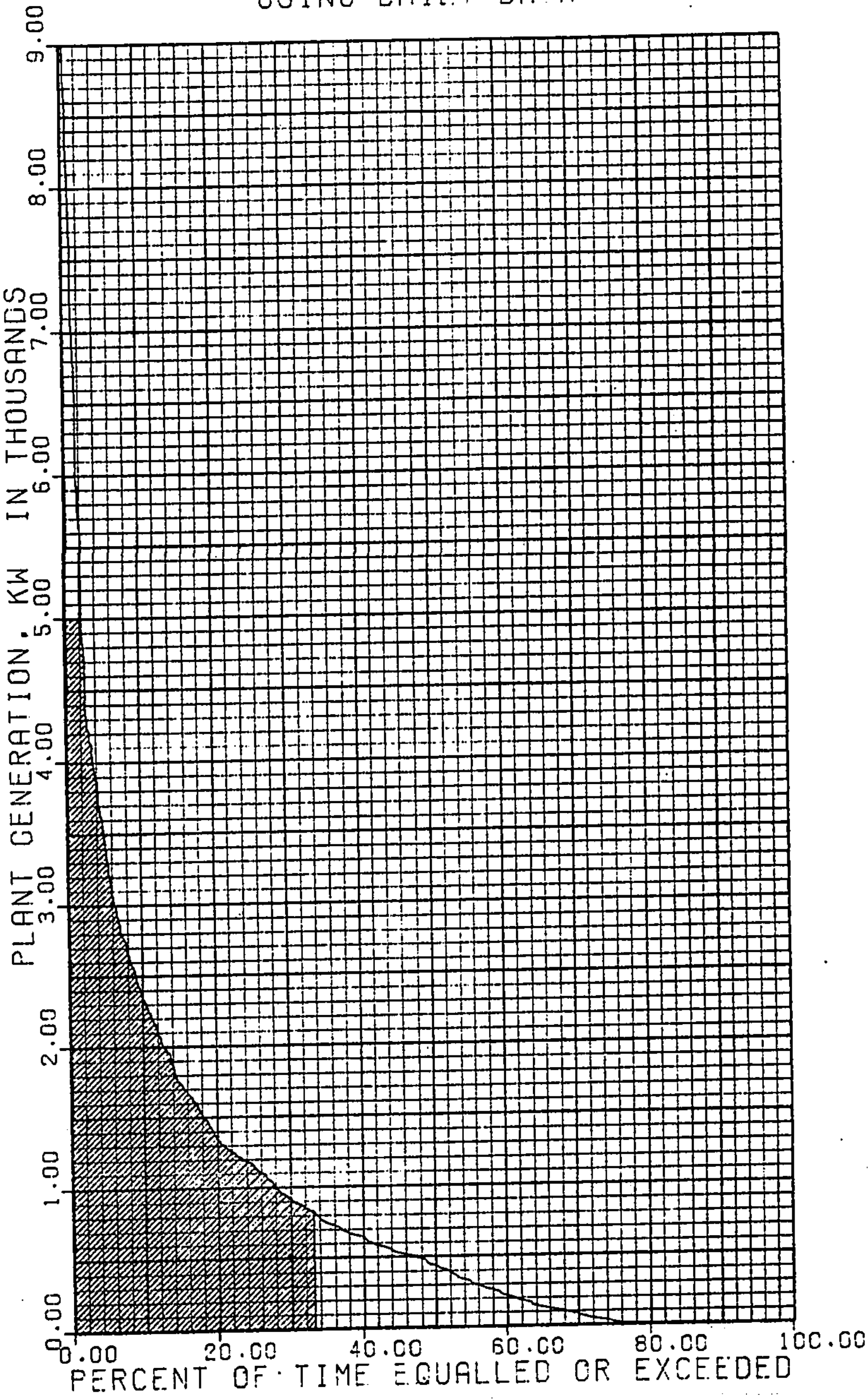
WAILUA -- KAUAI, HI (ALT. 1A)
POWER DURATION CURVE FOR APR
USING DAILY DATA

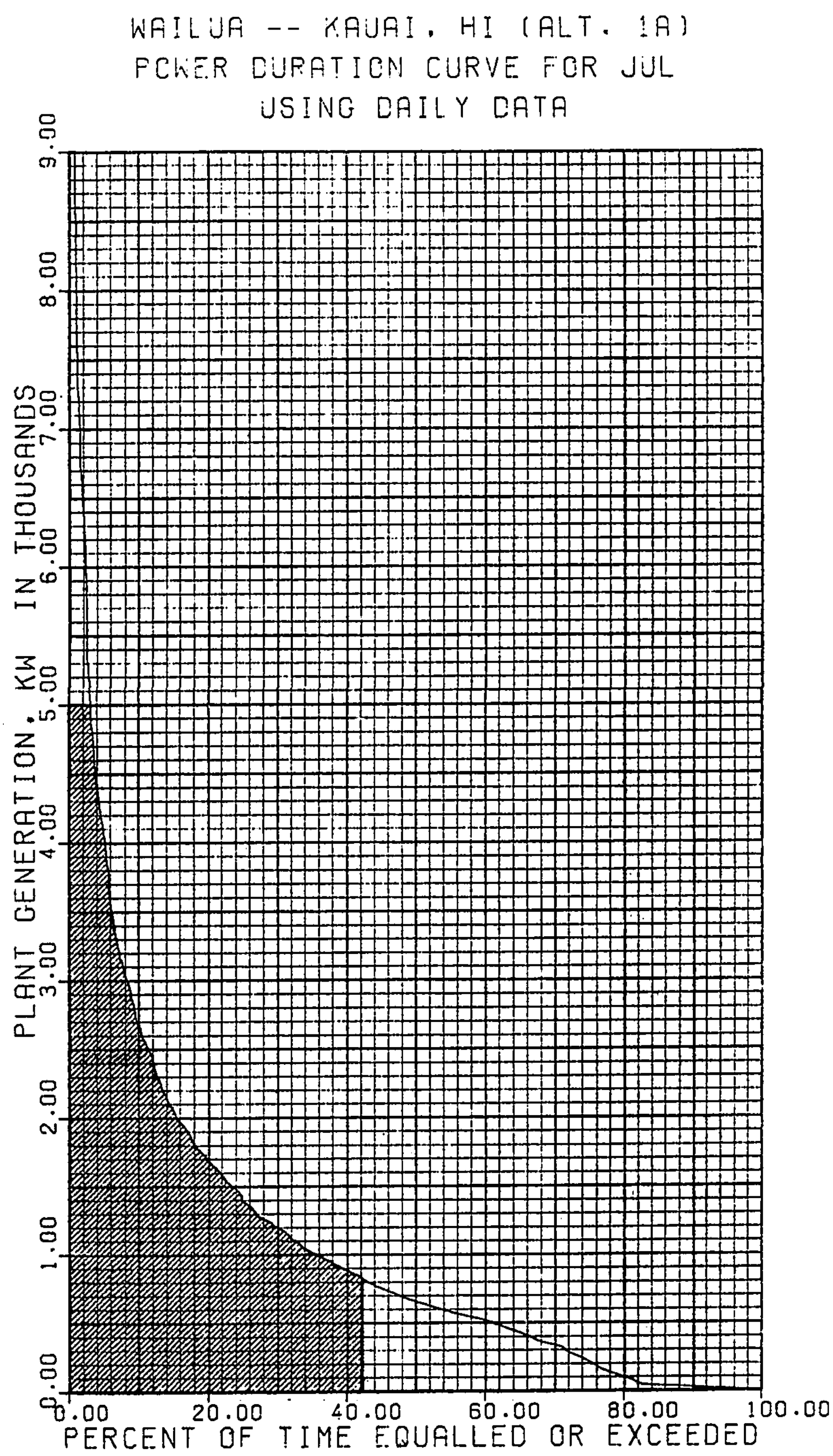


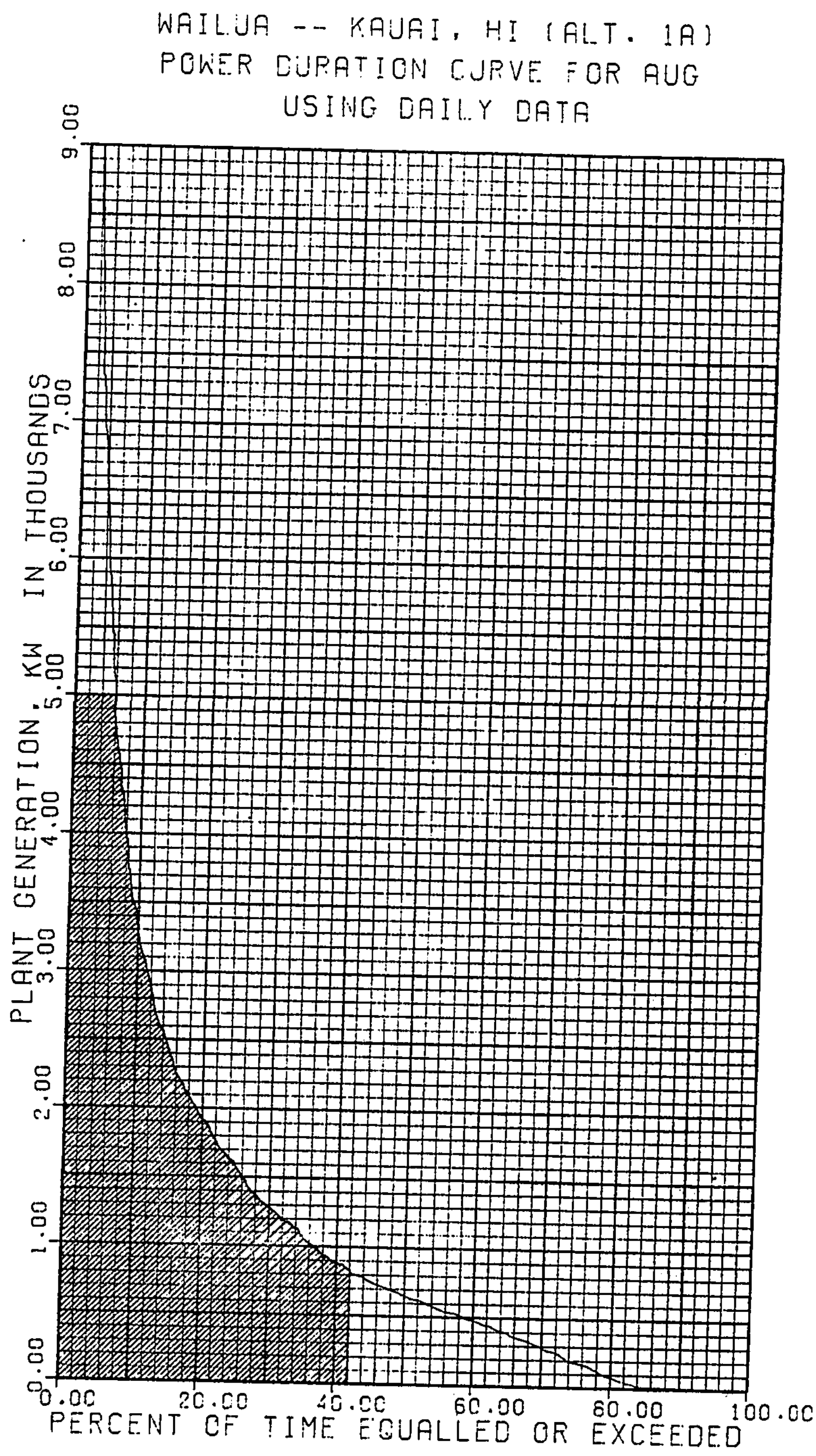
WAILUA -- KAUAI, HI (ALT. 1A)
POWER DURATION CURVE FOR MAY
USING DAILY DATA



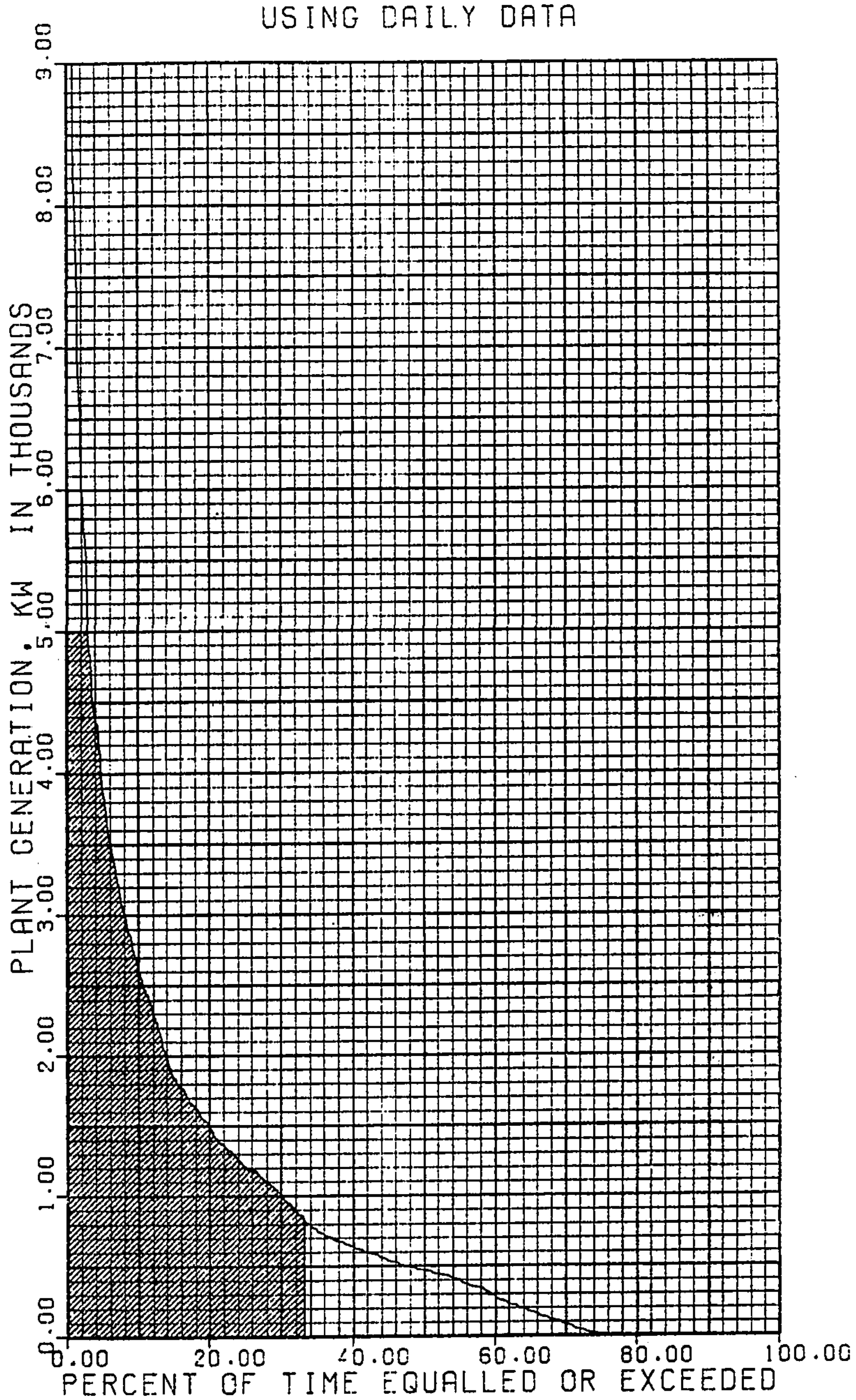
WAILUA -- KAUAI, HI (ALT. 1A)
POWER DURATION CURVE FOR JUN
USING DAILY DATA



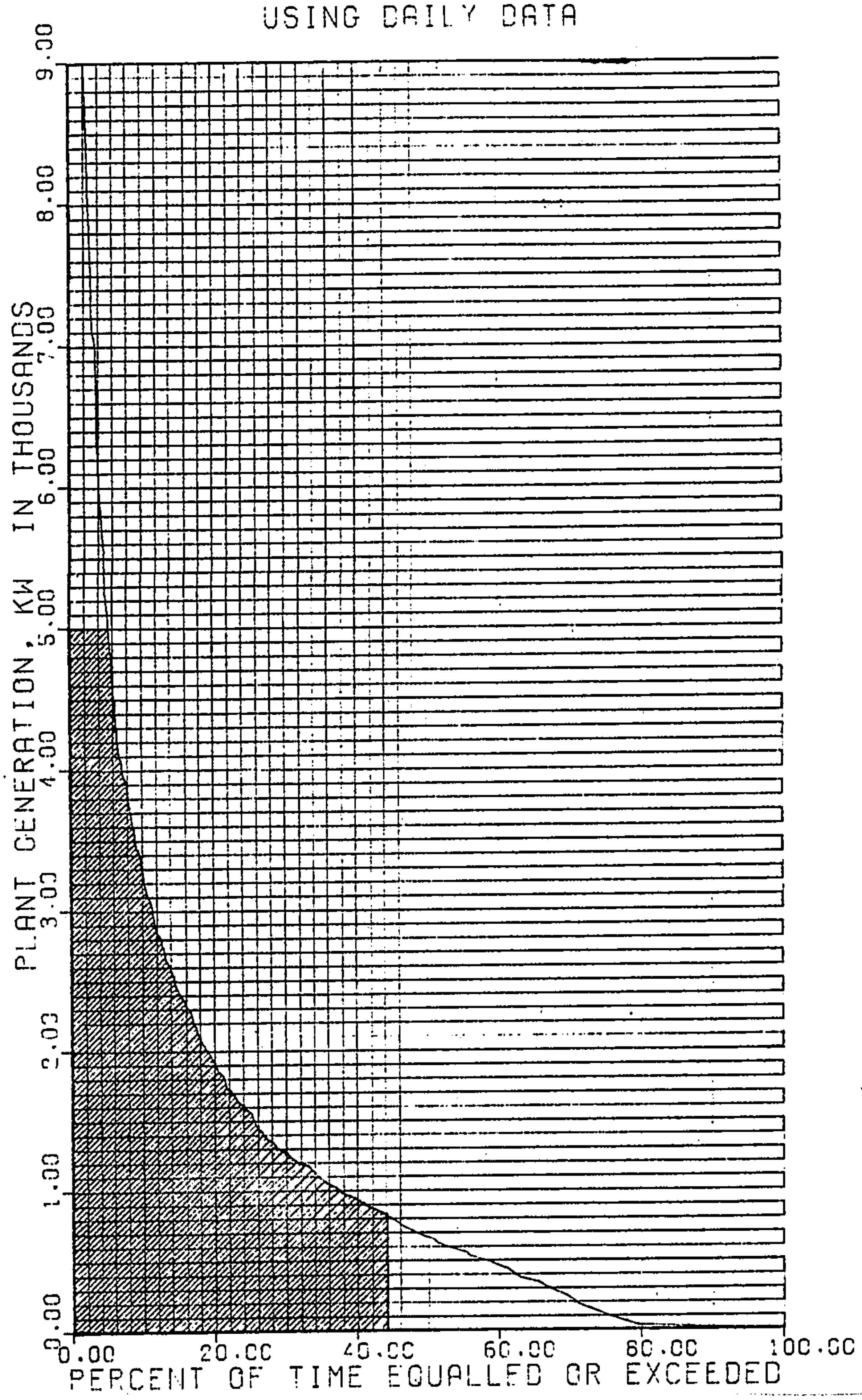

WAILUA -- KAUAI, HI (ALT. 1A)
POWER DURATION CURVE FOR JUL
USING DAILY DATA
PLANT GENERATION, KW IN THOUSANDS
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
0.00
20.00
40.00
60.00
80.00
100.00
PERCENT OF TIME EQUALLED OR EXCEEDED


WAILUA -- KAUAI, HI (ALT. 1A)
POWER DURATION CURVE FOR AUG
USING DAILY DATA
PLANT GENERATION, KW IN THOUSANDS
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
0.00
20.00
40.00
60.00
80.00
100.00
PERCENT OF TIME EQUALLED OR EXCEEDED

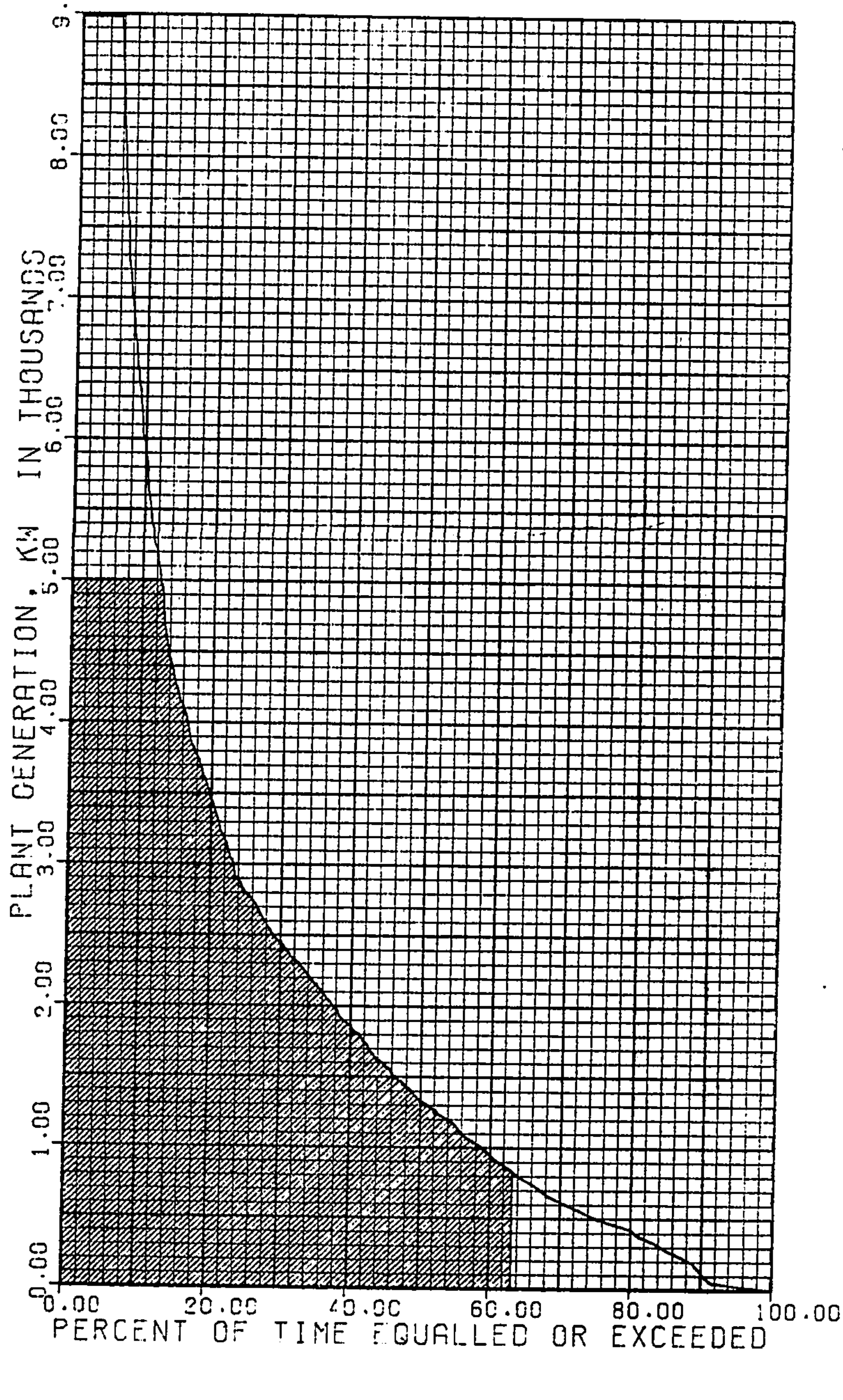
WAILUA -- KAUAI, HI (ALT. 1A)
POWER DURATION CURVE FOR SEP
USING DAILY DATA



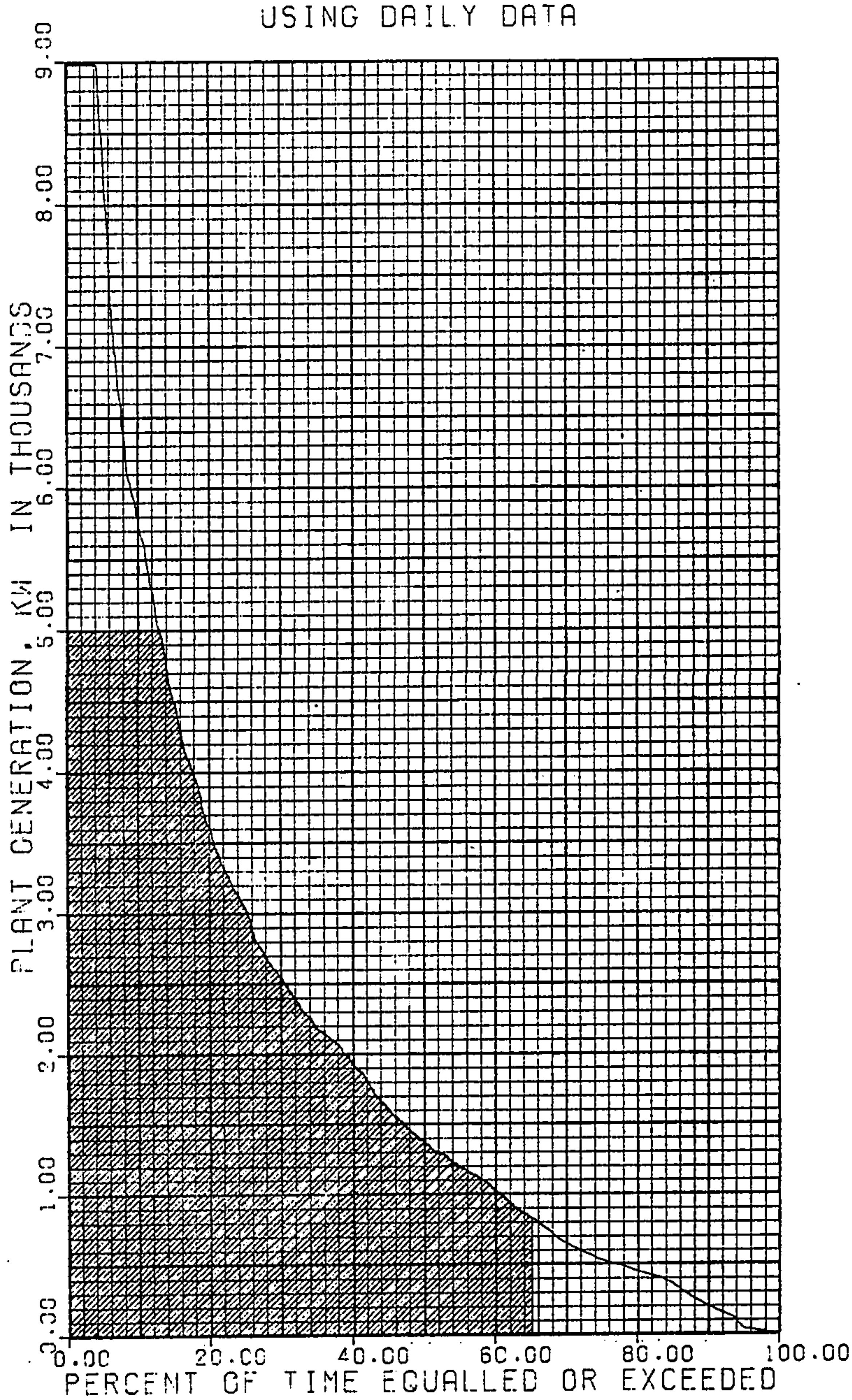
WAILUA -- KAUAI, HI (ALT. 1A)
POWER DURATION CURVE FOR OCT
USING DAILY DATA



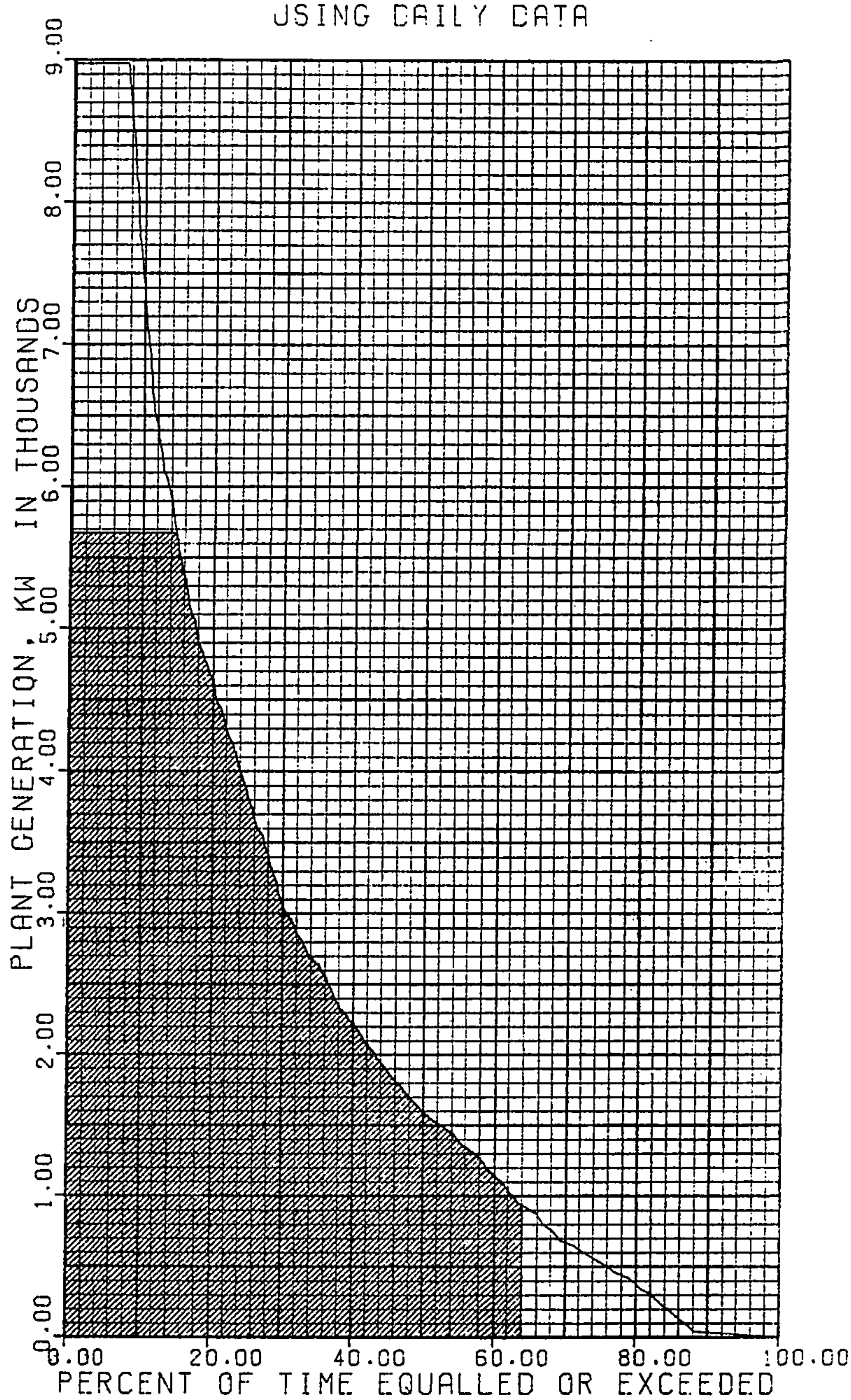
WAILUA -- KAUAI, HI (ALT. 1A)
POWER DURATION CURVE FOR NOV
USING DAILY DATA



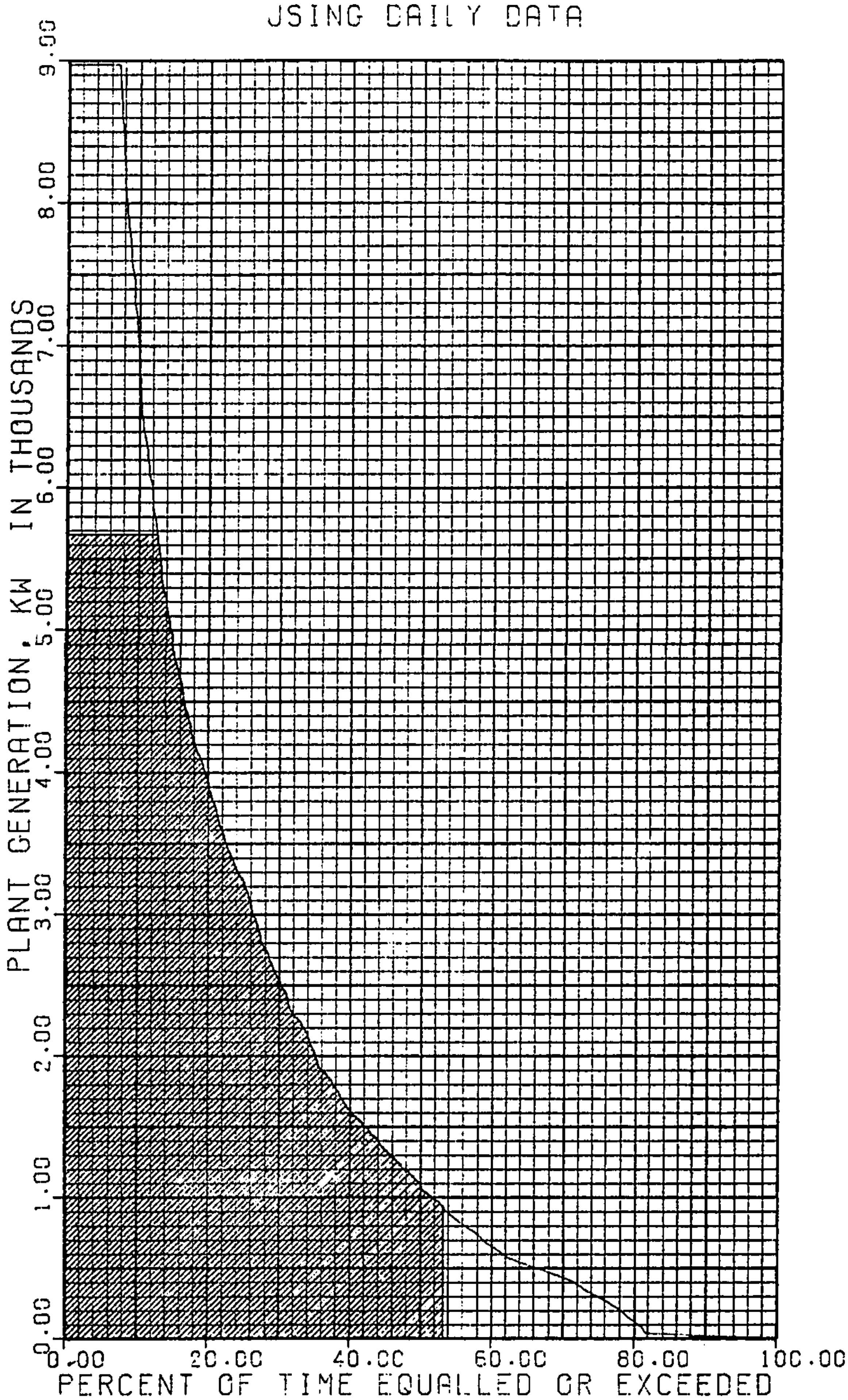
WAILUA -- KAUAI, HI (ALT. 1A)
POWER DURATION CURVE FOR DEC
USING DAILY DATA

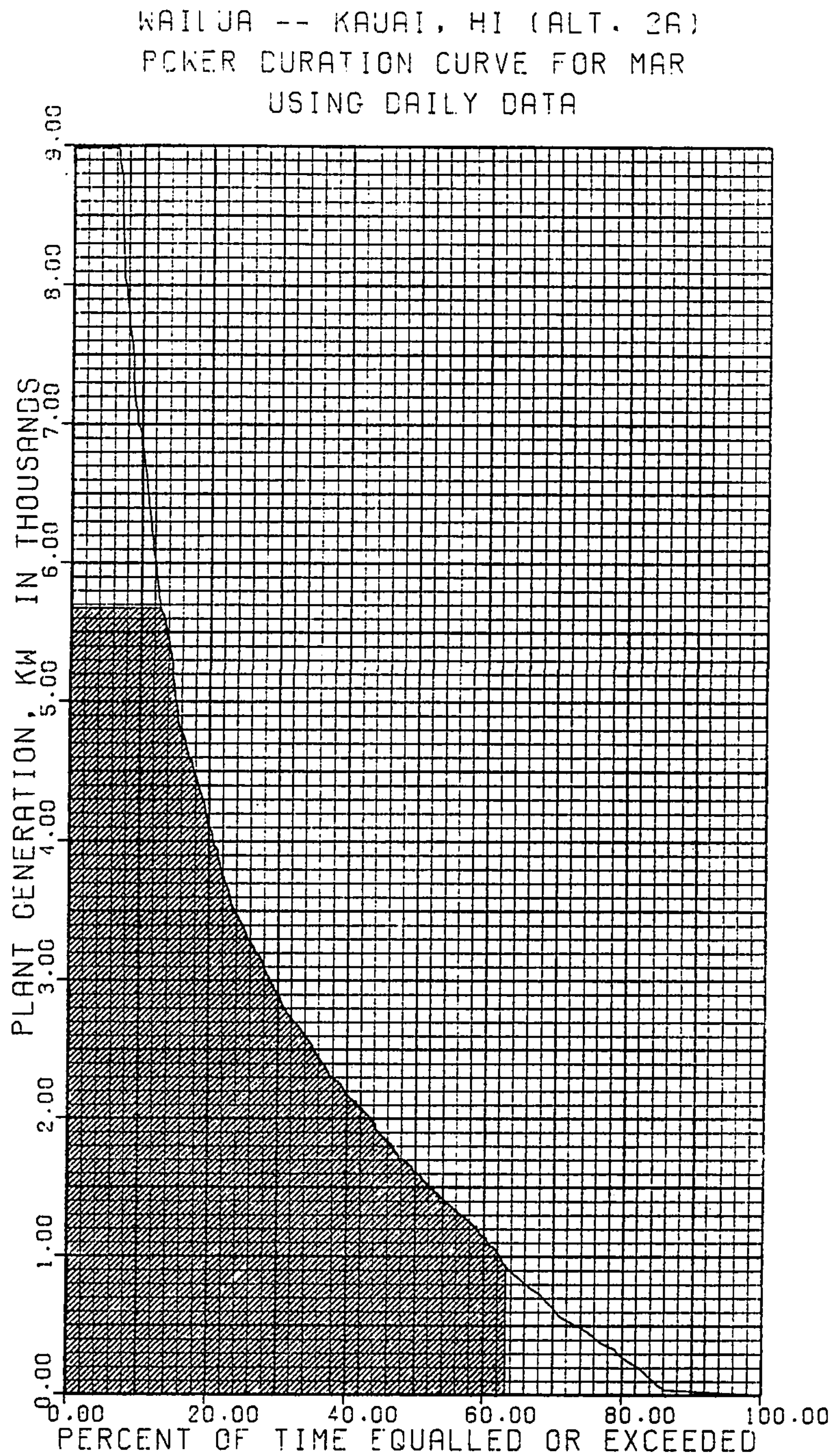


WAILUA -- KAUAI, HI (ALT. 2A)
POWER DURATION CURVE FOR JAN
USING DAILY DATA

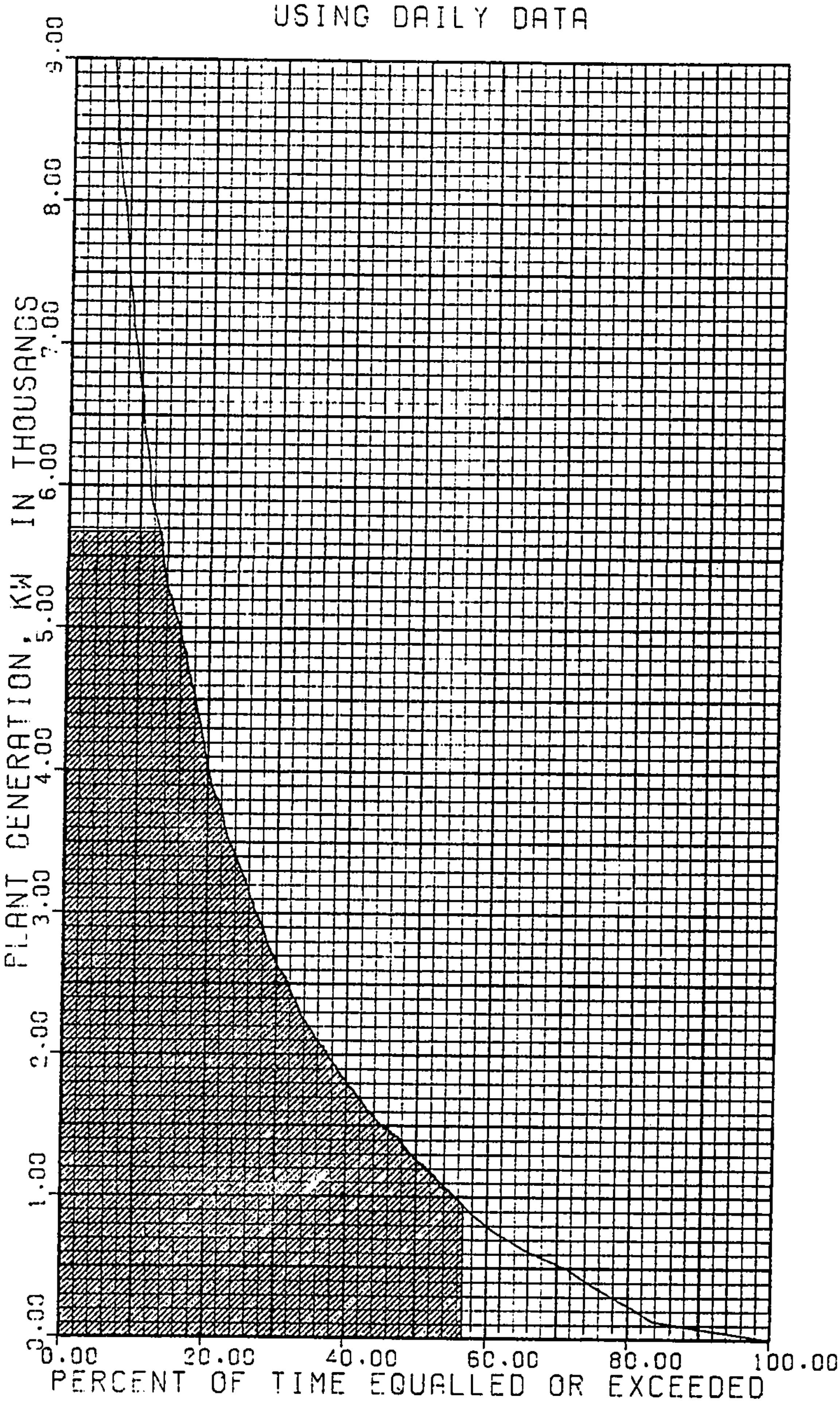


WAILUA -- KAUAI, HI (ALT. 2A)
POWER DURATION CURVE FOR FEB
USING DAILY DATA

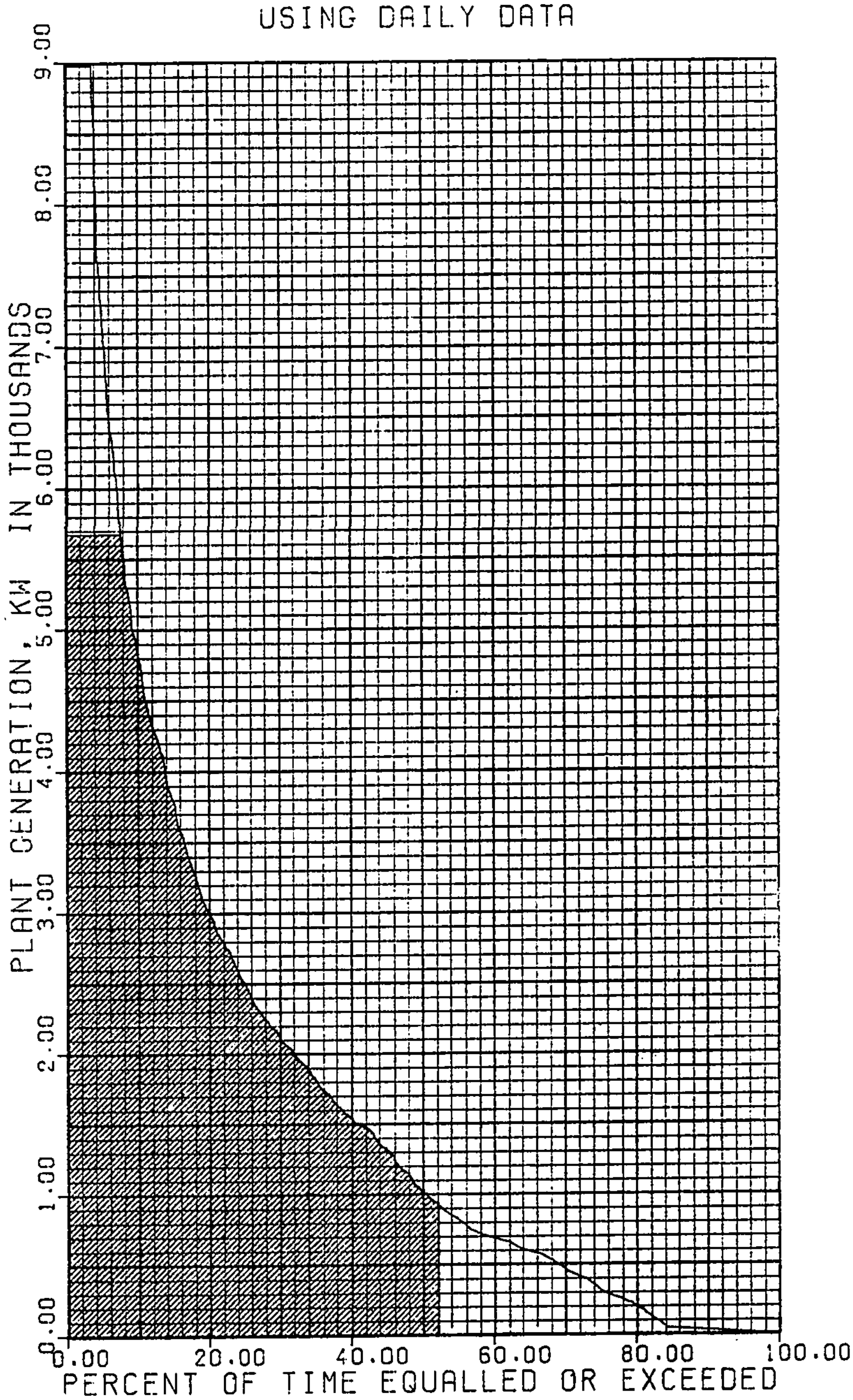



WAILUA -- KAUAI, HI (ALT. 2A)
POWER DURATION CURVE FOR MAR
USING DAILY DATA
PLANT GENERATION, KW IN THOUSANDS
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
0.00
20.00
40.00
60.00
80.00
100.00
PERCENT OF TIME EQUALLED OR EXCEEDED

