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DEPARTMENT OF LAND AND NATURAL RESOURCES
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File No.: HA-8/9/89-2155
Doc. No.: 5524E

Mr. Clark Mower
Island Power Company, Inc.
820 Mililani Street, Suite 701
Honolulu, Hawaii 96813

Dear Mr. Mower,

Subject: Final Environmental Impact Statement for the Upper Wailua Hydroelectric Power Project

We have completed our review of the final Environmental Impact Statement for the Upper Wailua River Hydroelectric Power Project that was submitted to us on March 20, 1989. We have determined that the document is acceptable as defined in Chapter 343, Hawaii Revised Statutes, and meets the criteria of an acceptable EIS as established by the Department of Health's Environmental Impact Rules, Title 11, Chapter200.

Specifically, the EIS satisfies (1) the procedural requirements, i.e.:

a. an assessment of the project was submitted to the Department on May 6, 1988 as part of the Conservation District Use Application;

b. a Preparation Notice was published in the OEQC Bulletin on August 23, 1989;

c. comments received during the comment period were incorporated into the draft EIS;

d. the draft EIS was officially filed with OEQC on December 8, 1989;

e. comments received during the consultation period were addressed and the draft EIS revised, responses to the comments on the draft EIS were incorporated in the final EIS;

(2) the content requirements of a final EIS, i.e.:

a. a revision of the draft EIS;

b. comments and recommendations received on the draft EIS;

c. a list of persons, organizations, and agencies commenting on the draft EIS;

d. responses to significant environmental points raised in the review and consultation process; and

(3) the responses to comments submitted are satisfactory to the Department.

As you may be aware, an accepted EIS means only that the document adequately discloses environmental impacts and satisfactorily responds to comments. The acceptance does not presuppose approval of the CDUA. Substantive concerns with the project must still be reviewed by the CDUA process. If you have any questions on the matter, please contact Roger Evans of our Office of Conservation and Environmental Affairs at 548-7837.

Very truly yours,

William W. Paty, Chairperson
Board of Land and Natural Resources

cc: OEQC

UPPER WAILUA RIVER
HYDROELECTRIC PROJECT

FINAL

ENVIRONMENTAL IMPACT STATEMENT

FOR

ISLAND POWER COMPANY, INC.

Ecosystem Research Institute

UPPER WAILUA RIVER HYDROELECTRIC PROJECT

FINAL

ENVIRONMENTAL IMPACT STATEMENT

FOR

ISLAND POWER COMPANY, INC.

Prepared by

ECOSYSTEMS RESEARCH INSTITUTE
1780 North Research Park Way
Suite 108
North Logan, Utah 84321

March, 1989

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1.0 DESCRIPTION OF PROPOSED PROJECT

1.1 LOCATION

Island Power Company, Inc., a Hawaii Corporation located at P.O. Box 625, Kalaheo, Kauai, Hawaii is proposing to develop and operate a 1.26 MW hydroelectric power facility at a site on the Maheo Stream, located approximately 7 miles northwest of Wailua, Kauai, Hawaii (Figure 1.1-1).

The project site is located on lands owned by the State of Hawaii that are zoned as a "conservation district". The majority of land to be utilized for the project is within a "resources" subzone.

The State of Hawaii is geographically important, based on its military and economic relationship to the Pacific Basin and the Far East (Figure 1.1-2). In terms of size, relative to the state as a whole, the island of Kauai is the fourth largest in area (620 square miles) as well as population (46,300) (State of Hawaii, Data Book, 1987).

The capital and major urban center of the state is Honolulu, located on the island of Oahu. The county seat for the island and county of Kauai is located at Lihue with a 1980 population of 4,000. Other population centers in Kauai County include Kapaa (4,467 persons), Kakaha (3,250 persons), and Hanamaulu (3,227 persons). Kawaihau District, where the project will be located, had a population of 12,700 persons in 1986 (State of Hawaii, Data Book, 1987).

1.2 GENERAL PROJECT DESCRIPTION

The proposed Upper Wailua Hydroelectric Project will utilize land and water in the Wailua River Basin currently owned by the State of Hawaii for the purpose of generating electricity (Figure 1.2-1).

The Draft Environmental Impact Statement for the proposed Upper Wailua Hydroelectric Project outlined Alternative #1 as the preferred alternative. A new project alternative, Alternative #4, is introduced in the Final EIS and is now the preferred project alternative. Alternative #4 is the preferred alternative over Alternative 1 for many reasons.

Project Alternative #4 (Figure 1.2-2) consists of a longer penstock, and a different penstock alignment than project Alternative 1 (Figure 1.2-3). The new penstock route is 2,525 feet longer in Alternative 4 and follows a more environmentally benign route from the diversion structure at the end of the Hanalei Tunnel to the power station site on Maheo Stream. The newer penstock route is located further away from Maheo Stream along most of its length. This penstock alignment will minimize potential

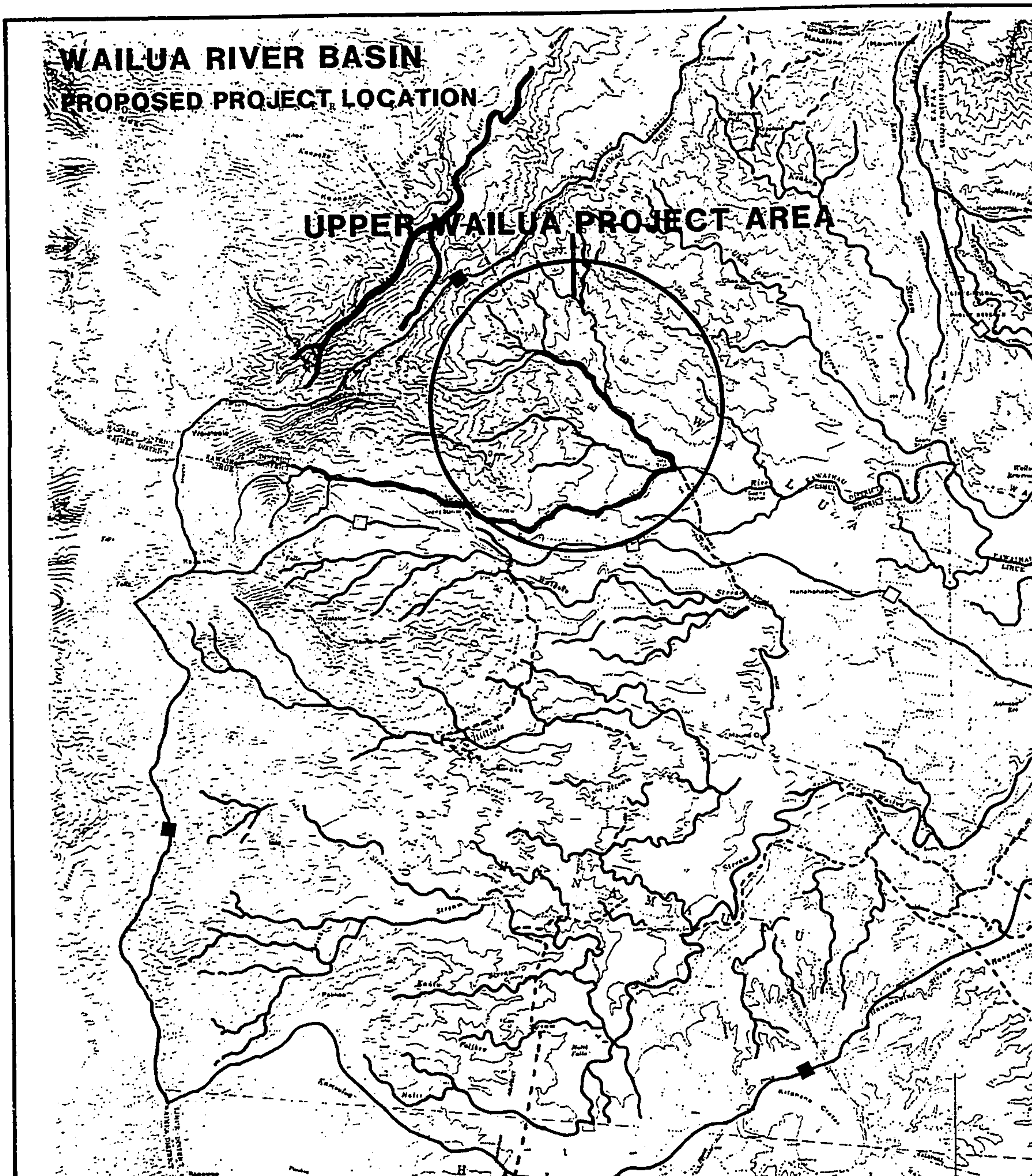
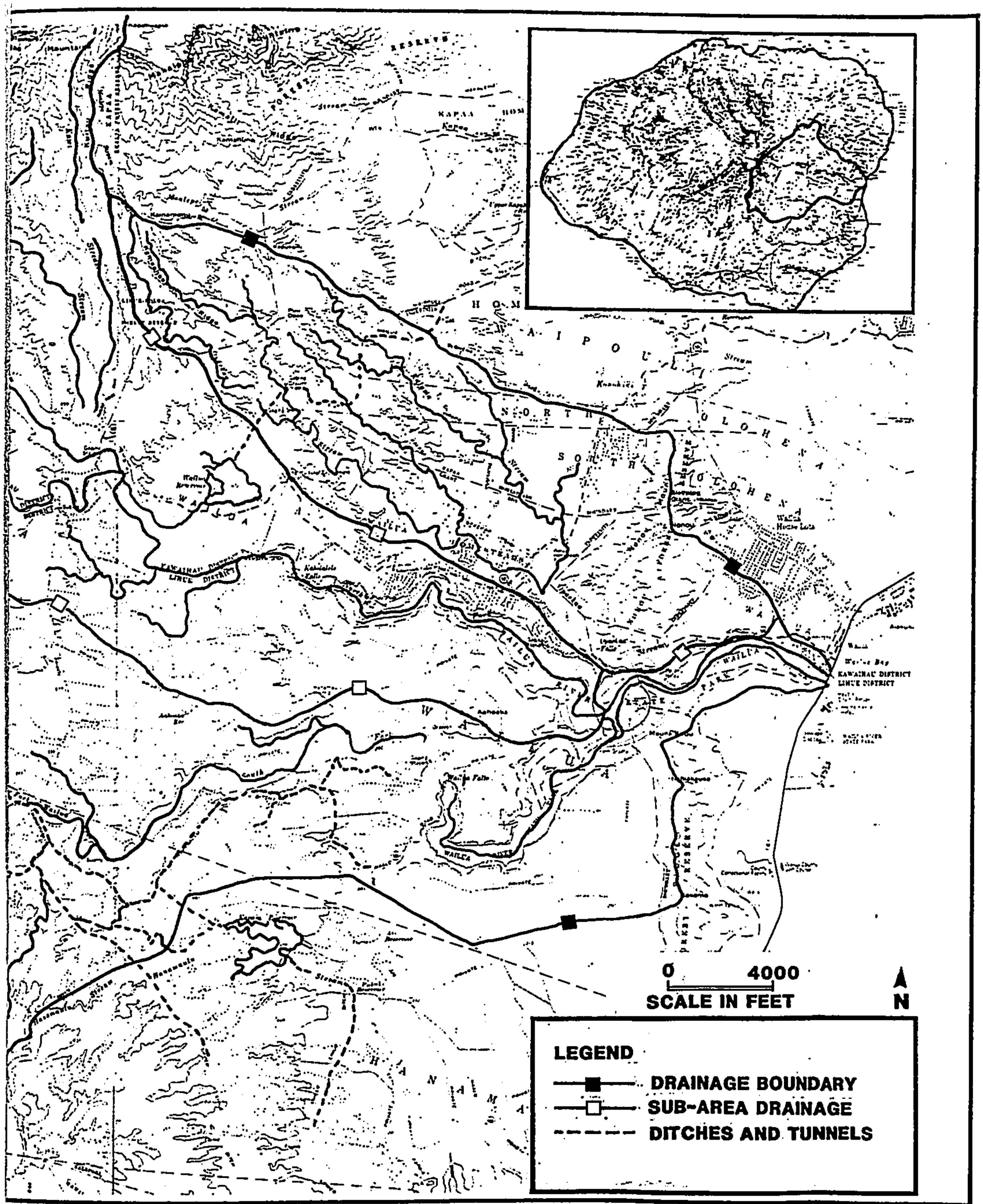