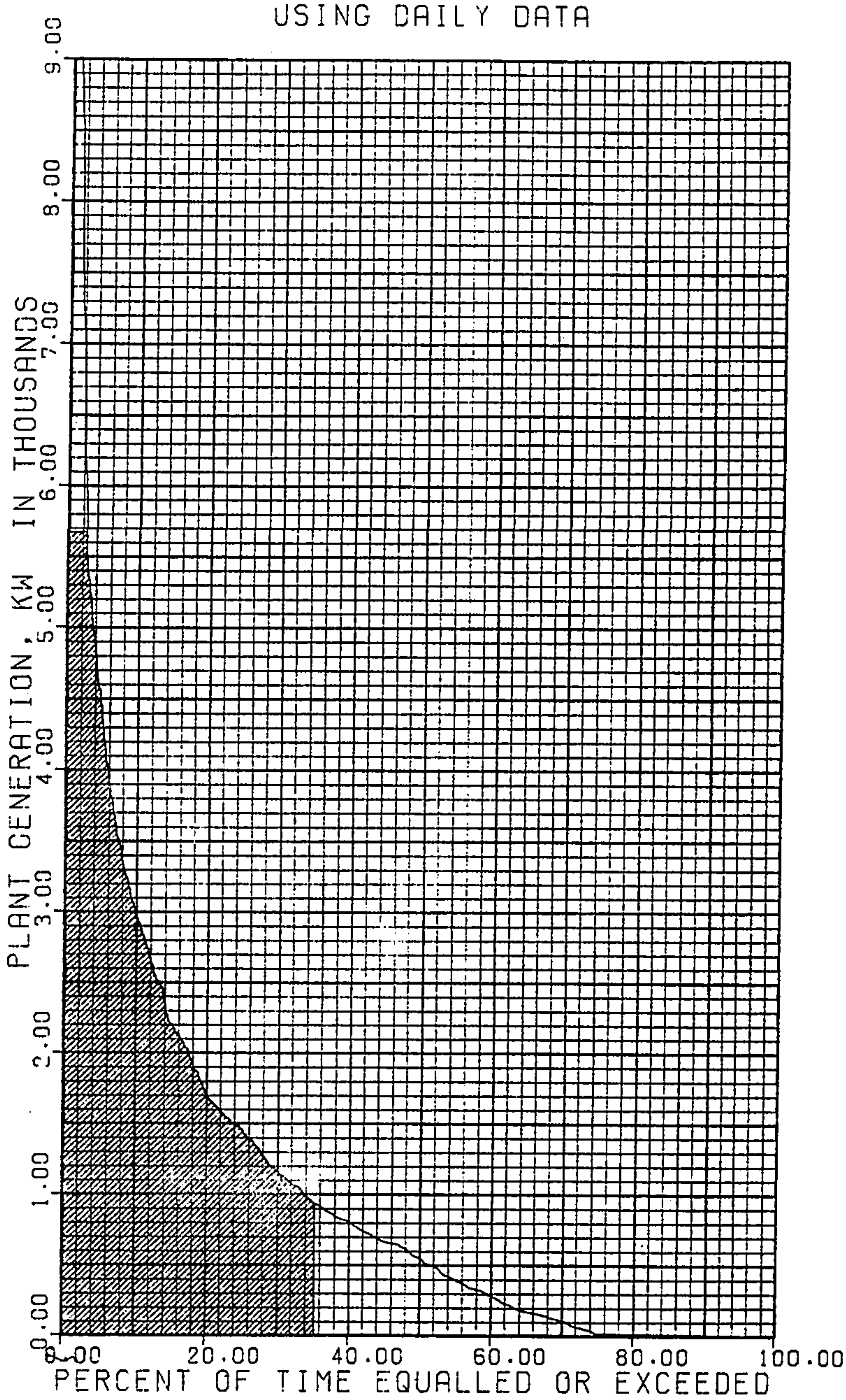
WAILUA -- KAUAI, HI (ALT. 2A)
POWER DURATION CURVE FOR APR
USING DAILY DATA



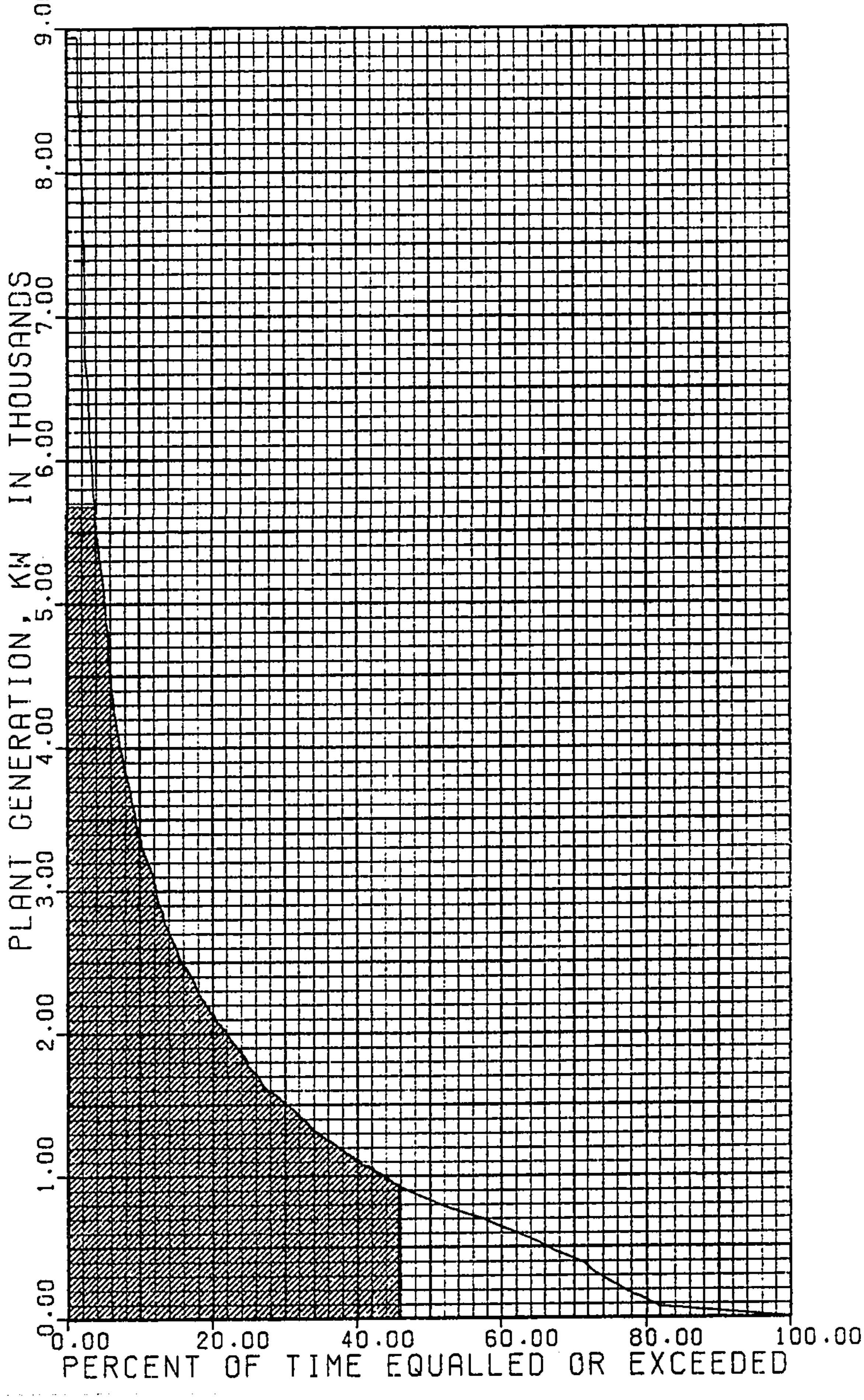
WAILUA -- KAUAI, HI (ALT. 2A)
POWER DURATION CURVE FOR MAY
USING DAILY DATA



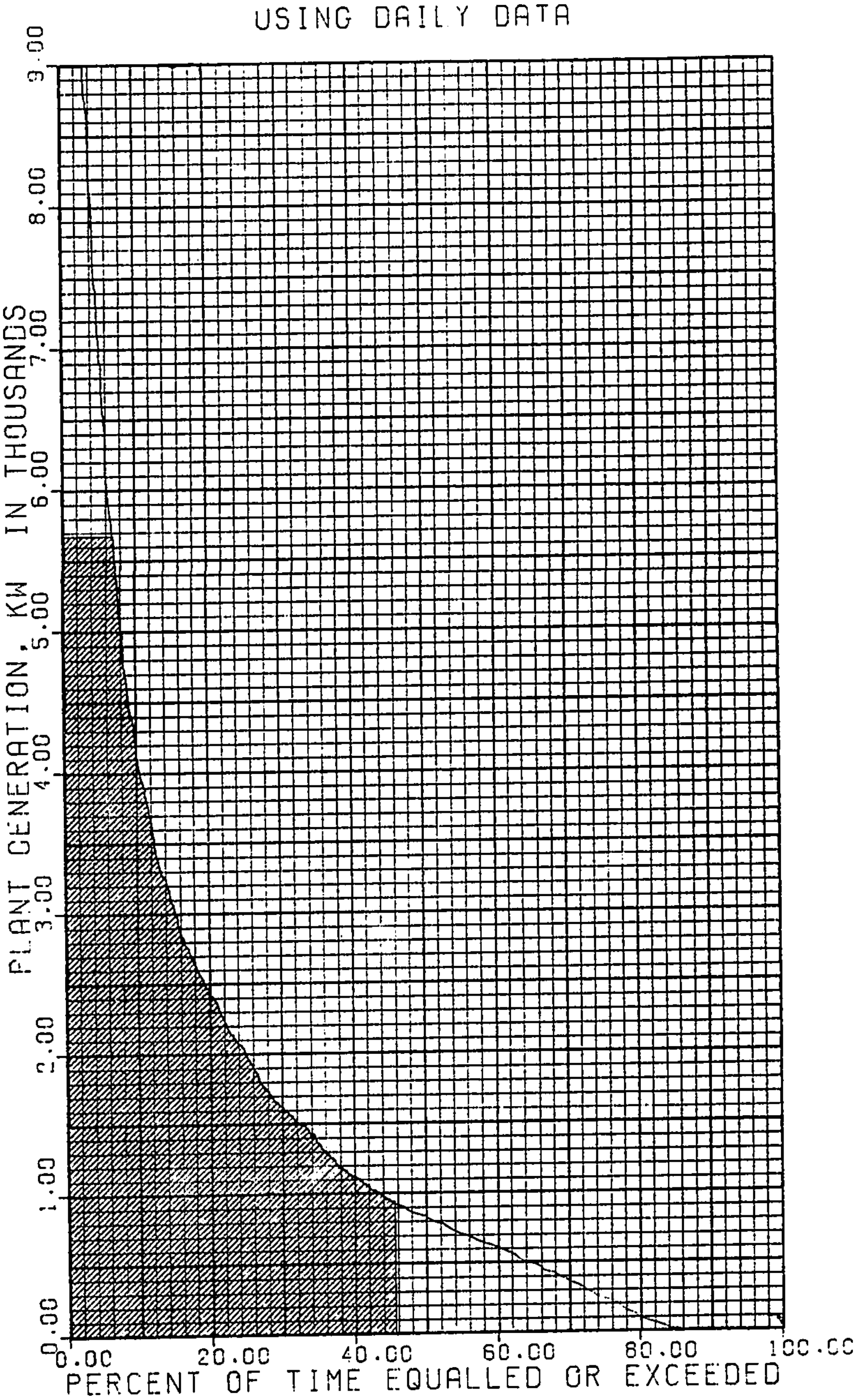
WAILUA -- KAUAI, HI (ALT. 2A)
POWER DURATION CURVE FOR JUN
USING DAILY DATA



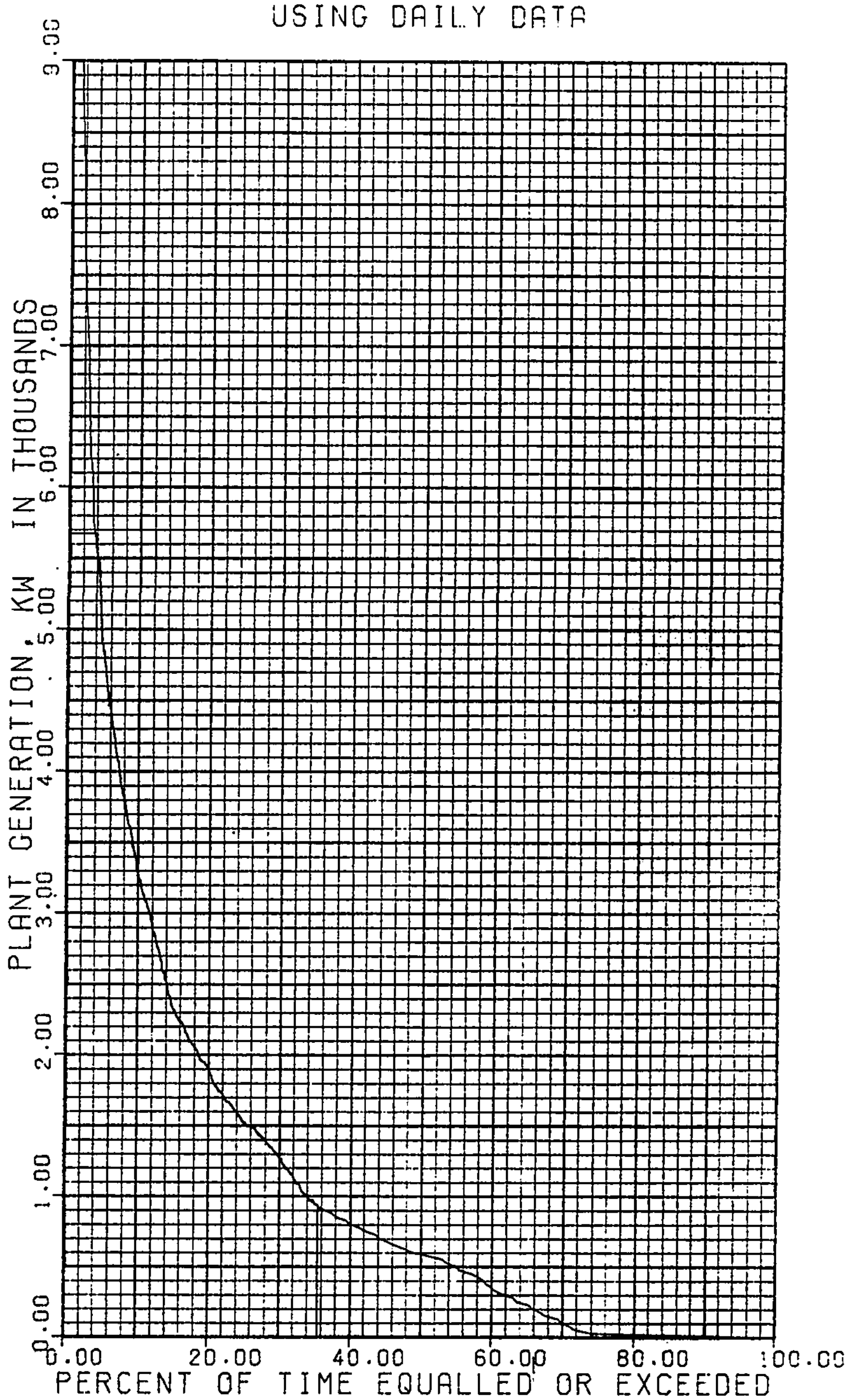
WAILUA -- KAUAI, HI (ALT. 2A)
POWER DURATION CURVE FOR JUL
USING DAILY DATA

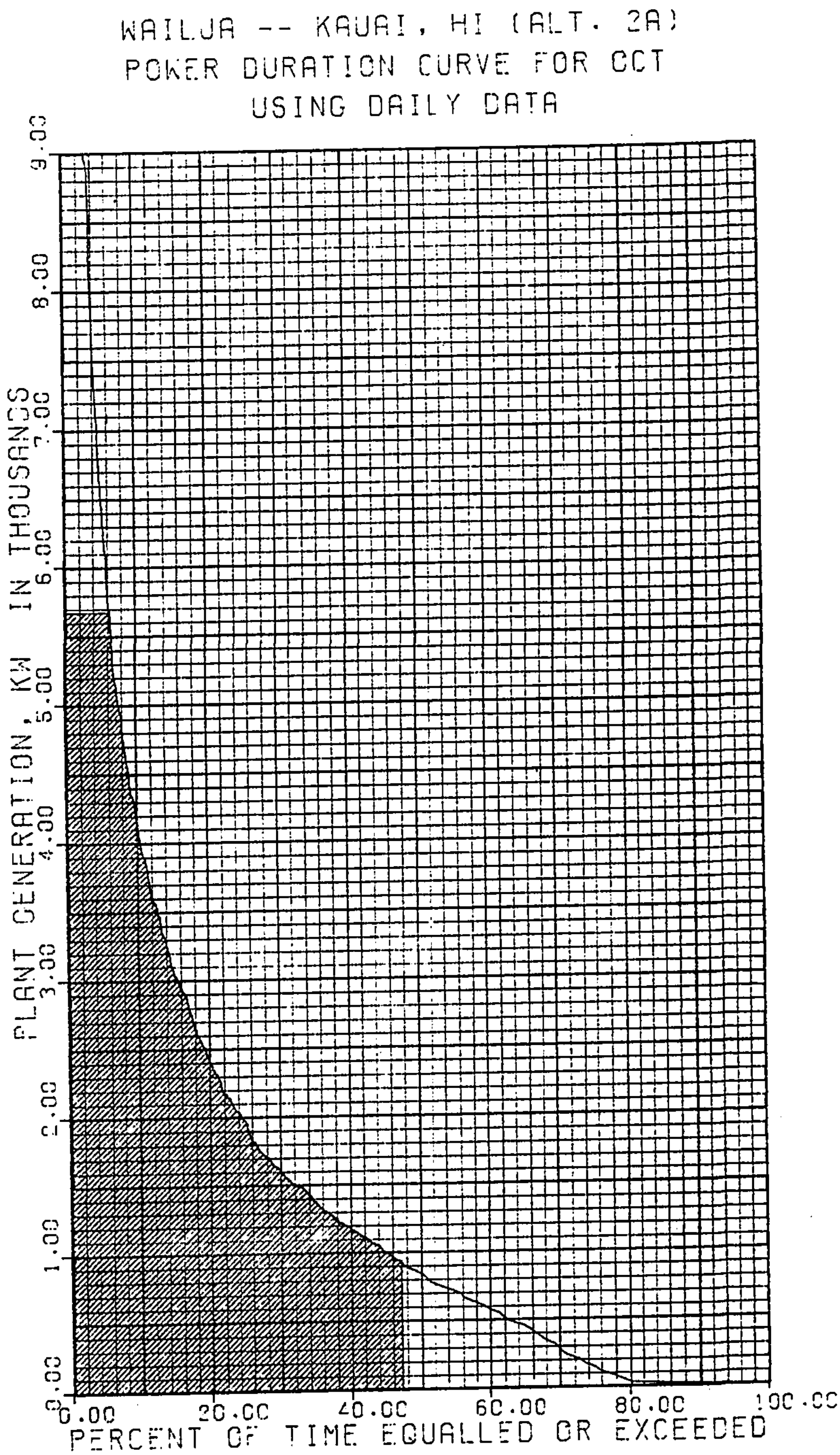


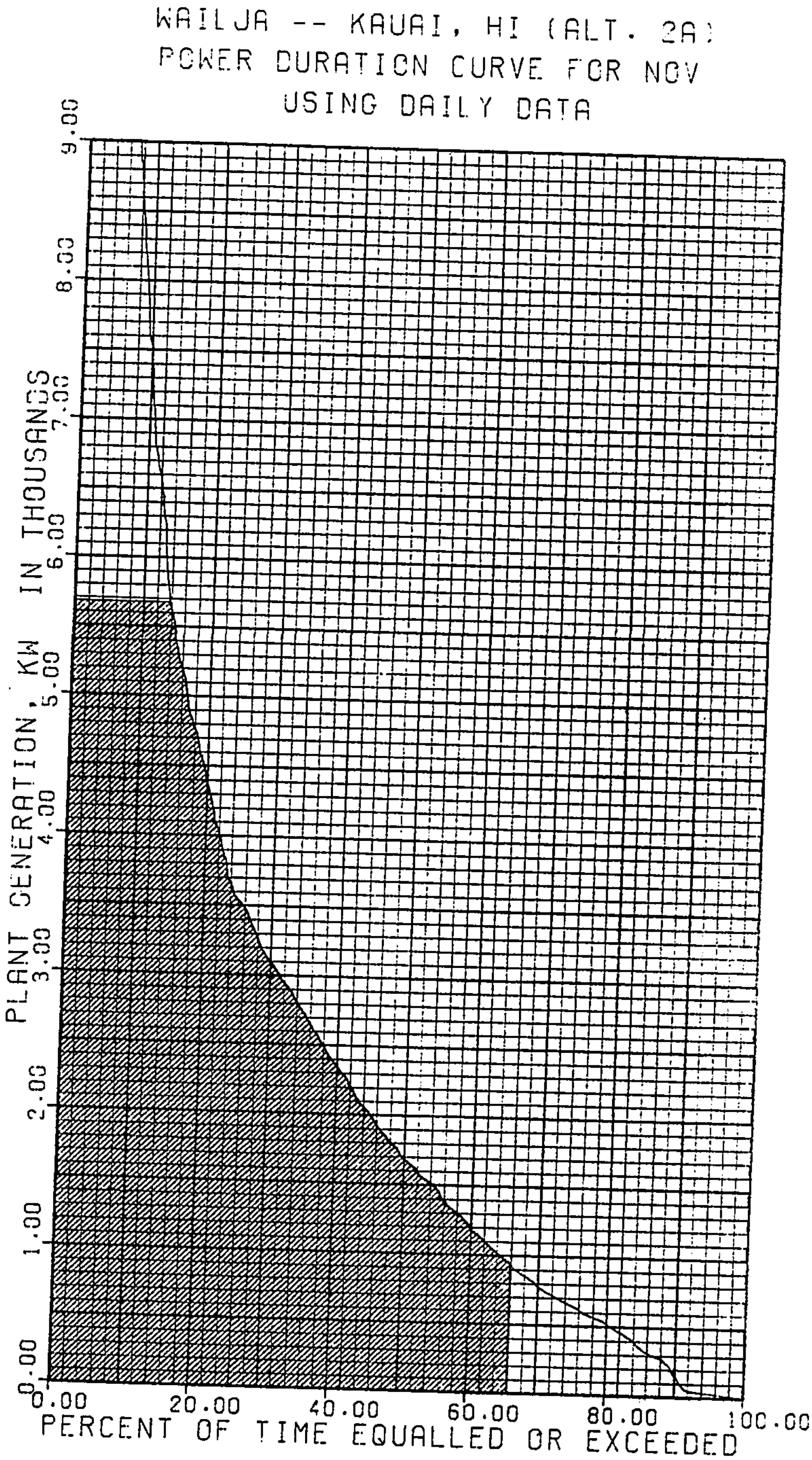
WAILUA -- KAUAI, HI (ALT. 2A)
POWER DURATION CURVE FOR AUG
USING DAILY DATA



WAILUA -- KAUAI, HI (ALT. 2A)
POWER DURATION CURVE FOR SEP
USING DAILY DATA




WAILUA -- KAUAI, HI (ALT. 2A)
POWER DURATION CURVE FOR CCT
USING DAILY DATA
PLANT GENERATION, KW IN THOUSANDS
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
0.00
20.00
40.00
60.00
80.00
100.00
PERCENT OF TIME EQUALLED OR EXCEEDED


WAILUA -- KAUAI, HI (ALT. 2A)
POWER DURATION CURVE FOR NOV
USING DAILY DATA
PLANT GENERATION, KW IN THOUSANDS
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
0.00
20.00
40.00
60.00
80.00
100.00
PERCENT OF TIME EQUALLED OR EXCEEDED

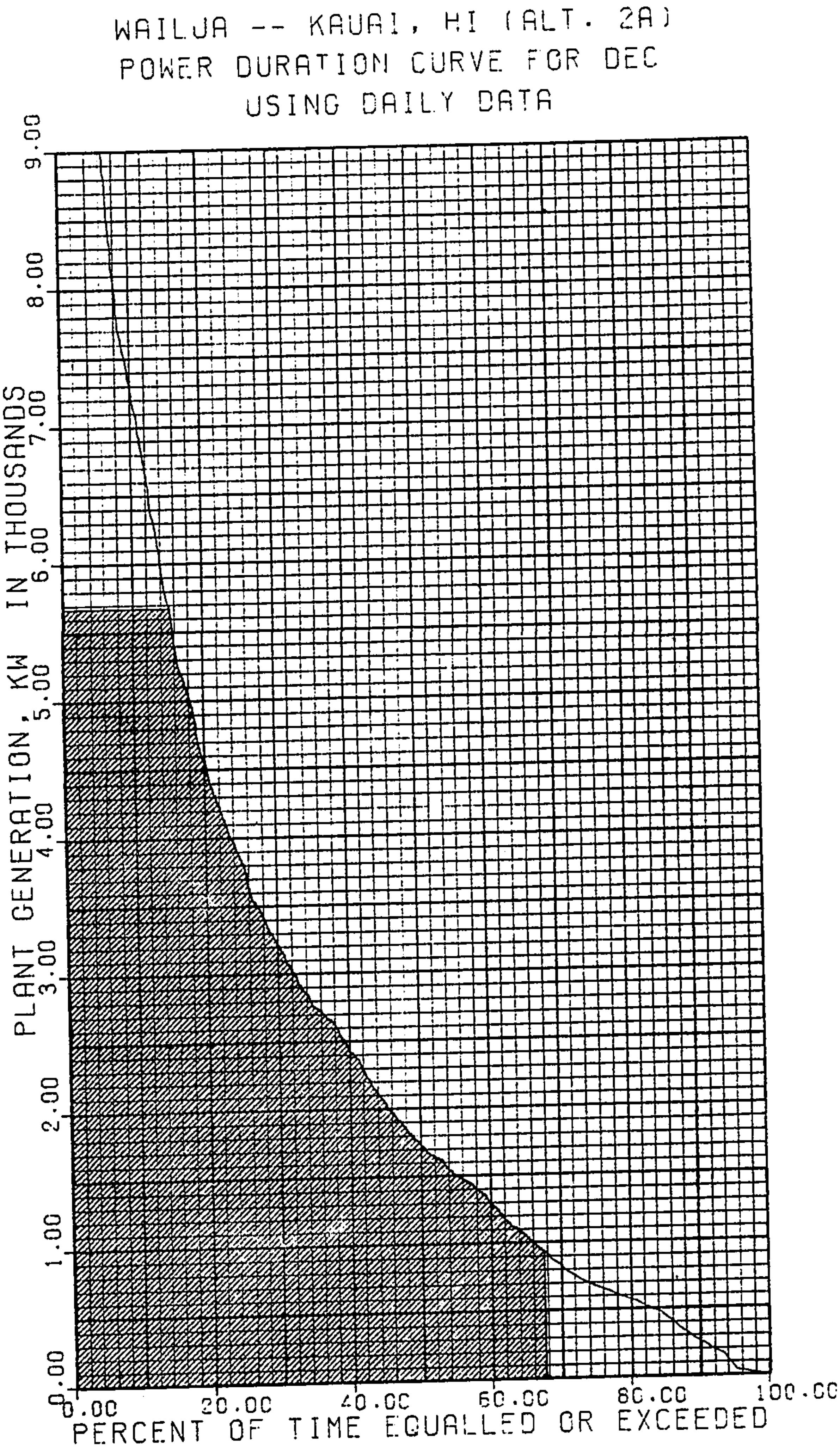

WAILUA -- KAUAI, HI (ALT. 2A)
POWER DURATION CURVE FOR DEC
USING DAILY DATA
PLANT GENERATION, KW IN THOUSANDS
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
0.00
20.00
40.00
60.00
80.00
100.00
PERCENT OF TIME EQUALLED OR EXCEEDED

EXHIBIT B

PERTINENT DATA AND CORRESPONDENCE

FEDERAL ENERGY REGULATORY COMMISSION
333 MARKET STREET, 6th FLOOR
SAN FRANCISCO, CA. 94105

May 11, 1982

COPY

Mr. Kisuk Cheung
Chief, Engineering Division
U.S. Army Engineer District, Honolulu
Ft. Shafter, Hawaii 96858

Dear Mr. Cheung:

As requested in your letter of February 10, 1982 (PODED-PJ), we have updated the estimated power values for your use in evaluating the economic feasibility of the Wailua River Hydropower Project, Kauai, Hawaii.

The most likely near-term plant additions would either be an additional bagasse-burning steam plant or conversion of existing gas turbines to combined cycle operation, depending upon developments in the sugar industry. However, our system analysis indicates the hydropower project would operate most beneficially as displacement energy for the existing system. The Kauai Electric Division system plant loadings are determined by a computer dispatching system to achieve lowest overall operating costs. Generally, changes in load are accommodated by output changes on several generators. The actual value of the displaced energy will be the weighted average of incremental energy costs for all of the affected machines.

Based upon January 1982 price levels, a project-on-line (POL) date of 1990, and projected escalation of real fuel costs, the system energy displacement value is estimated to be 79 mills per kilowatthour. This value may be used for both 7-5/8% and 7-7/8% discount rates because the difference is lost in rounding to 79 mills. Assuming a POL date of 1995, the system energy displacement value would increase to 87 mills/kWh. Relative fuel cost escalation follows the procedures recommended in the Water Resources Council publication "Implementing Procedures for Evaluating Hydroelectric Benefits," of December 1981. These total values are not influenced by the potential hydroelectric plant's capacity factor or dependable capacity.

As you know, the above values should be applied to the average annual energy output of each alternative and are applicable for National Economic Development power benefit evaluation purposes. Please advise us if additional information is required.

Sincerely,

WILLIAM F. KOPFLER II

W. F. Kopfler, II
Regional Engineer

Copy to Corps of Engineers, NPD, Portland, OR
" " WAPA, Sacramento, CA

WAILUA RIVER HYDROPOWER PROJECT
KAUAI, HAWAII

GEOTECHNICAL INVESTIGATIONS

APPENDIX D

APPENDIX D

GEOTECHNICAL INVESTIGATIONS

TABLE OF CONTENTS

LIST OF PLATES

GEOTECHNICAL INVESTIGATIONS

REGIONAL GEOLOGY

1. Kauai was formed by the activity of one large shield-shaped volcano. Toward the end of the growth of the shield, its summit and east flank collapsed and formed a broad depression or caldera known as the Lihue depression. Subsequent faulting and lava filling caused other collapses on the mountain. The rim of the depression or basin is formed by the Haupu Ridge on the south, the main mountain mass of central Kauai on the west, the Makaleha mountains on the north, and Nonou and Kalepa Ridges on the east. The basin rim consists of rocks of the Waimea Canyon Volcanic Series. These rocks are 5 to 6 million years old (Pliocene geologic age) and comprise the bulk of the island volcano. After the completion of the great Kauai shield and collapse of its summit, volcanic activity ceased and a long period of erosion formed thick soil over much of the mountain. Then, a new period of volcanism began that rests on the erosional unconformity. The eruptions occurred from a series of about 40 minor vents forming cinder cones, one tuff cone, and some lava cones. This period of volcanism is known as the Koloa Volcanic Series. The Lihue depression floor was buried under the later flows of the Koloa volcanics which are estimated to be one to 1-1/2 million years old (late Pliocene to Pleistocene geologic age). The present basin floor is made of younger lava basalts, mudflows, and thick alluvium from the decay of basalt and accumulation of saprolitic and lateritic rock-soil mixtures. Just before and during eruptions of the Koloa volcanics, landslides and mudflows brought down large amounts of debris and soils from the steep slopes of the central uplands. The Nonou and Kalepa Ridges and Aahoaka hills are steptoes or islands of older Waimea volcanics protruding through much younger lava flows of the Koloa volcanic series. The three conspicuous landforms influenced stream alignment and drainage in the basin. The north and south forks of the Wailua River join at the water gap between Nonou and Kalepa Ridges.

2. The Wailua River Basin and Wailua Falls (site of proposed facility) are located almost entirely within the Lihue depression. The surface geology in the vicinity of the falls is shown on the "Geologic Map," Plate D-1. It shows the land around the falls to consist of late Pliocene to Pleistocene lava flows of nepheline basalt, melilite-nepheline basalt, olivine basalt, picrite-basalt and basanite of the Palikea Formation. These lava basalts are in contact with and perhaps overlain by Pleistocene non-calcareous alluvial sediments (also of the Palikea Formation). Younger (recent-geologic age) unconsolidated, non-calcareous, alluvial sediments have been deposited along the channel of the Wailua River on both sides of the falls.

GEOTECHNICAL SITE CONDITIONS

3. Wailua Falls is located on the South Fork of the Wailua River approximately 2.5 miles upstream of the confluence of the north and south forks. The topography of the basin (ground surface) at the site is characterized by a low (elev. 275 feet to 325 feet msl) rolling terrain. The South Fork has cut approximately 250 feet into the basin surface downstream from the falls. Above the falls, the river has eroded about 50 feet below the basin surface. The erosion resulted in steep to vertical blocky cliffs along the river below the falls and comparatively gentle bank slopes in overburden above the falls. From its headwaters, the South Fork flows east but is diverted south by Aahoaka Hill at a distance of 2,000 feet north of the falls. The flow resumes an easterly to northeasterly direction approximately

2,500 feet below the falls. All bank slopes along the river are heavily vegetated with trees, brush, and other tropical plants. The rolling terrain of the basin surface on each side of the river is cultivated for sugarcane and traversed by unpaved haul roads.

SUBSURFACE INVESTIGATIONS

4. Subsurface materials along the proposed conduit alignments were explored on a preliminary basis with seven borings from 7 December 1981 to 31 December 1981. Locations of borings and a subsurface profile are shown on the "Boring Location Plan," Plate D-2 and "Profile of Borings," Plates D-3 and D-4, respectively.

The borings show massive lava basalt lying 35 to 50 feet below the ground surface in all borings except numbers 6 and 7. Lava basalt is overlain by alluvial/colluvial soils consisting of silts, clays, and gravel to cobble size pieces of basalt. In borings 6 and 7, massive lava basalt was not encountered and depths to rock were not determined. Additionally, the lava basalts in hole #5 are found intercalated with layers or zones of soil. Localized perched water was found at depths of 20 to 30 feet below the ground surface in boring numbers 1, 3, and 4.

SUBSURFACE CONDITIONS

6. Silts predominate the overburden materials. Resistance to standard penetration testing (SPT) indicates the silt to be of medium stiff to stiff consistency above the groundwater elevation. Below the perched water table, silts are considerably more penetrable with a consistency of soft to medium stiff. Frequent partially to wholly decomposed basalt rock fragments (gravels to cobbles) within these silts often demonstrate greater resistance to SPT.

7. Ten to 20-foot thick zones of basalt gravel and cobbles in a silt-clay matrix were encountered at or near the top of the lava basalt in boring numbers 1, 2, and 3. The top of a gravel zone was also encountered at a depth of 80 feet in hole #5. The basalt fragments vary in size from 3/8" diameter gravel to 12" diameter cobbles and are randomly graded (well to poor) and rounded (angular to round). These rock fragments also vary in stage of decomposition from unweathered to completely decomposed. These zones could not be effectively penetrated and sampled by SPT, and required coring. Core recovery in these zones was generally poor, ranging from 0 to 60 percent. The fine grain materials in these zones consist of a soft, reddish brown, plastic, clayey silt.

8. Although nearly all overburden is alluvial, some gravel and cobble materials directly overlying the lava basalt appear to be saprolitic (weathered in place). Several SPT samples displayed obvious rock structure suggesting that a portion of the overburden is a residual soil weathered from the basalt. The physical characteristics of overburden materials are treated in further detail in following paragraphs on laboratory testing.

9. The flow of solidified lava basalt appears continuous across borings 1 through 4. It is not known if the basalt found in boring 5 is an extension (or part) of the flow lavas around the falls. Although it appears similar in physical characteristics, it differs because it is found at higher elevations

and, as mentioned earlier, is intercalated with and underlain by soils. The stratigraphic profile "Rock Face Profile Sketch," Plate D-5 shows that, at the falls, the massive basalt extends in depth approximately to elevation 170 feet. The massive basalt layer is 80 to 100 feet thick. No lava basalt was found in borings 6 and 7. The proximity of boring 6 to the slope down to the Wailua River may account for its lack of lava basalt to the depth of boring. The slope of a wide floodplain (as the Wailua) receives more alluvial deposit than the plateau above it. Boring 7, which is located within the Wailua River floodplain, was also filled with alluvial deposit. The lava basalt at the site is massive, bluish-gray, hard, and vesicular. It is moderately fractured and exhibits a columnar fracture pattern in the vertical outcrops at the falls. With depth, vesicles are less frequent and smaller. Vugs, up to several inches in diameter and possibly larger, appear more frequent with depth. Some of the vesicles and smaller vugs are filled with a soft, white, sugar-textured quartzitic (silica) precipitate and larger vugs sometimes contain quartz crystals up to 0.5-inch in length. The rock in boring 5 is less massive than the basalt in the holes near the falls. Fractures and joints in rock contain little or no filling and may transmit water easily. Infrequent water losses during drilling and the presence of a high perched water table suggests the lava basalt layer is saturated. The rock is generally unweathered with fracture and joint surfaces showing only slight weathering. Sometimes the joints are partially filled with white quartzitic precipitate.

SEISMICITY

10. Practically all earthquakes of the Hawaiian Islands are associated with intermittent volcanic activity. Potential earthquakes on Kauai can be caused by deep-seated tectonic forces and not from the indirect action of volcanic activity. Recent explorations by geophysical methods show that faults and rift zones cut through the major islands and that these faults are branches of a gigantic fracture system known as the Molokai Fracture Zone. The seismic risk for Kauai should be determined from the major earthquakes that have occurred close to the Molokai Fracture Zone and not from earthquakes that have their epicenters close to the very seismically active areas close to the island of Hawaii. A Richter magnitude 7 earthquake on January 23, 1938 had an epicenter on the Molokai Fracture Zone 25 miles north of Pauwela Point on the north shore of Haleakala, Maui. The intensity of this earthquake at Wailua Falls is not known.

11. Technical Manual 5-809-10, February 1982, assigns a Zone One (1) seismic probability (seismic risk rating) and a Z-coefficient of 3/16 for the study area. Zone One (1) is described as minor damage hazard. No seismograph stations operate on Kauai, and no records are available on which to base a seismic risk evaluation.

LABORATORY TESTING

12. Testing of the overburden soils from the seven borings consisted largely of identification and classification. The silts vary from very fine-grained, as an ash or clay, to slightly coarse, as a fine sand. Laboratory values are shown on the boring profile Plates D-3 and D-4, and are summarized in Plates D-6 and D-7. Silts are generally a MH classification, in accordance with the Unified Soil Classification System; however, by grain size distribution the silt can be classified as a clay. The gravel layers are filled with a

silt-clay mixture, becoming less gravelly and more silty with depth. For design purposes, the following values may be assigned to the overburden material:

Unit weight	= 115 lbs per cubic foot
Internal friction	= 15 degrees
Cohesion, C	= 400 lbs per square foot
Maximum dry density (recompacted)	= 92 lbs per cubic foot
Optimum moisture content	= 32 percent

DESIGN CONSIDERATIONS

13. Conduit. - The excavation method for the conduit of Alternatives 1A and 2A is cut-and-cover excavation. The subsurface investigations show that the majority of excavation will be through silty alluvium. Although existing road cuts in the material stand at near vertical slopes for 15-foot depths, the excavation depth for the conduit is approximately 50 to 60 feet. Therefore, recommended slope for the excavation is 1 horizontal to 1 vertical. Additionally, 10-foot-wide benches at each vertical interval of 20 to 30 feet will provide stability from erosional forces during the period the excavated slopes are exposed.

14. Before the alluvium, approximately 10 to 15 feet of basalt will be excavated to reach the design invert elevation. As demonstrated by the exposed formation at Wailua Falls, the basalt is capable of standing on vertical cuts. The borings show that the basalt is more jointed and fractured at or near the upper surface of the flow than within the flow. Most of these rock defects are tension cracks formed as the lava cooled. It was also noted that the rock is more vesicular near the upper surface. The vesicular nature of the rock and moderately fractured condition within 10 feet of the upper surface of the flow should make excavation by ripping practical. However, hard massive zones of basalt are anticipated and will require blasting.

15. The strength of the basalt foundation below the conduit precludes the need for bedding material, except to level the floor of the excavation and to serve as a cushion to preclude point bearing.

16. Three of the seven borings recorded perched water at 20 to 30 feet below the ground surface. Dewatering by conventional methods, such as sump pumping or perimeter wells points, should be considered during excavation.

17. Penstock Foundation. No foundations investigations have been made for the penstock foundation design of either alternative. Future investigations will provide bearing and stability information for the design of footings, surface embedment, or alternative foundation proposals.

18. Diversion Dam at Wailua Falls. The proposed diversion dam would be a shaped, concrete gravity structure. The riverbed foundation material is firm lava basalt and would provide adequate support for the structure. Tie-in reinforcing bars with the basalt would require drilling effort into the basalt.

19. Upstream Stable Storm Ditch Diversion. The upstream flow diversion channel was designed as a rectangular concrete conduit. The foundation material in this area was investigated visually and consists of alluvial silts and river gravel on the surface, with lava basalt underlying it at an unknown, but shallow depth. Outcrops of cobble-covered basalt are visible in the river adjacent to the existing diversion. The existing structure would be removed, and approximately 2 feet of material would be excavated below it. It is probable that the excavation would remove the surface soils and expose the basalt beneath near the diversion. However, the alluvium is competent in bearing and would support the designed structure. Due to the highly erodible nature of the alluvium, revetment material or concrete shielding would be recommended in all areas where the soil is exposed.

20. At the downstream outlet of the conduit, the retaining wall provides protection against slope erosion. Provision for keying the retaining wall into the underlying basalt will be necessary. Further investigations of the subsurface profile will be provided at the next design stage.

CONSTRUCTION CONSIDERATIONS

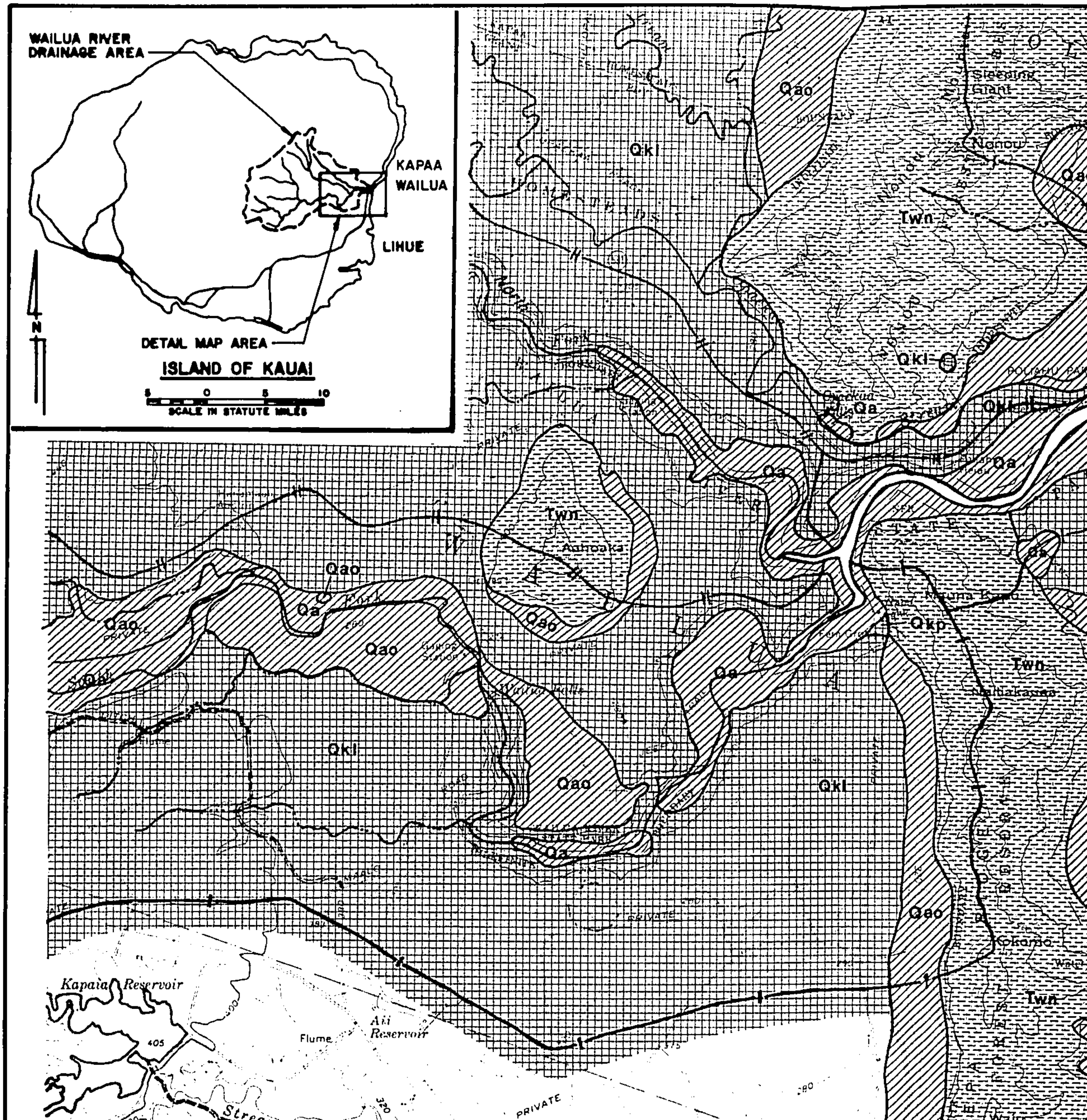
21. Sources of Construction Materials. Based on materials investigation for armor stone conducted in 1977 for Kekaha Beach Erosion Project, the following sites are possible sources for riprap stone: Hukipo Valley, Kapilimao Valley, Paua Valley, Waipao Valley, Kahoana Valleys (east and west), and Niu Valley. Any competent material from the excavation for the conduit will be considered for use as armor stone.

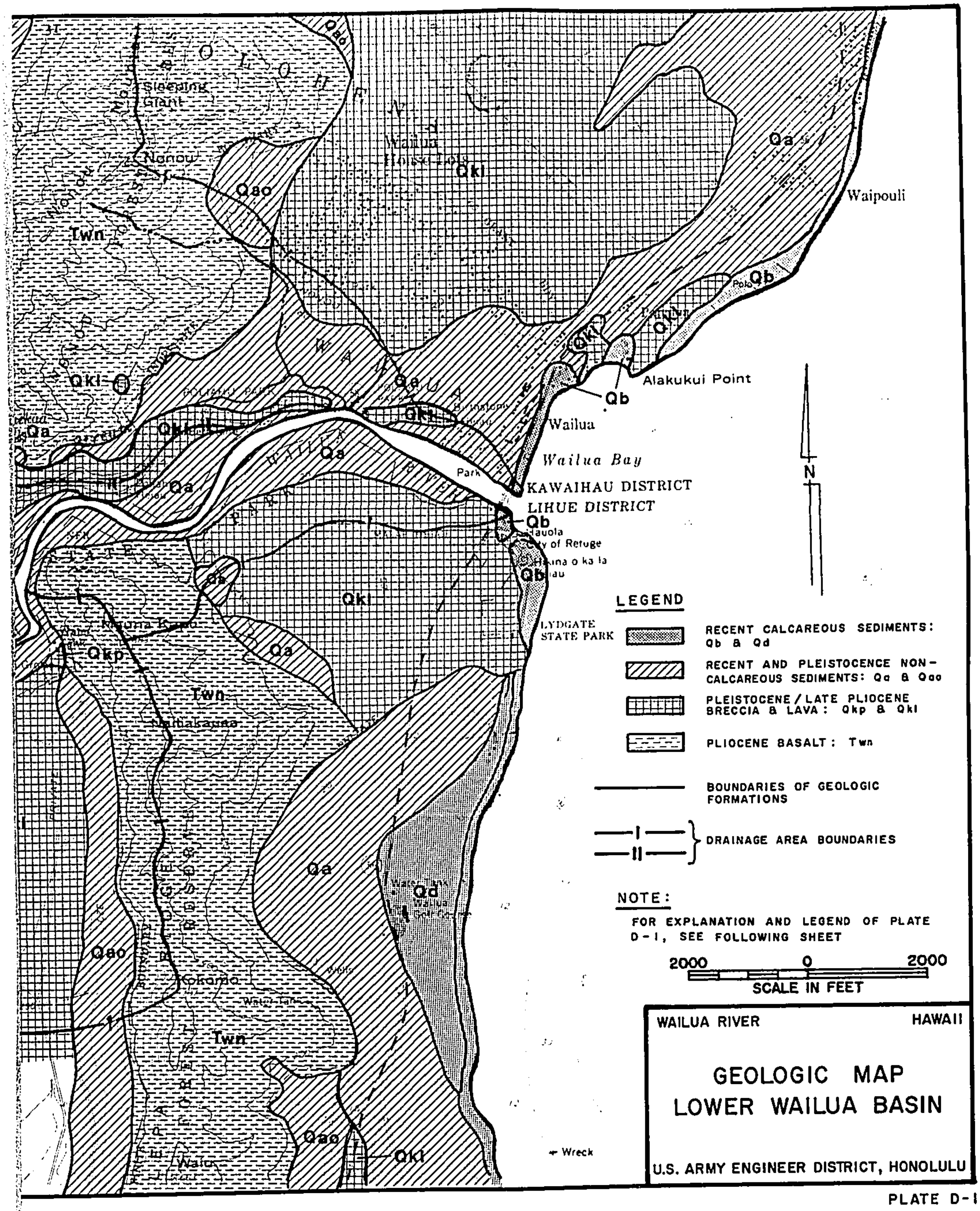
22. Crushed aggregate for concrete, asphaltic concrete, base course, and bedding material is available at the Hale Kauai Ltd. quarry located at Halfway Bridge near Lihue. Ready-mixed concrete with jobsite delivery is also available from Hale Kauai Ltd. which has four concrete plants. An asphaltic concrete batch plant operated by Hawaiian Bitumuls and Paving Company is located at Halfway Bridge near the Hale Kauai quarry.

23. Excess soil-rock material from excavation may be used for grading and fill at the proposed plant site. Placement should be 95 percent maximum density and at optimum moisture content plus or minus 3 percent. Cobbles in excess of 6" diameter are not suitable for fill. Unsuitable and excess material may be placed in a disposal site to be determined.

24. Dewatering. As discussed in the Design Considerations, dewatering may be required to facilitate excavation and placement of the conduit. At the diversion dam above the falls, re-routing of the riverflow by caissons or alternative channelling will be required during the placing and curing of the concrete. Similar treatment may be necessary at the Stable Storm Ditch Diversion for the culvert construction.

25. Access. Currently, there is no known access roadway to the proposed powerhouse location of Alternative 1A. Due to the steep grade of the existing hillside, careful design of conveyance, transfer chutes, and cable systems to transport construction supplies, equipment, and personnel, would be developed. A private gravel-and-dirt roadway presently gives access to the proposed powerhouse site of Alternative 2A. However, the grade, curves, and poor surface condition preclude its use by heavy construction equipment. Alternative access or widening of the existing road would be developed for this alternative. Existing cane haul roads to the general site area are adequate to support normal construction traffic with some maintenance.


WAILUA RIVER
DRAINAGE AREA
KAPAA
WAILUA
LIHUE
N
DETAIL MAP AREA
ISLAND OF KAUAI
5 0 5 10
SCALE IN STATUTE MILES
Qao
Qkl
Twn
Qa
Qkp
Sleeping Giant
Nonou
Aahoaka
Wailua Falls
Kapaia Reservoir
Aii Reservoir
Flume
Stream
Pukaki
PRIVATE
405
320
375


WAILUA RIVER
HAWAII
GEOLOGIC MAP
LOWER WAILUA BASIN
U.S. ARMY ENGINEER DISTRICT, HONOLULU
LEGEND
RECENT CALCAREOUS SEDIMENTS: Qb & Qd
RECENT AND PLEISTOCENCE NON-CALCAREOUS SEDIMENTS: Qa & Qao
PLEISTOCENE / LATE PLIOCENE BRECCIA & LAVA: Qkp & Qkl
PLIOCENE BASALT: Twn
BOUNDARIES OF GEOLOGIC FORMATIONS
I
II
DRAINAGE AREA BOUNDARIES
NOTE:
FOR EXPLANATION AND LEGEND OF PLATE D-1, SEE FOLLOWING SHEET
2000
0
2000
SCALE IN FEET
N
Waipouli
Alakukui Point
Wailua
Wailua Bay
KAWAIHAU DISTRICT
LIHUE DISTRICT
LYDGATE STATE PARK
Park
Sleeping Giant
Nonou
Qa
Qao
Qkl
Qkp
Qb
Qd
Twn
Wreck
PLATE D-1

EXPLANATION AND LEGEND FOR PLATE D-1

GEOLOGY ADAPTED FROM:
Macdonald, G. A., Davis, D. A. and Cox, D. C. "Geology and Ground-water Resources of the Island of Kauai, Hawaii," Bulletin 13, Hawaii Division of Hydrography, 1960.

LEGEND

SEDIMENTARY ROCKS

Qb — RECENT - calcareous sediments. Modern beaches composed largely of unconsolidated calcareous fragments of marine organisms.

Qd — RECENT - calcareous sediments. Dunes of unconsolidated calcareous sand blown inland from modern beaches.

Qa — RECENT - younger non-calcareous sediments. Unconsolidated alluvium along stream valleys and coastal plains, graded approximately to present base level.

Qao — PLEISTOCENE - older non-calcareous sediments, poorly to moderately well consolidated alluvium graded to former base levels and now undergoing dissection; in part, correlative in age with the Koloa volcanics.

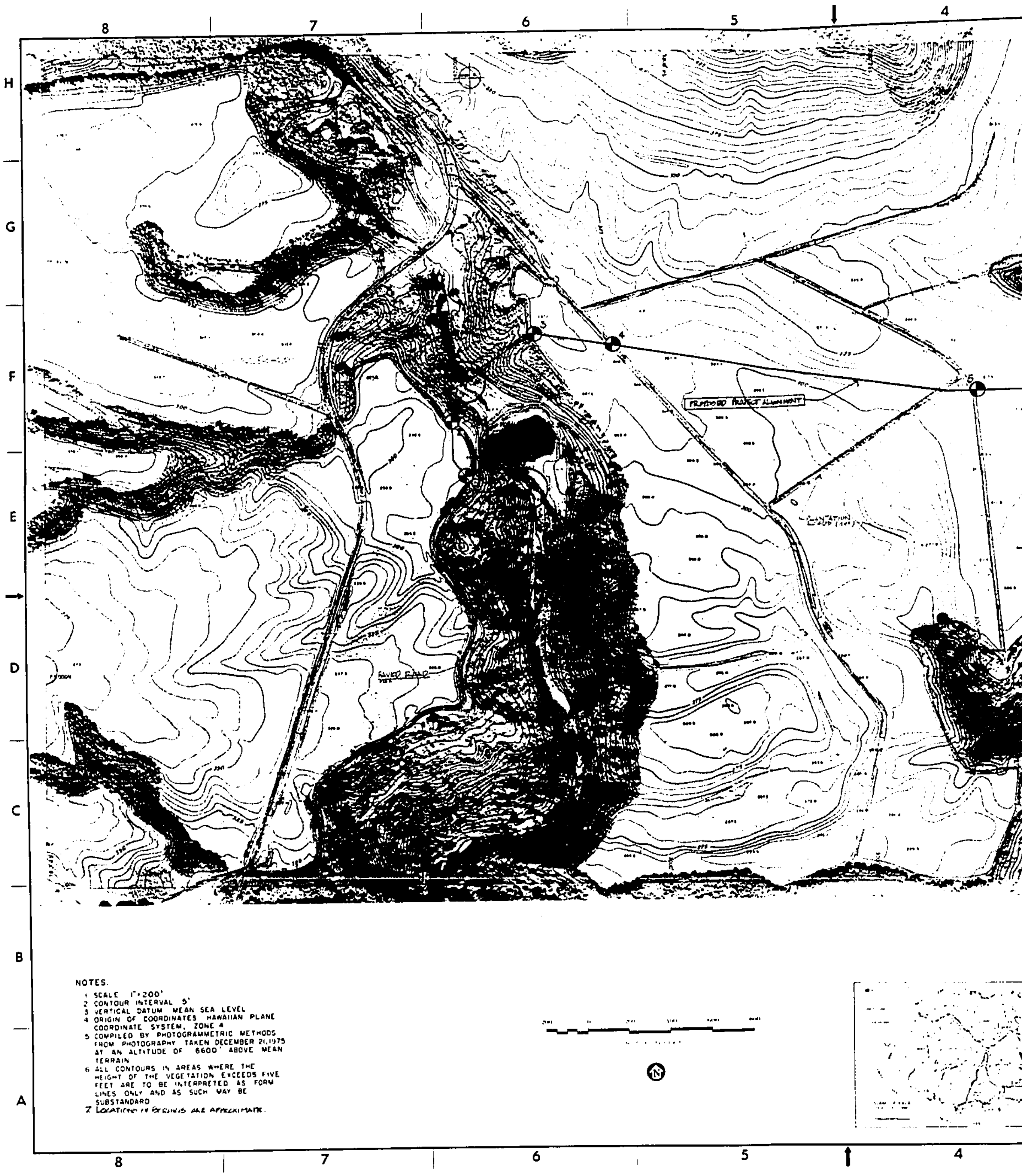
KOLOA VOLCANIC SERIES

Qkp — PLEISTOCENE OR LATE (?) PLIOCENE - masses of poorly sorted breccia and beds of conglomerate of the Palikea formation lie at the contact with the Waimea Volcanic Series and are intercalated between lavas of the Koloa Volcanic Series. Poorly permeable. Locally, small bodies of water are perched at high levels in the Palikea formation.

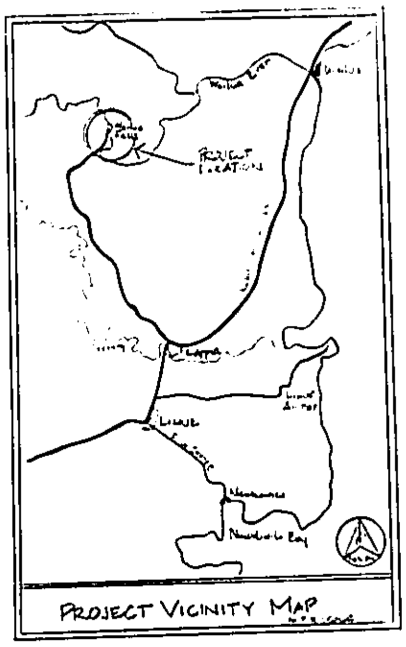
Qkl — PLEISTOCENE OR LATE (?) PLIOCENE - Aa and Pahoehoe lava flows of nepheline basalt, melilite-nepheline basalt, olivine basalt, picrite-basalt and basanite erupted from a large number of vents. Poorly to moderately permeable. Locally, small bodies of fresh water are perched at high levels by beds of ash and soil.

WAIMEA CANYON VOLCANIC SERIES

Twn — PLIOCENE - lower member (Napali formation). Thin flows of predominately olivine basalt accumulated on the flanks of the Kauai Shield Volcano. Highly permeable and yields basal water to wells and to high levels between dikes.



NOTES.
1 SCALE 1"=200'
2 CONTOUR INTERVAL 5'
3 VERTICAL DATUM MEAN SEA LEVEL
4 ORIGIN OF COORDINATES HAWAIIAN PLANE COORDINATE SYSTEM, ZONE 4
5 COMPILED BY PHOTOGRAMMETRIC METHODS FROM PHOTOGRAPHY TAKEN DECEMBER 21,1975 AT AN ALTITUDE OF 6600' ABOVE MEAN TERRAIN
6 ALL CONTOURS IN AREAS WHERE THE HEIGHT OF THE VEGETATION EXCEEDS FIVE FEET ARE TO BE INTERPRETED AS FORM LINES ONLY AND AS SUCH MAY BE SUBSTANDARD
7 LOCATIONS OF BORINGS ARE APPROXIMATE.
PROPOSED PROJECT ALIGNMENT
PAVED ROAD



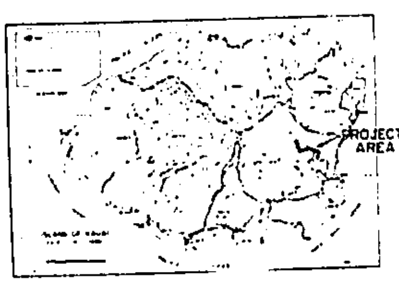
PROJECT VICINITY MAP

LEGEND

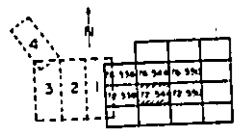
LOCATION AND IDENTIFICATION NO. OF BORING

BORING NO.	ESTIMATED DEPTH
1	60'
2	55'
3	70'
4	75'
5	87'
6	78'
7	30'

LOCATION OF PROPOSED INTAKE OR OUTLET



INDEX TO SHEETS

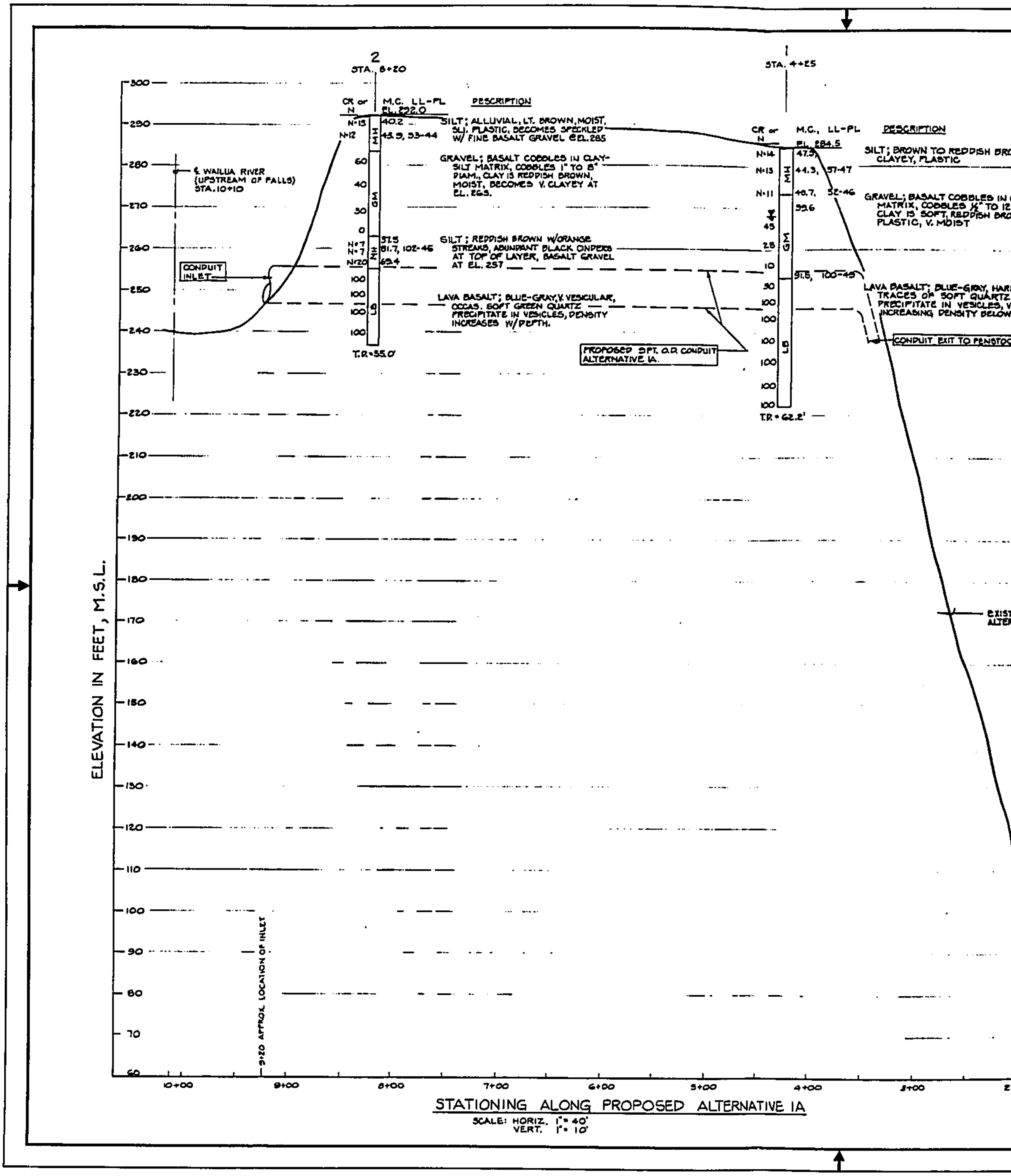


WAILUA RIVER — HAWAII

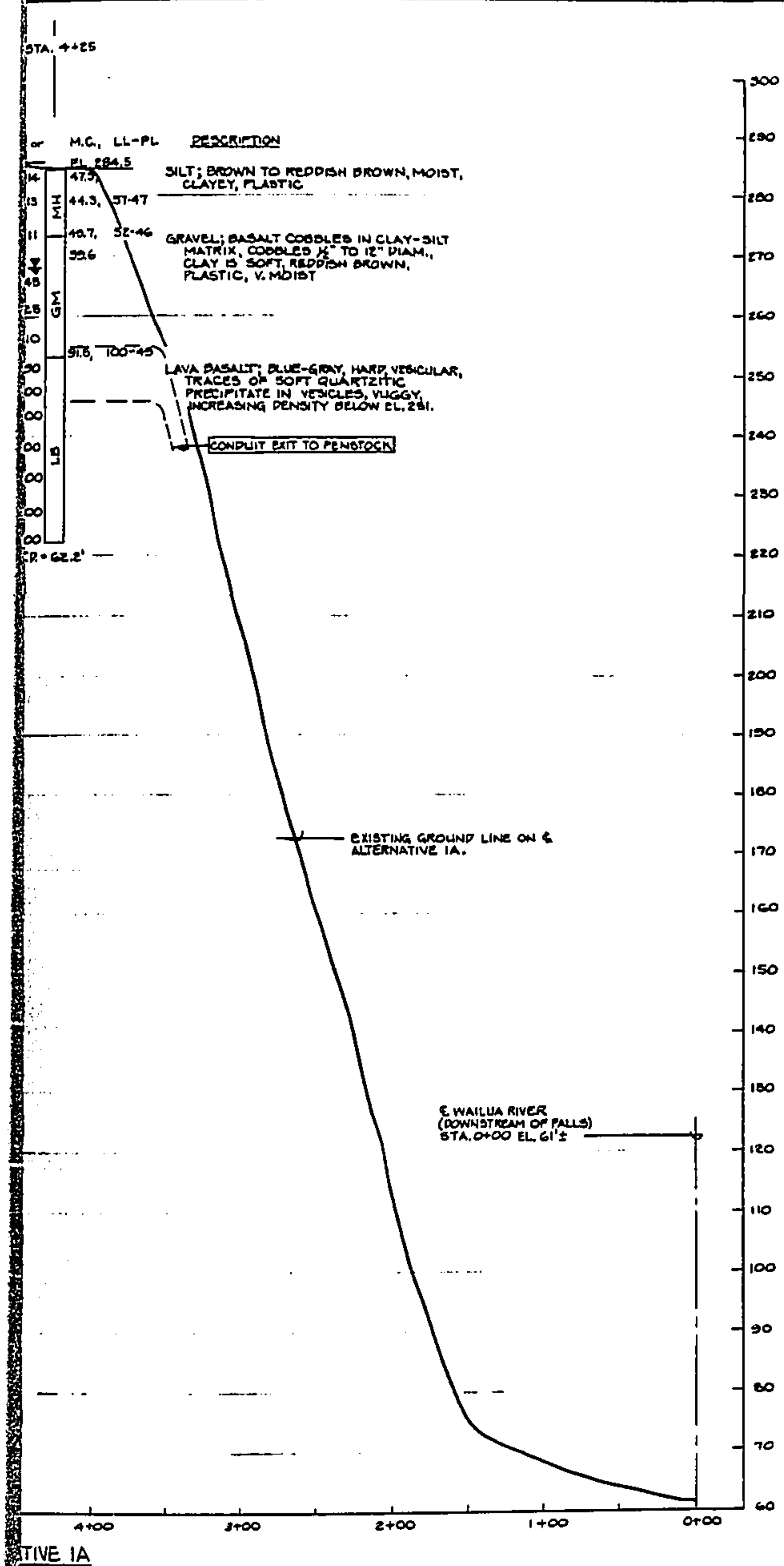
BORING LOCATION PLAN

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE D-2

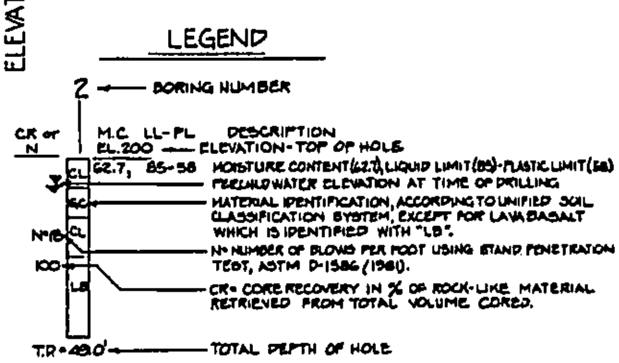


ELEVATION IN FEET, M.S.L.
STATIONING ALONG PROPOSED ALTERNATIVE IA
SCALE: HORIZ. 1" = 40'
VERT. 1" = 10'
2
STA. 8+20
CR or N
M.C. LL-PL
DESCRIPTION
EL. 292.0
SILT; ALLUVIAL, LT. BROWN, MOIST, SL. PLASTIC, BECOMES SPECKLED W/ FINE BASALT GRAVEL @ EL. 285
GRAVEL; BASALT COBBLES IN CLAY-SILT MATRIX, COBBLES 1" TO 8" DIAM., CLAY IS REDDISH BROWN, MOIST, BECOMES V. CLAYEY AT EL. 265.
SILT; REDDISH BROWN W/ORANGE STREAKS, ABUNDANT BLACK CINDERS AT TOP OF LAYER, BASALT GRAVEL AT EL. 257
LAVA BASALT; BLUE-GRAY, V. VESICULAR, OCCAS. SOFT GREEN QUARTZ PRECIPITATE IN VESICLES, DENSITY INCREASES W/DEPTH.
T.D. = 55.0'
℄ WAILUA RIVER (UPSTREAM OF FALLS) STA. 10+10
CONDUIT INLET
PROPOSED SPT. OR CONDUIT ALTERNATIVE IA.
9+20 APPROX. LOCATION OF INLET
1
STA. 4+25
CR or N
M.C., LL-PL
DESCRIPTION
EL. 284.5
SILT; BROWN TO REDDISH BRO CLAYEY, PLASTIC
GRAVEL; BASALT COBBLES IN MATRIX, COBBLES ½" TO 12 CLAY IS SOFT, REDDISH BRO PLASTIC, V. MOIST
LAVA BASALT; BLUE-GRAY, HAR TRACES OF SOFT QUARTZ PRECIPITATE IN VESICLES, V INCREASING DENSITY BELOW
CONDUIT EXIT TO PENSTOC
T.D. = 62.2'
EXIST ALTER



NOTES:

1. GROUND LINES AND ELEVATIONS ARE APPROXIMATE.
2. SEE PLATE D-2 FOR BORING LOCATION PLAN.
3. STATIONING AND ELEVATIONS FOR OPTION 1 ARE TO BE DETERMINED WITH THE NEXT DESIGN PHASE. OPTION 1, AS PRESENTED, IS CONCEPTIONAL AND APPROXIMATE.

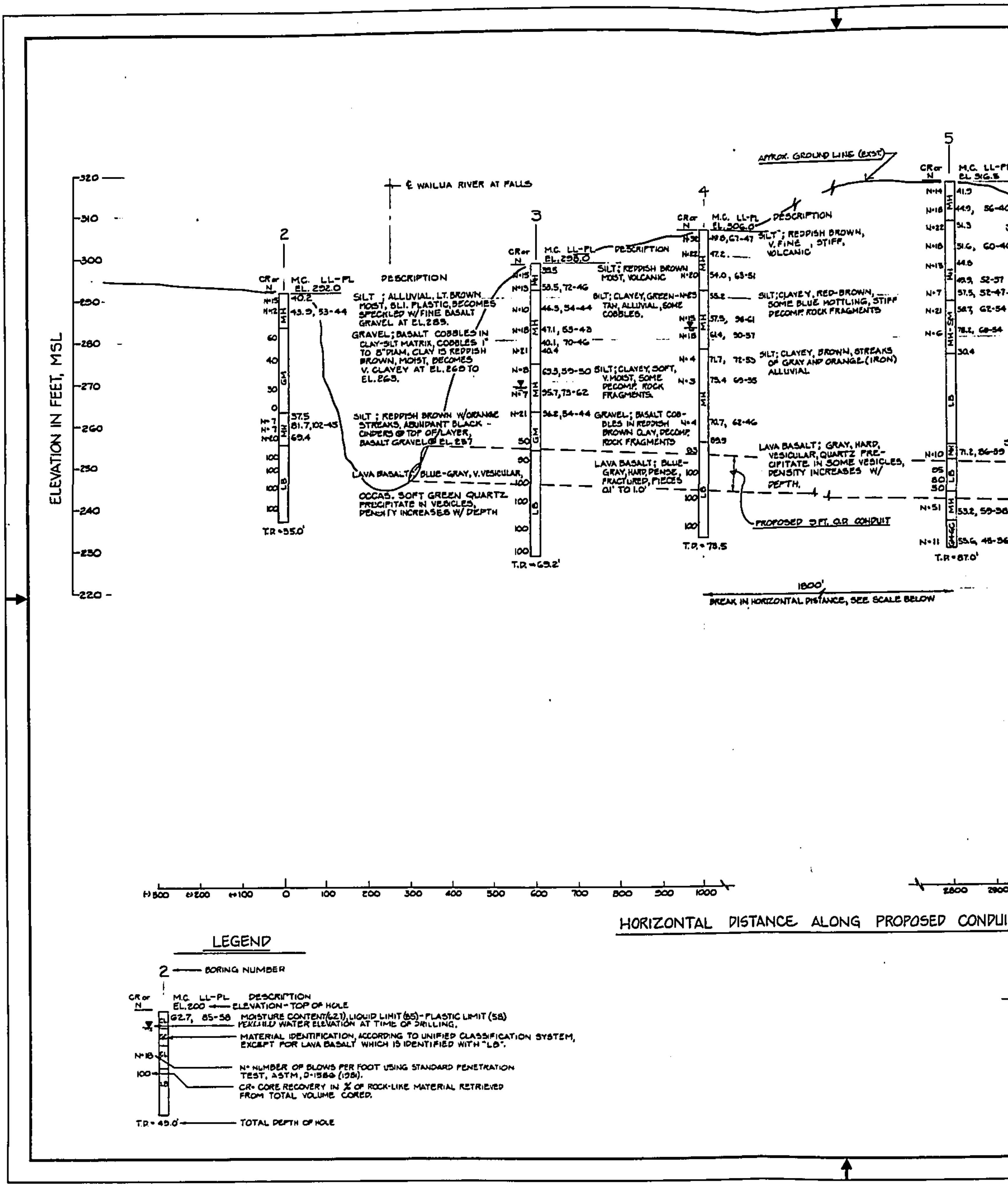


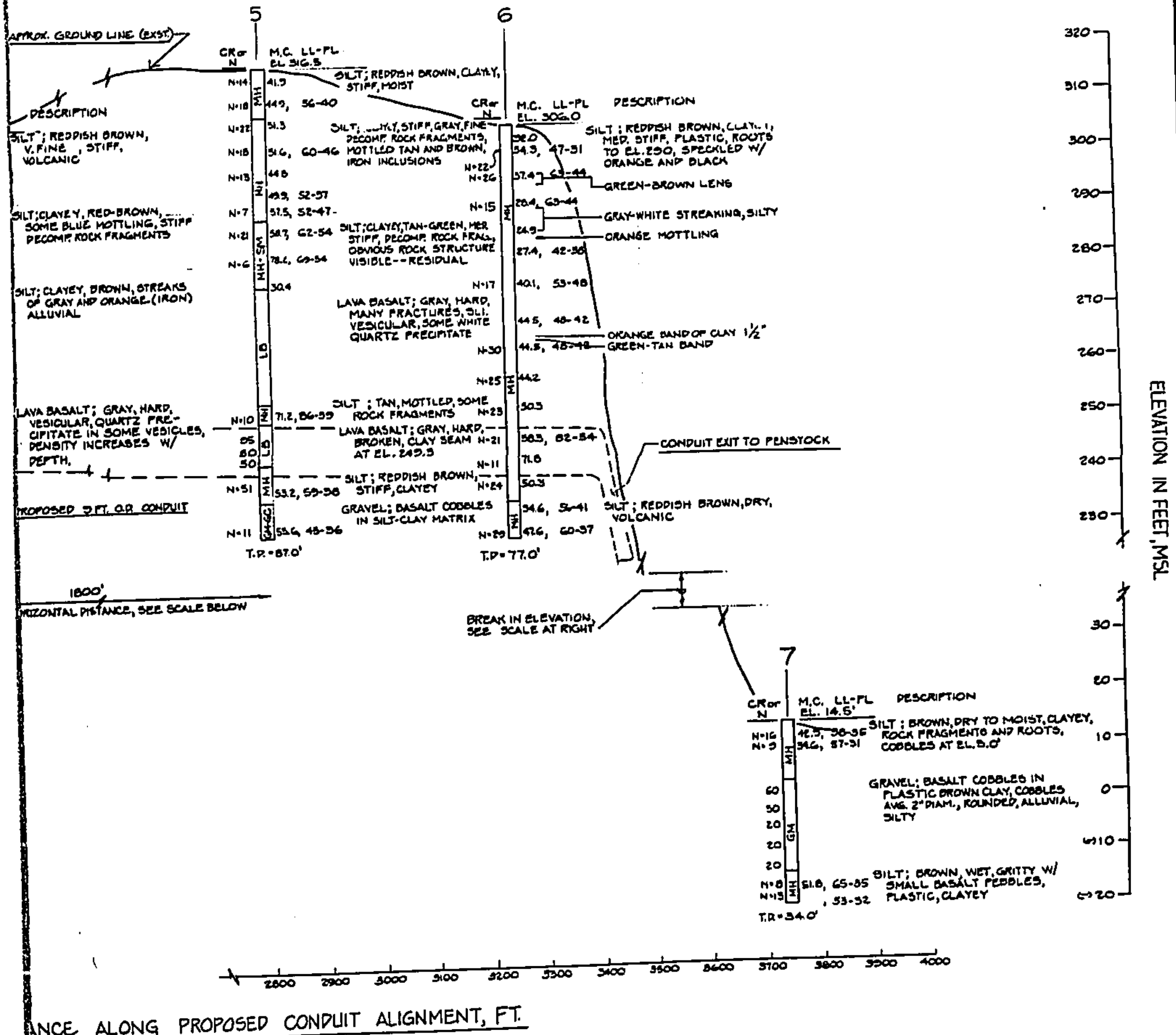
WAILUA RIVER HAWAII

PROFILE OF BORINGS ALTERNATIVE 1A

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE D-3


ELEVATION IN FEET, MSL
℄ WAILUA RIVER AT FALLS
APPROX. GROUND LINE (EXIST.)
SILT; ALLUVIAL, LT. BROWN, MOIST, SLI. PLASTIC, BECOMES SPECKLED W/FINE BASALT GRAVEL AT EL.285.
GRAVEL; BASALT COBBLES IN CLAY-SILT MATRIX, COBBLES 1" TO 8" DIAM. CLAY IS REDDISH BROWN, MOIST, BECOMES V. CLAYEY AT EL.268 TO EL.263.
SILT; REDDISH BROWN W/ORANGE STREAKS, ABUNDANT BLACK CINDERS @ TOP OF LAYER, BASALT GRAVEL @ EL.257
LAVA BASALT; BLUE-GRAY, V. VESICULAR, OCCAS. SOFT GREEN QUARTZ PRECIPITATE IN VESICLES, DENSITY INCREASES W/ DEPTH
SILT; REDDISH BROWN MOIST, VOLCANIC
SILT; CLAYEY, GREEN-TAN, ALLUVIAL, SOME COBBLES.
SILT; CLAYEY, SOFT, V. MOIST, SOME DECOMP. ROCK FRAGMENTS.
GRAVEL; BASALT COBBLES IN REDDISH BROWN CLAY, DECOMP. ROCK FRAGMENTS
LAVA BASALT; BLUE-GRAY, HARD, DENSE, FRACTURED, PIECES 0.1' TO 1.0'
SILT; REDDISH BROWN, V. FINE, STIFF, VOLCANIC
SILT; CLAYEY, RED-BROWN, SOME BLUE MOTTLING, STIFF DECOMP. ROCK FRAGMENTS
SILT; CLAYEY, BROWN, STREAKS OF GRAY AND ORANGE (IRON) ALLUVIAL
LAVA BASALT; GRAY, HARD, VESICULAR, QUARTZ PRECIPITATE IN SOME VESICLES, DENSITY INCREASES W/ DEPTH.
PROPOSED 9 FT. O.R. CONDUIT
1800'
BREAK IN HORIZONTAL DISTANCE, SEE SCALE BELOW
T.D.=55.0'
T.D.=65.2'
T.D.=78.5
T.D.=87.0'
HORIZONTAL DISTANCE ALONG PROPOSED CONDUI
LEGEND
BORING NUMBER
ELEVATION - TOP OF HOLE
MOISTURE CONTENT (62.7), LIQUID LIMIT (85) - PLASTIC LIMIT (58)
PERCHED WATER ELEVATION AT TIME OF DRILLING.
MATERIAL IDENTIFICATION, ACCORDING TO UNIFIED CLASSIFICATION SYSTEM, EXCEPT FOR LAVA BASALT WHICH IS IDENTIFIED WITH "LB".
N= NUMBER OF BLOWS PER FOOT USING STANDARD PENETRATION TEST, ASTM, D-1586 (1981).
CR= CORE RECOVERY IN % OF ROCK-LIKE MATERIAL RETRIEVED FROM TOTAL VOLUME CORED.
TOTAL DEPTH OF HOLE