FIGURE 1.1-1. Location map - Wailua River Basin, the proposed project area.


0 4000
SCALE IN FEET
N
LEGEND
DRAINAGE BOUNDARY
SUB-AREA DRAINAGE
DITCHES AND TUNNELS

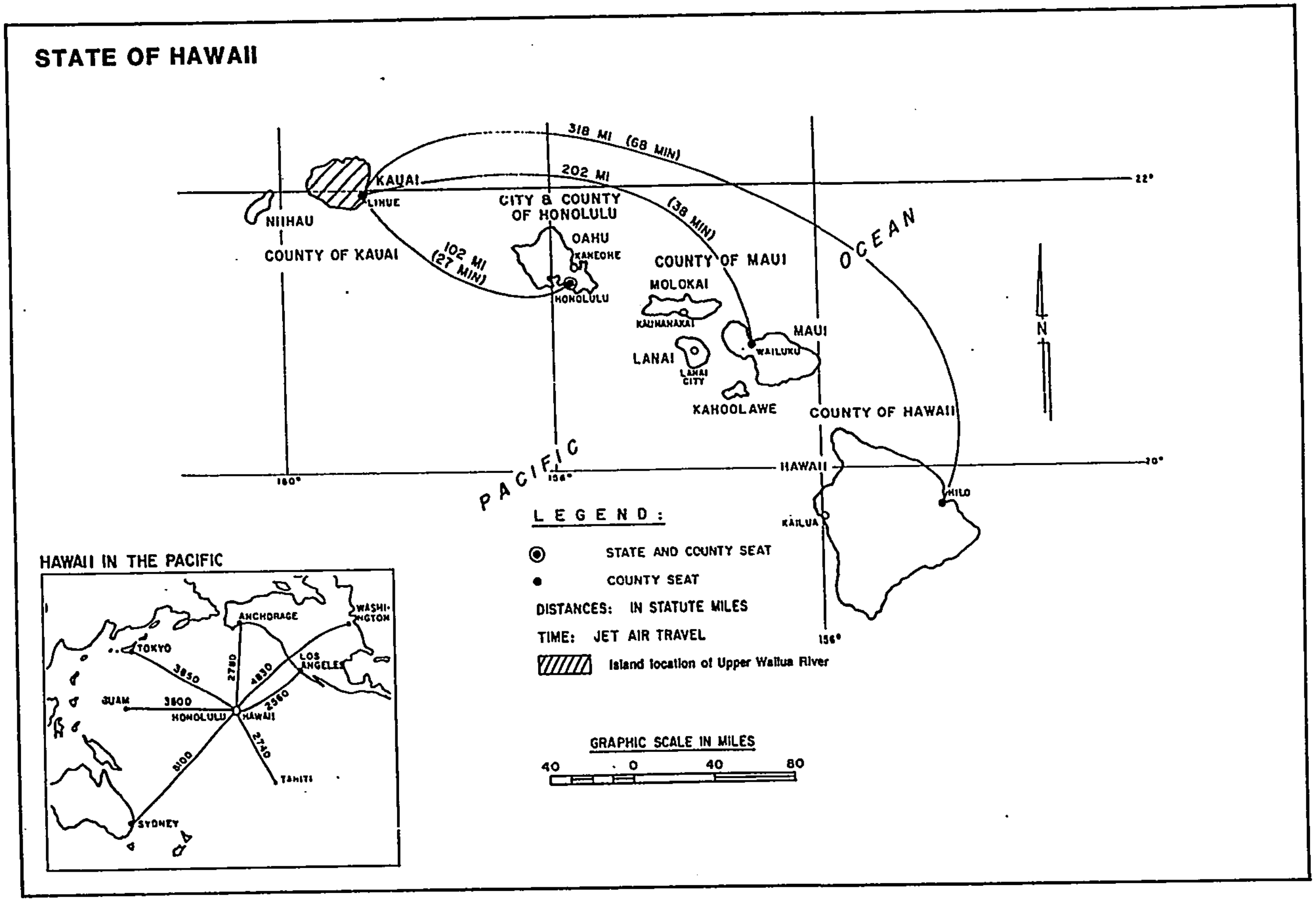


FIGURE 1.1-2. The location map of the State of Hawaii.