NOTES:

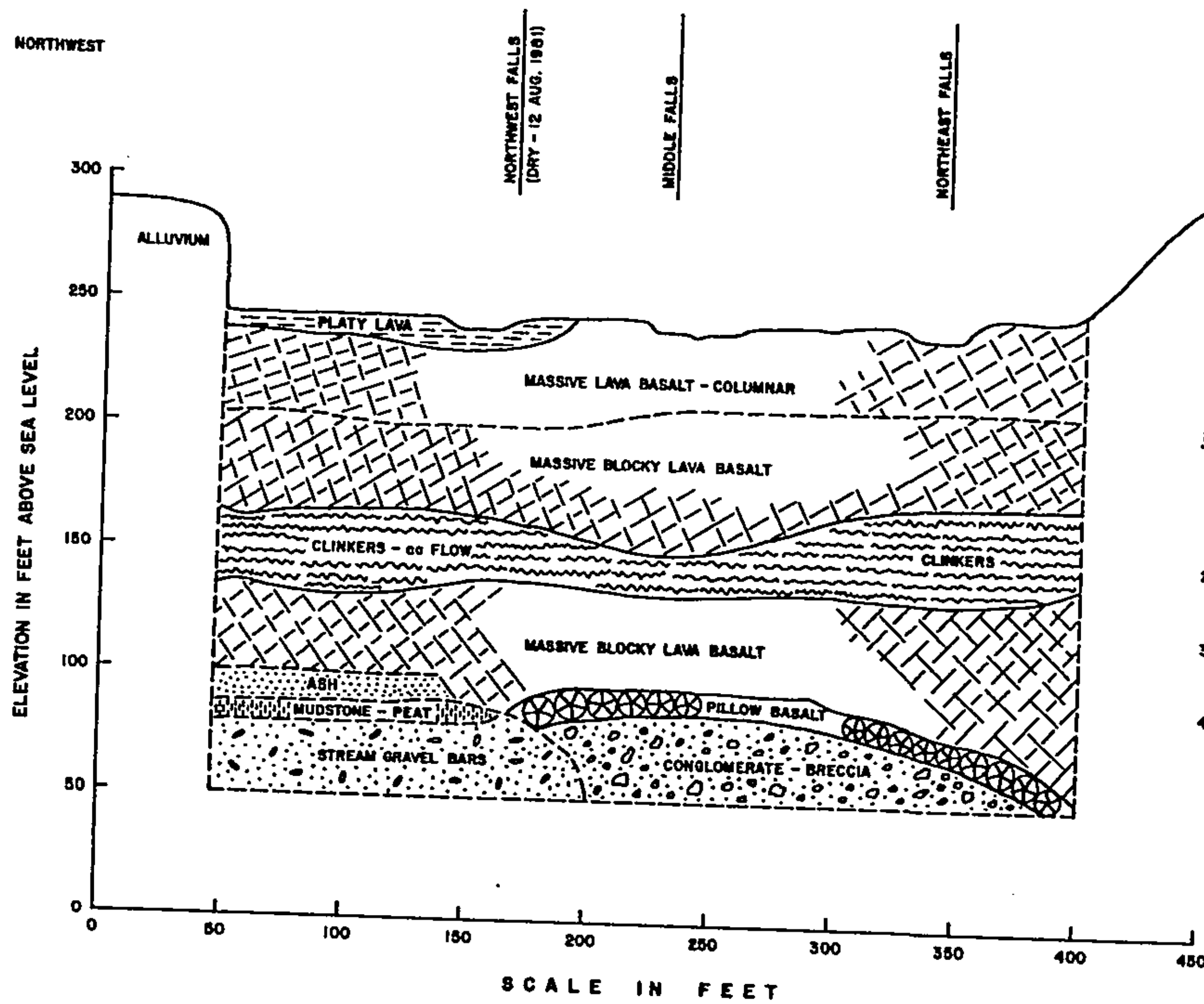
1. GROUND LINE AND ELEVATIONS ARE APPROXIMATE.
2. SEE PLATE D-2 FOR BORING LOCATION PLAN.

WAILUA RIVER — HAWAII

PROFILE OF BORINGS ALTERNATIVE 2A

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE D-4



NOTES:

1. ADAPTED FROM BULLETIN 13, FIGURE 13, "GEOLOGY AND GROUND WATER RESOURCES OF THE ISLAND OF KAUAI, HAWAII".
2. SKETCH SHOWS KIND OF ROCK AND RELATIVE THICKNESS OF LAYERS. NOT TO SCALE.
3. WATERFALL FORMED BY HEADWARD EROSION OF SOUTH WAILUA RIVER GORGE.
4. CONGLOMERATE - BRECCIA ARE CHAOTIC ASSEMBLAGE OF ANGULAR ROCK FRAGMENTS FROM MUD FLOW - SOIL AVALANCHE ORIGIN.

WAILUA RIVER — KAUAI, HAWAII

ROCK FACE PROFILE SKETCH OF WAILUA WATERFALL
(SOUTH FORK OF WAILUA RIVER)

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE D-5

TEST DATA SUMMARY SHEET

1/2

BORING NO.	SAM. NO.	DEPTH OR ELEV. OF SAMPLE	LABORATORY CLASSIFICATION (FIELD CLASSIFICATION)	MECHANICAL ANALYSIS GRAVEL %	SAND %	FINES %	D_{10}	ATTERBERG LIMITS LL	PL	SPECIFIC GRAVITY G	NAT. WATER CONT. %	ORGANIC CONTENT %	COMPACTION DATA OPT. WATER %	MAXIMUM DRY DENSITY LBS/CU FT
1	54	0^0-2^0	(Alluv. SILT)								47.9			
	55	5^0-7^0	(Alluv. SILT)					57	47		44.3			
	56	10^0-12^0	(Silty GRAVEL)					52	46		49.7			
	57	14^5-15^5	(" ")								39.6			
	58	$29^3-30^?$	(" ")					100	49		91.5			
2	1	0^5-2^5	(Alluv. SILT)								40.2			
	2	3^5-6^5	SM (" ")	19	61	20	–	53	44		43.9			
	3	28^5-31^0	(" ")								37.5			
	4	31^0-34^0	MH (" ")	0	26	74	–	100	45		81.7			
	5	34^0-36^5	(" ")								69.4			
3	46	0^0-2^0	(Alluv. SILT)								59.5			
	47	5^0-7^0	MH (" ")	0	3	97	–	76	46		53.5			
	48	10^0-12^0	(" ")					54	44		46.3			
	49	15^0-17^0	MH (" ")	0	16	84	–	53	43		47.1			
	50	$20^?-22^?$	(" ")								40.4			
	51	25^0-27^0	(" ")					59	50		69.3			
	52	30^0-32^0	MH (" ")	0	31	69	–	73	62	3.06	95.7	12.0		
	53	35^0-37^0	(Silty GRAVEL)					54	44		56.2			
	B-10	17^0-25^0	MH (Alluv. SILT)	0	12	88	–	70	46	2.99	40.1	11.1	32	91.5
4	36	0^5-2^5	(Alluv. SILT)					67	47		49.8			
	37	5^0-7^0	(" ")								47.2			
	38	10^0-12^0	(" ")					63	51		54.0			
	39	15^0-17^0	(" ")								55.2			
	40	20^0-22^0	MH (" ")	0	0	100	–	98	61		57.5			
	41	25^0-27^0	(" ")					90	57		61.4	11.4		
	42	30^0-32^0	MH (" ")	0	7	93	–	72	53	2.98	71.7	11.1		
	43	$35^0-37^?$	(" ")					69	55		75.4			
	44	$42^0-45^?$	(" ")					62	46		70.7			
	45	$50^0-53^?$									89.9			
5	24	1^5-3^0	(Alluv. SILT)											
	25	5^0-7^0	(" ")								41.9			
	26	10^0-12^0	(" ")					56	40		44.9			
	27	15^0-17^0	(" ")								51.3			
	28	20^0-22^0	(" ")					60	46		51.6			
	29	$25^0-27^?$	(" ")								48.0			
	30	30^0-32^0	(" ")					52	47		57.5			
								62	54		53.7			

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WAILUA HYDROPOWER

PLATE D-6

TEST DATA SUMMARY SHEET (CONT) 2/2

BORING NO.	SAM. NO.	DEPTH OR ELEV. OF SAMPLE	LABORATORY CLASSIFICATION (FIELD CLASSIFICATION)	MECHANICAL ANALYSIS GRAVEL %	SAND %	FINES %	D_{10}	ATTERBERG LIMITS LL	PL	SPECIFIC GRAVITY G	NAT. WATER CONT. %	ORGANIC CONTENT %	COMPACTION DATA OPT. WATER %	MAXIMUM DRY DENSITY LBS/CU FT
5	31	35^{5}-37^{5}	SM (Alluv. SILT)	1	61	38		69	54		78.2			
	32	40°-40^{5}	(" ")								30.4			
	33	63^{5}-65^{5}	(" ")					86	39		71.2			
	34	78^{5}-80^{5}	MH (" ")	0	2	98		59	38		53.2			
	35	85^{5}-87^{5}	(Silty Gravel)					45	36		55.6			
	B-7	22°-25°	SM	0	61	39		52	37		49.9	12.4		
6	8	0^{5}-2^{5}	(Alluv. SILT)								32.0			
	9	2^{5}-4^{5}	ML (" ")	0	12	88		47	31		34.5			
	10	8°-10°	(" ")								37.4			
	11	14°-16^{5}	MH (" ")	0	45	55		63	44		28.4			
	12	18°-20°	(" ")								24.9			
	13	22°-24°	(" ")					42	35		27.4			
	14	28°-30°	(" ")					53	48		40.1			
	15	35°-37°	(" ")								44.5			
	16	40°-42°	ML (" ")	0	34	66		48	42		44.5			
	17	45°-47°	(" ")					43	42		42.2			
	18	50°-52°	(" ")								50.3			
	19	55°-57°	(" ")								58.3			
	20	60°-62°	(" ")					82	54		71.8			
	21	65°-67°	(" ")								50.3			
	22	70°-75°	(" ")					56	41		34.6			
	23	75°-77°	MH (" ")	0	1	99		60	37		47.6			
	B-1,2	0°-2.0'		0	9	91		63	40		-		30	95.3
7	6	0^{5}-2^{5}	(Alluv. SILT)					53	35					
	7	3°-6°	MH (" ")	0	31	69		57	31	2.90		8.9		
	8A	28°-31°	(" ")					65	35					
	9A	31°-34°	MH (" ")	16	33	51		53	32					

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WAILUA HYDROPOWER

PLATE D-6

WAILUA RIVER HYDROPOWER PROJECT
KAUAI, HAWAII

ECONOMICS

APPENDIX E

APPENDIX E

ECONOMICS

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INTRODUCTION

1. A potential hydropower project must satisfy two basic criteria for authorization and construction by the US Army Corps of Engineers. First, the project must be economically feasible. The economic value of the output must be greater then the cost of production. Second, the project must be financially feasible. Its output must be marketable at rates sufficient to recover costs.

2. Economic feasibility is measured with benefit cost analysis. Costs are included in the National Economic Development (NED) account for all goods and services required for project construction, operation and maintenance. The benefit is society's measured willingness to pay for energy produced by the hydroelectric powerplant. The cost of the energy displaced by the production of hydroelectric output is taken as the benefit. This benefit measure is based on analysis and data from the Federal Energy Regulatory Commission (FERC) of the US Department of Energy (DOE). Appropriate sizing of the most economically efficient hydropower plant was performed jointly by the Corps' Honolulu District and North Pacific Division offices. Benefits and costs occurring at different points in time are made comparable by using the discount rate prescribed by the US Water Resources Council (WRC) for analysis of Federal water resource projects. This rate for FY82 is set at 7-5/8% per year.

3. Marketability and financial feasibility analysis has been conducted on a preliminary basis by the Western Area Power Administration, Department of Energy. Their effort included descriptions of the present power market, future power and energy requirements, alternative future generation, market and financial considerations, and an outline of procedures for developing a power marketing plan (Appendix F).

ECONOMIC CONDITIONS

POPULATION

4. There are two main sources of projected population growth for Kauai. They are the State of Hawaii Department of Planning and Economic Development (DPED), and OBERS 1980 projections by the Bureau of Economic Analysis (BEA), US Department of Commerce. The OBERS BEA projections for the non-SMSA portion of Hawaii, which includes Kauai, shows a growth rate somewhat lower than the latest figures resulting from DPED projections. The validity of the OBERS projections follows from the soundness of the control total approach, in which reliable national projections are first made, from which smaller regional projections are derived by disaggregation. The validity of the DPED projections, however, follows from County growth rate forecasts based on historical trends, and on econometric model projections for the State and its island components. The two projections are shown in Table E-1, and are depicted graphically in Plate E-1.

Table E-1. HISTORICAL AND PROJECTED POPULATION GROWTH FOR KAUAI

POPULATION (1,000's)

		PROJECTED		
		OBERS[1/]		
	Historical	Low	High	DPED[2/]
1950	30.7			
1960	27.8			
1970	30.1			
1980	39.1			36.5
1985		42	43	40.6
1990		45	47	46.5
1995		48	51	53.1
2000		51	55	60.4
2010		55	60	
2020		58	65	
2030		63	70	

1/ Based on growth rate for non-SMSA portions of Hawaii, 1980 OBERS BEA Regional Projections, US Department of Commerce, Bureau of Economic Analysis, July 1981.

2/ State of Hawaii, Series II-F Projections, March 1978.

5. The DPED projections are under revision at this time in response to 1980 census figures. Kauai's census, for example, is 39,082, or 6.6% higher than had been projected for 1980. All three scenarios show continuing growth, although at different rates.

ENERGY USE

6. Barring drastic changes in the economy and lifestyle, all three population growth scenarios represent a continuing requirement for electricity production. Population is of course only one of the variables linked to electricity generation and use. While population growth averaged about 2.6% per year during the 1970's, electricity generated increased by an average of about 5.3% per year, as shown in Table E-2. In addition to residential use, for which population is the primary indicator, commercial, industrial, and public use all have contributed to this growth. Future growth will be tied to developments in the economy in general, specifically in the agriculture and tourism sectors, and by extension the construction industry. The behavior of the world petroleum market will also be a significant factor along with related trends and developments in alternate forms of energy use and production, conservation, and changes in lifestyle. A forecast prepared for the Hawaii State Energy Plan shows electricity demand forecasts by County to the year 2000. The forecast shows growth rates of around 4% annually through 1990, decreasing to below 1% per year by the end of the forecast period. Projections by the utility, Kauai Electric Division, however, show a relatively constant rate of increase.

Table E-2. ANNUAL ELECTRICITY GENERATION, KAUAI 1/

Year	Net Electricity Generated (millions of kwh)	Annual % Change From Previous Year	From 1975
1975	167.6		
1976	169.6	1.2	1.2
1977	183.2	8.0	4.7
1978	201.0	9.7	6.6
1979	204.2	1.6	5.5
1980	211.1	3.4	5.2
1981	218.6	3.6	5.1

1/ FPC Form 12 data and State of hawaii PUC report for Kauai Electric 1980 and 1981.

Table E-3. KAUAI COUNTY ELECTRICITY DEMAND FORECAST, 1977-2000
(Million KWH)

	DPED Projection1/		Kauai Electric Projection2/	
Year	Energy Sold	Average Annual Percent Change	Energy Sold	Average Annual Percent Change
1977	167	-	167	-
1980	187	4.4	189	4.4
1985	230	3.7	227	4.0
1990	272	3.7	271	3.9
1995	297	1.8	323	3.8
2000	306	0.6	385	3.8

1/ From State Energy Plan and Technical Reference Document, Hawaii Department of Planning and Economic Development, September 1980.

2/ From Communication, Kauai Electric Division, February 1982.

ALTERNATIVE ENERGY AND SELF SUFFICIENCY

7. Kauai is remote for submarine transmission cable intertie systems. While a link via cable is the subject of a feasibility study for the islands of Oahu and Hawaii, Kauai's remoteness (102 miles from Honolulu, and 10,800 feet of water depth) makes any such intertie highly unlikely for the foreseeable future. With escalating world oil prices affecting Kauai, other non-fossil fuel sources have been the subject of planning efforts. The most recent step in Kauai's drive for oil independence came this year with the start-up of the Lihue Plantation Company's bagasse-fueled powerplant. Excess output is purchased under contract agreement by the local utility. Recent (1978) legislation enables private entities such as sugar companies to get higher prices for such excess electricity production. The new bagasse plant on Kauai is in part a response to this legislative incentive. Under a 20-year agreement, 12,000 kw of the plants' 20,000 kw capacity is at the disposal of the utility. In 1980, 13 percent of the utility's requirements were met by such agreements. With the new bagasse plant in operation, exceeding its expected performance, plantation-supplied power on Kauai was 43 percent of Kauai's total in 1981. This energy from both hydropower and bagasse - fuel sources represents a significant step toward oil independence for Kauai.

BENEFITS AND FEASIBILITY

POWER VALUES

8. Benefits are based on the estimated value of hydroelectric production. They are measured as the average cost of energy production requirements eliminated, or displaced, by the hydroelectric powerplant. The actual value of this displaced energy is a weighted average, reflecting the incremental costs of energy production for a mix of affected powerplants. Current WRC and FERC procedures provide for escalation of real fuel costs in the determination of average annual energy values. The fuel price, are escalated in accordance with Department of the Energy forecasts from the price level date for a period of 30 years. Following the 30 year period in the future, the prices are to remain constant for the balance of the 100-year economic life of the project. The discounting methodology is shown on Plate E-2. Studies by FERC, DOE, presently indicate that benefit values per unit of energy are as shown in Table E-4. The FERC correspondence is provided at the end of this appendix. Due to the relatively low plant factors resulting from non-firm flows, firm capacity would not be available for the hydropower schemes. Hence, no capacity component was included in the benefit values.

TABLE E-4

HYDROPOWER BENEFIT VALUES1/
(mills per kwh)

Discount Rate	Without Fuel Cost Escalation POL2/Date 1990	Without Fuel Cost Escalation POL2/Date 1995	With Fuel Cost Escalation POL Date 1990	With Fuel Cost Escalation POL Date 1995
7-5/8%3/	48	48	79	87
7-7/8%3/	48	48	79	87
10%	48	48	76	84

1/ Reflects January 1982 price levels.

2/ Power-on-line.

3/ No significant differences in value between 7-5/8 and 7-7/8 percent.

ANNUAL BENEFITS

9. Annualized benefit data for the two hydropower alternatives are outlined in Table E-5.

TABLE E-5

HYDROPOWER BENEFITS ALTERNATIVES 1A AND 2A

	Alternative 1A	Alternative 2A
Capacity	5.0 mw	5.65 mw
Average Annual Energy	11.28 million kwh	13.84 million kwh
Average Annual Plant Factor 1/	0.26	0.27
Benefit (mills per kwh) 2/ 4/	79	79
Annual Benefit 3/ 4/	$891,000	$1,093,000

1/ Plant factor is a measure of the average amount of time, that a given plant's capacity is in operation. It is equal to the ratio of the average load to the installed capacity of the plant.
2/ From Table E-4, discount rate = 7-5/8%, including fuel cost escalation.
3/ Benefit = average annual energy x benefit per unit of energy.
4/ POL date = 1990.

NON-STRUCTURAL PLAN

10. Another way of satisfying future requirements is through the implementation of a combination of conservation and active solar technology, discussed in the main report as Alternative 3. Table E-6 contains a summary of the estimated reduction in kwh consumption made possible by implementation of this primarily non-structural plan.

TABLE E-6

SUMMARY OF ALTERNATIVE 3 EFFECTS

Year	Total Annual Savings1/ Millions/kwh	Annual Savings From Solar Millions/kwh	Solar Contribution as a Percent of Total	Equivalent No. of Hot Water2/ Systems
1977	0	-	-	-
1980	10	1	10	700
1981	18	3	17	2,000
1985	26	5	19	3,300
1990	49	10	20	6,700
1995	67	16	24	10,700
2000	92	24	26	16,000

1/ From discussion of Plan, Main Report

2/ Based on average residential consumption on Kauai of 500 kwh/household, and a reduction in electricity consumption of 25% due to solar water heating system installation. One unit saves an average of 500 kwh/mo x .25 x 12 mo/yr = 1,500 kwh/yr. Therefore, 1,000,000 kwh of savings is equivalent to $\frac{1{,}000{,}000 \text{ kwh}}{1{,}500 \text{ kwh/unit}}$ = 700 units (rounded)

NON-STRUCTURAL BENEFITS

11. The benefits from implemention of Alternative 3 are based on the conceptual notion that the amount of reduction in electrical energy production requirements is considered equivalent to the provision of in-kind service. Using the FERC figure of 79 mills per kwh serves as a starting point. Since this figure includes real fuel price escalation, and is therefore POL date dependent (1990 in this case), some measure of adjustment is necessary to account for the different time frame involved in Alternative 3 (with a base year of 1980). The adjustment is based on the assumptions that;

- approximately 70% of a typical electric bill is for fuel cost; and,

- the DOE real energy price escalation forecast for distillate fuel Region 9, applies (3.1%/yr for 1980-1985, and 2.2%/yr for 1985-1990).1/

12. The FERC value of 79 mills/kwh is therefore converted for Alternative 3 to:

$$= \frac{79 \text{ mills/kwh}}{(1.031)^5\,(1.022)^5(.7) + (.3)}$$

$$= (.827)(79) \text{ mills/kwh} = 65 \text{ mills/kwh}$$

13. Estimated annual benefits from Alternative 3 using this approach are outlined in Table E-7 totals $811,000 per year (1980-2080, discount rate = 7-5/8 percent).

TABLE E-7

ESTIMATED ANNUAL BENEFITS, ALTERNATIVE 3

Year	Millions of kwh Per Year 2/	Annual 3/ Benefit
1980	1	$ 65,000
1981	3	195,000
1985	5	325,000
1990	10	650,000
1995	16	1,040,000
2000-2080	24	1,560,000

14. Similar to the benefit analysis, the costs for the solar component of Alternative 3 could be evaluated based on current market prices for initial installtion and material. However, the resulting annual costs for Alternative 3 would not be comparable to the structural Alternatives 1A and 2A. The structural plans each require a large initial investment at a definte point in time. The investment will ultimately be included into the utility system and its implementation may be predicted. However, for the nonstructural Alternative 3, the solar units do not produce but conserve energy. The approach is related to decentralized energy demand planning, normally outside of direct control of the utility industry. The implementation of the solar units is not predictable but is highly influenced by the marketplace, the government-related incentives, and individual preferences and could fluctuate over time. Finally the individual attractiveness of solar system would make implementation possible even with a centralized energy facility as a hydropower plant. Hence, although a determination of annual costs is possible, this analysis would not be meaningful.

1/ Table 4-3, p 4-8, Evaluating Hydropower Benefits, U.S. Water Resources Council, Water and Energy Task Force, December 1981

2/ From Table E-6

3/ kwh x 65 mills/kwh

CONSUMER EFFECTS

15. The economic viability of such an investment is worth assessing from the accounting stance of the household. With tax credits for such investments totaling approximately 40%, a new system will cost the individual household approximately $1,800 ($3,000 first cost less the tax credit). With a 20-year useful life, a maintenance cost of $500 in year 10 (for new hot water tank) and using the Federal discount rate (which in theory is a non-inflationary discount rate), the present value cost for an individual = $2,040 (in constant 1982 dollars). With resultant savings of (.25)(500 kwh)/mo = 125 kwh/mo, valued at approximately 16¢/kwh, the present value of 20 years of these monthly savings of ($0.16/kwh)(125 kwh) $20 is equal to about $2,510. Allowing for real price escalation in the monthly savings equivalent to about 3% per year, the present value of the savings is about $3,140. With a present value of met benefit to the consumer of between ($3,140-$2,040) = $1,100 and ($2,510-$2,040) = $470, the equivalent monthly net benefit falls in the range of approximately $4 to $9 (reflecting constant dollars, an a 7-5/8% discount rate).

SUMMARY

16. Benefit cost data for Alternatives 1A, 2A, and 3 are summarized in Table E-8.

TABLE E-8

BENEFIT COST DATA FOR ALTERNATIVES 1A, 2A, AND 3 ($1,000's)1/

	Alternatives 1A	2A	3
Annualized Benefit (B)	891	1,093	811
Annualized Cost (C)	677	968	N/A
B/C Ratio	1.3	1.1	N/A
Net Benefits (B-C)	214	125	N/A

1/ January 1982 price levels, 100 year period of analysis, discount rate of 7-5/8%. Costs include interest and amortization on initial investment, plus operation, maintenance and replacement. POL date 1990.

SENSITIVITY OF BENEFIT ANALYSIS

POWER-ON-LINE DATE AND FUEL COST ESCALATIONS

17. The selected benefit estimates for the hydropower plans are POL date - dependent, with real fuel cost escalation resulting in higher benefit amounts for later project implementation years. Without including real fuel price escalation, Alternatives 1A and 2A would have lower benefits, based on 48 mills/kwh (see Table E-4), amounting to $541,000/year and $664,000/year, respectively. Without accounting for fuel cost escalation, the hydroplants being considered would become economically infeasible with costs and benefits as presently estimated (Table E-9). As noted elsewhere in this report, the energy future for Kauai remains relatively uncertain, at least in the long term. With electrical energy production tied to a significant extent to activity in the sugar industry, electrical generation could eventually be even more dependent on imported fossil fuels.

DISCOUNT RATE

18. If the discount rate were 10%, benefit values for the hydropower plans are not affected unless fuel cost real escalation is included. Benefit values drop from 79 to 76 and from 87 to 84 mills/kwh for POL dates of 1990 and 1995, respectively, if a 10% discount rate were to apply annualized costs would increase to $861,000 for Alternative 1A (from $677,000 at 7-5/8%) and to $1,242,000 for Alternative 2A (from $968,000). The change in the economic feasibility resulting from the use of a 10% discount rate instead of a 7-5/8% rate is shown on Table E-9.

TABLE E-9

PROJECT FEASIBILITY SENSITIVITY TO
POL DATE, DISCOUNT RATE, AND FUEL COST ESCALATION

Item	Alternative 1A Annual Benefits ($000)	Alternative 1A BCR	Alternative 2A Annual Benefits ($000)	Alternative 2A BCR
With Fuel Cost Escalation				
POL 1990				
7-5/8%	891	1.3	1,093	1.1
7-7/8%	891	1.3	1,093	1.1
10%	857	1.00	1,052	0.8
POL 1995				
7-5/8%	981	1.4	1,204	1.2
7-7/8%	981	1.4	1,204	1.2
10%	947	1.1	1,163	0.94
Without Fuel Cost Escalation				
POL 1990				
7-5/8%	541	0.8	664	0.7
7-7/8%	541	0.8	664	0.7
10%	541	0.6	664	0.5
POL 1995				
7-5/8%	541	0.8	664	0.7
7-7/8%	541	0.8	664	0.7
10%	541	0.6	664	0.5

SUMMARY AND CONCLUSIONS

19. Based on the power value data supplied by FERC, which assume continued real price escalation for fossil fuel, and which reflect a system energy displacement effect, both hydropower alternatives (1A and 2A) appear to be economically justified, with B/C ratios of 1.3 and 1.1, respectively (POL date = 1990). With a POL date of 1995, the B/C ratios are sightly higher. On the basis of these economic considerations alone, the selected hydropower plan is Alternative 1A, with net average annual benefits amounting to $214,000.

FEDERAL ENERGY REGULATORY COMMISSION
333 MARKET STREET, 6th FLOOR
SAN FRANCISCO, CA. 94105

May 11, 1982

Mr. Kisuk Cheung
Chief, Engineering Division
U.S. Army Engineer District, Honolulu
Ft. Shafter, Hawaii 96858

Dear Mr. Cheung:

As requested in your letter of February 10, 1982 (PODED-PJ), we have updated the estimated power values for your use in evaluating the economic feasibility of the Wailua River Hydropower Project, Kauai, Hawaii.

The most likely near-term plant additions would either be an additional bagasse-burning steam plant or conversion of existing gas turbines to combined cycle operation, depending upon developments in the sugar industry. However, our system analysis indicates the hydropower project would operate most beneficially as displacement energy for the existing system. The Kauai Electric Division system plant loadings are determined by a computer dispatching system to achieve lowest overall operating costs. Generally, changes in load are accommodated by output changes on several generators. The actual value of the displaced energy will be the weighted average of incremental energy costs for all of the affected machines.

Based upon January 1982 price levels, a project-on-line (POL) date of 1990, and projected escalation of real fuel costs, the system energy displacement value is estimated to be 79 mills per kilowatthour. This value may be used for both 7-5/8% and 7-7/8% discount rates because the difference is lost in rounding to 79 mills. Assuming a POL date of 1995, the system energy displacement value would increase to 87 mills/kWh. Relative fuel cost escalation follows the procedures recommended in the Water Resources Council publication "Implementing Procedures for Evaluating Hydroelectric Benefits," of December 1981. These total values are not influenced by the potential hydroelectric plant's capacity factor or dependable capacity.

As you know, the above values should be applied to the average annual energy output of each alternative and are applicable for National Economic Development power benefit evaluation purposes. Please advise us if additional information is required.

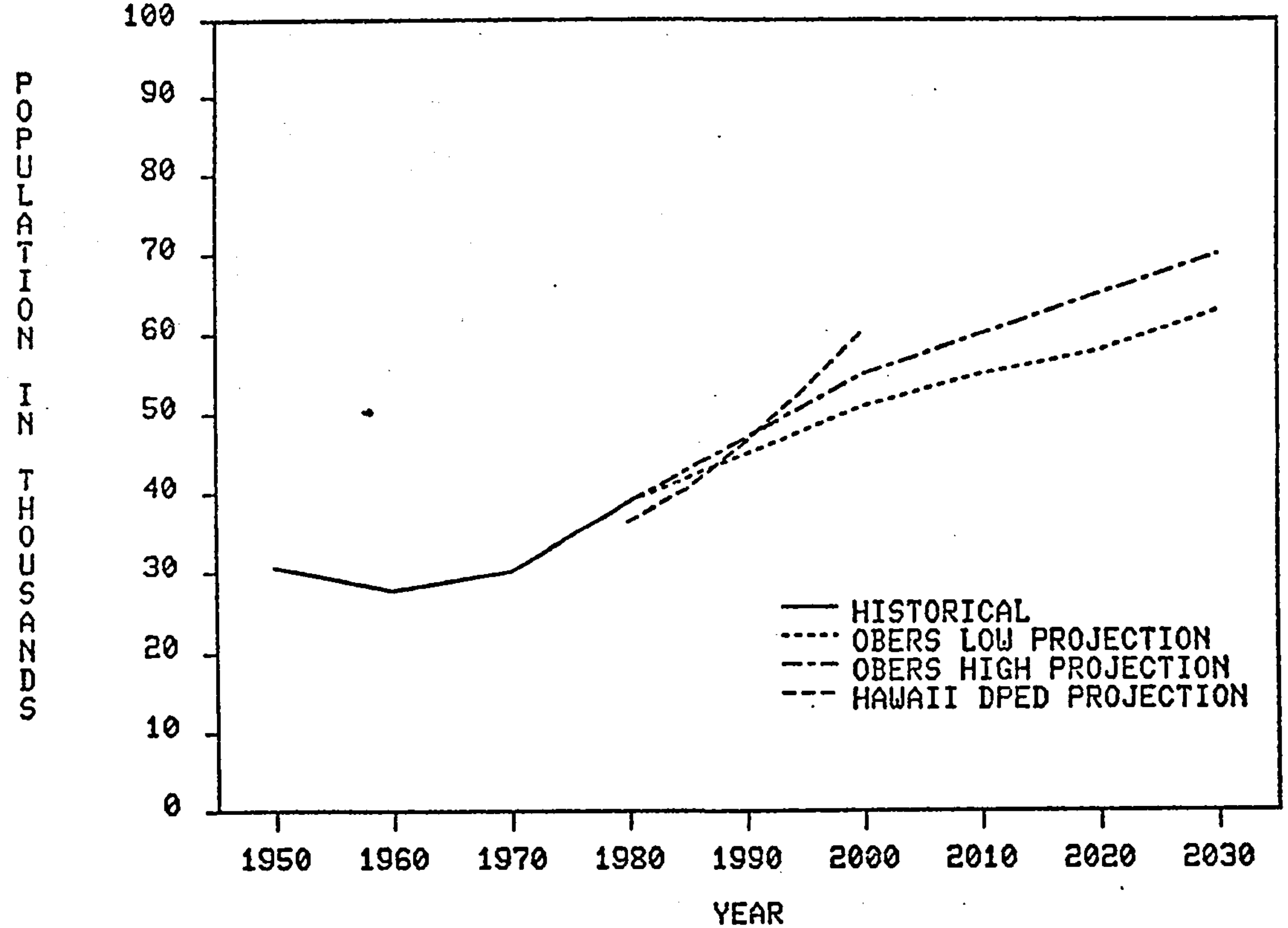
Sincerely,

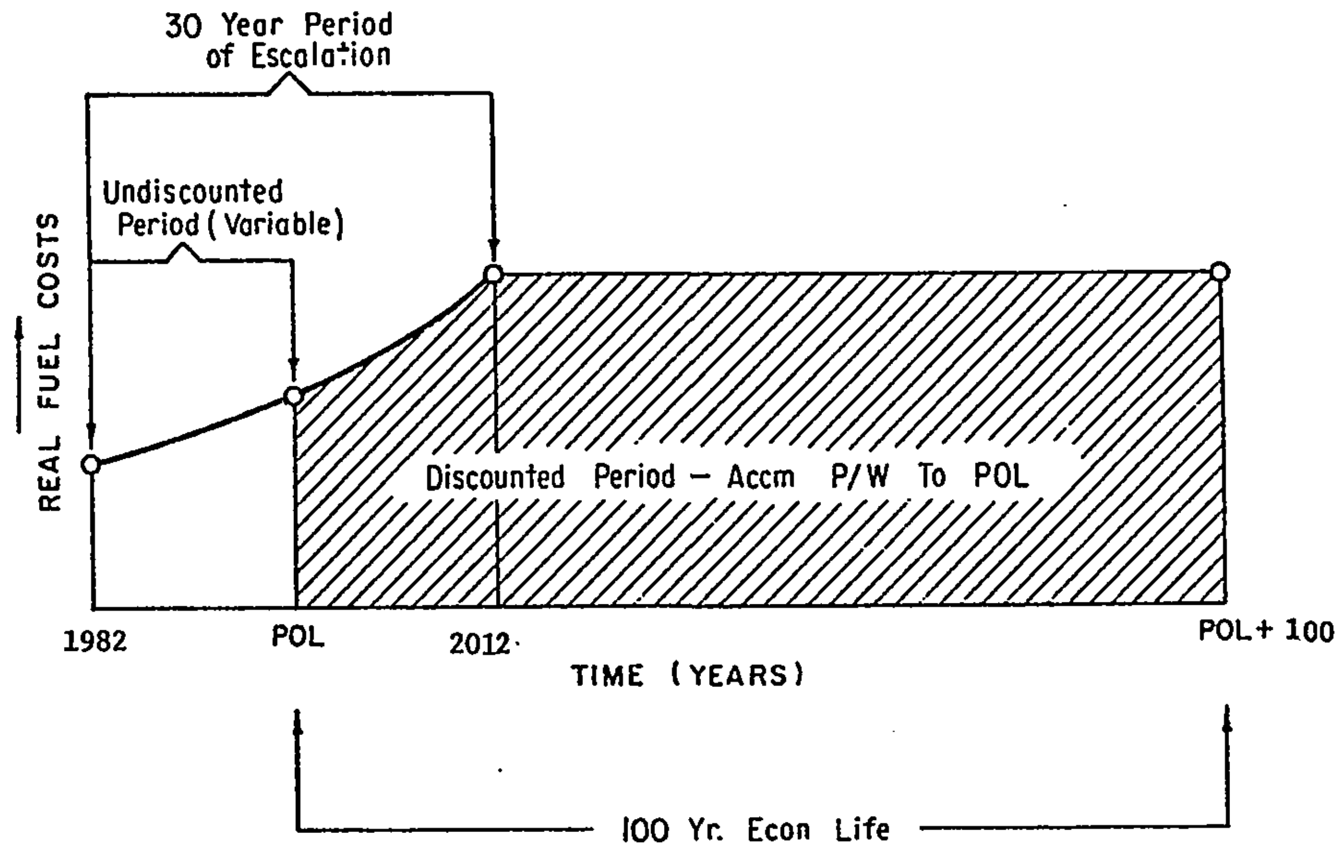
W. F. Kopfler, II

W. F. Kopfler, II
Regional Engineer

Copy to Corps of Engineers, NPD, Portland, OR
" " WAPA, Sacramento, CA

PLATE E-1. KAUAI POPULATION GROWTH





DISCOUNTING METHODOLOGY REAL FUEL ESCALATION

SOURCE: US Water Resources Council, Water and Energy Task Force, Evaluating Hydropower Benefits. Dec 1981.

WAILUA RIVER HYDROPOWER PROJECT
KAUAI, HAWAII

POWER MARKETING STUDY

APPENDIX F

Department of Energy
Western Area Power Administration
Sacramento Area Office
2800 Cottage Way
Sacramento, California 95825

In reply refer to: N6100

NOV 10 1982

Colonel Alfred J. Thiede
District Engineer
Department of the Army
Corps of Engineers
Pacific Ocean Division
Fort Shafter, Hawaii 96858

Dear Colonel Thiede:

The Sacramento Area Office of the Western Area Power Administration is pleased to submit its Final Power Marketing Study (Study) for inclusion in the Corps of Engineers' (Corps) Wailua River Hydropower Final Interim Survey Report and Environmental Statement. This document supersedes our previously transmitted draft study which was incorporated in the Corps' Draft Interim Survey Report and Environmental Statement (July 1982).

Our study focused on several issues relevant to the ultimate feasibility of marketing the project's power. Our findings are as follows:

- The project would be a prudent resource addition from both a resource planning and fuel diversity perspective.
- The project would be an economic benefit to Kauai when the total economic base of the County is considered.
- The project, under current assumptions, is economically competitive with other planned power resources given its 124 mill/kWh lifetime average cost.
- There are a number of customers who would qualify as preference customers under existing Federal reclamation law. The project's output when available would be totally used by these customers (see Table G).
- Excess energy that could be sold to Kauai Electric will probably be sold at a price that is based on the then current pricing concepts. The PURPA concept of "avoided cost" is one of several current concepts that may apply.

- Existing Federal law regarding the preference clause and the distribution of Federal power to preference customers could be incorporated into the congressional authorization for construction funding. Recent judicial decisions uphold the concept of the sale of power produced by a Federal project to be sold first to a preference customer before being made available to a private utility.

Given the above findings and the proposed plan of the Corps constructing the facility, the State of Hawaii being responsible for operation, maintenance, and replacement, and Western acting as the Power Marketing Agency, we conclude that the project power is marketable.

We have enjoyed working with the Corps on this project and appreciate the coordination efforts of Mr. Paul Mizue of your staff. Please do not hesitate to call us if we can be of any assistance in the future.