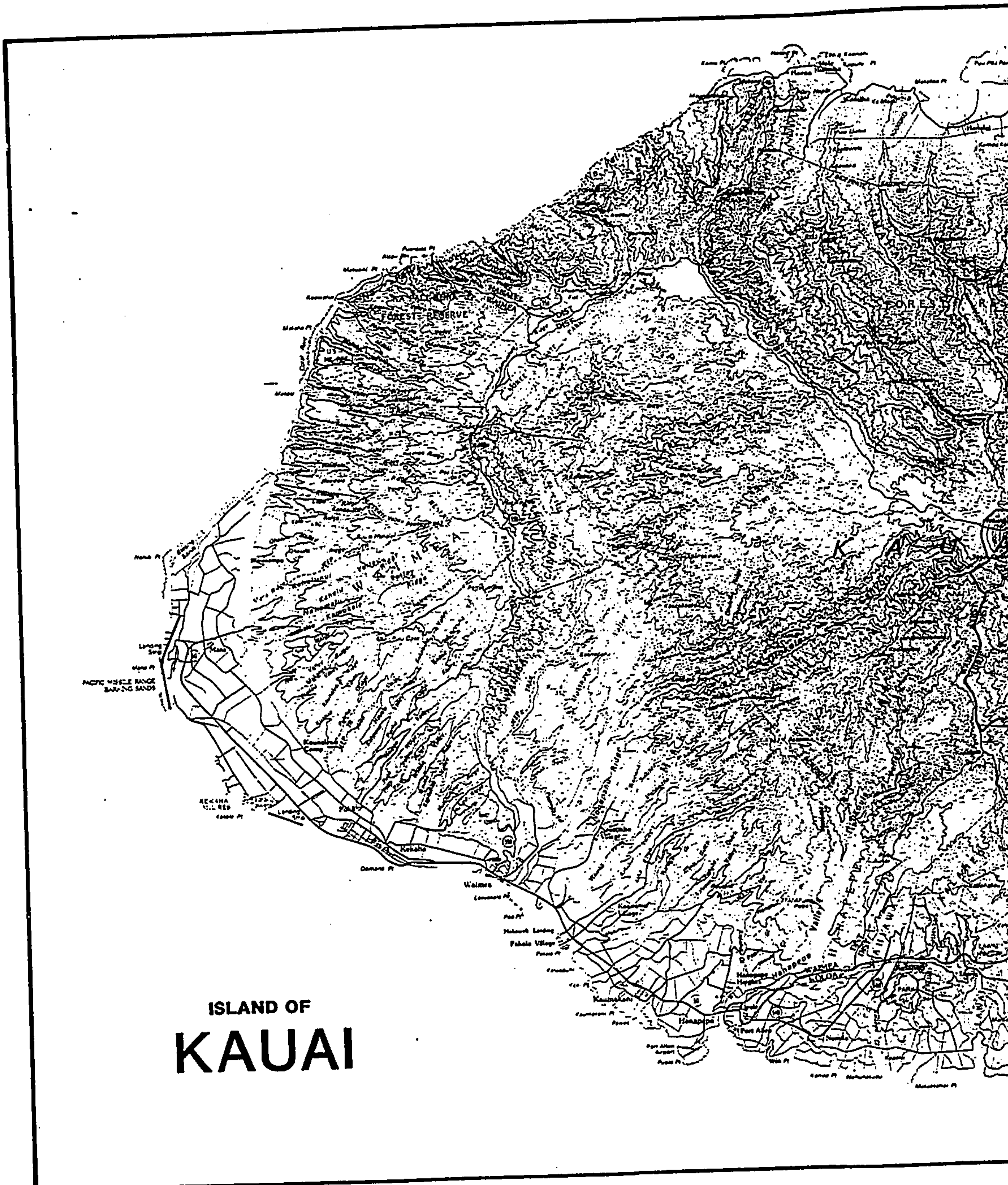
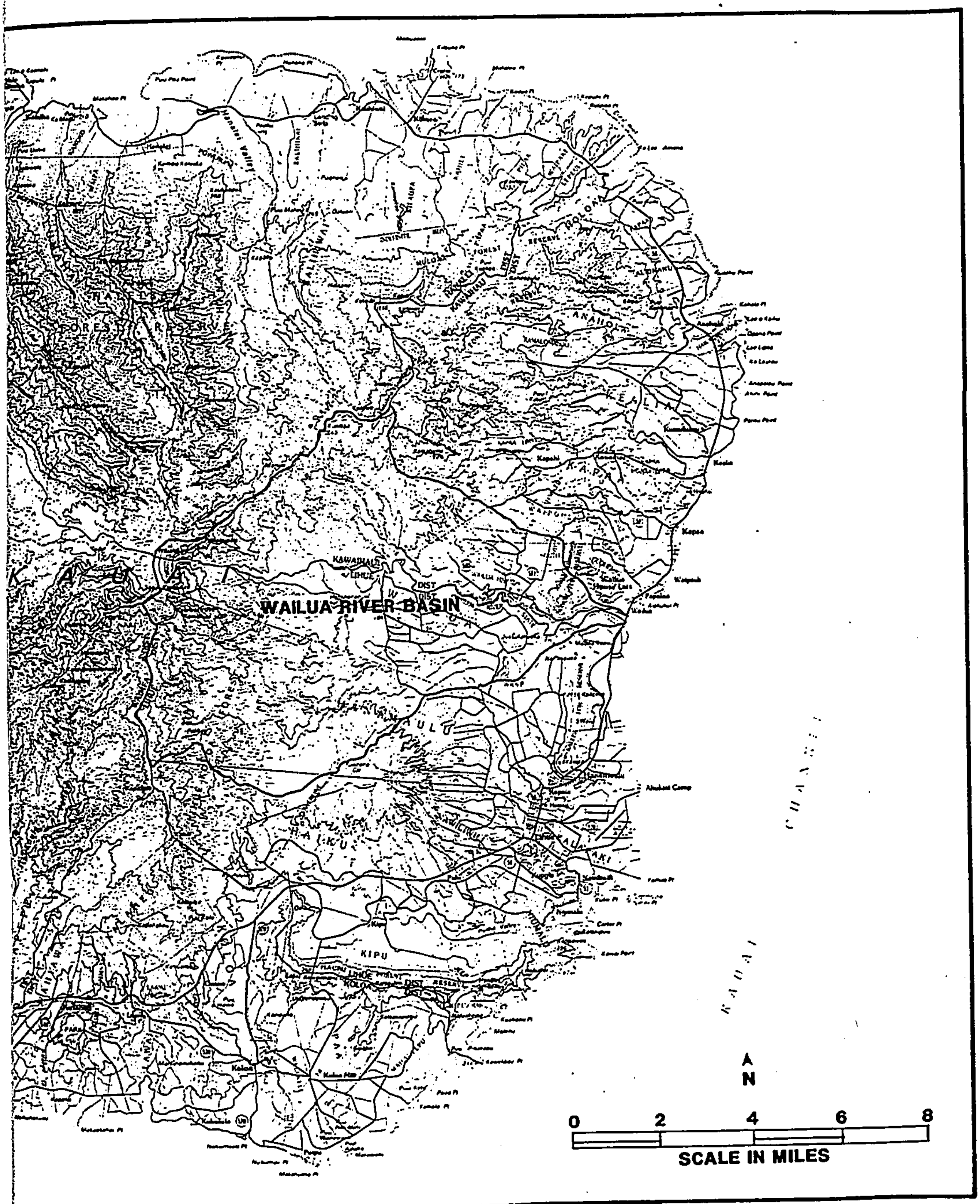
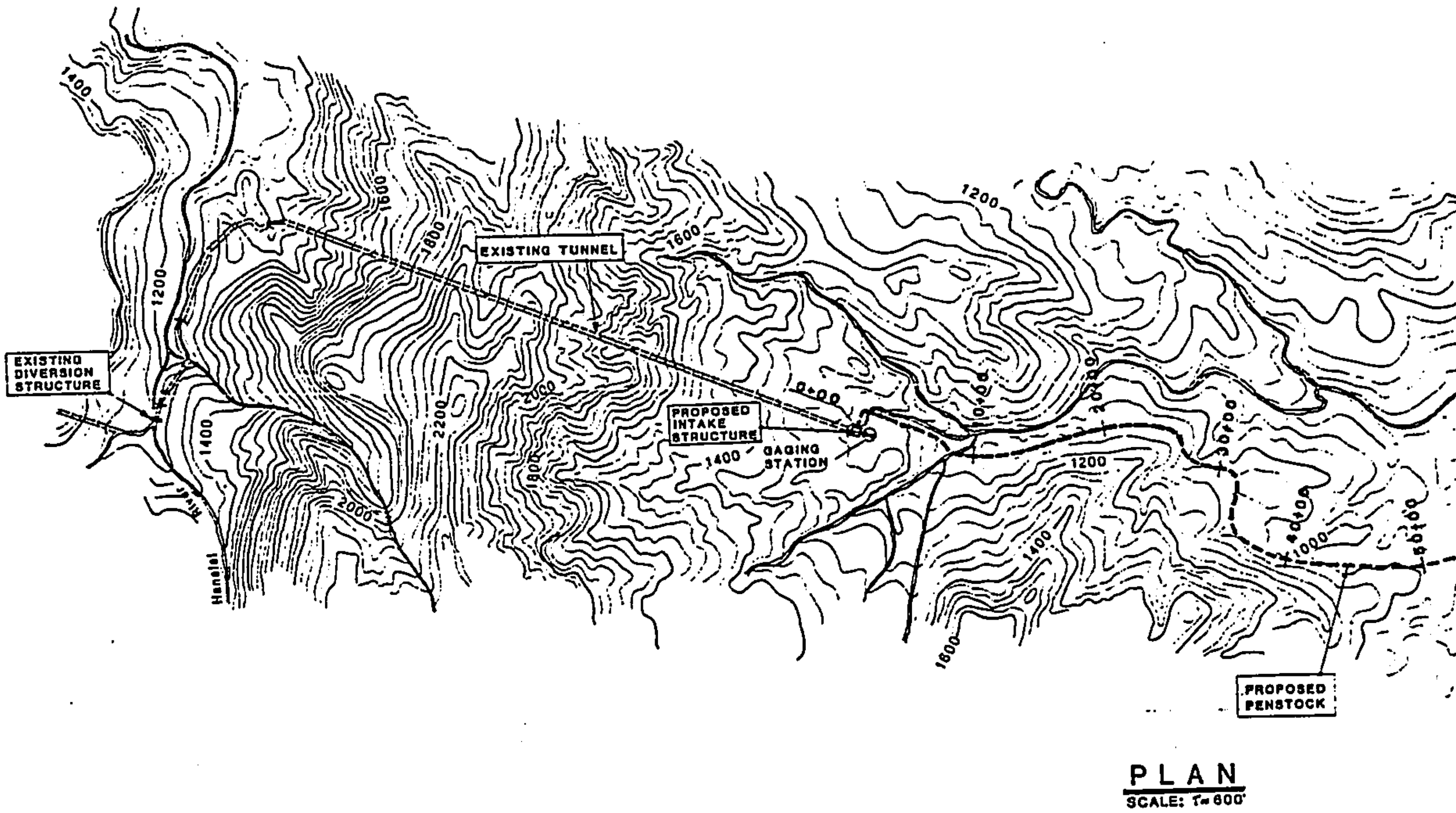


FIGURE 1.2-1. Location map - Island of Kauai, Wailua River Basin.


WAILUA RIVER BASIN
KAWAIHAU
LIHUE
KIPU
HAIKU
N
0
2
4
6
8
SCALE IN MILES



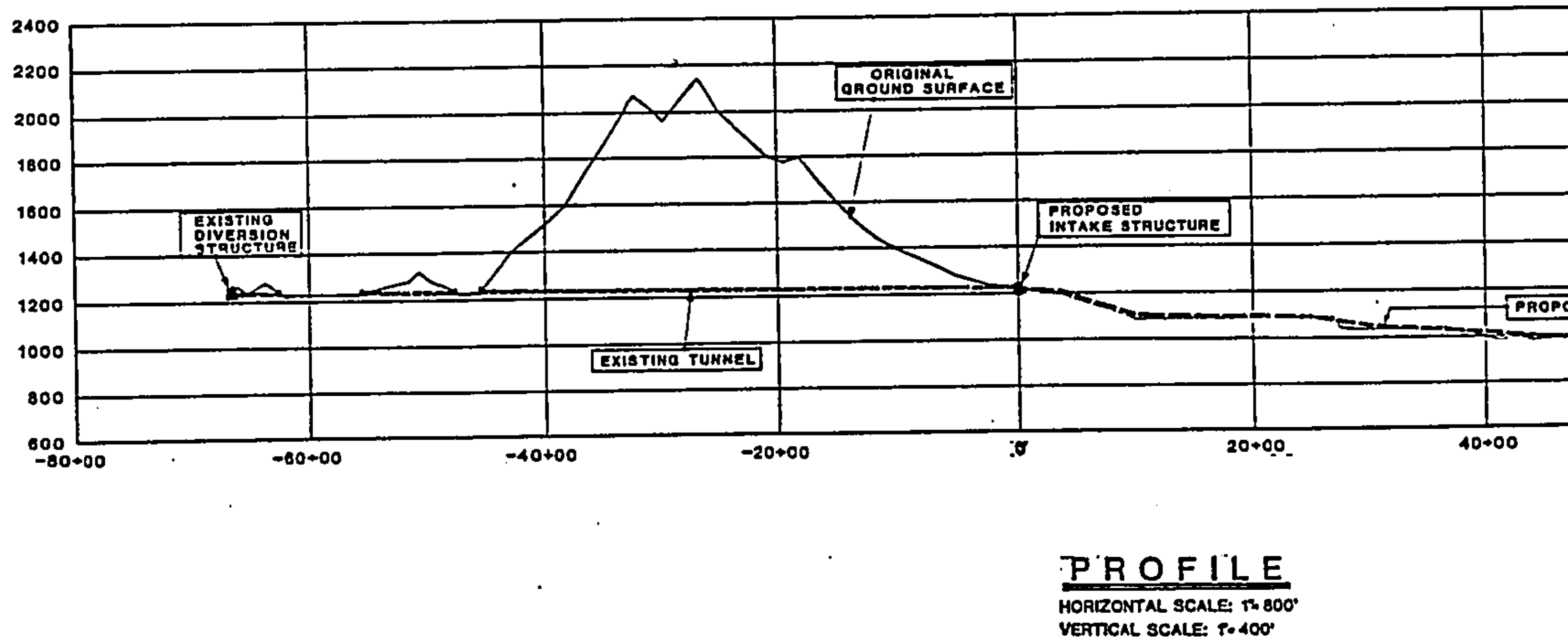
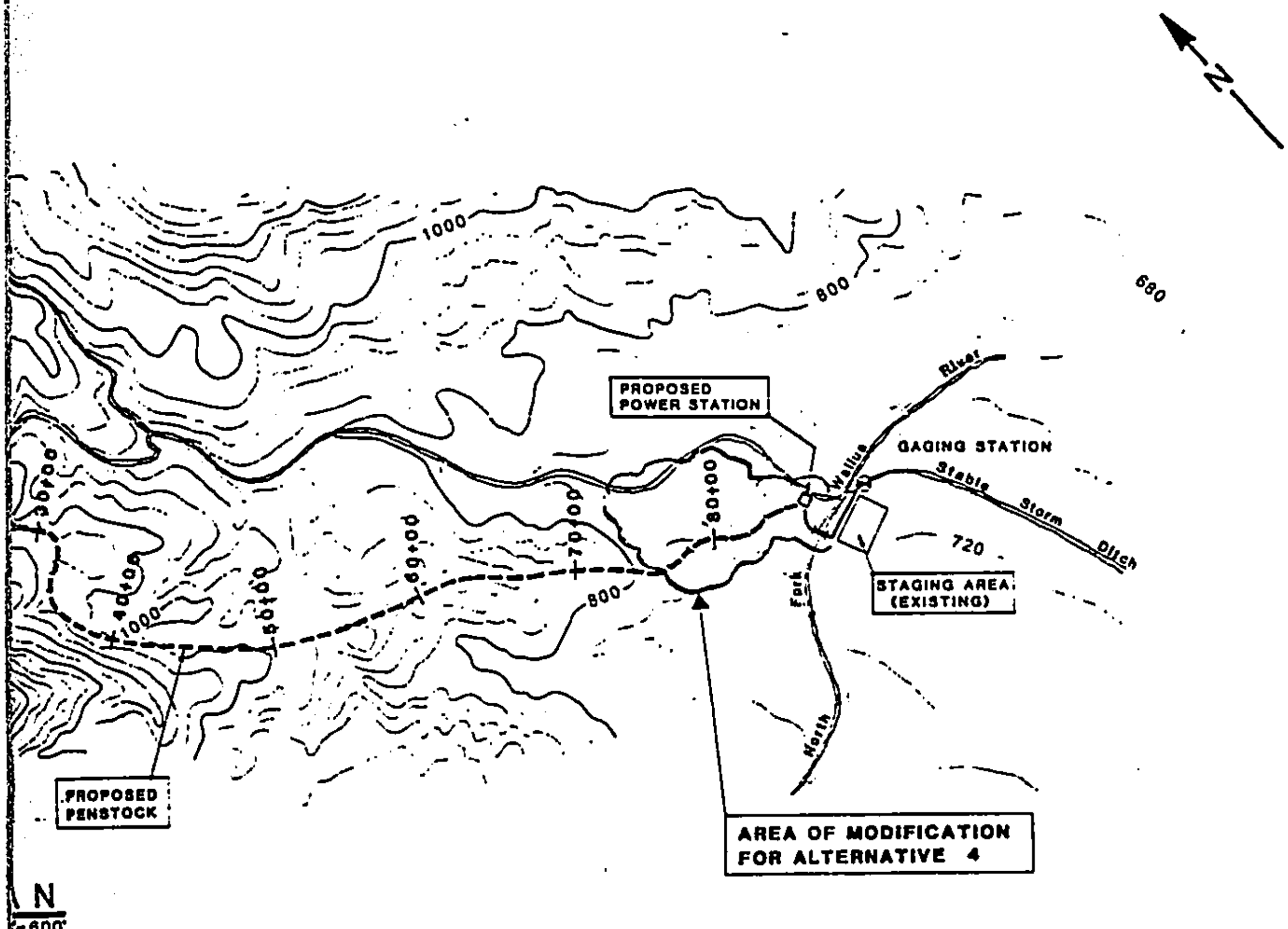
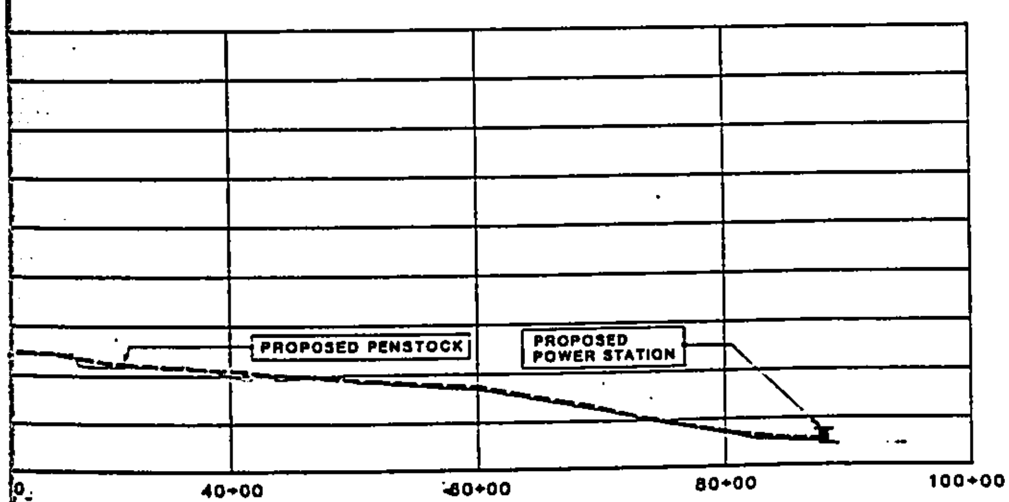


FIGURE 1.2-2. The plan and profile for the penstock alignment and powerplant location in the p Alternative #4





t location in the preferred

REVISION	DATE	DESCRIPTION	BY	APPR

UPPER WAILUA
HYDROELECTRIC PROJECT

PLAN & PROFILE
ALTERNATIVE 4 (PREFERRED)

ALPINE SAN JOSE CALIFORNIA

DRAWN FF	CHECKED JPR	APPROVED	DATE 3-1-85
DATE 3-1-85	SCALE AS SHOWN	DWG. NO.	