Sincerely,

David G. Coleman

David G. Coleman
Area Manager

Enclosure

APPENDIX F

POWER MARKETING STUDY

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POWER MARKET DESCRIPTION

o. Reference MAIN REPORT

EXISTING POWER SYSTEM (1981)

1. The existing electric generation systems consist of a mix of diesel generators, residual oil-fired steam boilers, gas turbines, hydroelectric plants, and one biomass fueled (Bagasse) unit (refer to Table A). These units exhibit the following mix:

	Units	Installed Capacity MW
Diesel Generators	7	13.15
Resid. Oil-Fired Boilers	12	46.75
Gas Turbines	2	39.93
Hydroelectric	9	8.70
Bagasse	1	20.00
TOTAL	31	128.75

2. The Kauai Electric Division (KED) assumed control of the major oil-fired generators at Port Allen in 1969, while the sugar companies (which had previously owned all electric generation facilities) retained ownership of several small oil units and all of the hydroelectric facilities. In addition, Lihue Sugar developed one new bagasse-fired unit in conjunction with KED in 1981. The split in ownership of existing units is as follows:

	Oil & Gas Fired	Hydro & Other	Total %
KED	62.08 MW	0 MW	48%
Sugar Co.	37.65 MW	28.7 MW	52%

3. The KED units were installed from 1964 to 1977; the sugar company units are typically 25-30 years or older. No new hydroelectric facility has been built on Kauai since 1954 except for an extremely small, privately owned (0.0015 MW) unit and some relatively minor upgrades.

4. 78% of the installed capacity on the island is oil or gas fired. All capacity on the island that is not oil or gas fired is fueled from renewable energy sources. (Note: prior to the 1981 installation of the 20 MW Lihue bagasse facility, 92% of the island's capacity was oil or gas fired).

5. KED's existing base load, peak capacity, and firm purchases are as follows (based upon a KED letter to the Western Area Power Administration February 2, 1982):

		Base Load KW	Peak Load KW
Diesel:	#1	1,825	2,000
	#2	1,825	2,000
	#3	2,500	2,750
	#4	2,500	2,750
	#5	2,500	2,750
	Subtotal	11,150	12,250
Steam:		9,700	10,000
Gas Turbine:	Hitachi	16,100	17,650
	JBE	20,530	22,180
	Subtotal	36,630	39,830
Firm Purchase:	Lihue	12,000	12,000
	TOTAL	69,480	74,080

6. For discussion of the existing electric transmission system, rates, and relationship of the sugar companies' system to KED refer to the MAIN REPORT.

TABLE A
COUNTY OF KAUAI - EXISTING ELECTRIC GENERATION FACILITIES (1981)

	OIL & GAS FIRED GENERATION				HYDRO & RENEWABLE GENERATION			
	CAPACITY (MW)		LIFETIME (YR)		CAPACITY (MW)		LIFETIME (YR)	
OWNERSHIP AND UNIT	INSTALLED	ACTUAL 1/	ONLINE	EST. RETIRE	INSTALLED	ACTUAL	ONLINE	EST. RETIRE
KAUAI ELECTRIC DIVISION								
Diesel 1	2.00	1.825	1964	1994				
Diesel 2	2.00	1.825	1964	1994				
Diesel 3	2.75	2.50	1968	1998				
Diesel 4	2.75	2.50	1968	1998				
Diesel 5	2.75	2.50	1968	1998				
Steam	10.00	9.70	1969	1999				
Gas Turbine 1(Hitachi)	17.65	16.10	1972	2000+				
Gas Turbine 2 (JBE)	22.18	20.53	1977	2000+				
Subtotal	62.08	57.48			0	0		
McBRYDE SUGAR CO.								
Steam 1	7.75	7.75	1965	1995				
Steam 2	7.75	0	1965	1995				
Steam (Old Site)	2.50	0	1952	1982				
Wainiha 1					1.8	1.6	1928	----
Wainiha 2					1.8	1.6	1928	----
Kalaheo					1.0	0.8	1928	----
Malumalu					0.3	0.0	1919	Retired
Subtotal	18.0	7.75			4.9	4.0		
KEKAHA SUGAR CO.								
Steam 1	1.0	1.0	1930	----				
Steam 2	2.5	2.5	1950	----				
Steam 3	2.5	2.5	1929	----				
Lower Waiawa					0.50	0.33	1907	----
Mauka					1.00	0.75	1954	1984
Subtotal	6.0	6.0			1.50	1.00		
LIHUE PLANTATION SUGAR CO.								
Steam 1	2.0	1.75	1949	----				
Steam 2	4.0	4.0	1957	1987				
Steam 3	4.0	4.0	1957	1987				
Hydro 1					0.8	0.8	1941	----
Hydro 2					0.5	0.5	1930	----
Bagasse 1					20.0	20.0 2/	1981	2000+
Subtotal	10.0	9.75			21.3	21.3		
OLOKELE SUGAR CO.								
Steam 1	2.0	2.0	1965	1995				
Steam 2	0.75	0	1941	----				
Diesel 1	0.45	0.45	1970	2000				
Diesel 2	0.45	0.45	1970	2000				
Nonopahu					0.5	0.5	1930	----
Subtotal	3.65	2.90			0.5	0.5		
TOTAL	99.73	83.88			28.7	26.9		
TOTAL GENERATION (MW)								
Installed	(128.43)							
Actual	(110.78)							

1/ Actual capacity for KED units reflects KED estimates of baseload capacity (Feb. 1, 1982 letter to WAPA from KED)
2/ 12 MW firm capacity sold to KED 11 months out of the year (except January).

FUTURE POWER AND ENERGY REQUIREMENTS

7. This section will discuss forecasts of electric capacity and energy for Kauai exclusive of the demand by the sugar companies, since these companies supply 100% of their demand through company-owned generation.

8. A report by the U.S. Army Corp of Engineers, "National Hydro-Electric Power Study Regional Report: Vol. XXIII," Hawaii, May 1981; has summarized energy and peak demand projections for the state of Hawaii based on several sources. Table B summarizes the applicable projections from Chapter 4 of the aforementioned report.

9. One of the two most recent reports analyzing future energy and power demand for the state of Hawaii was the Harza Engineering Company Report, "The Magnitude and Regional Distribution of Needs for Hydropower, The National Hydropower Study: Phase II - Future Electric Power Demand and Supply," 1980. This report made three projections based on different economic scenarios. Growth rates in energy and peak demand projections were as follows:

	Energy G.R. 1978-2000	Peak Demand G.R. 1978-2000
Projection I	3.2%	3.3%
Projection II	3.9%	4.0%
Projection III	5.2%	5.2%

Population in all cases was assumed to grow at an average annual rate of 1.3%. As this range of forecasts indicates, the state of Hawaii "State Energy Plan" Energy (GWH) Growth rate of 2.5% for KED (see Table B) is lower than projection I for the State. Similarly, KED's 1979 projections of 3.2% (see Table B) growth rate for peak load are comparable with the most conservative (Projection I) statewide forecasts in the Harza report.

10. The Federal Power Commission's Form 12 requires a four-year projection of energy and peak demand. KED's 1980 data is as follows:

	1981	1982	1983	1984	Ave. Annual Gr.
Peak (MW)	39.8	41.3	42.8	43.3	2.85%
Energy (GWH)	219.5	227.3	235.5	238.3	2.80%

(The 2.8% rate in peak growth is substantially lower than the 4.0% (1980-1984) growth rate KED submitted in Table B. Also note that these forecasts are before line losses of about 10.5% have been accounted.)

TABLE B

Summary of energy and peak demand forecasts relevant to Kauai - based on U.S. Army Corp of Engineer Report; "National Hydroelectric Power Study Regional Report," Hawaii, May 1981.

Table B-1: Kauai Electrical Energy Demand Forecast

	1980	1985	1990	1995	2000	2005
Energy	187	230	272	297	306	314
Growth Rate %		4.26	3.38	1.81	0.58	0.54

(Note: Average Annual Growth Rate 1980-2000 = 2.50%)

Source: "State Energy Plan," Dept. of Planning and Economic Development, State of Hawaii, Sept. 1980. State Projected Electrical Energy Demand Forecast, Hawaii, 1980-2005 (Kauai Data Excerpted from Table 4-1).

Table B-2: Kauai Peak Load and Generation Capacity Forecasts

	1980	1982	1984	1986	1988
Peak Load (MW)	38.0	41.2	44.4	47.7	50.9
Capacity (MW)	62.1	74.1	74.1	74.1	74.1
	1990	1992	1994	1996	1998
	54.2	57.4	60.7	63.9	67.2
	82.1	82.1	92.1	114.3	114.3

(Note: Average Annual Growth Rate (Peak Load Growth) 1980-1998 = 3.2%)

Source: Official KED projections 1979. Public Utilities Project Peak Load and Generating Capacities 1979-1998 (Kauai data excerpted for specific years from Table 4-2).

11. The most recent report analyzing the state's and Kauai's electricity energy demand was the "Hawaii Integrated Energy Assessment" LBL, June 1981. This report used "an econometric-based simulation" model to develop forecasts to the year 2005 by fuel type. The results of cases assuming various macro-economic conditions were as follows:

(GWH)	1980	1985	1990	1995	2000	2005
Baseline Macro	191.4	237.2	290.4	339.4	378.8	415.5
High World Oil Price	191.4	216.8	227.2	220.8	201.6	179.2
Low Macro-econ.	186.4	205.6	244.9	284.7	329.9	376.7
High Macro-econ.	196.9	258.0	355.9	515.4	760.4	1089.5

12. The last communication Western Area Power Administration received from KED was February 2, 1982. In Table 1 of this letter, KED projected a 3.6% average annual growth rate from 1982 to 1991 in both firm peak load and energy; the results of such a trend would be as follows:

	1981 1/	1982	1983	1984	1985	1986	1987
GWH	218.7	226.6	234.7	243.2	251.9	261.0	270.4
Peak (MW)	39.5	40.9	42.4	43.9	45.5	47.1	48.8

	1988	1989	1990	1991
GWH	280.1	290.2	300.7	311.5
Peak (MW)	50.6	52.4	54.3	56.3

(Note: Energy is prior to line losses of about 10.5%)

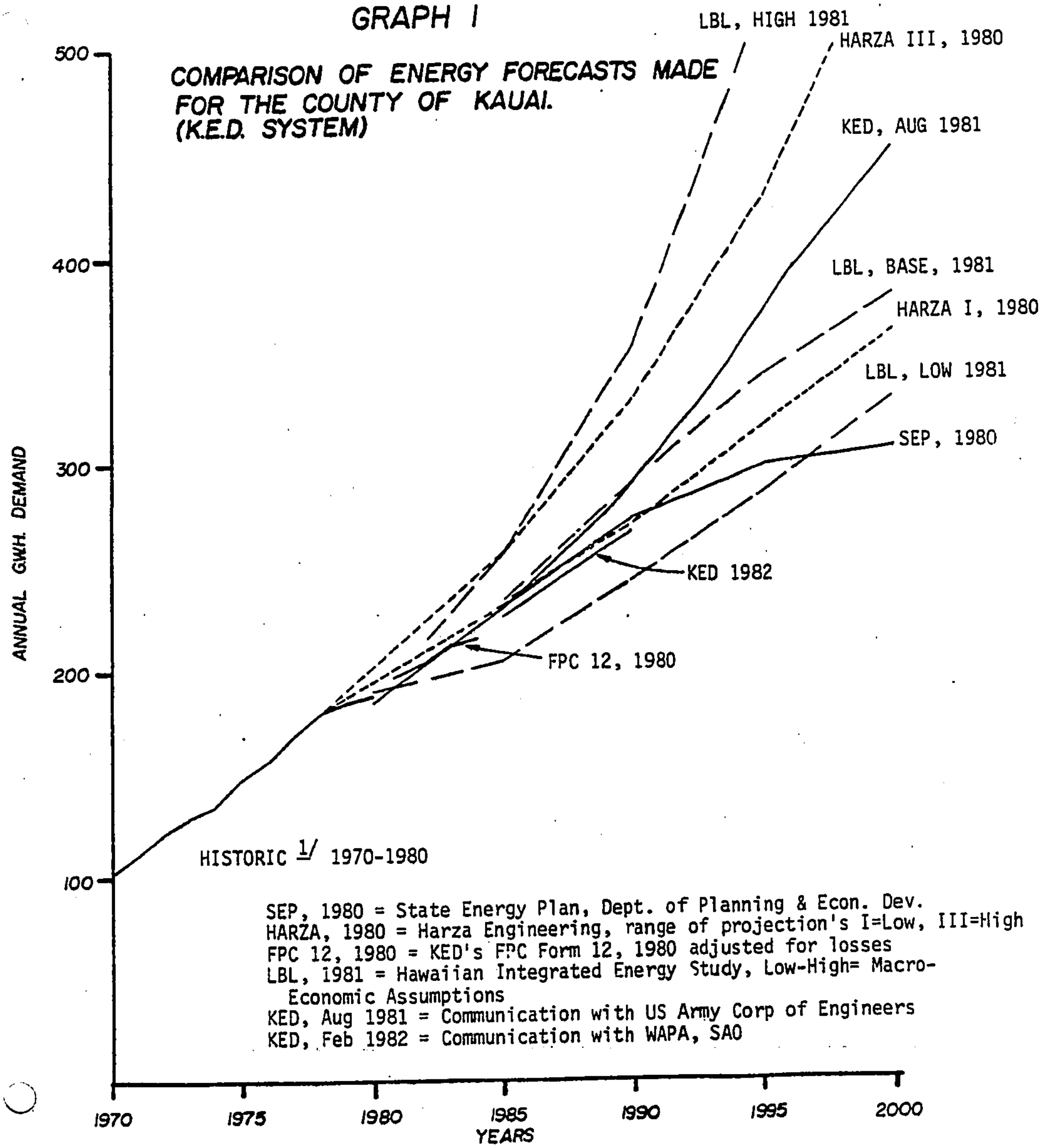
The energy growth rate is similar to Projection II of the Harza Report and is also similar to both the "State Energy Plan" and the Baseline Macroeconmic Scenario of the "Hawaiian Integrated Energy Assessment" of June 1981 (LBL).

13. The remaining data point regarding peak and energy forecasts is "personal communication" from KED officials to the U.S. Army Corp of Engineers in August 1981.2/ KED forecasts in that instance indicated the following future requirements:

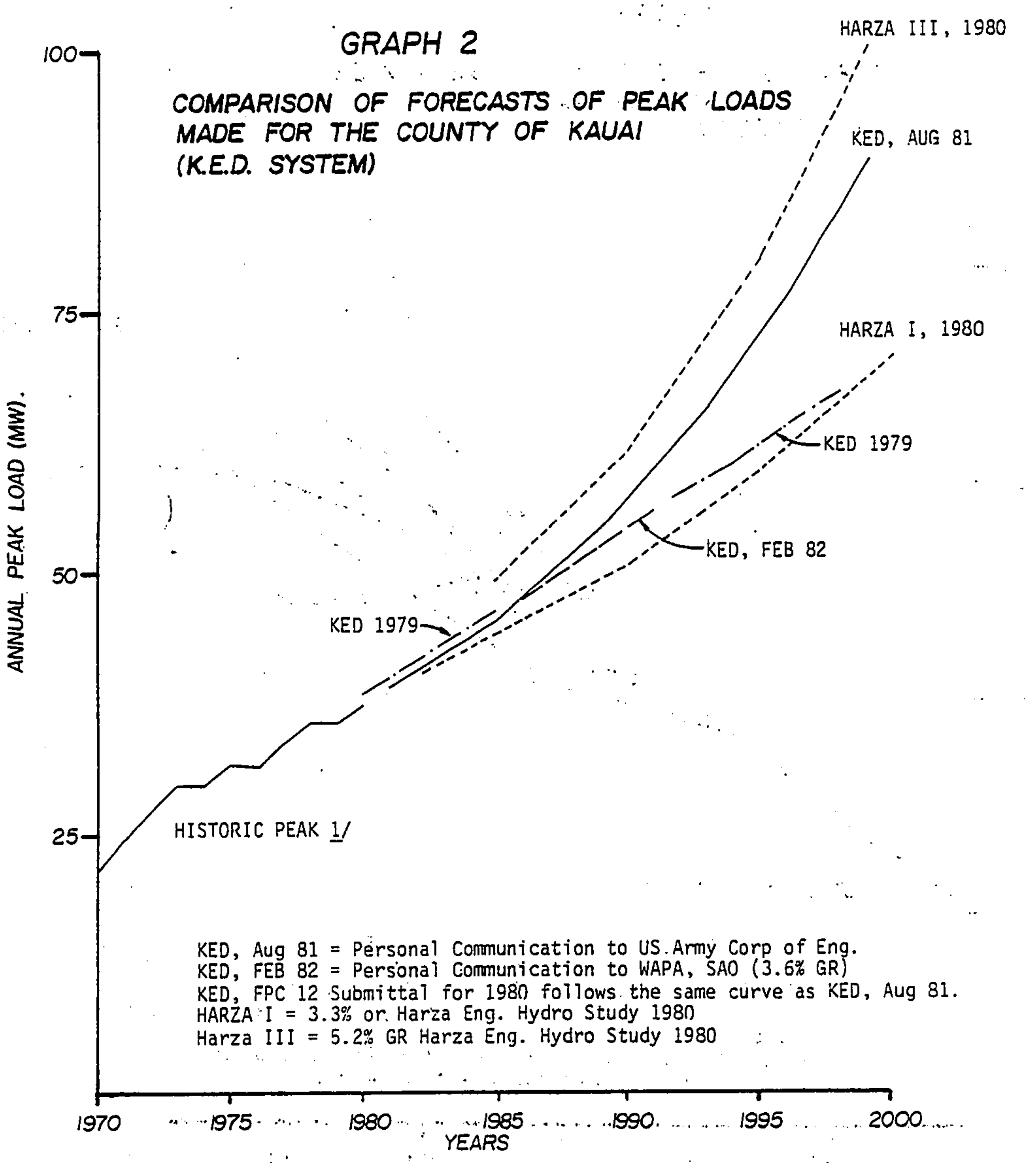
	1980	1981	1985	1989	1993	1996	1999
Peak Load (MW)	37.3	38.8	45.4	54.6	66.4	76.9	89.0
Energy (GWH)	189.2	196.8	230.2	277.1	336.8	389.9	451.4

14. Graph 1 (Energy) and Graph 2 (Peak) summarize the various projections of future energy and capacity requirements by the county of Kauai. Examination of Graphs 1 and 2 indicate that there is a wide range of variation in even the most recent energy and peak load forecasts. Since most energy forecasting models are driven by economic assumptions, (such as the rate of inflation, GNP, and real personal income growth) the more recent forecasts have shown less optimistic growth rates reflecting current economic conditions.

1/1981 data (actual) contained in 2/1/82 letter.
2/This data is contained on page 21 of the 1981 draft report.



1/ Based on various FPC Form 12's



KED, Aug 81 = Personal Communication to US.Army Corp of Eng.
KED, FEB 82 = Personal Communication to WAPA, SAO (3.6% GR)
KED, FPC 12 Submittal for 1980 follows the same curve as KED, Aug 81.
HARZA I = 3.3% or Harza Eng. Hydro Study 1980
Harza III = 5.2% GR Harza Eng. Hydro Study 1980

1/ Historic data from " Annual Report of Kauai Electric Division" to the state PUC

15. Table C summarizes all planned generation capacity additions on the island of Kauai as currently estimated (1981-1982) by the island utilities. The planned additions are proportioned as follows:

	Oil & Gas (MW)	Hydro (MW)	Other (MW)
KED	18 MW	0	0
Sugar Companies	0	5.25 MW	0
State of Hawaii	0	22.00 MW	0
U.S.Army Corp of Engrs.	0	4.0 to 7.0 MW	0
Total	18 MW	31 to 34 MW	0

Note that the 22 MW of hydro capacity planned by the State of Hawaii has all been indefintely suspended and that the Corp of Engineers' project is in the initial stages of a 10 to 14 year planning, engineering and construction cycle; therefore, the viability of all but the 18 MW planned by KED and 5.25 MW planned by the sugar companies is speculative.

16. The total installed capacity including the future planned additions and assuming no retirement of existing units will be 187.18 MW by year 2000 with 127.73 being oil or gas fired, 39.45 MW hydro electric, and 20 MW bagasse fired.

17. The 18 MW planned additions of KED are based on a February 2, 1982 letter from KED to the Sacramento Area Office of WAPA which contained the following information as "Table 3:"

> "18 MW steam turbine installed in 1989, to be operated at 8 MW using steam generated by the existing HRSG. HRSG installed in 1993 to operate in combined cycle with the Hitachi gas turbine and generate steam to operate the steam turbine at 18 MW."

This information reflects a change in KED's resource planning from as recently as August 1982 when KED's plans reflected an 8 MW addition in 1989 and a 22.2 MW addition in 1996.

18. Bagasse, solar, and wind power would be the most likely alternative energy source other than oil, gas, or hydro electricity based on the documents, "Energy Self-Sufficiency for the Island of Kauai, Vol. 1 & 2," Hawaii Natural Energy Institute, June 1979, and "Hawaii Integrated Energy Assessment, Vol. 2" LBL June 1981. Geothermal energy would not be considered as a likely option for Kauai based on the LBL study.

TABLE C

POTENTIAL AND PLANNED ADDITIONS IN GENERATION CAPACITY

OWNERSHIP/UNIT	OIL & GAS FIRED INSTALLED CAPACITY	OIL & GAS FIRED EST. ONLINE DATE	HYDRO PROJECTS INSTALLED CAPACITY	HYDRO PROJECTS EST. ONLINE DATE	OTHER POTENTIAL INSTALLED CAPACITY	OTHER POTENTIAL EST. ONLINE DATE	TOTAL MW 2000
KAUAI ELECTRIC DIVISION							
Existing Capacity (81)	62.08		0		0		
Planned Additions:							
1/ Steam Turbine	8.0	1989	0		0		
Steam Turbine	10.0	1993					
Subtotal	90.08		—		—		90.08
McBRYDE SUGAR CO.							
Existing Capacity	18.0		4.9		0		
Planned Additions	0		0		0		
Subtotal	18.0		4.9		0		22.90
KEKAHA SUGAR CO.							
Existing Capacity	6.0		1.5		0		
Planned Additions	0				0		
Waiawa Upgrade (w/AMFAC)			0.7	1986+			
Kokee Ditch (W/AMFAC)			1.4	1986+			
Subtotal	6.0		3.6		0		9.60
LIHUE PLANTATION SUGAR CO.							
Existing Capacity	10.0		1.3		20.0 (Bagasse)		
Planned Additions:	0				0		
Hydro Upgrade Project			1.9	1986+			
Subtotal	10.0		3.2		20.0		33.20
OLOKELE SUGAR CO.							
Existing Capacity	3.65		0.50		0		
Planned Additions:	0				0		
Hydro Upgrade Project			1.25	1982			
Subtotal	3.65		1.75		0		5.40
STATE OF HAWAII							
Planned Additions:	0						
Kokee Water Project			10.0	1990+			
Waialeale Hydro Proj.			9.2	1990+			
Puu Opae-Mana (w/AMFAC)			3.0	1990+			
Subtotal			22.0				22.0
U.S.CORP OF ENGINEERS							
Planned Additions:	0						
Wailua River Project			4 to 7	1990+			4.00
TOTALS	127.73		39.45		20.0		187.18

1/ Based on KED letter to WAPA 2/1/82. (Note: Only one 18 MW turbine to be installed in 1979; an additional HRSG adds 10 MW capacity in 1993.)

19. In regards to bagasse fuel potential, approximately 32.3 thousand tons of bagasse were being disposed of yearly as of 1978 with a heat content as a boiler fuel of about 4,500 BTU/lb.1/ This estimate indicates a substantial potential for additional bagasse units; however, the estimate of bagasse availability is contradicted by the 1979 Hawaiian Natural Energy Institute Report that indicates that almost all of the bagasse waste (96%) was being used as fuel in industry operations as of 1978.

20. The most recent resource addition on Kauai was a 20 MW bagasse unit in 1981. This indicates that such a facility is commercially available and cost competitive with at least marginal oil and gas fired generation. Bagasse units would appear to be able to produce firm capacity 11 out of 12 months of the year based on crop production.

21. For further discussion of alternative resources reference the text of the MAIN REPORT and the LBL June 1981 report "Hawaiian Integrated Energy Study, Vol. II: Alternative Energy Technologies for Hawaii."

1/ Hawaiian Integrated Energy Study, June 1981, LBL, P.102.

RESOURCE PLANNING ANALYSIS

22. The previous three sections have discussed the existing electric generation system's installed MW, age and diversity; identified the range in forecasts of energy and capacity; and, summarized potential generation capacity additions. This section will examine peak capacity versus peak loads and the balance of resources necessary to meet energy demand. A brief qualitative discussion of the integration of future units into the system will conclude the section.

23. Although it is assumed that all future sugar-company generation additions will serve only company loads, Graph 3 illustrates the magnitude of all existing, planned, and potential resource additions on the island of Kauai to year 2000 in terms of installed MW. If the Wailua River Hydro Project is compared to the capacities in Graph 3, it proportionally appears as the following (assuming 5.1 MW installed; option 1A):

	1990	1995	2000
% of total installed MW	3.2	3.0	3.6
% of KED installed MW	7.3	6.7	8.8
% of Hydro installed MW	14.6	14.6	14.6
% of KED additions after 1981	38.9	22.1	22.1

24. In considering peak capacity versus peak load projections, only KED resources and potential resources will be examined. To properly assess peak capacity available to KED in the long term, system dependable capacity needs to be assessed for each future year considering future retirements, and the single largest contingency. The following assumptions regarding the dependable capacity were applied in Graph 4:

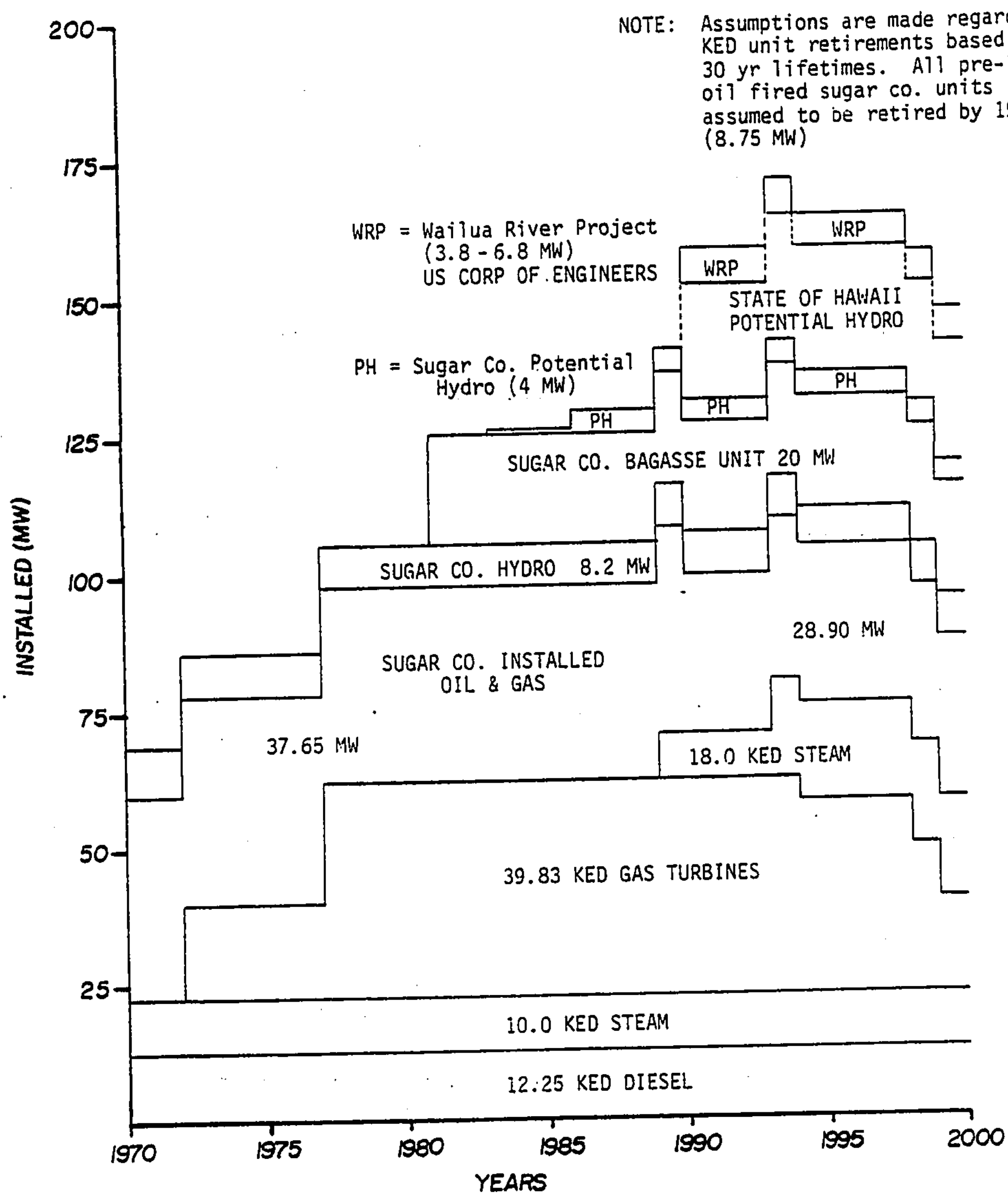
- Future retirements: KED system oil and gas-fired units were assumed retired at a 30-year lifetime which translates to 4 MW of diesel-fired generations being retired in 1994, and 8.25 MW in 1998. In addition, the 10 MW steam unit which was constructed in 1969 would be retired in 1999.

- Single largest contingency situation: Based on a review of the plant availability factors for KED's system, the units' per cent time down for scheduled or unscheduled maintenance is typically much less than 5% except for the JBE combustion turbine which is down 13.5% of the time. In the case of a system the size of KED's with no hydro increment, calculating the reserve margin as that capacity necessary to ensure system reliability when the single largest unit is down, is common practice[2/].

2/ FPC form 12, schedule 16, "Dependable and Assured Capacity Instructions."

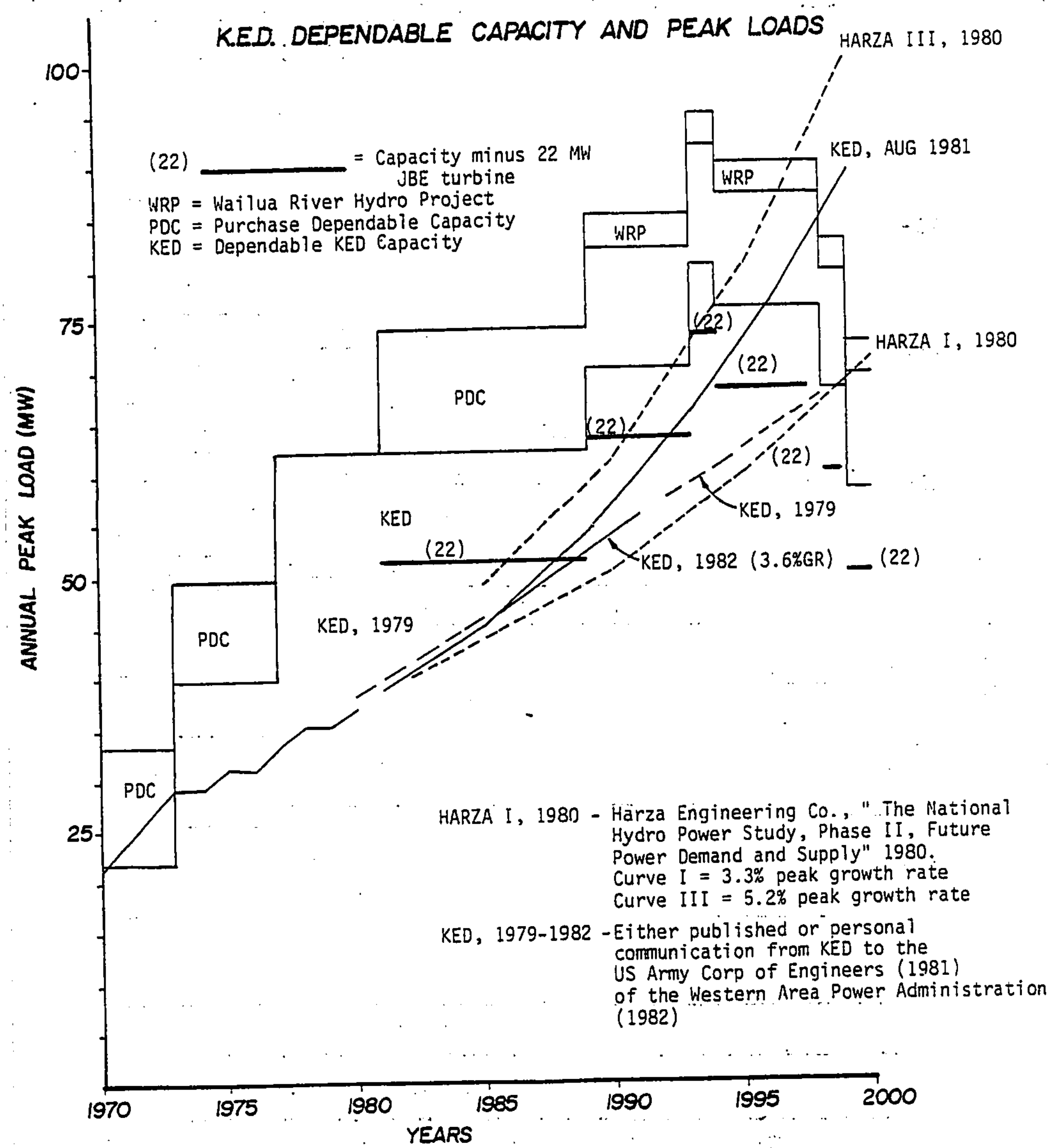
GRAPH 3

KAUAI POWER MARKETING STUDY — TOTAL EXISTING, PLANNED, AND POTENTIAL CAPACITY FOR THE COUNTY OF KAUAI.



GRAPH 4

K.E.D. DEPENDABLE CAPACITY AND PEAK LOADS



- Firm capacity purchases and the Wailua River Project: The Lihue Plantation bagasse unit is contractually committed to serve KED with 12 MW of firm (dependable) capacity except for the month of January. When considering the Wailua River Hydro Project, the Plan 1A Option will be assumed and the associated capacity of 5.1 MW installed will be discounted by a conservative 40% to represent average hydro conditions, which leaves approximately 3 MW as dependable capacity. In addition, it will be assumed that all such capacity will be available to KED's system with a plant on line date of 1990.

25. Graph 4 illustrates that even with the Lihue firm capacity purchase, that in the period 1981 to 1989 reserve margin will diminish to about 30% (when considering the KED, 1982 forecast), which is just sufficient to meet load without the JBE turbine on-line. After 1989, with the planned 18 MW additions KED should have adequate reserve margin until 1998 (assuming no retirements.) However, if the oil and gas units are retired as assumed, KED would have a reserve deficit. In the event of oil and gas unit retirements, the Wailua River Project seems to assist KED in terms of dependable capacity over the 1994 to 1998 time period. Finally, if the high peak growth forecasts (Harza III and KED August 1981) actually occur, the Wailua River Project would make no significant difference; in that KED would have to install or purchase additional capacity than already planned by the early 1990's.

26. A final important point in regard to peak loads, is that the purchased dependable capacity (Lihue 12 MW) will not be available in the month of January. During January, KED would appear to be extremely capacity short as shown in Graph 4 when the PDC is ignored.

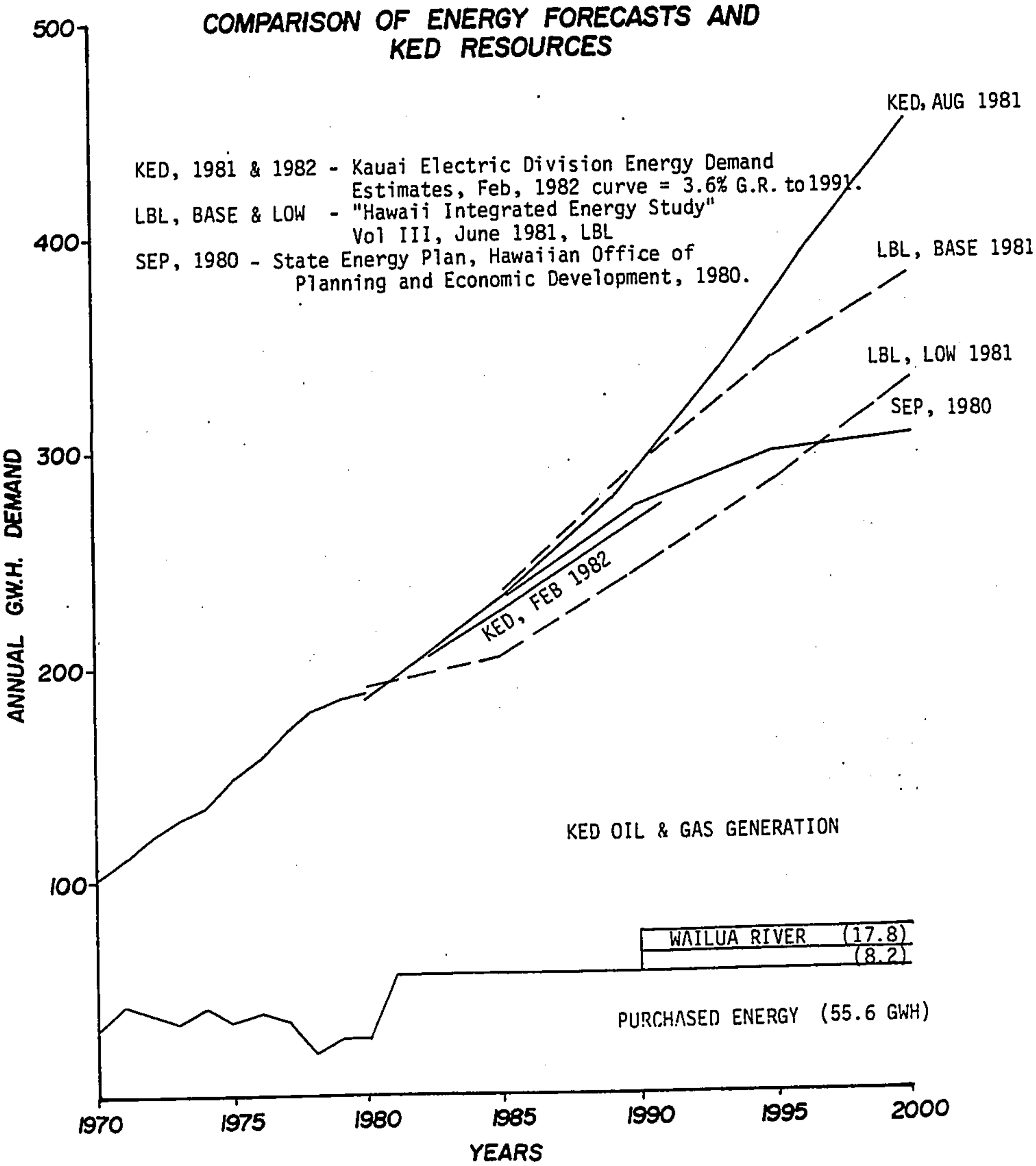
27. In terms of resource planning to meet energy demand, KED essentially must meet energy demand using its oil and gas generation after consideration of firm energy purchases. Graph 5 illustrates the historic and projected energy demand from resources available to KED. Historically, KED has not had to operate its oil and gas units at extremely high yearly average capacity factors to meet demand, as shown in 1978 and 1980 below (based on FPC from 12 data):

	1978	1980
Diesel Units, CF%	9%	5%
Steam Unit, CF%	62%	62%
Hitachi-CT, CF%	25%	8%
JBE-CT, CF%	39%	60%

28. Graph 5 assumes that the Lihue bagasse unit will supply 55.6 GWH energy annually, and that the Wailua River Project would produce between 8.2 and 17.8 average GWH per year.

GRAPH 5

COMPARISON OF ENERGY FORECASTS AND KED RESOURCES



29. According to Graph 5, the KED oil and gas system would have to generate the following approximate amounts of energy in future years to meet various forecasts (in GWH and assuming no Wailua River Project):

	1985	1990	1995	2000
LBL, Low 1980	149	194	229	274
LBL, Base 1980	177	235	285	324
SEP, 1980	175	217	243	238
KED, 1981	175	235	319	395
KED, 1982	169	210	-	-
(KED, MW of Oil & Gas)	62	70	76	58

30. Given the oil and gas capacities listed above (same retirement assumptions as for the capacity assessment), then the total KED oil and gas system would have to operate at an average yearly capacity factor to meet the forecasts as follows:

	1985	1990	1995	2000
LBL, Low 1980	27	32	34	54
LBL, Base 1980	33	38	43	64
SEP, 1980	32	35	36	47
KED, 1981	32	38	48	77
KED, 1982	31	34	-	-

If the Wailua River Hydro Project were considered, these capacity factors would be lowered by about 3 to 4% in 1990 and 2 to 3% in 1995 and 2000. The capacity factors shown are not unreasonable to expect from combustion turbines and combined cycle units, although the 77% average is at the margin.

31. Since the KED system is comprised of oil and gas units which are dispatched at the discretion of the utility, integration of a 3.8 to 6.8 MW hydro facility (project size under consideration) which would fluctuate in energy and capacity capability based on hydrologic conditions, should not present a problem to the integrity of the system.

FINANCIAL ANALYSIS

DEPARTMENT OF ENERGY REPAYMENT CRITERIA

32. Department of Energy (DOE) financial reporting policies, procedures, and methodology for Power Marketing Administrations (PMA's) require that an annual power repayment study be prepared and published for each power system. Each power repayment is to consist of historical and forecasted data which will be updated annually to test the continuing adequacy of existing rates. The annual repayment study must reflect the same basic power system included in the initial study, but forecast current operating results and update forecasts of revenues and costs for the remaining years of the study.

33. Whenever a current power repayment study shows that repayment requirements are not being met, action will be taken by the PMA to prepare and recommend a plan to be implemented at the next practical time to satisfy the repayment requirements (or explain why such requirements cannot be met). Such plan may include increasing rates, decreasing costs, changing contracts, or any other viable means for meeting cost recovery criteria. The plan will be supported by a revised power repayment study which will meet the cost recovery criteria.