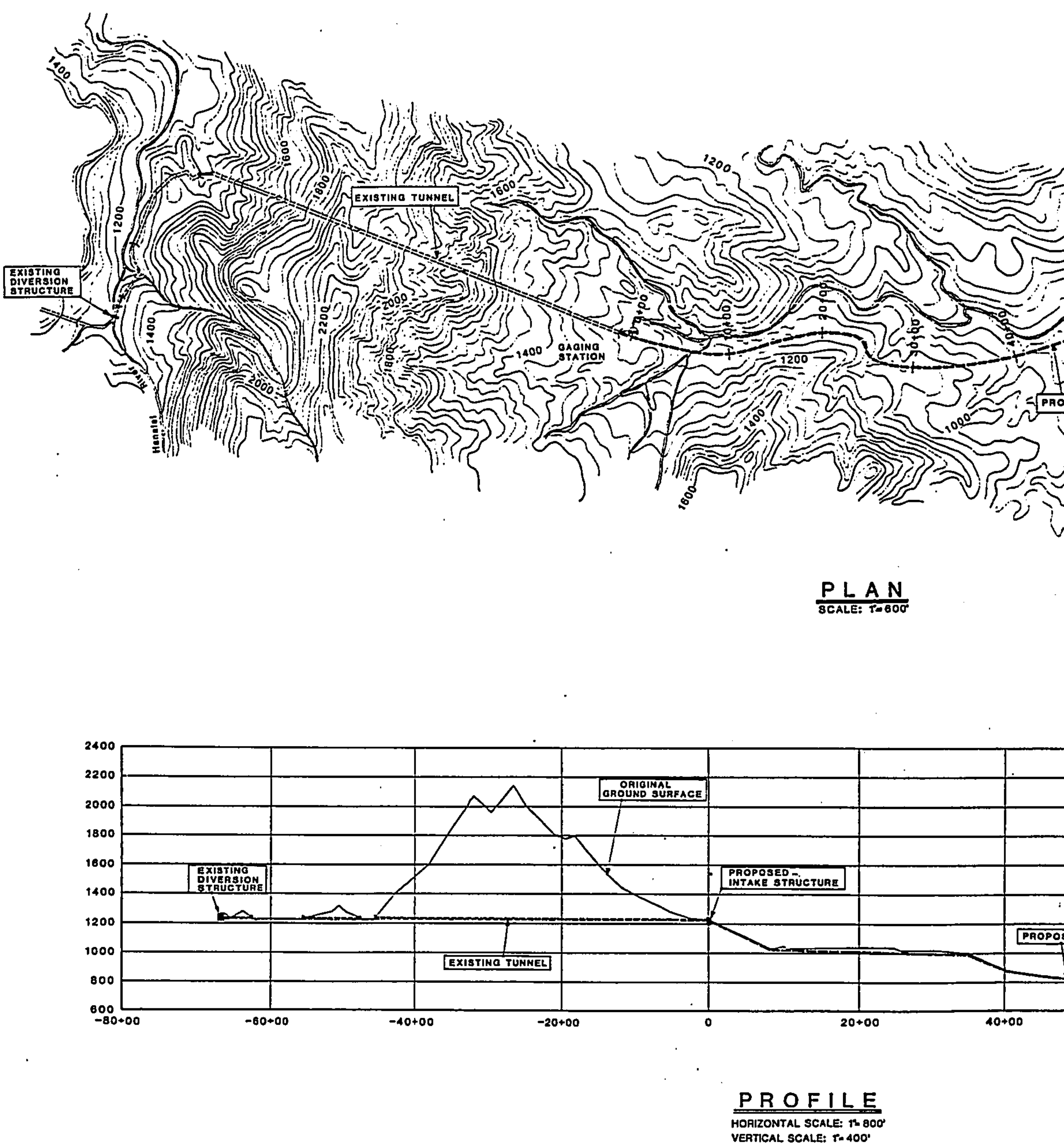
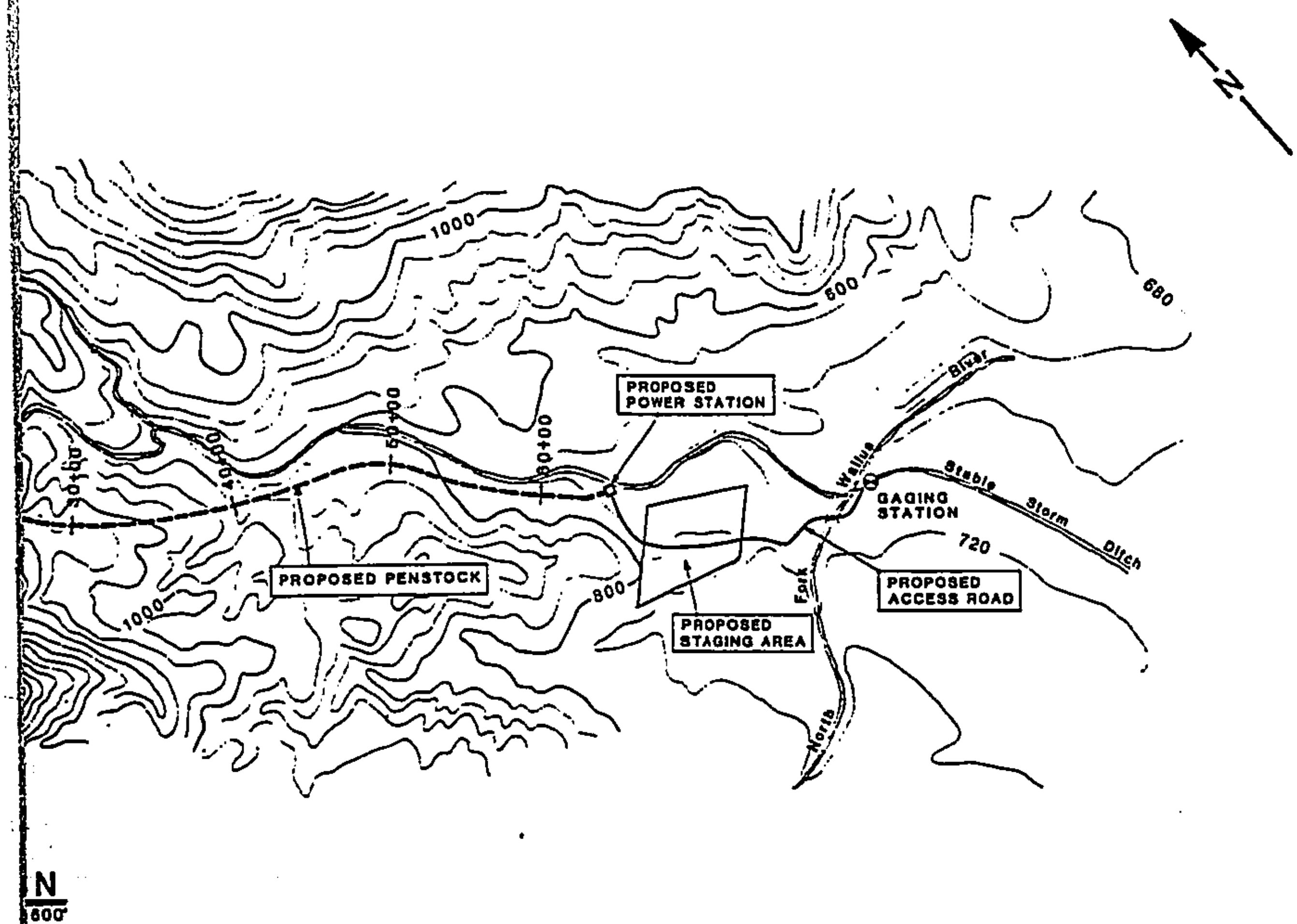
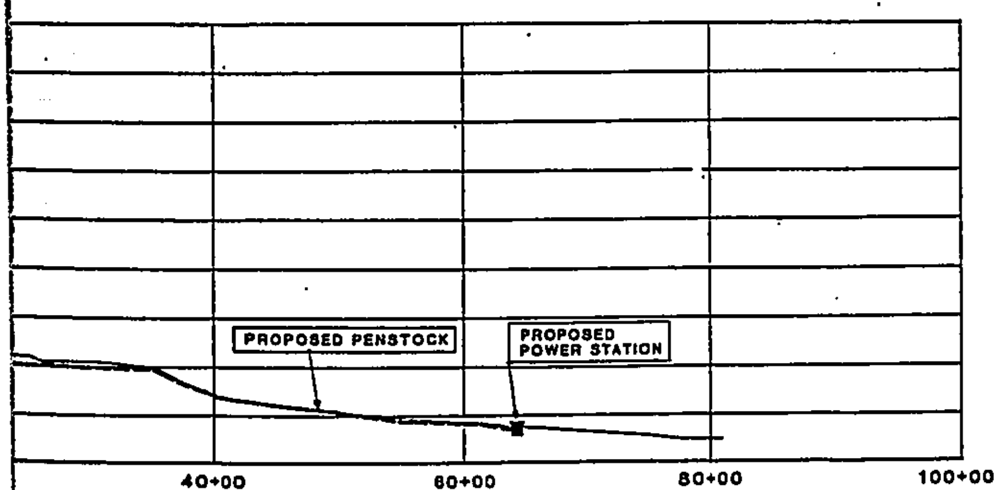


FIGURE 1.2-3. The plan and profile for the penstock alignment and powerplant location in Alternative





ion in Alternative #1.

REVISION	DATE	DESCRIPTION	BY	APPD

UPPER WAILUA
HYDROELECTRIC PROJECT

PLAN & PROFILE
ALTERNATIVE 1

CALPINE SAN JOSE CALIFORNIA

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DATE	SCALE	DWG. NO.	

soil loss into Maheo Stream, generate fewer cut and fill slopes, avoids the steeper slopes found within the project area, and is topographically more suitable for road construction and mitigation of impacts.