34. The time during which future estimates of costs and revenues may be modified to reflect changing conditions, such as an addition to the power system or inflation, for purposes of changing rates is normally five years. Revenue and costs for the remaining years of a power system repayment period should reflect price levels, rate levels, and contractual commitments consistent with conditions anticipated during the cost evaluation period.

35. The power revenues for the project must be adequate to repay those investment costs allocated to power and associated interest during construction (IDC), interest on unpaid investment, annual operation and maintenance costs (O&M), facility replacement costs (R) associated with the project, purchase and exchange power costs, transmission, and other costs. Costs associated with the sale and delivery of water are allocated/recovered through water revenues. At this time, no water revenues are anticipated with the Wailua project.

36. Unless otherwise prescribed by law, investment cost must be repaid with interest within a period not to exceed fifty years. Repayment periods of less than fifty years may be established when the facilities involved have useful life expectancies of less than fifty years.

37. Except as otherwise provided by law, the interest rate used to compute IDC, and the interest rate on the unpaid balance of the cost of a Federal project, the construction of which was initiated after January 29, 1970 (draft of financial reporting policies, procedures and methodology for all DOE, PMA's RA6120.2, dated September 20, 1979), and which was allocated to commercial power development, shall be the applicable rate during the fiscal year in which funds are first appropriated to initiate construction of project

facilities. The interest rate is set by the Secretary of the Treasury based on computations as of the beginning of the current fiscal year. The yield rate is the average yield during the preceding fiscal year on interest-bearing marketable securities of the United States which at the time of the computation is made, have terms of 15 years or more remaining to maturity.

The average yield being the average during the fiscal year of the daily bid prices. The computed rate being the multiple of one-eighth of one percent nearest to such average rate. If the computed yield rate doesn't differ from the applicable interest rate used by the PMA's during the previous fiscal year by more than one-half percent, the applicable rate to be used by PMA's shall be equal to the yield rate. If the yield rate differs from the previously used interest rate by more than one-half of one percent, the interest rate to be used shall equal the previous year's interest rate increased or decreased one-half of one percent toward the yield rate. The applicable interest rate for FY 1982 is nine percent. DOE is now considering changing the above methodology in the following respects: the interest rates would be the applicable rate during the fiscal year in which construction began; and, the applicable rate to be used each year would be the yield rate (no exceptions). These proposed policy changes have not been adopted to date.

WAILUA RIVER HYDROPOWER PROJECT

38. The procedure to financially analyze the Wailua River Hydropower Project would be to estimate the cost of power generated by the project and compare the cost to the estimated cost of power from an alternative source. This procedure is known as comparative economic cost analysis.

39. Preliminary composite energy rates for the Wailua River Project's Plans 1A and 2A were developed using the 1982 investment cost, IDC, and OM&R costs developed by the Army Corps of Engineers for their Draft Interim Survey Report and Environmental Statement (June 1982). These base data costs were updated to 1990 costs, assuming a 5 percent per year inflation increase. Payments to amortize investment cost and IDC during a fifty year repayment period are based on a 9 percent interest rate. The 5 percent per year increase in OM&R costs was assumed through year 2011, thirty years beyond 1982. The estimated costs and associated composite energy rates for Plans 1A and 2A are listed on Tables D and E. It should be noted that the costs and rates do not include capacity firming charges or wheeling costs. Adequate data is not available to estimate the firming and wheeling costs at this time. These costs would have to be negotiated with Kauai Electric.

40. Additional estimated costs to cover the cost of serving project generation to power customers would be required to compare the project's power rates with an alternative; the amount and type of these costs depend on the ultimate power marketing arrangement for the sale of the project's power.

41. The estimated project composite energy rate could be compared to the cost of power from an alternative source, which could be the present supplier's avoided cost (marginal cost) or the cost paid by the "final user". An estimate of transmission line losses and any additional costs of delivering power to the customer would have to be included in each power rate estimate. Power rates on Kauai are high due to heavy dependence on oil fired generation. The average residential rate on Kauai, based on the State of Hawaii, DPED, Hawaii Integrated Energy Assessment, Vol. IV, 1980, during 1981 exceeded 150 mills/kWh and has increased by an average annual rate exceeding 10% since 1969.

42. Kauai Electric's (KE) avoided cost varies from hour to hour depending on their load level and the last generating unit committed. KE's 1982 avoided costs, based on fuel prices of January 1, 1982, range from 50 to 70 mills per kWh depending on the mode of their last committed plant's operation. If KE's gas turbine-combined cycle is used, their estimated avoided costs are in the 50 mill/kWh range. If KE's steam and diesel units are used, their estimated avoided costs are in the 70 mill/kWh range. (Kauai Electric's February 1, 1982 letter to WAPA-Sacramento.)

43. During the next ten years, Kauai Electric anticipates that their load growth will require additional gas turbine-combined cycle generation. Assuming that No. 2 diesel fuel prices escalate by a certain amount per year through 1991, Kauai Electric states that their avoided costs should track the same rate of increase per year starting with 1982 at 50 mills/kWh. For example, based on annual fuel cost increases of 5 percent and 10 percent through 1991, their 1991 avoided costs would equal 78 and 118 mills/kWh, respectively.

44. In economic terms, "final users" would be the ultimate power user and total cost of service would include distribution, metering, billing, and other service expenses. Output from Federal projects such as municipal and industrial water supplies and power are normally sold to producers and distributors; that is, municipalities, irrigation districts, military bases, state agencies, etc., at bulk or wholesale prices. These Federal "customers" must pay as a minimum the incremental or marginal Federal cost of service provided by the project. However, the Federal "customers" may pass these costs along with distribution costs to their final consumers, but the rate is normally set by averaging bulk power costs with distribution costs to recover total cost. Assuming that lowest cost resources are developed first, marginal costs (excluding distribution) usually represent the highest cost source.

45. Assuming that the USACE constructed the facility, the State owned, operated and maintained the facility, and Western marketed and administered the project's output, Western would collect the revenues for power sales and disburse the revenues to the USACE for investment and IDC costs and to the State for OM&R costs. Western would retain a portion of the power revenues to cover power billing and administrative costs. Power firming and wheeling costs, if required, would also be disbursed by Western to the appropriate organization.

TABLE D

WAILUA RIVER
HYDRO POWER PROJECT
COMPOSITE ENERGY RATE
PLAN 1A

(1) Year No.	(2) Year	(3) Payments To Amortize Principal & IDC	(4) OM&R Cost	(5) Total Annual Cost Cols. (3 & 4)	(6) Annual Generation Available @ Project MWH	(7) Cost of Energy @ Project Mills/kWh	(8) Notes
1	1990	$ 1,095,000	$ 146,000	$ 1,241,000	11,280	110	Repayment based on 9% interest and a 50-year time period.
2	91						
3	92						
4	93						
5	94						
6	1995		180,000	1,275,000		113	OM&R was increased 5%/year through 2011, which is 30 years beyond 1992.
7	96						
8	97						
9	98						
10	99						
11	2000		236,000	1,331,000		118	
12	01						
13	02						
14	03						
15	04						
16	2005		292,000	1,387,000		123	
17	06						
18	07						
19	08						
20	09						
21	2010		360,000	1,455,000		129	
22	11						
50	2039	1,095,000	360,000	1,455,000	11,280	129	
Totals		$54,750,000	$15,070,000	$69,820,000	564,000	*124	

*Average

TABLE E

WAILUA RIVER
HYDRO POWER PROJECT
COMPOSITE ENERGY RATE
PLAN 2A

(1) Year No.	(2) Year	(3) Payments To Amortize Principal & IDC	(4) OM&R Cost	(5) Total Annual Cost Cols. (3 & 4)	(6) Annual Generation Available @ Project MWH	(7) Cost of Energy @ Project Mills/kWh	(8) Notes
1	1990	$ 1,627,000	$ 214,000	$ 1,841,000	13,840	133	Repayment based on 9% interest and a 50-year time period.
2	91						
3	92						
4	93						
5	94						
6	1995		269,000	1,896,000		137	OM&R was increased 5%/year through 2011, which is 30 years beyond 1982.
7	96						
8	97						
9	98						
10	99						
11	2000		352,000	1,979,000		143	
12	01						
13	02						
14	03						
15	04						
16	2005		435,000	2,062,000		149	
17	06						
18	07						
19	08						
20	09						
21	2010		532,000	2,159,000		156	
22	11						
50	2039	1,627,000	532,000	2,159,000	13,840	156	
Totals		$81,350,000	$22,310,000	$103,660,000	692,000	*150	

*Average

EXTENT OF FEDERAL INVOLVEMENT

46. This section discusses the potential role of the federal government in marketing the Wailua River Hydroelectric Project power, assuming that the current plans of the U.S. Army Corps of Engineers (USACE) are implemented, wherein the USACE would construct the powerplant, the State of Hawaii would operate and maintain the project, and the Western Area Power Administration (Western) would be the power marketing agent.

47. As the marketing agent, Western's responsibility would be to determine: which specific loads on Kauai should receive the federally produced power and then to ensure that the benefits of such power were delivered to the designated customers. This delivery of benefits does not necessarily have to be through the direct transmittal of the lower cost project power, but could take place via actions such as displacement contracts with the utility (Kauai Electric Division - KED) in the region of the project, or through the direct sale of the project energy at the generation busbar and the application of those revenues to energy purchases at the designated loads.

48. The role played by the Federal government in power generation and distribution has long been established and is discussed further below. On the mainland, five Power Marketing Administrations (PMA) carry out the power functions of distributing electric power from Federal facilities through most of the 48 states (excluding northeast states) and parts of Alaska.

49. The State of Hawaii, although a regulator of private electric utilities, has not itself been involved in the ownership or operation of a power plant. It appears that there are no prohibitions, constitutional or statutory which would prevent the state from entering the power business. If such authority, which would enable the state to conduct itself in the electrical utility business, does not as yet exist, then the legislature would have to empower such an activity.[3/]

50. Involvement by the Western Area Power Administration (Western) in the marketing of the project's power will be subject to Federal authorization. Drafting of the authorization (construction funding) for the project will be completed by the Secretary of the Army. Not only will this authorization define Western's role to act as the marketing agent, but it could also designate the end-use recipients or criteria for receiving the power from the project, particularly with respect to utility responsibility (see items 70 and 71, infra).

3/ Phone conversation between Mr. Eric Wong, WAPA, and Mr. Hiromu Suzawa, Counsel, Legislative Division, Office of the Attorney General; January 4, 1982. Mr. Suzawa's opinion is unofficial.

51. Although the congressional authorization may dictate other plans for the disposition of the project's power, the concept of dispersing power from federally sponsored projects to public entities has significant precedence as stated in the Reclamation Project Act of 1939, (43 U.S.C. 485 h(c)), particularly section 9 (c), which provides that "...preference shall be given to municipalities and other public corporations or agencies; and also to cooperatives and other nonprofit organizations financed in whole or in part by loans made pursuant to the Rural Electrification Act of 1936...."

52. The concept of public power has long been an aspect of American history. As far back as 1877, when Congress passed the first Federal statute which provided that surplus reclamation water should be held for the public, through the ensuing fifty years when Congress provided for various forms of preference to states and municipalities in the award of licenses for hydroelectric plants (Federal Power Act), the concept of public or preference power became firmly rooted. Although the passage of such acts often drew heated opposition, primarily from investor-owned utilities, the public policy underpinning --that publicly-owned resources belong to the people and should be distributed to the people where possible -- provided the necessary vehicle for continued passage of numerous acts. As a result, numerous Federal statutes (containing the preference clause) provide that power generated at Federal facilities should be sold to state and local government agencies, Rural Electric Cooperatives and to other public entities which are able and willing to purchase the electricity. Only after these preferred customer needs have been met should excess power be distributed to profit making investor-owned utilities.

53. Where reasonable, the presence of a public utility helps preserve the electric generation industry as a pluralistic industry. The argument that only a certain segment of the public benefits from public power, and therefore should be abandoned, does not apply. In fact, in the case of Federal power, rates for the sale of power to preference and non-preference customers are not subsidized, but are set at levels which fully repay no more than the Federal investment and costs of operation and maintenance of the facilities. Competition, and possible lower rates, can be enhanced wherever public and private utilities provide service.

54. In order for the power from the project to be made available on a first priority basis to preference entities in Kauai, the U.S. Congress would need to authorize construction of the project by the Corps of Engineers and either apply existing Federal reclamation law or create new law embodying the preference clause. Implementation of the preference clause would be by the applicable Federal Power Marketing Administration, in this case, Western.

55. Judicial interpretation of the preference clause is clear in stating that if there are preference customers that are ready, able, and willing to take power, then the power must be made available to the preference customers before any non-preference customers such as an investor-owned utility (City of Santa Clara v. Duncan, 572 F. 2d 660, 9th Cir. 1978; Central Lincoln Peoples' Utility District v. Bonneville Power Administration, Opinion No. 81-7561, 9th Cir. 1/6/82).

56. In terms of the role which Western would take regarding contractual matters related to the project; Western would be responsible for the following:

a. Negotiate all power contracts to preference customers
b. Negotiate contract for sales of excess power to KED or the sugar companies.
c. Negotiate firming capacity contracts with KED or other sources.
d. Negotiate wheeling contracts with Kauai transmission system owners.
e. Assist as necessary in the negotiation of supplemental or stand-by contracts for each load.

57. Western's role would typically also include making arrangements for all necessary metering and energy accounting systems as well as establishing a billing system. In terms of revenues, Western would disperse funds received from power sales as necessary to repay the cost of the project's initial capitalization to the USACE, the costs of OM&R to the State, and, the cost of any of the aforementioned transmission or supporting contracts and billing and marketing administration to Western. Western would have to be authorized to distribute these funds to other entities than the U.S. Treasury. Such authorization may develop methods for this dispersement of payments such as a revolving fund.

58. The previous section defined the role of the power marketing agent to be the delivery of the benefits of the publicly financed project to the public. Two major viable options exist as avenues to dispense the benefits: the first would be to sell the power to the Kauai Electric Division (KED); and the second would be to sell the power directly to designated public agencies.

59. In either of the above cases, the inclusion of this renewable energy resource into Kauai County's economic base is prudent because of the favorable project economics and the additional resource diversity provided. In the years to come, particularly when congressional authorization is sought for the construction financing, those affected will debate the distribution of the project's benefits and whether the preference clause should be included in such authorization. In all cases, it must be realized that if the project is economically feasible, all of Kauai will benefit. If built with Federal funds, Federal law is clear that to the extent that a power project can be built at a lower cost than if the project was privately financed, then the benefits are to flow to the people.

DISTRIBUTION OF PROJECT POWER BY KED

60. Distribution of public power (in contrast with the construction of power resources) by the local, state, or Federal government on Kauai may not be economically advantageous. Consideration must be given to use of the existing privately owned transmission system rather than the construction of new facilities or the acquisition of the existing transmission facilities by a newly formed public utility.

61. Due to the relatively small amount of capacity and energy associated with the project, unless additional new projects are built and dedicated for the benefit of public use, consideration should be given to developing an independent marketing and energy delivery method.

62. Investor owned utilities in Hawaii (such as KED) are presently not allowed rates of returns on purchased power. Therefore, while no capital profit would be realized by KED through the purchase of the project power, KED would use the project's output to displace its most expensive generation.

63. The sale of the project power to KED would allow the benefits of the project to be directly melded into the existing energy system in Kauai, and as such, each KED customer would receive a proportion of the facility's benefits. In examining the end-use sectors which would actually receive the benefit one must review the KED distribution of sales and revenues for 1981 as illustrated in Table F.

TABLE F

KED NET REVENUES BY END-USE SECTOR

Sector	% of Total KWH Sold, 1981	Average Net Revenue Per KWH Sold, 1981
Residential	36.2%	15.15¢/kWh
Commercial	27.7%	15.60¢/kWh
Industrial	33.5%	14.56¢/kWh
Governmental St., Hwy, & Park Lighting	1.2%	21.63¢/kWh
Irrigation	0.9%	10.87¢/kWh
Electric Service for KED Employees	0.4%	9.93¢/kWh

64. As shown in Table F, about 36 percent of the project energy would actually be delivered to residences in Kauai with a large proportion of the benefits of the federally developed resource going to private industrial and commercial businesses. In addition, prior to this distri-bution of energy to the end-use sectors approximately 8.6 percent (FPC Form 12, 1981, KED) of the energy would be lost or unaccounted for in the KED system.

65. The distribution of benefits to non-public interests is shown further by the KED rate structure, in which the residential, governmental, and commercial building customers pay higher average electricity prices than the industrial, irrigation, and KED employee sectors. This rate structure is depicted by listing the 1981 average net revenue per kWh sold, by end-use category, in Table F above. In Kauai, the average residential customer rate on a kWh basis is 53 percent higher for energy than a KED employee; 39.3 percent more than a business using energy for irrigation; and, 4 percent more per kWh than an industrial customer. The government as a customer pays the highest price for its energy service -- street, highway and park lighting -- a service that is 48.6 percent more than industrial users. These differences may in fact be attributed to the "cost of service" in delivering electricity to each end-use sector. It should also be noted, however, that the industrial sector receives a declining block rate, i.e., the average unit energy cost declines as more energy is consumed.

66. The amount of energy assumed to be available from the project yearly is 11,280,000 kWh. This amount compares to energy sales by KED in 1981 of approximately 200,000,000 kWh. The project energy, if melded into the KED 1981 level of sales would represent approximately 5.6 percent of total energy sales.

67. KED officials have stated that the Company's "avoided cost" in 1982 is approximately 50-60 mills/kWh[4/]. The financial analysis shows that in the initial years the cost of the project (assuming option 1A) could be in the range of 110 mills/kWh. Given these costs and considering that the on-line date may be as long as 10 years hence and the size of the project relative to the KED system, it is conceivable that the project, if melded with KED, would have a minimal impact on either levelizing or lowering the rates for any period of time. In addition, if KED's avoided cost is not in the range of about 110 mills at the time in which the project comes on-line, then the rates could potentially be adversely impacted; whereas, if the project were marketed directly to public agencies even in today's market, significant savings would be realized by those specific end-users.

68. The concept of "avoided cost" and the pricing of any surplus energy sold to Kauai Electric was raised at the July 28, 1982 public meeting on the Draft Interim Survey Report and Environmental Statement. The specific question which arose was whether Kauai Electric would be required to pay their avoided cost for any power it purchased from the Federal government.

The Public Utilities Regulatory Policy Act of 1978 (PURPA) requires, among others, major utilities to pay their avoided cost to owners of small power production facilities (30 megawatts; 80 megawatts if electric energy is solely derived from biomass). To be a "Qualifying Facility" under PURPA for avoided cost payments, the fuel must also be more than 75 percent biomass waste, or a renewable resource; and, no more than 50 percent ownership in the facility is to be held by a utility or utilities.

It should be further noted that the avoided cost concept has received legal challenge and is under judicial review. Most recently, the U.S. Court of Appeals, District of Columbia, vacated and remanded the FERC rule on avoided cost (American Electric Power Service Corporation v. FERC, 675 F2d 1226). The Court held that the FERC did not adequately justify its adoption of the full avoided cost standard with respect to the two other statutory criteria: the rates for purchase be in the public interest and be just and reasonable to electric consumers. This case is presently on appeal to the U.S. Supreme Court.

The negotiation of a fair price for surplus power will invariably be based upon the then current rate making policies. The concept of avoided cost will probably be considered along with the market value concept, the split-the-savings concept, the pass-through of the repayment rate concept. A market value rate would be that which the market would pay given Kauai Electric's rates. A split savings rate would essentially meld the costs of Kauai Electric and the Federal government in providing comparable electric service and dividing the sum by two. A pass-through rate would price the surplus energy at exactly the repayment rate.

69. In summary, distribution of project power through KED would allow the energy to be as widely distributed as possible, completely utilizing the existing utility infrastructure.

4/ Meeting between Western staff representatives and Mr. Boyd Townsley, KED, September 21, 1982 at KED's office.

DISTRIBUTION OF PROJECT POWER THROUGH DIRECT SALES TO PREFERENCE CUSTOMERS

70. As stated in the section titled, Developing a Power Marketing Plan, significant historic legislative precedence exists for directly delivering federally derived power from public resources directly to agencies which offer services to the public in a non-profit fashion. The Western Area Power Administration's role would be to develop criteria for the selection of those agencies which would receive such power, and then to develop the means by which the power would be reliably delivered to those designated preference customers.

71. Examples of preference customers are county and city buildings, fire houses, school and water districts, public utility districts, and military bases and installations. Certain entities such as public utilities are required, under existing reclamation law to be empowered to purchase, sell and distribute electrical energy in order to receive federal electric power to supply their own needs. These entities must both qualify as a preference entity and be authorized and capable to distribute and administer electrical energy service to end-use customers within their service area. Furthermore, both Federal reclamation law and Western Area Power Marketing Administration (Western) contracting provisions expressly prohibit the sale of Federal electric power to any preference entity who in turn resells it to a private entity/utility for use in its system (sells it for a profit).

72. Based on the above, the Western Area Power Administration would determine whether candidate entities on Kauai are eligible preference entities, and authorized and capable to distribute electrical power. If the preference customer criteria can be met, but not the latter, then the entities must look to the creation of an organizational structure that will provide electrical distribution and resale services or ensure that the congressional authorization waives such requirements for the Wailua River Project.

73. A preliminary review of public agencies in Kauai, indicates that various federal, state, and county agencies may be potential candidates to receive the Wailua River Project power. These agencies and their respective energy usages (where available) are listed in Table G. (Note: This list is based on a preliminary market analysis performed in September 1982 and probably does not represent all potential customers on Kauai).

74. The expected annual energy available from the project is 11.28 GWh per year. This amount compares to the identified loads, Table G, of about 12.34 GWh per year plus whatever the NASA-Kokee and National Guard requirements may be. In all likelihood the amount of non-firm energy available would not exceed the preference customer needs. However, in the event that any excess energy was available, it could be exchanged or sold to KED.

TABLE G

PARTIAL LISTING OF POTENTIAL PREFERENCE CUSTOMERS REQUIREMENTS

(1) Nawiliwili Harbor Coast Guard Station (calendar years)

Energy usage1/

1979	18,750	kWh/yr
1980	26,350	"
1981	33,060	"
1982	18,460	"

Assume usage to be approximately - 20,000 to 25,000 kWh/yr.

(2) State of Hawaii energy usage for: (Fiscal year: 7/1 - 6/30)

a) State office/judiciary bldg.
b) Bldg 320, Lihue baseyard
c) Koloa district court
d) Bldg 301, plant inspection

Cumulative energy usage: 2/

FY 1981 815,601 kWh
FY 1982 769,394 kWh

Assume usage to be approximately - 770,000 kWh/yr.

(3) County of Kauai	kWh/yr
o (1981) County bldg, Annex II, Elderly Affairs, Lihue Civic Center	355,597
o (1981) Neighborhood centers	170,915
o (1981) Parks and Recreation	366,149
o (1981) Convention Hall (including various recreation facilities)	70,097
o (1981) Hanalei baseyard	1,045
o (1981) Office of the Prosecuting Attorney	4,046
o (1981) Fire Department	118,533
o (1981) Police Department	170,899
TOTAL	1,257,281 kWh/yr

(4) Barking Sands, Pacific Missile Range Facility	8,531,000 kWh/yr
(5) National Bureau of Standards	1,548,480 kWh/yr
(6) ERDA	208,800 kWh/yr

(7) NASA - Kokee Tracking Station (unknown energy usage)

(8) State of Hawaii, Department of Defense
- o Hawaii Army National Guard (unknown energy usage)
  - Recruiting office
  - Armory
  - Headquarters and service center and administration

1/ Yearly Data estimated from available quarterly data

2/ Letter from Department of Accounting and General Services to Steve Oliver, April 30, 1982

3/ Letter from Department of the Navy, Pacific Missile Range Facility to the Western Area Power Administration, October 7, 1982.

75. If energy is to be directly sold to preference entities, two major concerns must be confronted: the ability to use existing transmission and distribution systems; and, the fact that the project only contemplates providing energy approximately 50 percent of the hours in a given year. Although it is currently unclear how these matters will be resolved, two facts offer options for resolution:

a. Other industry on Kauai owns and operates (or leases to KED) significant amounts of transmission.

b. Excess energy from the project may be available to be "banked" or exchanged with KED for project supporting services during periods of non-generation.

FUTURE CONSIDERATIONS

76. When congressional authorization to the Corps of Engineers is sought for construction funding, authorization to the Western Area Power Administration to act as the Power Marketing Agency will also be sought (see item 50).

77. The criteria establishing preference should also be considered for inclusion in the congressional authorization (see items 54, 55, 59, 70 and 71).

78. A public proceeding of adequate length would be conducted in order to provide an open forum for resolution of the following issues:

- o What are the requirements for becoming a preference customer?
- o What is required to become a bonafide distributor of electrical energy for resale to end-use customers?
- o How much power and energy will each eligible preference customer be entitled?
- o What would be appropriate wheeling tariffs if Kauai Electric's transmission/distribution system was used to transmit power to the preference customers?
- o What would be the cost (rate) of the power sold to preference customers?
- o What arrangements and approvals will be necessary if the project generates power in excess of preference customers needs?

79. Each of the issues above are complex and will require sufficient time for careful evaluation. The latter issues, in particular, will involve other regulatory agencies. Although the rate for power to preference customers will be determined by Western, one component -- the wheeling tariff, would have to be approved by the State Public Utilities Commission. Western must also file its rate with the Federal Energy Regulatory Commission (FERC). The FERC renders its approval on the adequacy of the rate for repayment purposes. If power in excess to preference customer needs are sold to Kauai Electric, then arrangements and costs would have to be negotiated.

80. Experience dictates that at least a year of public hearings will be required. The Administrative Procedures Act followed by Western requires a minimum of thirty (30) days between forums, and publication of all proposed rules and decisions in the U.S. Government's Federal Register notice. In the recently concluded Power Marketing Plan by the Sacramento Area Office (1981), four public information forums and three public comment forums were held over a span of eighteen months. Numerous comments were filed by affected and interested parties and responses to all were provided and documented in the Federal Register. The responsibility for all decisions resides with the Administrator of Western.

81. It is recommended that the Power Marketing Plan be conducted while the Corps of Engineers is in the construction-planning-specification stage of the project. This stage is estimated to be two to three years in length. The Power Marketing Plan proceeding would be completed in time so that all eligibility, procedural, and administrative issues would be resolved, along with the negotiation and execution of power sales contracts, prior to actual power production.

WAILUA RIVER HYDROPOWER PROJECT
KAUAI, HAWAII

ENVIRONMENTAL COMPLIANCE DOCUMENTS

APPENDIX G

APPENDIX G

ENVIRONMENTAL COMPLIANCE DOCUMENTS

TABLE OF CONTENTS

COASTAL ZONE MANAGEMENT ACT

FEDERAL COASTAL ZONE MANAGEMENT CONSISTENCY DETERMINATION

The following consistency determination is prepared in accordance with the Coastal Zone Management (CZM) Act of 1972 (Public Law 92-583) and the regulations on Federal Consistency with approved Coastal Management Programs (15 CFR 930). Federal activities must be consistent to the maximum extent practicable with approved State CZM programs. The Hawaii Coastal Zone Management Program (HCZMP) has been authorized by State law, Hawaii Revised Statutes, Chapter 205A, enacted 1977. Furthermore, the State program was approved by National Oceanic and Atmospheric Administration, Department of Commerce in 1978.

The determination, as documented below, specifically addresses the impacts of the selected plan for hydropower improvements on the Wailua River, Kauai, Hawaii on the Hawaii Coastal Zone Management Program (HCZMP). The specific items of documentation are defined in the Procedures Guide for Achieving Federal Consistency With the Hawaii Coastal Zone Management Program, prepared by the Department of Planning and Economic Development, State of Hawaii (1980). For this determination, the terms "proposed action", "project", and "hydropower improvements" refer to features of Alternative 1A as documented in this Interim Survey Report for the Wailua River Hydropower Study, Kauai, Hawaii.

RECREATIONAL RESOURCES

1. Objective: Provide coastal recreational opportunities accessible to the public.

2. Policies:

a. Improve coordination and funding of coastal recreation planning and management.

Consistency: Existing institutional processes and funding mechanisms would be utilized by local interests subsequent to project completion in relation to the project's recreational features. The project planning and implementation will not specifically improve coordination and funding of coastal recreation planning.

b. Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area by the itemized methods.

(1) Protecting coastal resources uniquely suited for recreational activities that cannot be provided in other areas.

Consistency: The recreational resources would be under the protection and jurisdiction of the Department of Land and Natural Resources, State of Hawaii. However, the resources, although valuable and not exactly reproduced elsewhere, cannot be considered unavailable in other areas.

(2) 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.

Consistency: The proposed action will not require replacement of any resources unavoidably damaged.

(3) Providing an adequate supply of shoreline parks and other recreational facilities suitable for public recreation.

Consistency: The project will enhance the accessibility and potential enjoyment of existing natural resources. The view of Wailua Falls will be improved; a transport system will allow access into the river bank area. The gross area and number of recreational facilities on Kauai will not be significantly affected.

(4) Encouraging expanded public recreational use of County, State, and Federally owned or controlled shoreline lands and waters having recreational value.

Consistency: The area of improvements is owned by the State of Hawaii. Certain portions above the existing Wailua River State Park may require dedication for specific recreational use. No areas within two miles of the shoreline would be affected.

(5) Adopting water quality standards and regulating point and non-point sources of pollution to protect and where feasible, restore the recreational value of coastal waters.

Consistency: The project will not result in point source pollution nor significantly impact the existing State water quality standards in the vicinity.

(6) Developing new shoreline recreational opportunities, where appropriate, such as artificial reefs for surfing and fishing.

Consistency: The hydropower improvement will not result in development or damage to any existing shoreline recreational area.

(7) 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.

Consistency: Any dedication of additional recreational areas will be the responsibility of the State of Hawaii.

HISTORIC RESOURCES

1. Objective: Protect, preserve, and where desirable, restore those natural and man-made historic and prehistoric resources in the coastal zone management area that are significant in Hawaiian and American history and culture.

2. Policies:

a. Identify and analyze significant archaeological resources.

Consistency: In partial compliance to the National Historic Preservation Act and to the National Environmental Policy Act (NEPA), the cultural resources in the area of improvement were investigated in reconnaissance surveys associated with the Corps' Survey Report process. Additional surveys will be conducted in Advanced Engineering and Design stages.

b. Maximize information retention through preservation of remains and artifacts or salvage operations.

Consistency: Provided cultural and archaeological artifacts are discovered which are eligible for nomination to the National Register of Historic Places, recovery and salvage operations will be conducted prior to project construction.

c. Support State goals for protection, restoration, interpretation, and display of historic resources.

Consistency: The investigations and salvage operations will indirectly support State goals for historic resources.

SCENIC AND OPEN SPACE RESOURCES

1. Objective: Protect, preserve and, where desirable, restore or improve the quality of coastal scenic and open space resources.

2. Policies:

a. Identify valued scenic resources in the coastal zone management area.

Consistency: The proposed project will not add to the identification of scenic resources. The Wailua Falls and Wailua River are already known for their scenic value.

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.

Consistency: The proposed features of the hydropower project would be designed to minimize adverse visual impacts and to be located in a manner compatible with existing landforms to the maximum extent practicable. The diversion dam would not be readily visible from visual vantage points of the Wailua Falls. The powerplant would be suitably placed against the existing formations and would not adversely affect views except when visitors are directly in the river bottom. Minor alterations will be tramway/cable car access to the river bottom and transmission lines up the hillside.

c. Preserve, maintain and, where desirable, improve and restore shoreline open space and scenic resources.

Consistency: Although the existing scenic resources will not be specifically improved or restored, they will be made more accessible for the public's use and enjoyment. Administration of the area by the State of Hawaii will protect and maintain the area.

d. Encourage those developments which are not coastal dependent to locate in inland areas.

Consistency: The project will not specifically encourage any development.

COASTAL ECOSYSTEMS

1. Objective: Protect valuable coastal ecosystems from disruption and minimize adverse impacts on all coastal ecosystems.

2. Policies:

a. Improve the technical basis for natural resource management.

Consistency: Existing technical information was used predominantly to formulate and to evaluate impacts of the plan of improvement. Research-oriented and new technical information were not within the scope of the investigation.

b. Preserve valuable coastal ecosystems of significant biological or economic importance.

Consistency: The coastal ecosystems of the Wailua River will remain essentially unaffected by the proposed improvements and will be preserved in their natural state. Short-term adverse construction impacts are expected in the immediate area of improvements. However, the habitats are expected to recover to their former state prior to construction.

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.

Consistency: An improved diversion through the Stable Storm Ditch for additional waters from the North Fork Wailua River to the South Fork Wailua River is proposed. The additional flow would significantly add to the energy development but would not alter existing stream patterns nor water needs. Although limited channelization would be required in the areas of powerplant discharge waters, there would be no disruption of the natural water course along the river. Natural water flows will be decreased from the South Fork diversion to the powerplant outlet for approximately 35 percent of the time. However, high flows (occurring 15 percent of the time or less) and low flows (occurring 50 percent of the time and more) would not be affected.

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.

Consistency: This project would not specifically add to planning and management practices related to ecosystems nor would prohibitions be imposed on land and water use.

ECONOMIC USES

1. Objective: Provide public or private facilities and improvements important to the State's economy in suitable locations.

2. Policies:

a. Concentrate in appropriate areas the location of coastal dependent development necessary to the State's economy.

Consistency: The plan of improvement would be located in an appropriate physical location of abundant water resources for the development of hydropower. In addition, the project would add to the developed supply of an indigenous non-fossil energy source, effectively reducing dependence upon petroleum fuels.

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.

Consistency: The proposed energy generating facility would be located, designed, and constructed to minimize, to the maximum extent practicable, potential adverse environmental impacts. The specific nature of the impacts are documented in the Environmental Statement for the subject project.

c. Direct the location and expansion of coastal dependent developments to areas presently designated and used for such development and permit reasonable long-term growth at such areas, and permit coastal dependent development outside of presently designated areas when: utilization of presently designated locations is not feasible, adverse environmental effects are minimized, and important to the State's economy.

Consistency: The project's intent and purpose does not direct or designate any area for development. The land use, development, and zoning issues would be State and local responsibilities.

COASTAL HAZARDS

1. Objective: Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, and subsidence.

2. Policies:

a. Develop and communicate adequate information on storm wave, tsunami, flood, erosion, and subsidence hazard.

Consistency: Information on flood hazard in the area has been developed in the evaluation report pursuant to Executive Order 11988 on Floodplain Management contained in the Interim Survey Report. The proposed facilities have been formulated for structural integrity under the 0.2 percent flood conditions. The pool area upstream of the diversion structures and the tailwater outlet channel will be the only significant portions of the project which would require cleanout and repair subsequent to major floods.

b. Control development in areas subject to storm wave, tsunami, flood, erosion, and subsidence hazard.

Consistency: The project would not have direct influence on controlling future development.

c. Insure that developments comply with requirements of the Federal Flood Insurance Program.

Consistency: The Federal Flood Insurance Program is not specifically applicable for Federal water resource projects. The hydropower improvements, however, comply with the general provisions of the Executive Order 11988 on Flood Plain Management.

d. Prevent coastal flooding from inland projects.

Consistency: The project would not impact coastal flooding. Flood control is not a project purpose.

MANAGING DEVELOPMENT

1. Objective: Improve the development review process, communication, and public participation in the management of coastal resources and hazards.

2. Policies:

a. Effectively utilize and implement existing law to the maximum extent possible in managing present and future coastal zone development.

Consistency: The project would comply with existing laws to the maximum extent practicable. Any adjustment to State and/or County administrative rules and regulations pursuant to any laws would be the responsibility of the local interests.

b. Facilitate timely processing of application for development permits and resolve conflicting permit requirements.

Consistency: The project in its planning, engineering, or construction phases would not influence processing times nor the administration of permits.

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.

Consistency: A public involvement program is an integral part of the project's planning process. The public, including government agencies and special interest groups, would have periodic opportunities to review project reports. The public involvement program has been documented in this Interim Survey Report.

PRESIDENTIAL EXECUTIVE ORDER 11988 ON FLOOD PLAIN MANAGEMENT

EVALUATION REPORT

GENERAL

Presented in this evaluation report is pertinent information required by Executive Order (E.O.) 11988 on Flood Plain Management, dated 24 May 1977, for any proposed action in the base flood plain. The "action" is any Federal activity involving:

a. Acquiring, managing, and disposing of Federal lands and facilities.

b. Providing Federally undertaken, financed, or assisted construction and improvements.

c. Conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating and licensing activities.

OBJECTIVE

The objective of E.O. 11988 is to avoid to the extent possible, the long- and short-term adverse impacts associated with the occupancy and modification of flood plains, and to avoid the direct and indirect support of flood plain development whenever there is a practicable alternative. The order requires Federal agencies to:

a. Avoid the base flood plain unless it is the only practicable alternative.

b. Reduce the hazards and risk associated with floods.

c. Minimize the impact of floods on human safety, health, and welfare.

d. Restore and preserve the natural and beneficial values of the flood plain.

POLICY

The order establishes general policy on flood plain management by citing the above requirements for compliance by Federal agencies.

The preferred method for satisfying these requirements is to avoid sites on the base flood plain altogether. If an action must be located on the base flood plain, the order then requires that agencies minimize potential harm to people and property, and to natural and beneficial flood plain values.

IDENTIFICATION OF THE FLOOD PLAIN

The term flood plain refers to any land area susceptible to being inundated from any source of flooding. The base flood plain is defined as the area subject to inundation from a 100-year flood which is an event that has a one percent chance of being equaled or exceeded in any given year. The Federal

Insurance Administration (FIA) of the Federal Emergency Management Agency prepared the Flood Insurance Study for the County of Kauai, which is a detailed study of the flood-prone areas on the island of Kauai.

FLOOD HAZARD EVALUATION OF THE PROPOSED ACTION LOCATION

The site of the proposed Wailua Hydropower project is designated Zone C, or area of minimal flooding under the FIA flood study, and is beyond the limit of the existing FIA Wailua River flood map. The proposed project siting, however, constitutes activity in the 100-year flood plain, based on extending the Wailua River flood plain approximately 1.5 miles upstream.

IMPACT OF THE PROPOSED ACTION

The selected plan for the hydropower features includes powerplant, diversion dam, intake structure and other appurtenant facilities. The inclusion of the powerplant structure, being relatively small in area, will have no significant impact on the regulatory flood elevation. The structures also would be designed to withstand all foreseeable impacts of major flooding and no additional flood damage potential would result. The hydropower project purpose will provide additional energy production for development purposes. However, the project measures and use of the surrounding lands do not specifically encourage or increase incompatible flood plain development. The trailrace outflows from the powerplant (maximum of 400 cfs) will not be significant compared to the regulatory flood discharge in the river (approximately 68,000 cfs).

MITIGATIVE MEASURES

Any future development in the flood plain areas adjacent of the hydropower site should conform to Federal flood plain management criteria for proposed structures in flood-prone areas. These requirements would include such measures as siting outside of the flood plain whenever there is a practicable alternative, or adjusting to the flood plain by flood proofing to minimize or eliminate flood damage potential. Although there are numerous other potential sites for a hydropower facility on the Wailua River, none would be as economically and technically practical as the selected plan site. Environmental quality enhancement measures would be provided by the inclusion of an additional lookout and access into the river. The stream habitat would not be significantly affected; hence, additional mitigative measures would not be mandatory.

PUBLIC NOTICE

The general public was advised by public notice that the recommended plan for improvements will result in activity in the flood plain. The public was given the opportunity to address and comment on the proposed action during the formal public meeting held on 28 July 1982 in Lihue, Kauai. There were no significant comments or concerns expressed by the public regarding flood plain management.

United States Department of the Interior

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

IN REPLY REFER TO:
ES
1-2-81-SP-207

January 7, 1981

Kisuk Cheung
Chief, Engineering Division
U.S. Army Engineering District, Honolulu
Fort Shafter, Hawaii 96858

Dear Mr. Cheung:

This replies to your request of December 10, 1980 (PODED-PV) for information on endangered or threatened species, listed or proposed, which may be present in or adjacent to the South Fork of the Wailua River, Kauai.

To the best of our knowledge, no proposed species of plants or animals occur in the immediate area of the South Fork project area. However, three listed endangered waterbirds do occur in the area outlined on your Wailua River Basin map. These are the Hawaiian coot, Hawaiian gallinule, and the koloa, or Hawaiian duck.

Should you have any additional questions, please feel free to contact us again. Thank you for your interest in endangered species.

Sincerely yours,

Pacific Islands Administrator

United States Department of the Interior

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

IN REPLY REFER TO:
ES
Room 6307

SEP 3 1982

LTC Kenneth E. Sprague
U.S. Army Engineer District, Honolulu
Building 230
Fort Shafter, Hawaii 96858

Re: Final Coordination Act Report, Wailua River Hydropower Study, Phase 3 Pre-authorization Survey Report, Wailua, Kauai, Hawaii

Dear Colonel Sprague:

This is the Final Coordination Act Report prepared by the Fish and Wildlife Service for the Wailua River Hydropower Study, Phase 3 Pre-authorization Survey Report. It has been prepared under the authority of and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and other authorities mandating Department of Interior concern for environmental values. It is also consistent with the intent of the National Environmental Policy Act.

We request that you formally indicate which, if not all, of the mitigation measures recommended in this report will be implemented in the design and construction of the proposed hydropower development. Please provide the Corps' rationale should you reject any of the Service's recommendations. This report has been forwarded to the Hawaii Department of Land and Natural Resources for comment.

Sincerely yours,

Robert Shallenberger

ACTING Pacific Islands Administrator

Enclosure

cc: OEC, Washington, D.C.
Regional Director, FWS, Portland, OR (AE)
EPA, San Francisco
National Marine Fisheries Service
Hawaii Department of Land and Natural Resources

UNITED STATES DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

FINAL COORDINATION ACT REPORT

Wailua River Hydroelectric Power Study
(Phase 3 Pre-authorization Survey Report)

Wailua, Kauai, Hawaii

Table of Contents

PREFACE

This document constitutes the U.S. Fish and Wildlife Service's report on the Wailua River Hydropower Interim Survey Report (Phase 3 Pre-authorization). It has been prepared under the authority of the Fish and Wildlife Coordination Act, P.L. 85-624 Section 2(b), and in keeping with the spirit and intent of the National Environmental Policy Act. As required by law, a copy of the Service's report shall accompany the Corps' Survey Report to Congress.