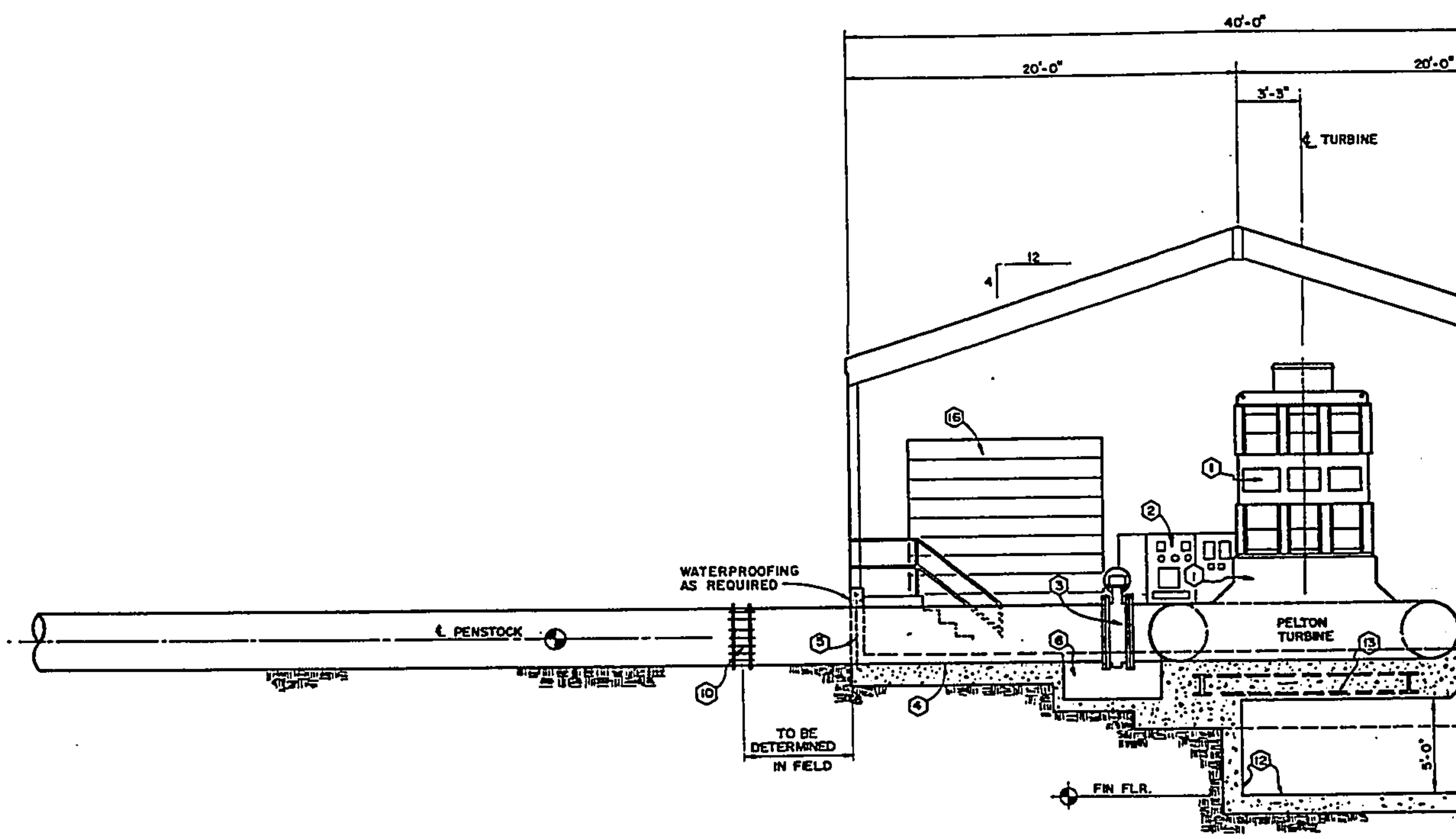
The other significant change found in Alternative 4 over Alternative 1 is the location of the powerhouse. The powerhouse in alternative 4 is located 50 feet from the left bank of Maheo Stream approximately 200 feet upstream of the confluence with North Fork Wailua River.

Initially, the available assessment of soils indicated boggy, unfavorable conditions in the area of the North Fork Wailua and Maheo Stream confluence. The area is also vulnerable to flooding and these factors led to an initial preference for locating the powerhouse somewhat upstream (Alternative 1).

Subsequent field work has indicated that the problematic soils are of limited depth and would be removed when preparing the powerhouse foundation. The primary engineering restraint is thus removed. Although possible flooding of the powerhouse is still a significant concern, it can and will be addressed in design by minimizing the powerhouse area, anchoring and/or weighting the powerhouse down (to avoid buoyancy), and by flood-proofing the floor and walls (no openings) up to the elevation of the design flood. With the above mitigation, the downstream powerhouse location (Alternative 4) must be preferred since it provides a significant increase in available energy and thus enhances project economic viability and the contribution to supplying Kauai's energy needs. Figures 1.2-4 and 1.2-5 provide the powerhouse building section, and powerhouse floor plan for the project.

The proposed project will divert irrigation water from the Hanalei Tunnel outlet by means of a concrete diversion weir approximately 5 feet high and 30 feet across, located at an elevation of 1,210 feet above mean sea level (msl). The water will be conveyed through a pressure penstock approximately 8,925 feet long. The diameter of the penstock will vary from 48 to 32 inches.

The penstock will convey Hanalei tunnel irrigation water (approximate maximum flow of 48 cfs) to a powerhouse containing one pelton turbine and generator with a maximum capacity of 1,260 KW. The dimensions of the powerhouse will be approximately 40' wide x 40' long x 20' high. The powerhouse will be sited on the west bank of the Maheo Stream approximately 200 feet upstream from the confluence with the North Fork Wailua River at an approximate elevation of 710 feet above mean sea level. The water from the penstock will be discharged back into Maheo Stream at this location via a 50 foot long tailrace. An above ground 12 KV transmission line approximately 3 miles long will interconnect the project to existing Kauai Electric transmission lines near the project area (Figure 1.2-6). The electricity will be sold to Kauai Electric, a Division of Citizens Utility Company, who will then distribute it to their customers. The proposed project would produce approximately 7.2 million KW hours each year.



POWERHOUSE SE

¼" = 1'-

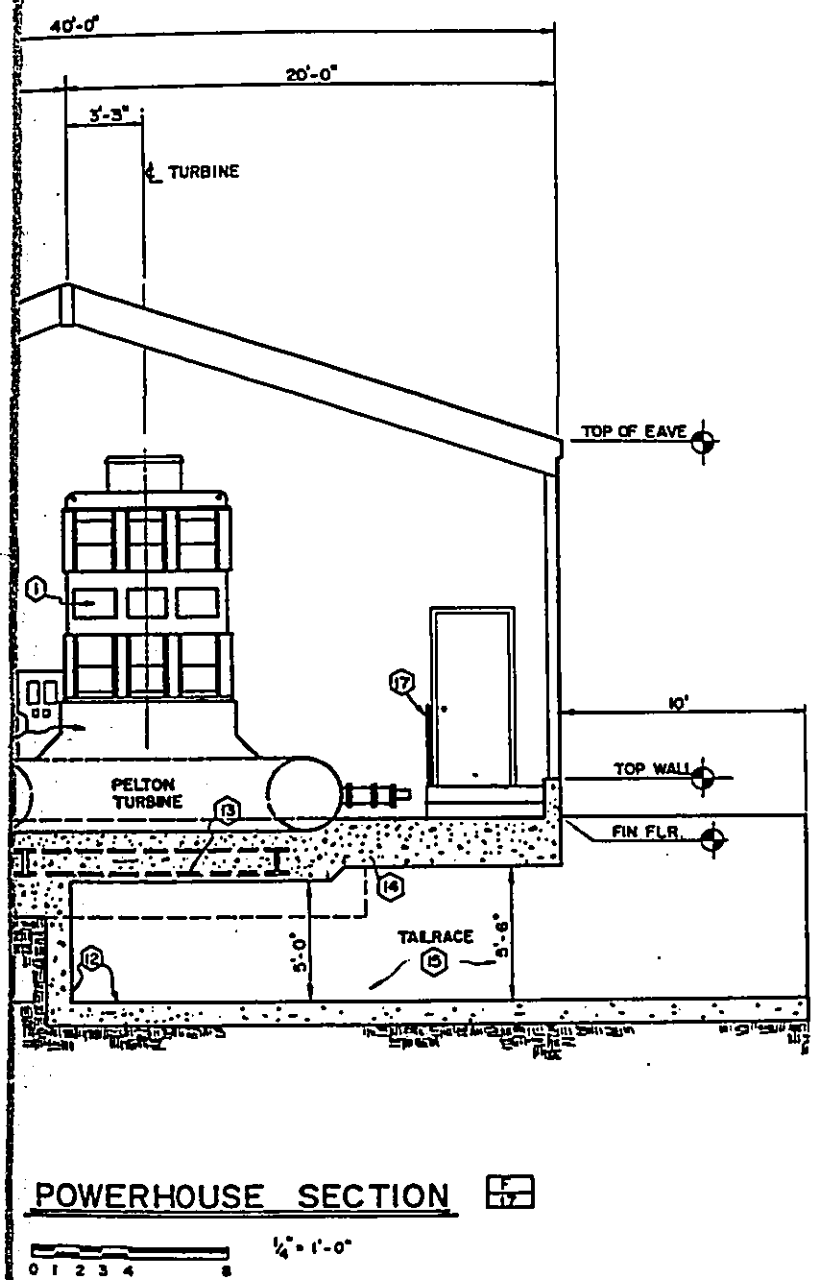
REFERENCE NOTES

REFERENCE NOTES:

1. TURBINE, GENERATOR, TAILRACE LINER AND FRAME ASSEMBLY TO BE SUPPLIED AND INSTALLED BY OTHERS.
2. SWITCHGEAR EQUIPMENT SUPPLIED AND INSTALLED BY OTHERS.
3. 36"BUTTERFLY VALVE AND ACTUATOR SUPPLIED AND INSTALLED BY OTHERS.
4. 36" O.D. STEEL PENSTOCK TO BE INSTALLED BY FDTN CONTRACTOR. PREPARE PIPE EXPOSED WITHIN BLDG. FOR FINISH PAINTING BY OTHERS. EXTERIOR PIPE WALLS TO HAVE 2 COATS RED OXIDE PRIMER PRIOR TO INSTALLATION.
5. 3/8" STEEL PL. SEEPAGE RING. 36" I.D., 42" O.D. FILLET WELD TO PENSTOCK PRIOR TO PAINTING. PROVIDE #4 BARS HORIZ., VERT. AND DIAGONALLY AROUND PENSTOCK W/3" MIN. CLEARANCE
6. RECESSED VALVE ACCESS PIT COVERED W/1/4" GALV. DECK PLATE BRACED TO PREVENT SAGGING.

10. 36" DIA. DRESSER COUPLING SUPPLIED BY OWNER AND TO BE INSTALLED BY CONTRACTOR
12. ROLLED STEEL TAILRACE LINER SUPPLIED AND INSTALLED BY OTHERS.
13. PRE-FABRICATED STEEL, WIDE FLANGE BASE FRAME SUPPLIED AND INSTALLED BY OTHERS.
14. 4" DEEP X 12" W. COVERED CABLE TRAY SUPPLIED AND INSTALLED BY OTHERS. FINISH CONC. FLUSH W/EDGES.
15. SEE DETAIL SHEET FOR DIMENSIONS AND REINFORCING FOR TAILRACE ROOF WALLS AND FLOOR.
16. 10' W X 12' H. STEEL OVERHEAD DOOR IN STEEL JAMB WITHIN WEATHER SEAL AND INSIDE LOCK MECHANISM.
17. CONC. STAIRWAYS W/HANDRAILS. SEE FLOOR PLAN.

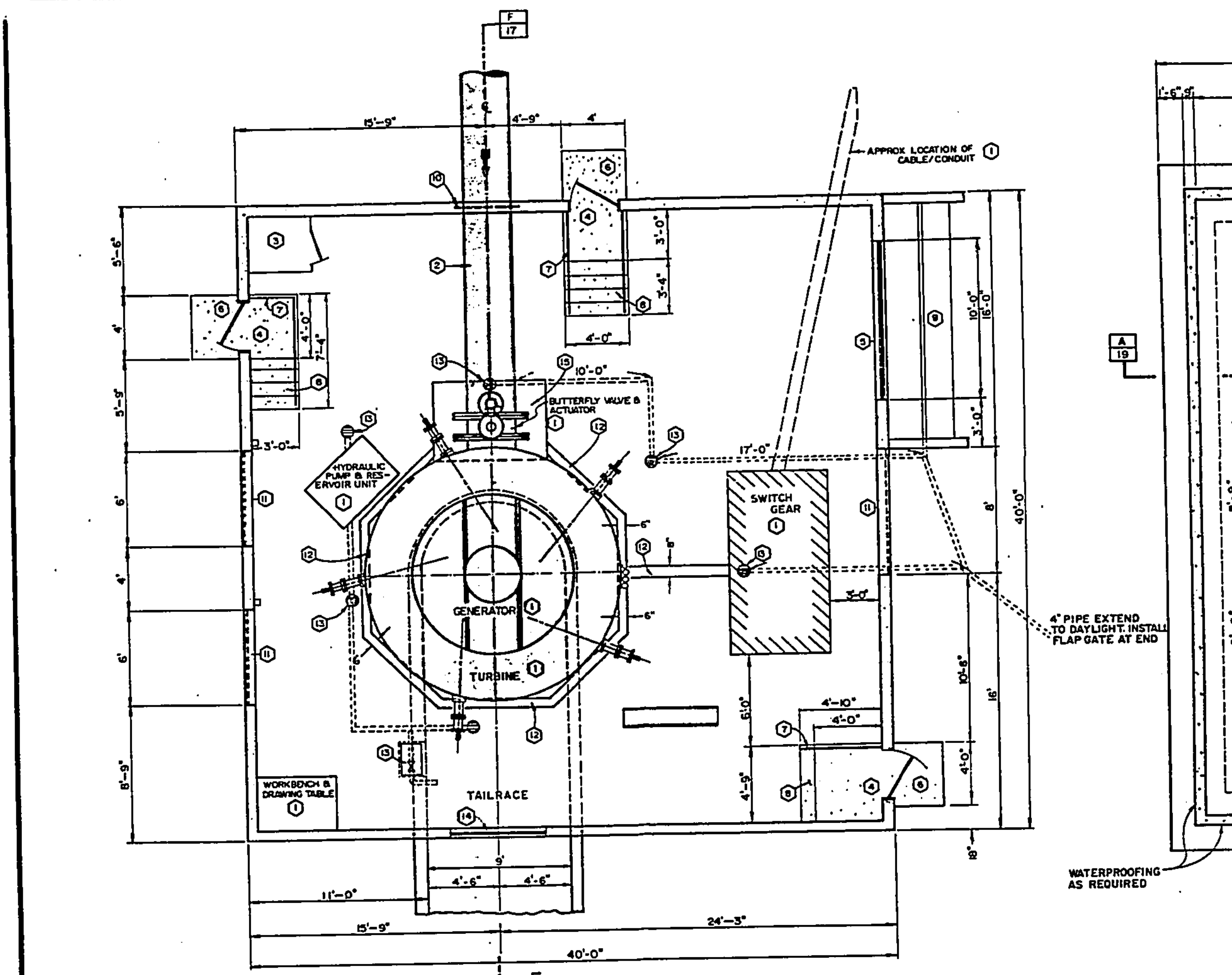
FIGURE 1.2-4. A



GENERAL NOTES:

1. CONTRACTOR SHALL COORDINATE ALL FOUNDATION WORK WITH MAJOR EQUIPMENT SUPPLIER.
2. UNLESS OTHERWISE DIRECTED BY ENGINEER, ALL SLAB CONC. TO BE POURED ON 4" LAYER OF 1" MINUS GRAVEL BASE COURSE.
3. SEE CONCRETE REINFORCING DETAIL SHEET FOR NOTES APPLICABLE TO ALL POURED CONCRETE.
4. CONTRACTOR RESPONSIBLE FOR PROTECTION, WRAPPING AND CLEANUP OF EQUIPMENT DURING CONC. POURING OPERATIONS.
5. INSIDE WALLS AND FLOOR AREA TO BE SEALED W/ GENCO-SEAL 301 OR EQUAL FOLLOWING FINISHING AS PER MANUFACTURER'S RECOMMENDATIONS.

FIGURE 1.2-4. A cross-section of the proposed powerhouse for the Upper Wallua Project.



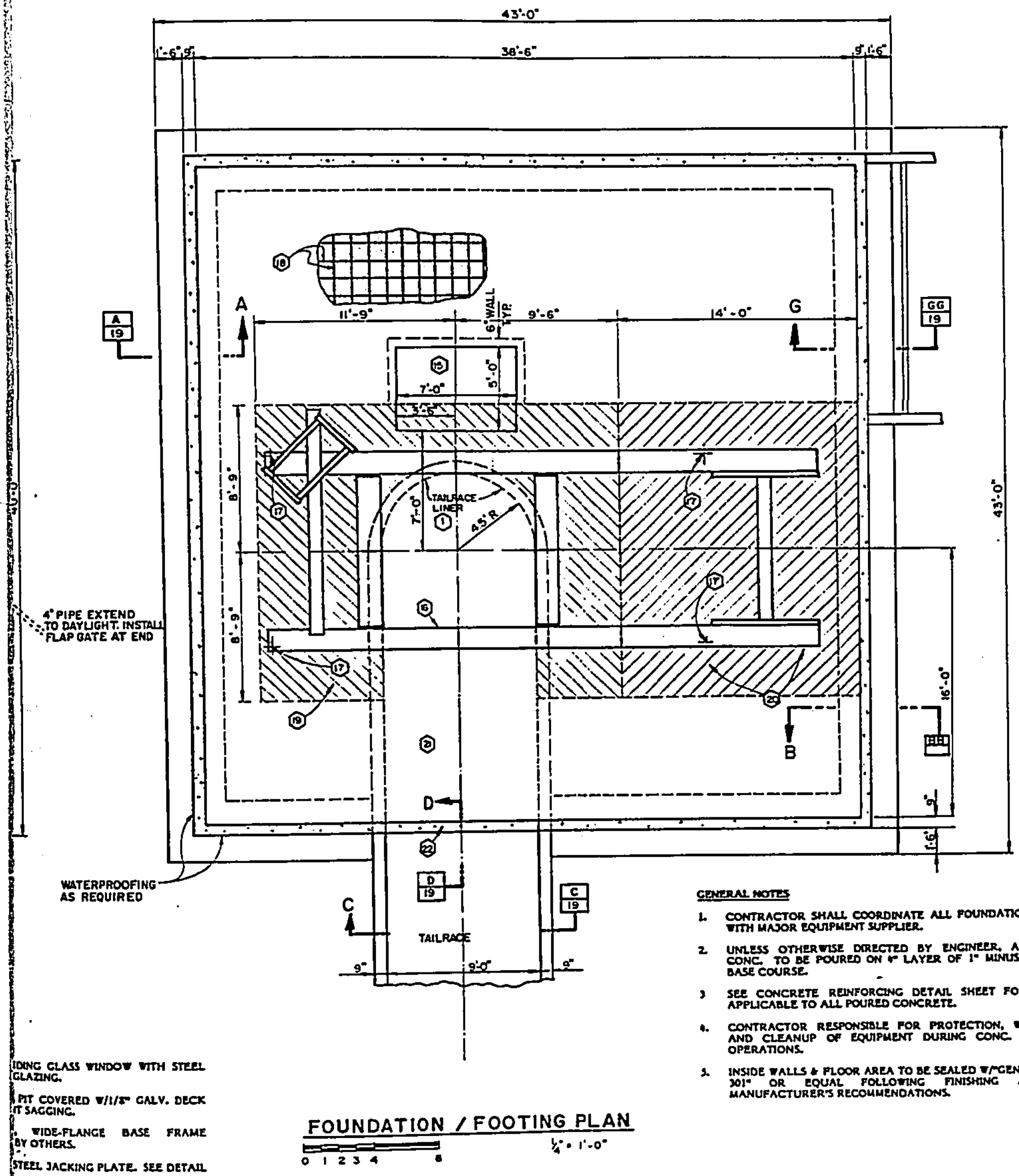
FLOOR PLAN

¼" = 1'-0"