This study was authorized by Section 209 of the River and Harbor Flood Control Act of 1962 (P.L. 87-874). It was restricted to two principal alternatives identified by the Honolulu District, Corps of Engineers. The goals of the Service in its study involvement were: (1) to evaluate the impact each of the principal alternatives would have on fish and wildlife resources, their habitat, and their utilization by the public, and (2) to recommend methods for preserving, compensating and enhancing these resources. The Service's findings are based on project data furnished prior to July 28, 1982. A prior Service report and a Planning Aid Letter provided on July 7, 1981 and June 25, 1982 are superseded by this report.

This document includes a review of various reports, unpublished materials and personal communications provided by the Corps and the Hawaii Division of Aquatic Resources during the course of the study. Field data from three site inspections made in 1977, 1981 and 1982 by Corps and Fish and Wildlife Service biologists, and other relevant information about the Wailua River watershed are incorporated in the report. Field surveys were conducted at sampling stations shown in Figure 1 utilizing electroshockers and opae nets. Visual surveys were also made with the use of face masks. No attempt has been made to quantitatively evaluate populations of indigenous fauna or introduced game fishes during this phase of investigation. Recommendations for detailed fish and wildlife studies during Phase 1 Post-authorization Studies appear later in this report.

This report was prepared by John I. Ford, Fishery Biologist (Management), of the Office of Environmental Services, U.S. Fish and Wildlife Service, Honolulu, Hawaii.

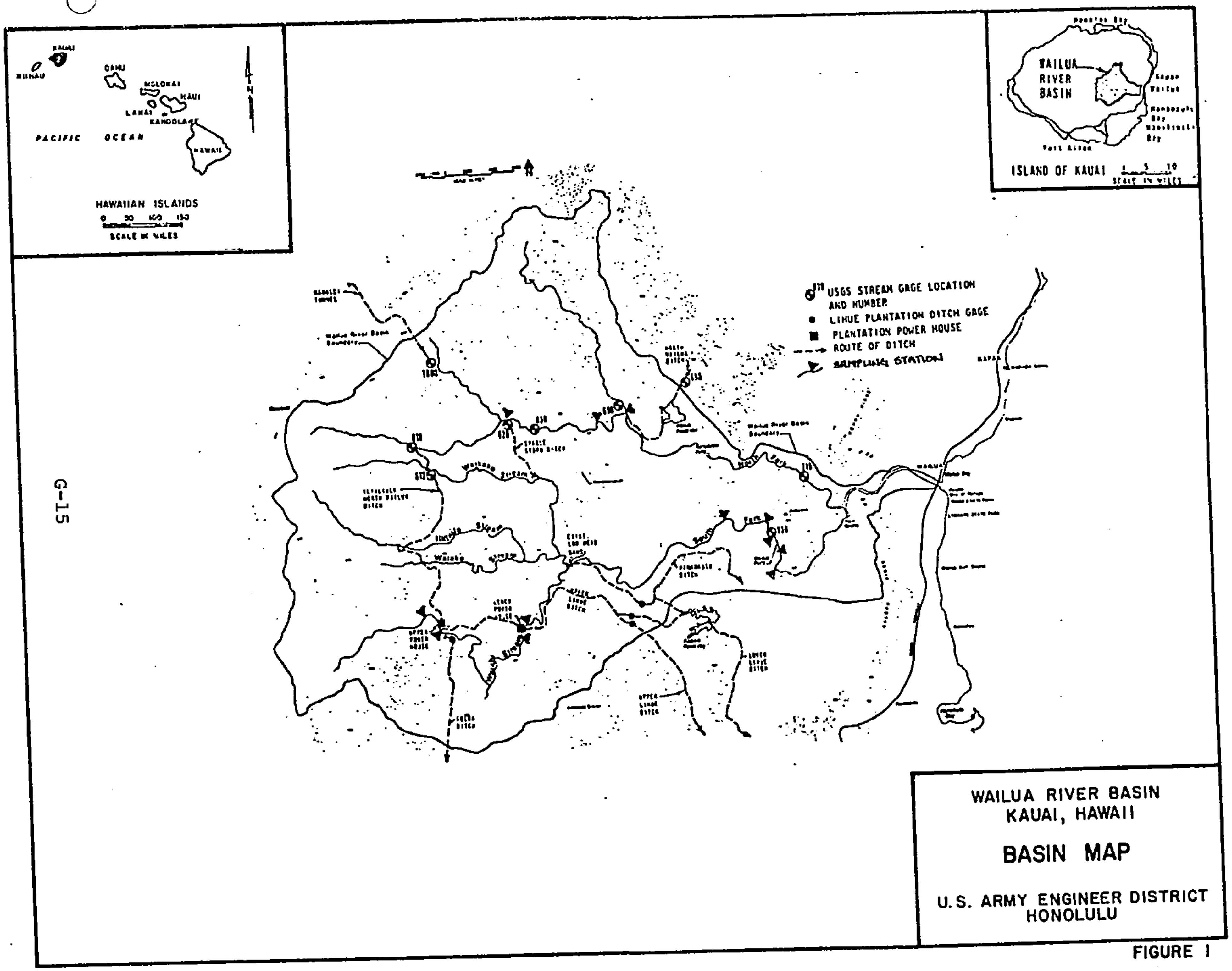

HAWAIIAN ISLANDS
SCALE IN MILES
PACIFIC OCEAN
WAILUA RIVER BASIN
ISLAND OF KAUAI
USGS STREAM GAGE LOCATION AND NUMBER
LIHUE PLANTATION DITCH GAGE
PLANTATION POWER HOUSE
ROUTE OF DITCH
SAMPLING STATION
WAILUA RIVER BASIN
KAUAI, HAWAII
BASIN MAP
U.S. ARMY ENGINEER DISTRICT
HONOLULU

FIGURE 1

GENERAL DESCRIPTION OF THE PLANNING AREA

1. Wailua River Watershed

The study area lies within the Wailua River watershed, which is situated on the east coast of the Island of Kauai, Hawaii (Figure 1). The Wailua River basin is the second largest drainage on the island, and occupies a large portion of the Lihue depression. The basin lies between the massifs of Kawaikini and Waialeale and has a total drainage basin area of approximately 53 square miles. Except for the western wall of the basin, the Wailua area is characterized by relatively open, rolling country which presents a contrast to the rugged terrain of Kauai's other stream basins.

The Wailua River is a fourth-order, perennial river. The North and South Fork streams comprise the two principal branches of the river, and drain areas of 23 square miles and 29 square miles, respectively. These two branches converge into a terminal estuary which is some 2.4 miles in length. A smaller stream, Opaekaa, also drains into the estuary but is not included within the study area. Together, the North and South Fork streams form a broad, dendritic, drainage pattern. The total tributary length from headwaters to the head of the estuary is 89 miles.

The major tributaries enter the mainstream between 500-750 feet elevation. Streams entering the mainstream below this altitude are few in number and inconsequential in discharge (Davis 1960). The headwaters of the North Fork tributaries are located at 1,800-3,000 feet altitude between Waialeale and Kapehuaala peaks. The South Fork headwaters are situated near 2,200-4,000 feet between Kawaikini and Kapalaoa peaks.

The bounding ridges of the Wailua River basin consist of eroded Pliocene lavas of the Napali formation (MacDonald, Davis, and Cox 1960), which are considered part of the original dome. These lavas are highly permeable and confine much water to high elevations. The floor of the Lihue depression is believed to have been formed by the collapse of the dome on the eastern portion of the island. Headwater tributaries of the North and South Fork Wailua River indent the west wall of the depression, forming deep and relatively short gorges. About two miles upstream from the terminus, the Wailua River is incised in Pleistocene lava flows that overflowed the depression. The gap carved by the river between Kalepa and Nonou ridges marks the remains of the east wall of the depression. West of the gap, the headward erosion of waterfalls in both the North and South Fork has entrenched the lower reaches in 200-300-foot deep gorges.

Soils which form the stream channel and banks have been described only as rough, broken lands and rock outcroppings (USDA 1973). Kolokolo clay loam and Kolokolo extremely stoney clay loam also are found along a major portion of the stream course. Soils in the terminal reach of the stream are principally stream-laid gravel, sand, and silt. This alluvium underlies the bottom lands along the Wailua estuary.

The transverse profile of the Wailua River watershed shows an average rise in elevation along the South Fork of only 70 feet per mile from the sea to the headwall (Davis 1960). The precipitous headwater regions and broad, gradually sloping plain are characteristic of relatively older, well weathered, stream valleys in Hawaii.

Average annual rainfall over the basin ranges from 45 inches along the western wall of the depression to 50 inches near the shore (Belt, Collins & Associates 1978). Rainfall within the basin averages approximately 325 million gallons per day (mgd).

Development of an accurate surface runoff budget within the Wailua River basin is extremely difficult due to the extensive diversion of streamflow for irrigation and because stream gauging stations are located well up into the watershed. Transportation of water outside the watershed for agricultural irrigation dates from 1856 when the Rice Ditch was constructed to carry water from the mountain streams to lands cultivated in sugarcane. Four major ditch systems divert an average of about 158 mgd from the rivers. Maximum and minimum flows do not always occur in the same year on the North and South Forks due to differences in rainfall within each sub-basin changing water use demands (Davis 1960).

Average discharge at elevation 240 feet (USGS Gauge No. 600) on the South Fork over the 63-year period of record is 116 cubic feet per second (cfs), or about 75 mgd, taking into account upstream diversions of flow. Minimum instantaneous discharge over the same period of record occurred on September 21, 1953 and equalled only 2.69 cfs, or 1 mgd (USGS 1980). The average discharge of the North Fork measured at USGS Gauge No. 710 at an elevation 18 feet below Kaholalele Falls over a 28-year period of record is 127 cfs, or about 82 mgd. Minimum instantaneous flow occurred on October 28, 1953 and dipped to 2.12 cfs, or 1.4 mgd. About 88% of the flow in the North Fork originates in the basin, while the remainder is supplemented by diverted flows from the Hanalei River. Some of the water from the Hanalei flows into the South Fork through the Stable Storm Ditch, while the remainder enters the North Fork. The Hanalei flow is particularly important for the maintenance of aquatic resources during extended dry periods, when it can provide up to 20% of Wailua's total flow.

The dry season extends from June through October. Flows in the North Fork during this period are approximately 26% below the year-round average; and flows in the South Fork are 23% below the year-round average during this period. Detailed descriptions and estimates of stream and ditch flow in the Wailua River basin are presented in Belt, Collins & Associates (1978).

2. Riparian Resources

Land use within the North and South Fork sub-basins is predominantly sugarcane cultivation. The headwaters lie within the Lihue-Koloa Forest Reserve (State). Activities within the Reserve include tree-planting experiments (*Eucalyptus spp.*), an arboretum, hiking trails, and preservation of native floral habitat. Public hunting areas and game bird reserves are located within the Opaekaa and North Fork sub-basins. A significant recreational fishery exists within the South and North Fork Wailua River. Access to most of the Wailua Basin is controlled by the Lihue Plantation Company. Two small run-of-the-river hydroelectric power plants are operated by the sugar company within the Waiahi tributary of the South Fork. The South Fork, from Wailua Falls to the sea, lies within the Wailua River State Park. The terminal estuary is a popular recreational area which accommodates water skiing, boat rides, fishing and crabbing, and a botanical garden maintained as a tourist attraction (Paradise Pacifica). The Hawaii Department of Parks and Outdoor Recreation has estimated that 4 million persons visited the park in 1980.

3. Wildlife Resources

Wetlands surrounding the terminal estuary and botanical garden provide habitat for three species of endangered Hawaiian waterbirds: the gallinule (*Gallinula chloropus sandvicensis*), coot (*Fulica americana alai*), and duck (*Anas wyvilliana*). Only the Hawaiian duck, or koloa, is known to occur infrequently within the reach of the Wailua River which will be affected by the proposed action. No other species listed or eligible for listing as endangered is known to inhabit the project area.

4. Aquatic Resources

The terminal estuary is believed to support populations of euryhaline and itinerant marine fishes and crustaceans of sport and commercial fishing value. The lower reaches of the South Fork Wailua River below Wailua Falls and the North Fork below Kaholalele Falls support indigenous Hawaiian stream fauna. The stream above Wailua Falls and Kaholalele Falls supports populations of introduced fishes, predominantly smallmouth bass, and swordtails (Poeciliidae). A major portion of the Wailua supports an important sport fishery based upon smallmouth and largemouth bass, bluegill, carp, Chinese catfish, and tilapia.

DETAILED PROJECT DESCRIPTION

The purpose of the present Corps study is to establish the feasibility of potential improvements in the interest of hydroelectric power development for the Wailua River basin, Island of Kauai, State of Hawaii. The Corps' study provided an analysis of the electrical utility needs and the alternatives available to meet the needs for this Island of Kauai.

Among the technical criteria and plan formulation goals identified by the Corps, the following concepts are important to fish and wildlife resources:

a. Any change in flow rate should not adversely affect the existing irrigation operations.

b. Plans should not significantly disrupt or destroy existing ecosystems within the area of improvement.

c. Plans should not significantly impair the scenic beauty of Wailua Falls and Kaholalele Falls through physical structures or major diminution of flow.

d. Any increases in flow along man-made or natural channels should be within reasonable capacity of the facility and not cause failure of banks or significant increase in sedimentation.

Possible solutions investigated within the Wailua River basin area have included new fossil fuel power plant(s), electrical interties, conservation and solar hot water heating, a new bagasse power plant, wind power plant, hydropower plant retrofitting and development at existing small hydro sites, new conduit hydropower diversion and power plant, and a new dam/reservoir and hydropower plant.

New conduit hydropower diversion and power plant is the alternative considered in detail in this report. Two principal structural alternatives have been identified. These alternatives, along with a non-structural plan, are discussed in detail below, and are illustrated in Figure 2.

a. Plan 1A: <u>Power Plant Near Falls With Additional Diversion</u> <u>(Tentatively Selected Plan)</u>

This plan involves a low, 13.5-foot high, 220-foot wide, concrete diversion structure located approximately 300 feet upstream of Wailua Falls. The structure would be an overtopping spillway constructed to withstand the effects of a probable maximum flood. Streamflows exceeding the conduit capacity would pass downstream. Under design conditions, the diversion would pond water upstream to an approximate elevation of 255 feet (MSL). The permanent pool would have a surface area of 4.4 acres, and would store 23.5 acres-feet of water. Pool depths will range from 15 to 32 feet depending upon discharge. The intake would include a trash rack upstream from the conduit connector, a sluice gate for debris cleanout, a vortex preventer, and a second trash rack of one-inch diameter at the opening. For the purpose of initial estimates, the design flow includes additional waters diverted from the North Fork Wailua River via the Stable Storm Ditch to augment flows available for hydropower development and to provide sufficient downstream flows for native fisheries. A 550-foot long, 108-inch diameter, reinforced concrete pipe would be constructed along a semi-oval shaped route below the left side of the Wailua River (looking upstream), around Wailua Falls. At the terminus of the conduit, water would flow into

FIGURE 2. Alternate plans 1A and 2A for hydropower development, Wailua River, Kauai.

a concrete headbox. Excess flows entering the headbox would be discharged into the river. Penstock would consist of a 72-inch diameter pipe. The pipe would be supported by anchors and supports along its 282-foot length.

Flows would enter the power plant, to be located on the left bank of the Wailua River, approximately 100 yards below Wailua Falls. The power plant would be sized for 5.0 mw, and would operate in the range of 65-390 cfs with a Francis two-turbine system. Actual power plant housing will require excavation into the side walls of the river channel. The floor of the power plant would be set above the 500-year flood elevation.

The outlet channel would be a trapezoidal-shaped, riprap-lined channel approximately 30 feet long which would exit into the river. Access to the power plant from the ridgeline road would be made possible by tramway system. A new access road would be constructed to the upstream diversion structure. Electrical transmission lines would connect directly to the Kauai Electric Lydgate Substation located near Lydgate State Park.

In order to divert additional flows from the North Fork, some structural changes to the Stable Storm Ditch will be necessary. To supplement flow by some 92 cfs, a 5-foot wide by 4-foot high, rectangular concrete conduit depressed 1.9 feet below existing grade would be installed. The weir at USGS Gauging Station No. 620 would also be depressed by one foot. The existing 150-foot long conduit would be replaced by a 54-inch RC pipe due to its presently deteriorated condition.

b. Plan 2A: Power Plant Downstream With Additional Diversions

The intake structure for this alternative would be functionally the same as that for Plan 1A; however, flow would be diverted through a 3,100-foot long, 108-inch, concrete pipe conduit from the right stream bank (looking upstream). The power plant, designed for 5.6 mw, would be located approximately 1.7 river miles below Wailua Falls. Unlike Plan 1A, the power plant in this alternative would be elevated on fill. The outlet channel from the plant would be approximately 500 feet long and buried for the majority of its length. An existing jeep trail would be improved to serve as the access road for the power plant. Flow would be diverted from the North Fork as proposed in Plan 1A.

c. Plan 3: Solar Conservation

This plan consists of a combination of solar collector/heat exchange system for residences in Kauai and volunteer conservation measures by the public in concert with technological and regulatory measures affecting energy use. This plan would not involve placement of features in any natural ecosystem.

BIOLOGICAL AND SOCIAL EVALUATIONS

1. Future Without the Project

a. Riparian Resources. Flat pasture lands border the terminal reach of the Wailua River although most of the sloping hillsides are heavily forested. A dense overgrowth of hao (*Hibiscus tiliacenous*) lines the estuary. The lowest flatlands along the Wailua, once a tidal marsh, were modified considerably in 1960 by the construction of seven ponds for the Paradise Pacifica gardens. Only a portion of the undeveloped marshlands lies adjacent to the boundary of Paradise Pacifica today. Experimental taro farms line the terminal reach of the Opaekaa Tributary.

Riparian vegetation throughout the lower and middle reaches of the river remains relatively constant, and is dominated by exotic or naturalized species. Characteristic plants include hao, kukui (*Aleurites moluccana*), guava (*Psidium guajava*), java plum (*Eugenia cumini*), California grass (*Brachyaria mutica*), and other exotic and native trees, shrubs, and herbs. Native species of plants are abundant only in the headwater regions of the streams beyond the boundaries of the project area. Most of the watershed has been cleared for either sugarcane and/or forestation projects based largely on trees.

b. Wildlife Resources. Non-aquatic avifauna observed by Shallenberger (1977) within the terminal reaches of the Wailua River and estuary included exotic passerines such as common mynah (*Acridotheres tristis*), Japanese white-eye (*Zosterops japonicus*), house finch (*Carpodacus mexicanus*), house sparrow (*Passer domesticus*), and barred dove (*Geopelia striata*). The western meadowlark (*Sturnella neglecta*), ring-necked pheasant (*Phasianus versicolor*), and spotted dove (*Streptopelia chinensis*) were less common and confined to open pasturelands. Within the dense hao forests bordering the stream, shama thrush (*Copsychus malabricus*), Chinese thrush (*Garrulax canorus*), and northern cardinal (*Cardinalis cardinalis*) were common.

Observations of waterbirds within the lower reaches of the Wailua River and estuary were made by Shallenberger (1977). The wetlands of the Wailua River and Opaekaa Stream provide good waterbird habitat for the Hawaiian coot (*Fulica americana alai*), gallinule (*Gallinula chloropus sandvicensis*), and duck (*Anas wyvilliana*). Coots prefer the Opaekaa taro fields to the lower Wailua River; however, gallinule were widely dispersed throughout the river bottomlands. Paradise Pacifica was found to support the largest population of gallinule in the river system. In fact, more gallinule were observed within the botanical garden than in any other wetland habitat within the state. Few ducks (koloa) have been observed in the lower Wailua area since the decline of rice farming; however, one recent sighting (1981) of a single duck near the proposed power plant for Plans 2A and 2B was made by the Corps' contract archaeologist.

The Hawaiian Waterbirds Recovery Plan (1977) identifies the Opaekaa-Wailua wetlands as areas of secondary importance for the enhancement of endangered waterbird habitat.

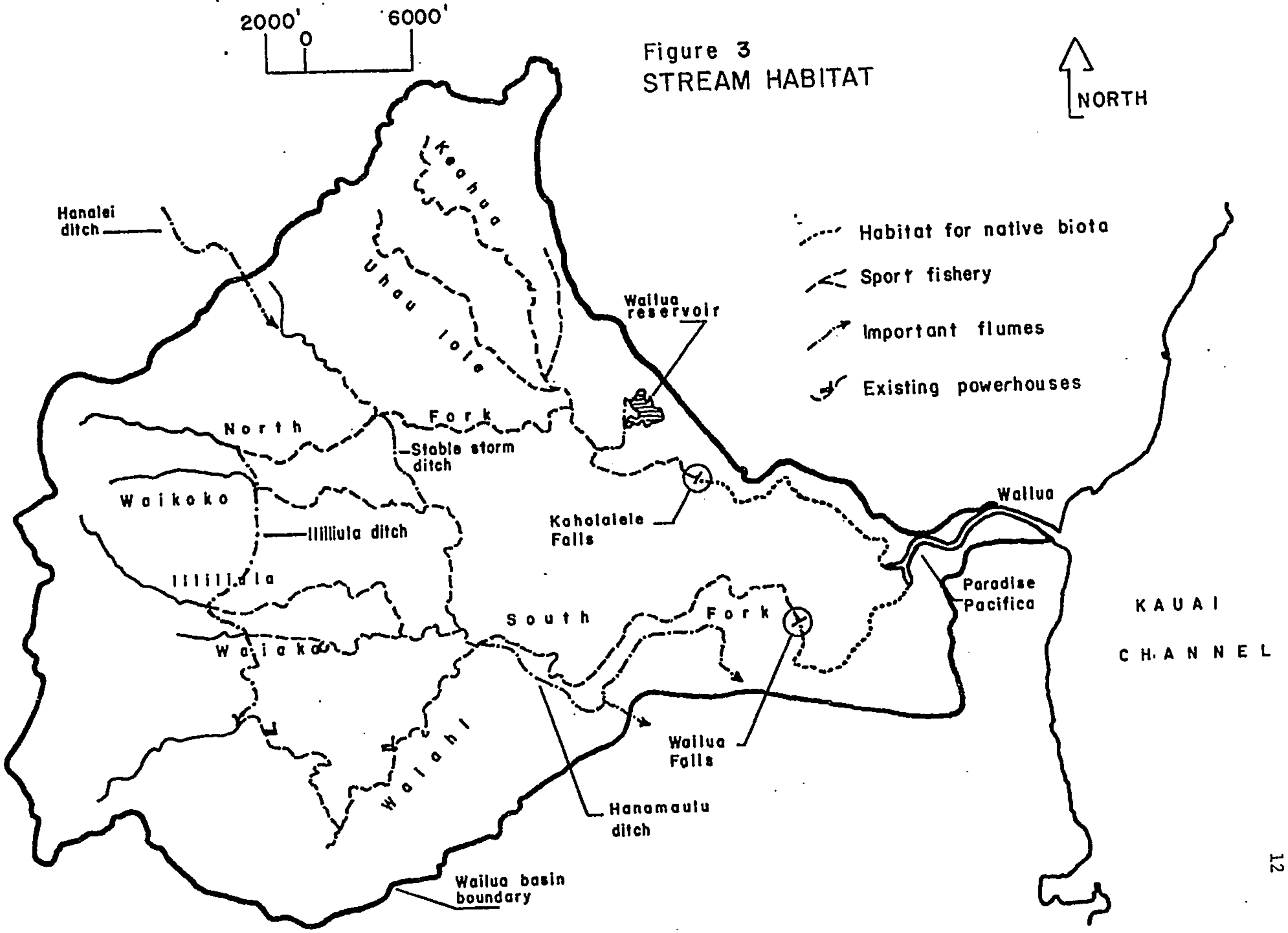
c. Aquatic Resources. The Wailua River system was not included in the statewide inventory of streams conducted by Timbol and Maciolek (1978). There are few published biological or limnological studies about the Wailua watershed. Unpublished records of the Hawaii Cooperative Fishery Research Unit indicate that the river system supports several introduced species of continental, warm-water game fishes and crustaceans. Populations of the native fauna appear to be in decline, possibly due to interactions with exotic competitors and predators, and to habitat reduction caused by dewaterment. Figure 3 illustrates the present distribution of aquatic resources in the Wailua River system based upon field surveys conducted by the Corps and the Fish and Wildlife Service during the course of study for the proposed development, and upon information provided by state aquatic biologists. This figure demonstrates that habitat for native stream Gobiidae is presently confined to the stream reaches below Wailua Falls on the South Fork of the Wailua River, and below Kaholalele Falls on the North Fork. Endemic atyid shrimp (*Atya bisulcata*) are still known to be abundant in the upper reaches of most North and South Fork tributaries. Their populations are locally depressed where smallmouth bass are abundant.

Table 1 presents a rough estimate of the availability of habitat (stream length) with each of the principal tributaries of the Wailua River system.

Table 2 lists species which have been collected or observed in the stream within the study area. Smallmouth bass, swordtails, Chinese catfish, and mosquito fish appear to be the most abundant fishes throughout the stream above Wailua Falls. Smallmouth bass were introduced to Kauai in 1956 and have flourished throughout the Wailua River system. It is the dominant species in streams wherever it occurs on the islands of Kauai and Oahu.

The smallmouth bass fishery, which exists within the South Fork between Wailua Falls and the mauka ditch intake on all tributaries and in the North Fork between Kaholalele Falls and the Iliiliula Ditch, involves more than 40 river miles, or roughly 47% of the total South Fork stream length and 50% of the North Fork stream length. Remnant populations of largemouth bass from reservoir spillover are also known to exist within the North and South Forks. Population estimates for either species are not available. Other species which are occasionally taken by recreational fishermen include tilapia, bluegill, carp, and Chinese catfish.

Figure 3
STREAM HABITAT



USFWS - ES

TABLE 1. TRIBUTARY LENGTHS FOR WAILUA RIVER[1]

Tributary Name	Length in miles[1]	Productive Habitat[2]
North Fork	18.41	9.00
Uahu Iole	6.63	2.50
Keahua	4.05	2.50
Kawi	2.88	2.00
Total North Fork	31.97	16.00
South Fork	11.10	10.90
Halii[3]	3.41	00
Palikea[3]	1.59	00
Kaulu[3]	1.52	00
Waiahi	12.50	7.00
Iole	3.03	2.00
Waiaka	3.52	0.50
Iliiliula	10.23	3.00
Waikoko	9.70	4.00
Total South Fork	56.60	27.40
Total Stream Length	88.57	43.40
Wailua Estuary	2.40	2.40
GRAND TOTAL	90.97	45.80

Note: [1]Opaekaa Stream not included within project area or this estimate. Lengths (to headwaters) estimated by map measure using USGS quadrangle maps.
[2]Includes habitat (in miles) for both indigenous and game fishery resources.
[3]Intermittent streams.

TABLE 2. AQUATIC MACROFAUNA OBSERVED IN WAILUA RIVER 1980-1982.

Key: - rare; + occasional; ++ common; +++ abundant; [1] endemic; [2] native; [3] introduced

Class / Family / Species	Common Name	Above Wailua Falls	Below Wailua Falls	Above Kaholalele Falls North Fork
Insecta				
Chirnomidae[2]	midges		++	
Ephydridae[2]	brine flies		++	
Culicidae[3]	mosquitoes	+++	+++	
Tipulidae[2]	crane files		++	
Order: Tricoptera				
Cheumatopsyche analis[3]	caddisfly	++	+++	++
Order: Odonata				
Coenagriidae				
Enalagma civille[3]	damselfly			++
Crustacea				
Atyidae				
Atya bisulcata[1]	opae	++	+++	++
Palaemonidae				
Macrobrachium grandimanus[1]	opae oeha'a		+++	
Macrobrachium lar[3]	Tahitian prawn	+	+++	++
Procambarus clarkii	crayfish	++	++	++
Gastropoda				
Ancylidae				
Ferrissia sharpi[1]	limpet		-	

TABLE 2 (Continued)

Class Family Species	Common Name	Above Wailua Falls	Below Wailua Falls	Above Kaholalele Falls North Fork
Lymnaeidae				
Erinna aulocospira[1]			++	
Pseudisidora rubella[1]			++	
Thiaridae		+++		
Osteichthyes (Pisces)				
Centrarchidae				
Micropterus salmoides[3]	largemouth bass	+	+	+
Micropterus dolomieui[3]	smallmouth bass	+++	++	+++
Lepomis macrochirus[3]	bluegill	++		+
Clariidae				
Clarias fuscus[3]	Chinese catfish	+++	+	
Poeciliidae				
Poecilia reticulata[3]	guppy	+		
Gambusia affinis[3]	mosquitofish	+++		
Xiphophorus sp.	swordtail	+++	+++	+++
Cyprinidae				
Cyprinus carpio	carp	-	-	-
Gobiidae				
Eleotris sandwicensis[1]	o'opu akupa		+++	
Awaous stamineus[1]	o'opu nakea	+	+++	
Sicydium stimpsoni[1]	o'opu nopili		+	

Limnological reconnaissance surveys have identified significant numbers of indigenous species in the South Fork below Wailua Falls. This reach is not easily accessible due to steep valley walls and slippery trails. This may account for the infrequent exploitation of this native fishery. Fishing for native, itinerant marine species, such as mullet, barracuda, and certain crabs, also occurs within the estuary. Wailua Falls apparently acts as a passage barrier to some of the native, diadromous species during prolonged periods of reduced streamflow. Those individuals that are able to surmount the falls must contend with predation pressure by exotic species. The native mountain opae and introduced Tahitian prawn are the only diadromous species found in abundance above Wailua Falls.

No significant biological surveys of the Wailua River estuary have been identified. No surveys were conducted as part of this study since the estuary lies beyond the area of the river which will be impacted by the proposed hydropower development. A general description of characteristic fauna, and physicochemical parameters of small Hawaiian estuaries appear in Maciolek and Timbol (1981).

d. Social/Economic Resources. The smallmouth bass is the central species of interest in the unmanaged recreational fishery. Unfortunately, there are no catch or user/day statistics available for the fishery. No published information is available which describes the fishing effort exerted on the native fishery within the estuary and lower reaches of the stream. It is believed that the take is regular and occasionally quite heavy.

Kauai is still recognized as the center of the State's seasonal commercial fishery based upon gobiid fishes. Heaviest fishing pressure appears to be exerted on Lumahai, Wainiha, Kalihiwai, and Hanalei rivers along Kauai's north coast. The Hanapepe and Waimea rivers were once also major centers of this native fishery. The fishery is not managed or monitored, and catch in recent years may have declined. Principal species of interest in this fishery are *Awaous* (*Chonophorus*) *stamineus*, "o'opu nakea"; and *Eleotris sandwicensis*, "o'opu akupa." Other species of interest include the native shrimp *Atya bisulcata*, "opae kalaole"; and *Macrobrachium grandimanus*, "opae oeha'a"; and the endemic mollusk *Neritina granosa*, "wi." The introduced Tahitian prawn (*M. lar*) is also one of the more commonly sought-after species in streams.

The existing conditions within the South Fork and North Fork Wailua River are not expected to change significantly in future years provided that water demands, floodplain and upland development do not increase significantly. Populations of native stream fauna may decline unless water development projects or upland development do not seriously jeopardize remaining stream habitat.

2. Future With Project

a. Riparian Resources. The proposed alternative schemes for hydropower development on the South Fork Wailua River will not adversely affect any significant riparian resources.

b. Wildlife Resources. Some nesting sites for exotic birds will be removed, and other terrestrial fauna may be displaced during construction. A total of approximately .75 acres of riparian habitat will be cleared for Plan 1A; and about 2.5 acres will be cleared for Plan 2A. The permanent pool above the proposed intake is expected to inundate approximately three acres of wooded stream bank. (Creation of a recreational pond below the power plant in Plan 2A as illustrated in the Interim Survey Report is not a component of the Corps project; rather it is part of the Wailua River State Park master plan.)

While the endangered Hawaiian duck has been seen in the lower reaches of the Wailua River, the Fish and Wildlife Service did not recommend that formal consultation be initiated for this action (January 7, 1981). The project will have no effect upon resources within the Lihue-Koloa Forest Reserve, or within designated public hunting areas and game bird reserves. No significant resources will be affected along the short alignment of the power transmission lines.

c. Aquatic Resources. Plan 1A has the potential to degrade productive habitat for native species below Wailua Falls due to sedimentation created by construction activities. Flows would be reintroduced to the stream approximately 300 feet downstream of the plunge pool at the base of Wailua Falls, thereby resulting in partial dewaterment of approximately .11 miles of stream habitat (including Wailua Falls). Plan 2A has a similar potential for damage from sedimentation; however, a total of 1.7 river miles (including the falls) would be subject to partial dewaterment. Diversion of North Fork waters through the Stable Storm Ditch in Plans 1A and 2A would significantly reduce the impacts of partial South Fork dewaterment; however, it would also result in a reduction of flow and important habitat for smallmouth bass in the North Fork below the Stable Storm Ditch.

Short-term impacts of the two structural alternatives involving excavation, transport, and placement of fill material within the Wailua River can be expected. Impacts will include disturbance, displacement, and destruction of aquatic fauna, suspension of fine sediments resulting in increased turbidity, and introduction of potentially toxic substances, such as petroleum products from construction machinery. Short-term impacts mentioned above may also extend to the Wailua estuary during construction.

The long-term impacts of sediment resulting from construction and operation of the diversion may result in the loss or reduction of significant aquatic habitat unless sufficient flow velocities are maintained to prevent sediment accumulation, and to periodically purge the fines.

Long-term impacts include partial diversion of the stream below the diversion structures causing reduction of flow, alteration of normal seasonal flow regimes, and subsequent habitat reduction and population decline of indigenous and introduced fauna inhabiting the lower stream course between Wailua Falls and the power plant outfall, and below the Stable Storm Ditch on the North Fork. The impoundment structures may constitute barriers to migration of shrimp and prawns. No thermal stress is anticipated due to power plant effluent; however, reduced flows between the intake and power plant may increase solar insulation of waters within this reach, possibly leading to thermal stress and exclusion of some organisms (Hathaway 1978).

No adverse impacts to fishes are anticipated due to potential gas saturation of power plant tailwaters; however, periodic monitoring of total gas pressures in tailwaters should be conducted to insure that conditions which may lead to mass mortality of fishes are not allowed to occur. These impacts have been observed and documented at small hydro facilities within the continental U.S. (Ross Antipa, Washington State Fisheries; pers. comm.).

d. Social/Economic Resources. None of the proposed alternative plans will significantly impact the smallmouth bass fishery above Wailua Falls on the South Fork, provided that public access to the stream and 4.4-acre pool above the intake is maintained year-round. Unless mitigated by appropriate technology (such as rotating fish screens), substantial numbers of game fishes may be lost through the intake structure. The additional flow made available from the North Fork will not significantly alter or enhance habitat in the South Fork for this species. No decrease in flow will occur in the South Fork above the intake structure as a result of the proposed development. It is imperative that future Coordination Act studies conducted during Phase 1 Post-authorization identify and quantify the most important reaches for maintenance of sport fishery habitat so that adequate allotment of instream flows will be insured in both North and South Forks.

The impoundment pond above the intake should be enhanced for public sport fishing and should provide facilities for additional water-related recreation.

Alternative Plan 3 will have no impacts within the Wailua River watershed on fish and wildlife resources. Future of riparian and aquatic resources with this alternative would be similar to those identified in the "Future Without the Project" section of this report. Table 3 presents a summary of effects.

MITIGATION PROPOSAL

1. Plan Description and Justification

The Fish and Wildlife Service is recommending mitigation to minimize adverse impacts associated with short-term impacts to water quality and long-term alteration of flow regimes. Studies to be conducted during Post-authorization are also identified here.

The following measures have been identified as the most effective mitigation measures which may be practicably employed for either Plan 1A or 2A to protect fish and wildlife resources within the project area:

Erosion Control

a. Construction in the water (diversion structure, outlet structures) and along the channel walls (access roads, penstocks, power plant, and tramway) is to be conducted during periods of low rainfall, and should be scheduled for the months of June-September.

b. Dredged or excavated material should be removed from the stream channel, and may not be temporarily stockpiled into the water.

c. Movements of heavy construction machinery in the stream should be avoided or minimized.

d. Automatic shutoff valves should be installed to prevent soil erosion on riparian areas in case of penstock failure.

e. Silt should be periodically cleaned from the pool above the intake structure.

f. Stream and impoundment banks subject to clearing during construction should be stabilized as soon as practicable to reduce soil erosion.

Maintenance of Stream Flows

a. The diversion structure must be designed to allow continuous downstream discharge during peak power development. Adequate instream flow regimes to conserve important sport fishing habitat in the South Fork must be determined through field analysis in consultation with the Service and the State.

TABLE 3. SUMMARY OF PRIMARY EFFECTS OF ALL PLANS ON STREAM HABITAT IN THE WAILUA RIVER, KAUAI

ESTIMATED AVAILABLE HABITAT[1]

		Future Without Project		Future With Project			
				Without Mitigation		With Mitigation[2]	
		native fisheries	game fisheries	native fisheries	game fisheries	native fisheries	game fisheries
1A:	South Fork	2.4	27.4	1.3	27.4	2.3	27.4
	North Fork	2.8	16.0	0.5	10.0	2.5	16.0
	TOTAL	5.2	43.4	1.8	37.4	4.8	43.4
2A:	South Fork	2.4	27.4	0.6	27.4	2.3	27.4
	North Fork	2.8	16.0	0.5	10.0	2.5	16.0
	TOTAL	5.2	43.4	1.1	37.4	4.8	43.4
3:	South Fork	2.4	27.4	NO CHANGE - - - - - - - - - - - - -			
	North Fork	2.8	16.0	NO CHANGE - - - - - - - - - - - - -			
	TOTAL	5.2	43.4				

NOTES: 1) All values in river miles; 2) FWS mitigation recommendations.

Furthermore, the diversion must be designed to permit periodic passage of flows necessary to flush accumulated silt from the lower stream course, and to accommodate spawning requirements of the native fishery resources in the lower reaches of the South Fork. Passage and spawning flows must be negotiated through consultation with the State and the Service.

b. The diversion structure on the North Fork at the Stable Storm Ditch must provide for continuous downstream discharge. Adequate instream flow regimes to conserve important sport fishery habitat in the North Fork must be determined through field analysis in consultation with the Service and the State.

c. During construction of the diversion structure and conduit, allowance must be made to provide continuous flows downstream of the construction.

d. Appropriate ramping rates must be negotiated with the State and Service to prevent dewaterment during rapid start-up and shutdown.

e. Consideration must be given to the installation of automatic flow continuation valves to protect instream flows below the diversion structure in the event of sudden flow rejection at the powerhouse.

Maintenance of Passage

a. Rubble and/or boulders should be grouted into a portion of the downstream face of the diversion structure forming an irregularly shaped, sloping cascade to provide appropriate pathway for migration of indigenous species.

b. Powerhouse tailwaters should be agitated (by jumps, baffles, or falls) to prevent excessive total gas pressures.

c. To prevent migration of fishes and crustaceans into tailrace waters, fish racks, falls and/or a flow dissipation structure should be installed below the powerhouse.

General

a. All applicable grading ordinances and water quality standards shall be met during construction. Should the Corps be advised with appropriate particularity by the Fish and Wildlife Service that the hydropower development is resulting in unacceptable impacts to fish, wildlife or riparian resources, the Corps will temporarily cease construction or hydropower plant operation until such time as said impacts are mitigated.

b. Detailed surveys of sport fishery populations and their instream flow requirements will be conducted during Phase 1 Post-authorization studies.

c. The Corps shall conduct a systematic pre-, during, and post-construction water quality and aquatic biology monitoring program. This program will be initiated immediately preceding construction, and the scope of study will be prepared with the assistance of the Fish and Wildlife Service. Biological surveys will be conducted within the Kalepa Forest Reserve, along the alignment of the proposed power transmission lines, during Phase 1 Post-authorization studies.

Implementation of these mitigation measures is necessary and appropriate to minimize expected adverse impacts to water quality and fishery resources in the Wailua River, and to meet planning criteria identified by the Corps.

BIBLIOGRAPHY

Belt, Collins & Associates. 1978. Waialeale Power Study. Report prepared for Division of Water and Land Development (DLNR), State of Hawaii.

Davis, R. 1960. Major streams of Kauai and their utilization. M.A. thesis, University of Hawaii at Manoa.

Hathaway, C.B. 1978. Tolerance of native stream species to observed levels of environmental variability. IN: Stream channel modification in Hawaii. FWS/OBS-78/18.

MacDonald, G.A., D.A. Davis, and D.C. Cox. 1960. Geology and Ground-water Resources of the Island of Kauai, Hawaii. Bulletin 13, Hawaii Division of Hydrography.

Maciolek, J.A. and A.S. Timbol. 1981. Environmental features and macrofauna of Kahana Estuary, Oahu, Hawaii. Proc. Symp. Bays and Estuaries. Bull. Mar. Sci. 31:712-722.

United States Department of Agriculture, Soil Conservation Service. 1973. Soil Survey of Island of Hawaii, State of Hawaii.

U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT SHAFTER, HAWAII 96858

PODED-PV

29 October 1982

Mr. Dale Coggeshall
Pacific Islands Administrator
Fish and Wildlife Service
U.S. Department of Interior
P. O. Box 50167
Honolulu, HI 96850

Dear Mr. Coggeshall:

We are responding to your 3 September 1982 letter forwarding the Fish and Wildlife Service Final Coordination Act (FWCA) Report for the Wailua Hydropower Study Interim Survey Report. Measures recommended in your report will be generally adopted by the U.S. Army Corps of Engineers. However, there are certain items in the FWCA report which we wish to clarify or which require statements of our current position. Further explanations are provided in the inclosure.

We appreciate your cooperative effort in this study, particularly the timeliness of your draft and final report submission. We will keep you informed of further developments with the study.

Sincerely,

1 Incl
As stated

ALFRED J. THIEDE
Colonel, Corps of Engineers
District Engineer

PODED-PV 29 October 1982

WAILUA RIVER HYDROPOWER STUDY
CORPS RESPONSES TO FWCA REPORT

EROSION CONTROL

Item d. The penstock will be designed for all foreseeable hydraulic conditions, hence penstock failure is extremely unlikely. A gatewell with manual shutoff valve is provided in the present design (refer to Plates B-18 and B-26 of the draft survey report). Conversion of this feature to an automatic valve will be considered for the protection of hydraulic machinery.

MAINTENANCE OF STREAM FLOWS

Item d. Dewaterment will not take place during start-up or shutdown of the hydropower systems proposed in the draft interim survey report.

Item e. The features proposed in item e. are not considered necessary. The flow gates would be designed to close gradually, allowing flow to simultaneously increase over the diversion structure and downstream so that flows below the tailrace will not be subject to sudden decreases as a result of powerplant operations.

MAINTENANCE OF PASSAGE

Item b. These features will be considered during design of the confluence. At the present time it has not been determined that total gas pressures would be great enough to warrant treatment. The final FWCA report (para 3, p 18) states that no adverse impacts to fish are anticipated due to potential gas saturation of powerplant tailwaters.

Item c. These features are not considered necessary because the tailrace will be short and water velocities at the outlet will be relatively high (greater than 10 feet/sec). This will preclude the possibility of aquatic organisms migrating into powerplant machinery. Organisms migrating into the tailrace will have no problem returning to the main stream.

GENERAL

Item a. This requirement would be subject to discussion and negotiation. The Corps is charged with administering the construction contract. Any work stoppage would result in contractor claims. The limits of acceptability would require enforceable specifications by the USFWS. If these requirements are adopted by the Contracting Officer, they will be incorporated into the contract documents.

Item b. These surveys would be conducted during post-authorization studies but not necessarily during Phase I.

Item c. Identified potential impacts resulting from the proposed project do not at this point warrant the recommended intensive water quality and aquatic biology monitoring program. If during the course of post-authorization investigations, unforeseen adverse impacts to water quality or aquatic biota appear likely, a monitoring program may be necessary.

Biological surveys along transmission line alignments within the Kalepa Forest Reserve will be conducted during post-authorization studies.

CLEAN WATER ACT

SECTION 404(b)(1)
EVALUATION OF THE EFFECTS OF THE
DISCHARGE OF DREDGED OR FILL MATERIAL INTO
WATER OF THE US 1/

PROJECT DESCRIPTION

a. Location: Wailua River, Wailua, Island of Kauai.

b. General Description: The Honolulu District, US Army Corps of Engineers, has investigated the feasibility of hydroelectric power generation on the South Fork Wailua River and associated impacts on the environmental, social, cultural and economic resources of the area. Two structural plans have been developed that would require the discharge of fill material, mainly concrete and riprap, within the stream. The principal structural feature within the stream would be a diversion structure. Portions of the penstock and tailrace structures would also require placement of fill material. The nonstructural plan (Alternative 3) would not affect waters of the US.

c. Authority and Purpose: This report was prepared under the authority of Section 209 of the Flood Control Act of 1962 (Public Law 87-874). This section authorizes the Secretary of the Army, through the Chief of Engineers, to study water and related resources problems and needs in the State of Hawaii. The Honolulu District, US Army Corps of Engineers, was requested to perform investigations for small-scaled hydropower development in the Wailua River, Kauai, by the State of Hawaii. This study is in response to that request.

d. General Descriptions of Dredged or Fill Materials:

	Alternatives 1A	2A
(1) General Characteristics of the Material.	Concrete consisting of cement, aggregates and water with reinforcement bars. Riprap material consisting of quarried rock.	Same as Plan 1A
(2) Quantity of Material to be Discharged. 2/	3,160 CY	3,160 CY
(3) Source of the Material.	Aggregates will probably come from existing quarries in the vicinity of Hilo, Hawaii. Cement will be factory produced.	Same as Plan 1A

1/ Using US Environmental Protection Agency (EPA) Guidelines.
2/ Material includes concrete and bedding.

e. Description of the Proposed Discharge Site.

	Alternatives 1A	2A
(1) Location (see map, Figure 2 & 3 of Main Report).	Diversion structure would be located approximately 300 feet upstream of Wailua Falls. Tailrace would be located 0.1 mile below the falls.	Diversion Structure same as Plan 1A. Tailrace located 1.7 miles downstream of falls.
(2) Size (acres)	0.25 acres.	0.25 acres.
(3) Type of Site.	Perennial stream.	Perennial stream.
(4) Type(s) of Habitat.	Aquatic freshwater habitat.	Aquatic freshwater habitat.
(5) Timing and Duration of Discharge.	The project will probably be implemented within 8 to 10 years and will take 31 months to construct (18 to 24 actual field time).	Same as Plan 1A.

f. Description of Disposal Method:

(1) Method of Discharge.	Material will be used to construct a diversion dam and tailrace at the discharge sites. Material will be placed by crane into form work across Wailua River above Wailua Falls (diversion dam and downstream (tailrace).	Same as Plan 1A except tailrace will consist of buried 72" RCP.

FACTUAL DETERMINATIONS

	Alternatives 1A	2A
a. Physical Substrate Determinations:		
(1) Substrate Elevation and Slope.	240' - 260' MSL.	Same as Plan 1.
(2) Sediment Type.	(pp. D-1-6).	(pp. D-1-6).
(3) Dredged/Fill Material Movement.	NA 2/	NA
(4) Physical Effects on Benthos.	Burial.	Burial.
(5) Other Effects.	NA	NA
(6) Actions Taken to Minimize Impacts.	NA	NA
b. Water Circulation, Fluctuation and Salinity Determination:		
(1) Water, Effects on:		
(a) Salinity.	NA	NA
(b) Water Chemistry.	No effect.	No effect.
(c) Clarity.	No effect.	No effect.
(d) Color.	No effect.	No effect.
(e) Odor.	No effect.	No effect.
(f) Taste.	No effect.	No effect.
(g) Dissolved Gas Levels.	Increased below powerplant tailrace.	Increased below powerplant tailrace.
(h) Nutrients.	No effect.	No effect.

2/ NA: Not applicable.

b. Water Circulation, Fluctuation and Salinity Determination: (Cont)

	Alternatives 1A	2A
(2) Current Patterns and Circulation:		
(a) Current Patterns.	No effect.	No effect.
(b) Velocity.	No effect.	Decrease during powerplant operation between diversion structure and powerplant tailrace.
(c) Stratification.	No effect.	No effect.
(d) Hydrologic Regime.	The dam will divert water from the river to a hydroelectric powerplant and return it to the river. When the plant is in operation, 10 CFS conservation flow will be maintained in the river reach between the diversion and the tailrace.	Same as Plan 1A.
(3) Normal Water Level Fluctuations.	No effect.	No effect.
(4) Salinity Gradients.	NA	NA
(5) Actions That Will Be Taken to Minimize Impacts.	10 CFS conservation flow will be maintained during periods of powerplant operation.	

c. Suspended Particulate/Turbidity Determination:

	1A	2A
(1) Expected Changes in Suspended Particulate and Turbidity Levels in Vicinity of Disposal Site.	No effect.	No effect.
(2) Effects (degree and Duration) on Chemical and Physical Properties of the Water Column.		
(a) Light Penetration.	No effect.	No effect.
(b) Dissolved Oxygen.	No effect.	No effect.
(c) Toxic Metals and Organics	No effect.	No effect.
(d) Pathogens.	No effect.	No effect.
(e) Aesthetics.	No effect.	No effect.

c. Suspended Particulate/Turbidity Determination: (Cont)

	Alternatives 1A	2A
(3) Effects on Biota		
(a) Primary Production, Photosynthesis.	No effect.	No effect.
(b) Suspension/Filter Feeders.	No effect.	No effect.
(d) Sight Feeders.	No effect.	No effect.
(4) Actions Taken to Minimize Impacts.	NA	NA
d. Contaminant Determination:	NA	NA
The proposed discharge is free of contaminants.		
e. Aquatic Ecosystem and Organism Determinations:		
The proposed discharge is free of contaminants.		
f. Proposed Disposal Site Determinations:		
(1) Mixing Zone Determination.	NA	NA
(2) Determination of Compliance with Applicable Water Quality Standards.	NA	NA
(3) Potential Effects on Human Use Characteristics.	No effect.	No effect.
g. Determination of Cumulative Effects on the Aquatic Ecosystem.	Insignificant.	Reduction of available habitat between diversion structure and powerplant tailrace.
h. Determination of Secondary Effects on the Aquatic Ecosystem.	Insignificant.	Reduction of available habitat within a 1.7-mile reach of the river between the diversion structure and power plant tailrace resulting from reduced flows during power plant operation.

FINDING OF COMPLIANCE
FOR
WAILUA RIVER HYDROPOWER STUDY

1. No significant adaptations of the guidelines were made relative to this evaluation.

2. The discharge (concrete and riprap) is necessary to construct a diversion dam and tailrace for the proposed hydropower project on the site of Wailua River. The discharge site is project specific; there are no practicable alternatives to the proposed discharge site that would achieve the desired project purpose. The discharge will not result in significant adverse impacts on the aquatic ecosystem.

3. The discharge of concrete material and riprap at the site would not violate any applicable State Water Quality Standards. Nor would it violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.

4. The discharge of fill material at the proposed site will not harm any endangered species or their critical habitat.

5. The proposed discharge will not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. The life stages of aquatic life and other wildlife will not be adversely affected. Significant adverse effects on aquatic ecosystem diversity, productivity and stability, and recreational, aesthetic and economic values will not occur.

6. On the basis of the guidelines, the proposed site for the discharge of fill material is specified as complying with the requirements of these guidelines.

82 DEC 21
Date

Alfred J. Thiede

ALFRED J. THIEDE
Colonel, Corps of Engineers
District Engineer

WAILUA RIVER HYDROPOWER PROJECT
KAUAI, HAWAII

ENVIRONMENTAL EFFECTS

APPENDIX H

APPENDIX H

ENVIRONMENTAL EFFECTS

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APPENDIX H

ENVIRONMENTAL EFFECTS

CULTURAL AND SOCIAL RESOURCES

HISTORIC PROPERTIES

1. Identification of historic sites is required by the Reservoir Salvage Act of 1960 as amended, Section 110 of the National Historic Preservation Act of 1966, and Executive Order 11593 (1971). The Federal agency must evaluate the significance of the sites in order to determine possible eligibility for the National Register of Historic Places. If any sites in the project area are determined eligible for or already listed on the National Register, they would be protected by Federal law and regulation to the extent that the Federal agency must consult with the State Historic Preservation Officer and the US Advisory Council on Historic Preservation to determine the effect of the Federal project and to identify measures to either avoid or mitigate for any adverse effects.

2. The identification of historic sites within the study area is based on an "Archaeological Surface Survey of Wailua State Park, Kauai" conducted by Mr. Francis K. W. Ching in 1968 when he was employed by the State Department of Land and Natural Resources. The results of this study are reported in the planning document "Wailua River State Park, Island of Kauai, State of Hawaii" prepared by the joint venture of Eckbo Dean, Austin & Williams and Muroda Tanaka & Itagaki Inc., for the State in 1970 and in Ching's "A Cultural Resources Reconnaissance for the Wailua River Hydropower Study, Wailua, Puna, Kaua'i Island" by Archaeological Research Center Hawaii (ARCH), Inc., in 1981 for the U.S. Army Corps of Engineers. Ching's report is reproduced in this appendix without its large-scale maps of sited areas in conformance with the Archaeological Resources Protection Act of 1979 (P.L. 96-95) and applicable Corps regulations (Engineering Regulation 1105-2-50, 29 January 1982). Most of the sites identified and discussed in the ARCH report lie within areas of potential environmental impact that were considered earlier in the planning process for this hydropower study. At present, construction is proposed under Alternative Plans 1A and 2A only in ARCH Study Areas A, B, and I. The areas which would be potentially impacted by construction of the diversion barrier, intake structure, and conduit above the Wailua Falls (excepting Lihue Plantation sugarcane land) and the penstock and powerplants below the falls for both alternative sites were previously examined by Ching 1968. None of the sugarcane lands proposed for excavation and placement of conduit lines will be archaeologically surveyed because of the low likelihood of finding any remains of agricultural sites in areas so heavily modified by long-term mechanized agriculture.

3. Figure H-1 depicts the historic sites known as of 1970 in the study area (shown in outline inscribed on the map). The square symbol on Figure H-1 above Wailua Falls refers to the approximate location of Kawelowai (underwater) cave. as discussed on Page 18 of the ARCH report. M.D. Monsarrat's 1900 <u>Map of the Lihue Plantation, Northern Portion</u>, Scale 1:6,000 however indicates the Cave to be located about 750 feet upstream of Ching's location. Ching's Sites 205, 206, 207 and 208 are depicted in the State Park Plan as proposed lagoon for future development.

4. About 200 feet above Wailua Falls is an abandoned railroad bridge spanning the shallow river gorge (Figure H-1). Just upstream from the bridge is an abandoned cable car crossing the gorge. The railroad was an internal 30-inch guage standard system owned and operated by Lihue Plantation Company to haul cane initially to its mill at Hanamaula and thence by railroad to Ahukini Landing on Hanamaula Bay (U.S. Geological Survey, Topographic Map of the Island of Kauai, Scale 1:62,500, Surveyed 1910). Monsarrat's earlier 1900 map indicates that the railroad, the construction of which began in 1895, has not yet been extended to the South Fork Wailua River. Thus the bridge probably was constructed between 1900 and 1910. The track has been removed from the bridge and all that remains are two concrete bridge abutments and the truss. The truss form has not yet been analyzed.

5. No archaeological surveys have been conducted along the two proposed rights-of-way for electric powerlines connecting the powerplants with the Lydgate Park substation. The exact route of the powerlines have not been determined so that conducting premature archaeological surveys would not be cost effective. An archaeological reconnaissance survey will be performed during post-authorization studies, following plan selection.

EFFECTS EVALUATION

6. None of the two plans, as now conceptually designed would affect the railroad bridge but consideration may be given in future planning to constructing a walkway through the existing truss to span the river gorge. The pool backed up behind the twelve-foot high diversion dam under Plan 1A could cover the area which Ching previously identified as the legendary location of Kawelowai Cave. Because the cave has not actually been physically located, no adverse effect is anticipated by the creation of the pool. Based on the recent archaeological surveys conducted by Archaeological Research Center Hawaii (ARCH) near the old rice mill and State Park proposed lagoon feature and Ching's earlier 1968 survey) construction of a penstock and powerplant under Plan 1A would appear not to affect any remaining Hawaiian agricultural features. The present alignment of powerline running east from the Powerplant under Plan 1A could adversely affect the Makea agricultural terrace complex which was shown in an 1846 map as under rice cultivation. This is the same area proposed by the 1970 Wailua State Park plan for development as a lagoon.

7. The effects of Plan 2A above Wailua Falls are similar to Plan 1A. No additional prehistoric or historic sites appear to be affected. Construction of the penstock and powerplant also appear to not affect any known historic properties. Construction of the powerline running east to the Lydgate Substation may affect unknown historic properties in the Kalepa (Ridge) Forest Reserve. Neither Plan 1A or 2A will affect any sites in the vicinity of the Stable Storm Ditch in the upper Wailua River watershed.

OTHER SOCIAL EFFECTS

8. Social Impact Assessment of U.S. Army Corps of Engineers water resources projects requires display of "Other Social Effects." The Other Social Effects component analysis derives from the Water Resources Council's "Principles and Standards for Planning Water and Related Land Resources - Level C" (P&S), 45 Federal Register 64366-64400, 29 September 1980. The Other Social Effects components now required by P&S consist of (a) Urban and community impacts such

as income distribution, employment distribution, population distribution and composition, the fiscal condition of the local government, and the quality of community life; (b) Life, health and safety; (c) Displacement including people, businesses, and farms; (d) Long-term productivity involving renewable resources; and (e) Energy requirements and energy conservation both during construction and operation of facilities.

9. The social effects of the proposed project are mainly island-wide in nature. All of the project's components are physically located far from population centers, and in fact would displace no people, or individual businesses or farms. No changes in existing income, employment or population distribution or composition are anticipated as a result of implementing any of the alternative plans. Non-Federal project first costs which would be borne directly by the State have yet to be fully determined. Assuming the Federal participation is maximized, there will be little burden on local governmental finances. All hydropower Federal costs would be reimbursed to the Federal Government over a maximum period of fifty years by sales of electrical power. The quality of community life will be affected, but the nature of that quality is believed to be related to recreational activities and aesthetic perception more than any other factors. These factors are treated in the subsequent section. There are few life, health and safety considerations. The likelihood of dam failure with resultant flash floods is miniscule both because of the design of the diversion structure (designed up to the Probable Maximum Flood) and because of the comparatively small amount of water impounded behind the barrage. There are some safety elements involved in provision of new access to the stream and creation of an enlargend pool above the falls, but these will be considered in the subsequent section on Recreation and Aesthetics. The components of the OSE Account involving long-term productivity and energy are fully covered in the Main Report and Appendix E.

10. The following table (Table H-1) depicts the changing population distribution on Kauai between 1970 and 1980 which saw unusually high growth of the census tracts comprising Hanalei and Wailua-Anahola (excluding Kapaa). Even by the 1974 sample survey, these trends could be perceived. Detailed census tract-level socioeconomic data for 1980 are not yet available. Table H-2 depicts these regional characteristics for the inter-census of 1974. Census tracts 402 to 405 surround the project area.

RECREATIONAL RESOURCES

11. Major portions of both Plans 1A and 2A lie almost entirely within Wailua River State Park which has 1,113 acres of outstanding scenic, natural, historical and recreational resources. The State Park was established by the Territory of Hawaii in 1954 with a focus on Fern Grotto and the Wailuanuiho'ainana, a complex of heiau and other kapu areas and habitation areas alongside the river estuary. Fern Grotto is the principal visitor attraction. The present park has long-range plans to expand to about 1,700 acres. Development and expansion of the Park is governed by the Wailua River State Park plan prepared for the State in 1970. Almost none of the many recommended components of the plan relating to recreation, circulation or landscaping have yet been implemented, but State Park officials report that the 1970 plan still remains the only planning guidelines for the area. Between 1965 and 1969, Wailua River State Park accounted for almost 20 percent of all state parks and historic site attendance. State Department of Land and

TABLE H-1. POPULATION DISTRIBUTION ON KAUAI ISLAND, 1970-1980

		CENSUS TRACTS								
Year	Total Kauai	401 Hanalei	402 Wailua Anahola	403 Kapaa	404 Puhi-Hanamulu	405 Lihue	406 Koloa-Poipu	407 Eleele-Kalaheo	408 Kaumakani-Hanapepe	409 Kekaha-Waimea
1970[1]	29,524	1,182	3,599	3,794	3,642	3,124	3,141	3,660	3,173	4,159
1974[2]	29,460	1,700	4,220	3,630	3,140	3,090	2,850	3,910	2,700	4,220
1980[1]	38,856	2,668	6,030	4,467	4,590	4,000	3,879	4,855	3,111	5,256

1 State Department of Planning and Economic Development. The State of Hawaii Data Book 1981, A Statistical Abstract. November 1981.

2 Anderson, Robert N. and others. Kauai Socioeconomic Profile. Departmental Paper 35. Honolulu; Center for Nonmetropolitan Planning and Development, Cooperative Extension Service and Hawaii Agricultural Experiment Station, University of Hawaii, May 1975, Table 9.

TABLE H-2. POPULATION CHARACTERISTICS BY CENSUS TRACTS
KAUAI, 1974

Characteristics	Total	Census Tracts 401	402	403	404	405	406	407	408	409
Number of households	8,550	490	1,240	1,030	800	1,210	880	1,210	800	1,110
Percentage	100	5.7	14.5	12.0	9.4	11.6	10.3	14.2	9.4	13.0
Median household size	3.2	2.75	2.89	3.04	3.75	2.85	3.00	2.89	2.50	3.40
Median household income in dollars	10,750	11,600	13,620	10,190	10,330	14,290	10,600	9,680	7,750	10,110
Median number of years of adults in the community	27.7	14.5	24.0	26.7	27.0	32.5	23.5	27.9	37.5	34.5
Adults born on Kauai in percentages	53.6	36.8	48.8	57.5	43.5	63.9	50.3	56.8	54.2	59.4
Sex										
Male	51.8	49.4	48.4	50.9	55.7	52.8	51.1	54.7	53.4	50.0
Female	48.2	50.6	51.6	49.1	44.3	47.2	48.9	45.3	46.6	50.0
Median age	27.1	23.7	26.9	24.9	23.9	28.5	27.0	29.7	35.3	24.1
Adults living their whole life on Kauai										
Yes	52.8	30.5	47.2	57.3	43.5	63.9	46.6	56.8	54.9	60.5
No	47.2	69.5	52.8	42.7	56.5	36.1	53.4	43.2	45.1	39.5

Source: Anderson, Robert N. and Others. Kauai Socioeconomic Profile. Departmental Paper 35. Honolulu: Center for Nonmetropolitan Planning and Development, Cooperative Extension Service and Hawaii Agricultural Experiment Station, University of Hawaii, May 1975.

Natural Resources statistics for the fiscal year ending 30 June 1981 show this percentage increasing to over 30 percent or about 4,532,000 visits. Sixty-five percent of the visits were made to areas excluding Fern Grotto and Lydgate Beach Park. In 1970, it was estimated that only about 50 percent of th park visitors were from out-of-state.

12. Very few of the many tropical scenes along the Wailua River (North or South Fork) upstream of Fern Grotto are readily accessible to Park visitors. Access to Fern Grotto is available only by commercial group charter boats. Ground access to the upper reaches of the river is possible but seldom utilized. No count of visitors to Wailua Falls is available. The falls is the only and terminal designation of County Road 583. A turn-around or unimproved parking lot terminates the County road with space for about 16-20 cars. Based on a short visit to the falls area in August 1980, it was estimated that 20 cars per hour visit the falls. Assuming 3 passengers per car and 20 cars per hour over an 8-hour visitor day, approximately 175,000 people visit the waterfall each year. It is also estimated that about 25% of the visitors may climb down a forty-foot high embankment to visit the upper falls area during periods of low flow. Another 10 percent or less may climb down the arduous, and unimproved trail to the lower falls area, which lies about 100 feet down a rather precipitous bank. The 1.4 acre pool at the foot of the waterfalls is an occasional swimming place when the flow is low.

13. Approximately 30 percent of the entire length of the South Fork comprises smallmouth bass fishery under the control of Lihue Plantation Company. This 17 mile stretch of the river is accessible primarily only to plantation workers. Chinese catfish, mosquitofish and guppies are also found there. Several groups of presumed plantation workers and their families were observed in slack-water portions of the upper South Fork swimming in the river and picnicking along its banks. These activities were also observed just above the falls.

14. The State Park long-range development plan prepared in 1970 recommends construction of a horse stable above the falls, a walkway over the falls via the old railroad bridge, and a downstream trail access to the pools beneath the falls for swimming and picnicking (Figures H-2 and H-3). In the meadow east of the Plan 2A powerplant, a lagoon feature would be provided to combine water-oriented recreational activities, a refuge for wildlife, and a flood control detention basin (Figure H-3). None of these features have been provided to date (1982).

15. The proposed project features would in some cases conflict with the recommended park facilities and in other cases would complement them. Under both structural plans, creation of an enlarged slack-water pool of almost 5 acres above the falls could conflict with the siting of the proposed horse stables near there. In any case, it would be inappropriate to site a horse stable so close to body of water that could be used for swimming or fishing. There is a possibility that the new impoundment may enhance the existing smallmouth bass fishery. Both structural plans may also require the use of the present turn-around at the end of Route 558 for a construction staging area. Unless provisions are made for another construction staging area or another waterfalls viewing area, access to the overlook may be denied or restricted during the 24-month construction period. After completion of the project, restoration of this area may include improvements to the parking lot

and viewing area. Roads and trails constructed to gain good access to the barrage site and the powerplant site under Plan 1A would contribute to post-construction visitor access to the upperfall pool and the lagoon that is proposed by the long-range Park plan. Permanent trails accessing the powerplant below the falls under Plan 1A could also be made available to public access following construction, depending on the wishes of the State Park officials. It is also possible that use of the tramway for park visitors could be arranged to gain access to the pools below the falls. During post-authorization planning, coordination will be carried out in conjunction with the State Division of Parks to develop a recreational plan suitable to both Park and Corps planning purposes.

NATURAL RESOURCES

TERRESTRIAL BIOLOGICAL RESOURCES

16. Vegetation. The entire watershed of the South Fork Wailua River is dominated by sugarcane cultivation. Only the headwaters lie in steep, heavily forested areas where native plant species remain abundant. The dominant riparian vegetation along the South Fork Wailua are exotic species (hau, California grass, Guava, Java plum). Indigenous plants such as tis, gingers, and a variety of ferns and mosses also occur along the stream. The terminal reaches of the river are bordered by relatively flat pasturelands. The lowest flat lands along Wailua River were modified considerably in 1960's by the construction of several ponds for the Paradise Pacifica Garden. Experimental taro farms line the terminal reach of the Opaekaa tributary.

17. Avifauna. Three species of endemic waterfowl, the Hawaiian coot, gallinule and duck are found in the Wailua River basin. The coot and gallinule have been observed in the upper reaches of the South Fork above the proposed project site but occur most commonly below the convergence of the North and South Fork and in adjacent taro fields. All three birds are listed endangered species. Other water birds associated with the river system include the black-crowned night heron and cattle egret. Non-waterbird avifauna include the shama, melodious laughing-thrush and northern cardinal within the hau thicket bordering the streams. Western meadowlark, ring-necked pheasant and spotted dove are associated with the canefields and open pasturelands within the river basin.

18. Mammals. Mammals within the Wailua River basin include dogs, cats, feral pigs, cattle, horses, rats and mongoose. No wetlands, wildlife sanctuaries or refuges occur within the proposed project area.

AQUATIC BIOLOGICAL RESOURCES

19. Stream Biota. The aquatic fauna above Wailua Falls is dominated by introduced species which come from both Asia and continental North America, including the small-mouth bass (*Micropertus dolomieui*), Chinese catfish (*Clarius fuscus*), and the wild guppy (*Poecilia reticulata*). Along with the bass and catfish, the less abundant bluegill sunfish (*Lepomis macrochirus*) provides a sport and subsistence fishery on Kauai. The middle and upper reaches of the river are devoid of native Hawaiian fishes or mollusks; however, diadromous mountain shrimp (*Atya bisulcata*) has been found above the lip of Wailua Falls. The introduced Tahitian prawn *Macrobrachium lar* occurs

uncommonly above the falls. A significant number of native, diadromous species occur in the stream below Wailua Falls. (See U.S. Fish and Wildlife Coordination Act Report, Appendix G.) Apparently, because of the geological configuration of the face of Wailua Falls, most diadromous species are not able to ascend beyond the falls and thus do not inhabit the mid and upper reaches of the river. Those that do are subject to intensive predation by smallmouth bass and bluegill.

20. Wetlands. No wetlands are located in the proposed project area in the vicinity of Wailua Falls. The lower reaches of Wailua river and Opaekaa Stream, which runs parallel to and eventually joins Wailua River, approximately 1/2 mile west of its mouth, is bordered by extensive pasture land, some of which is flooded during heavy rain. The lowest flatland along Wailua River, once a tidal marsh, was modified considerably by the construction of Paradise Pacifica, a tropical botanical garden built in the 1960's. A portion of the undeveloped marshlands still exists adjacent to the Paradise Pacifica boundary.

ENDANGERED SPECIES

21. Three listed Endangered Species, the Hawaiian coot, gallinule and duck, are found in the Wailua River basin. The coot and gallinule have been observed in the upper reaches of the South Fork above the proposed project site but occur most commonly below the confluence of the North and South Fork and in adjacent taro patches. The Hawaiian duck is also most common in the lower reaches of the river. According to the U.S. Fish and Wildlife Service, Office of Endangered Species, no listed or proposed species have been observed in the immediate project area. No endangered species critical habitat is located in the project area.

WATER QUALITY

22. The terminal and lower reaches of the Wailua River which fall within the boundaries of the Wailua River State Park have been designated Class 1.a. waters by the State of Hawaii, Department of Health Water Quality Standards. The objective of this classification is to protect waters in their natural state as nearly as possible with an absolute minimum of pollution from any human-caused source. Uses to be protected in Class 1.a. waters include scientific, educational, compatible recreation, aesthetic enjoyment and other nondegrading uses. The middle and upper reaches of the South Fork Wailua River are Class 2 in inland waters protected for fish and wildlife propagation, agricultural and industrial water supplies, and recreation. The State of Hawaii does not regularly monitor river water quality, and there is a lack of recent data which describes the physical and chemical environment of this river system. The principal factors influencing water quality in the South Fork Wailua are the activities associated with large scale sugarcane cultivation: soil erosion, water diversion and stream dewaterment, channel modification (causeways, culverts and fords) and leaching of agricultural chemicals. A system of diversion dams, intakes and ditches exports a significant volume of flow from both the North and South Fork Wailua. Although average residual flow downstream exceeds 16 cfs, minimum flows approached zero during the lowest flow on record (October 1953).

AIR QUALITY

23. Existing air quality within the project area is generally good and usually free of pollutants. It is effectively removed from urban areas and industrial point sources such as sugar mills. Influence from these sources is negligible. However, activities related to sugar cultivation, most notably cane burning and soil preparation prior to planting, periodically contribute significant amounts of dust and other objectionable pollutant materials.

OTHER RESOURCES OF NATIONAL OR LOCAL SIGNIFICANCE

24. Wildlife Refuges

No national or local wildlife refuges occur within the project area.

25. Migratory Birds

No migratory bird breeding or nesting habitat is located within or adjacent to the project area.

26. Scenic and Wildlife Rivers

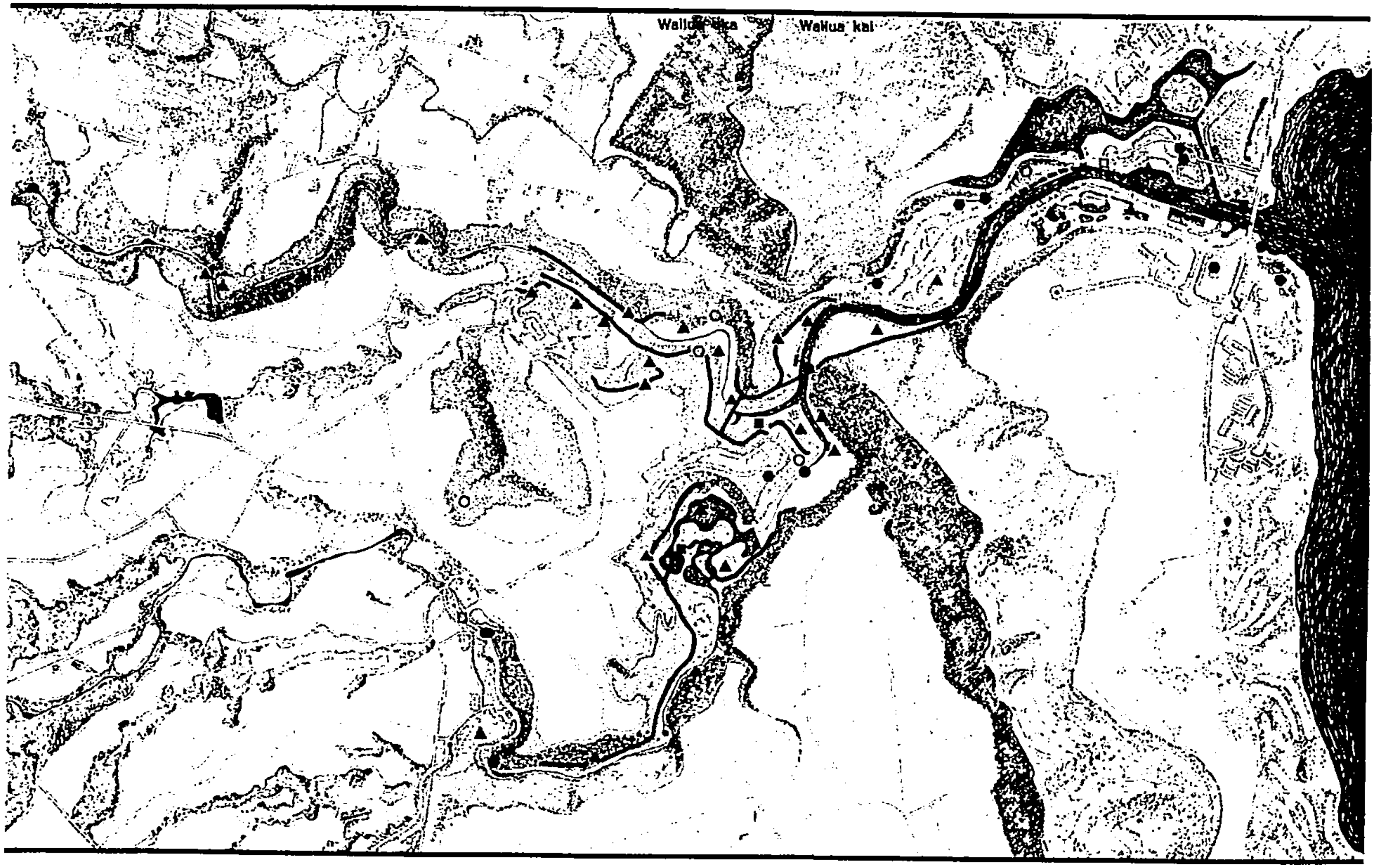
None are present in the project area.

27. National Trails

None are located in the project area.

28. National Shoreline, Parks or Beaches

None are located in the project area.



- ○ Shrine
- ● Heiau
- ○ Burial Site
- ● Stone
- □ Cave
- ■ Mill Site
- ▲ Agriculture
- — ʻauwai
- -- King's Highway

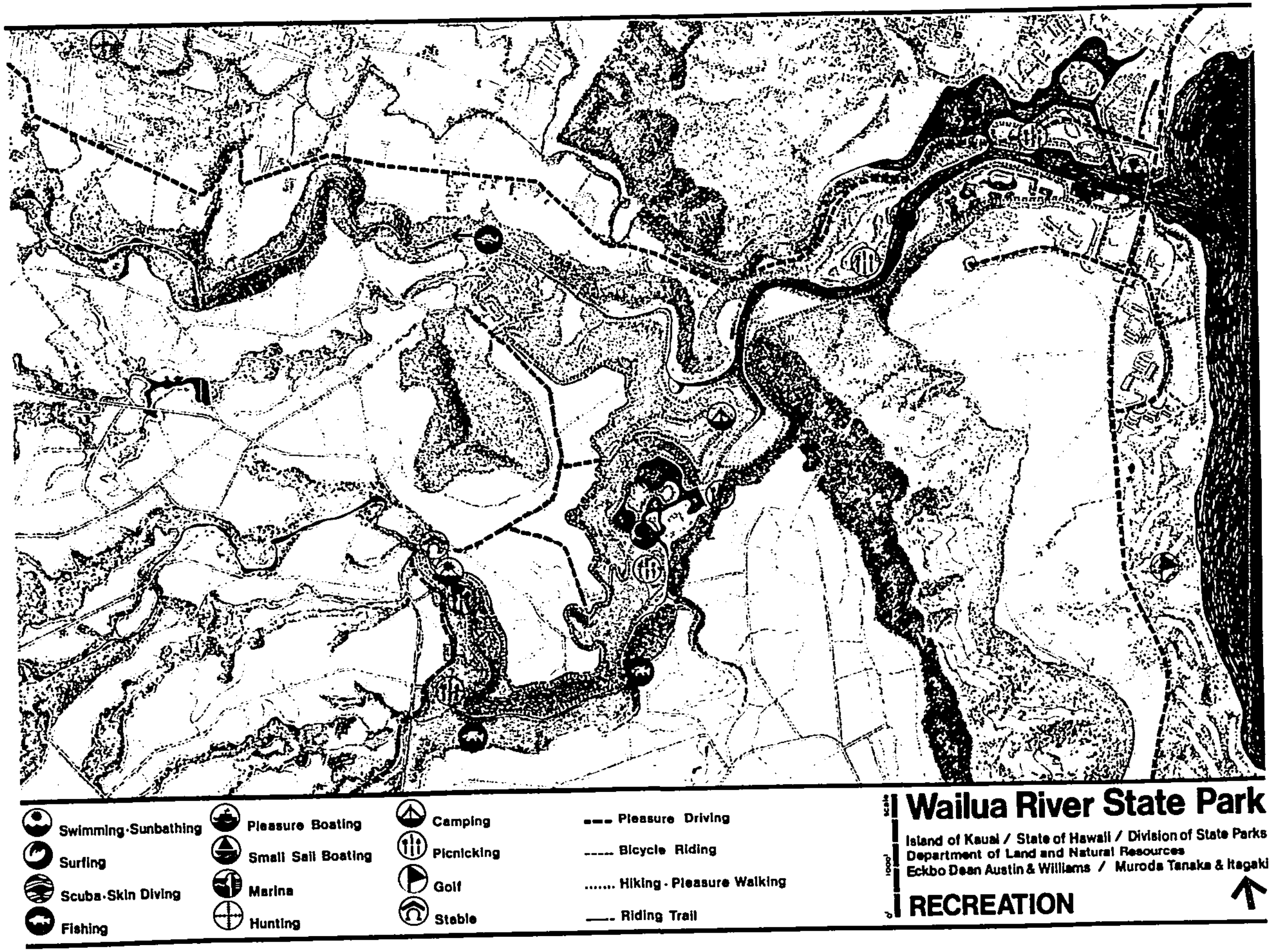
scale 0 1000'

Wailua River State Park

Island of Kauai / State of Hawaii / Division of State Parks
Department of Land and Natural Resources
Eckbo Dean Austin & Williams / Muroda Tanaka & Itagaki

HISTORY·ARCHAEOLOGY ↑

PLATE H-1


Swimming·Sunbathing
Surfing
Scuba·Skin Diving
Fishing
Pleasure Boating
Small Sail Boating
Marina
Hunting
Camping
Picnicking
Golf
Stable
Pleasure Driving
Bicycle Riding
Hiking · Pleasure Walking
Riding Trail
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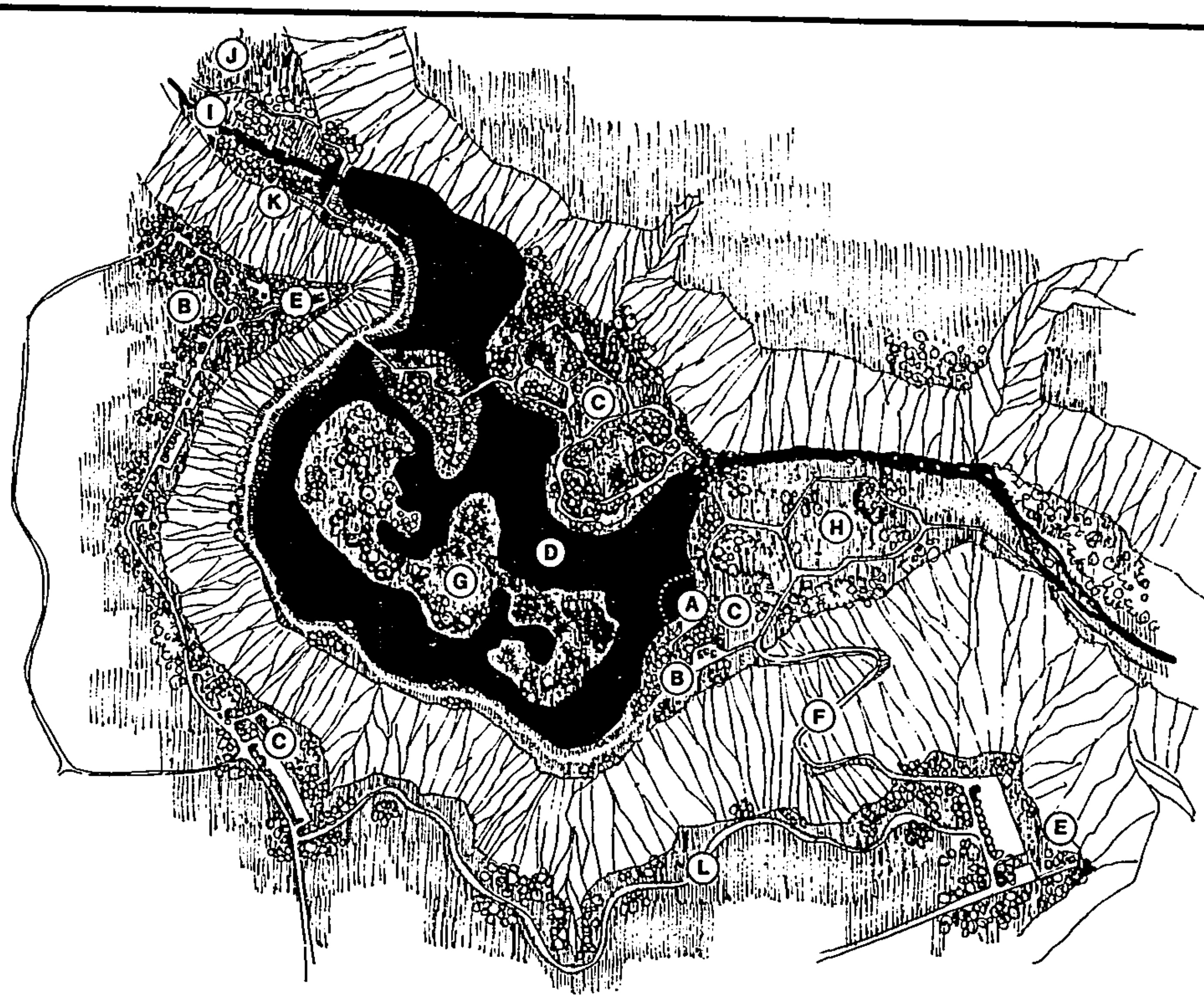
Wailua River State Park
Island of Kauai / State of Hawaii / Division of State Parks
Department of Land and Natural Resources
Eckbo Dean Austin & Williams / Muroda Tanaka & Itagaki
RECREATION

PLATE H-3



A	Swimming	G	Wildlife Refuge
B	Camping	H	Meadow Grass
C	Picnicking	I	South Fork
D	Fishing / Canoeing	J	Plant Demonstration
E	Overlook	K	Veranda House
F	Wiki Wiki Access	L	River Rim Way

Wailua River State Park

Island of Kauai / State of Hawaii / Division of State Parks
Department of Land and Natural Resources
Eckbo Dean Austin & Williams / Muroda Tanaka & Itagaki

THE MEADOW