0 1 2 3 4 8

REFERENCE NOTES

1. EQUIPMENT TO BE SUPPLIED AND INSTALLED BY OTHERS.
2. 36" O.D. STEEL PENSTOCK TO BE INSTALLED BY FDTN CONTRACTOR. PREPARE PIPE EXPOSED WITHIN BLDG. FOR FINISH PAINTING BY OTHERS. EXTERIOR PIPE WALLS TO HAVE 2 COATS RED OXIDE PRIMER PRIOR TO INSTALLATION.
3. CHEMICAL TOILET TO BE SUPPLIED AND INSTALLED BY FOUNDATION CONTRACTOR. PROVIDE FOR REQUIRED VENTING AND WASTE REMOVAL.
4. 3' X 7' INSULATED STEEL DOOR IN STEEL FRAME W/ALUM. THRESHOLD, WEATHER SEAL & LOCKSET.
5. 10' X 12' H. STEEL OVERHEAD DOOR IN STEEL JAMB W/WEATHERSEAL AND INSIDE LOCK MECHANISM.
6. 3' X 4' X 4" TH. CONC. LANDING. SLOPE 1/4" PER FT. AWAY FROM DOOR. PROVIDE 1/2" EXP. JOINT BETWEEN OUTSIDE LANDING AND FOUNDATION WALL.
7. 1 1/2" DIA. FABRICATED STEEL HANDRAILS. HANDRAILS TO BE PRIMED W/RED OXIDE PRIMER PRIOR TO INSTALLATION AND SECURED TO STEPS AND LANDING W/1/2" DIA. EXPANSION ANCHORS. TYPICAL HEIGHT = 36". HANDRAILS TO INCLUDE TOP & INTERMEDIATE RAILS, ANCHORING ATTACHMENTS, ETC. FOR A COMPLETE INSTALLATION. SUBMIT SHOP DRAWINGS FOR APPROVAL.
8. REINFORCED CONC. STAIRWAY WITH 8" RISERS & 10" TREADS. REINFORCING TO INCLUDE #4 BAR MAT (12" O.C.E.W.) AND #4 NOSING BAR @ EA. STEP. DOWEL HORIZ. BARS INTO WALL. BROOM FINISH.
9. CONC RAMP DRAIN PIPE. SEE SHEET 20 FOR DETAILS.
8. REINFORCED CONC TRANSFORMER PAD. SEE SHEET COORDINATE CONDUIT PLACEMENT W/EQUIP'T SUPPLIER.
10. 3/8" STEEL PL SEEPAGE RING. 36" I.D., 42" O.D. FILLET WELD TO PENSTOCK PRIOR TO PAINTING. PROVIDE #4 BARS HORIZ., VERT. & DIAGONALLY AROUND PENSTOCK W/3" MIN. CLEARANCE.
11. INTAKE AND EXHAUST VENTS SHOWN FOR REFERENCE ONLY. FINAL SIZING AND LOCATION BY ENGINEER.
12. 4" DEEP COVERED CABLE TRAY SUPPLIED AND INSTALLED BY OTHERS. FINISH CONC. FLUSH W/EDGES.
13. FLOOR DRAIN SYSTEM TO BE FIELD LOCATED. SEE SHEET 20.
14. 6' X 4' SINGLE HORIZ. SLIDING GLASS WINDOW WITH STEEL FRAME & 3/8" LAMINATED GLAZING.
15. RECESSED VALVE ACCESS PIT COVERED W/1/8" GALV. DECK PLATE BRACED TO PREVENT SAGGING.
16. PRE-FABRICATED STEEL, WIDE-FLANGE BASE FRAME SUPPLIED AND INSTALLED BY OTHERS.
17. CONC. BASE SUPPORTS W/STEEL JACKING PLATE. SEE DETAIL SHEET 19.
18. TYPICAL REINFORCING THROUGHOUT SLAB TO BE #5 BARS @ 12" O.C.E.W. PLACED 3" ABOVE BASE OF SLAB. 6" SLAB TO BE POURED OVER 4" GRAVEL BASE COURSE.
19. 36" DEEP CONC. SECTION AROUND TURBINE FRAME. SEE SECTION F-F.
20. 18" DEEP CONC. SECTION IN SWITCHGEAR AREA.
21. SEE DETAIL SHEET 19 FOR DIMENSIONS AND REINFORCING FOR TAILRACE ROOF, WALLS & FLOOR.
22. REINFORCED CONC. WALL OVER TAILRACE OPENING. SEE DETAIL SHEET 19.



GENERAL NOTES

1. CONTRACTOR SHALL COORDINATE ALL FOUNDATION WORK WITH MAJOR EQUIPMENT SUPPLIER.
2. UNLESS OTHERWISE DIRECTED BY ENGINEER, ALL SLAB CONC. TO BE POURED ON 4" LAYER OF 1" MINUS GRAVEL BASE COURSE.
3. SEE CONCRETE REINFORCING DETAIL SHEET FOR NOTES APPLICABLE TO ALL POURED CONCRETE.
4. CONTRACTOR RESPONSIBLE FOR PROTECTION, WRAPPING AND CLEANUP OF EQUIPMENT DURING CONC. POURING OPERATIONS.
5. INSIDE WALLS & FLOOR AREA TO BE SEALED W/"GENCO-SEAL 301" OR EQUAL FOLLOWING FINISHING AS PER MANUFACTURER'S RECOMMENDATIONS.

IDING GLASS WINDOW WITH STEEL GLAZING.

PIT COVERED W/1/8" GALV. DECK IT SAGGING.

. WIDE-FLANGE BASE FRAME BY OTHERS.

STEEL JACKING PLATE. SEE DETAIL

IROUGHOUT SLAB TO BE #5 BARS @ 3OVE BASE OF SLAB. 6" SLAB TO BE BASE COURSE.

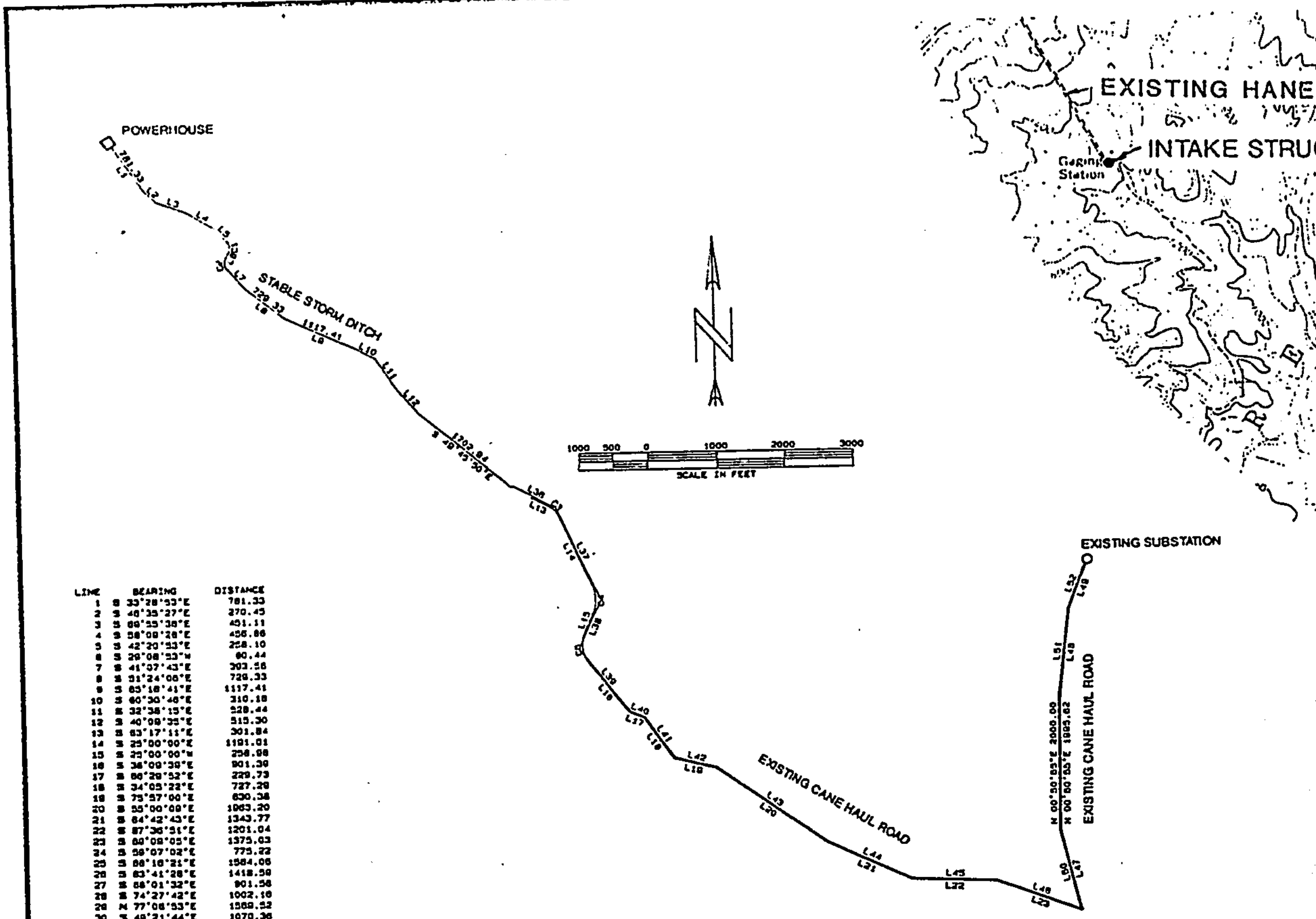
AROUND TURBINE FRAME. SEE

N SWITCHGEAR AREA.

R DIMENSIONS AND REINFORCING LS & FLOOR.

L OVER TAILRACE OPENING. SEE

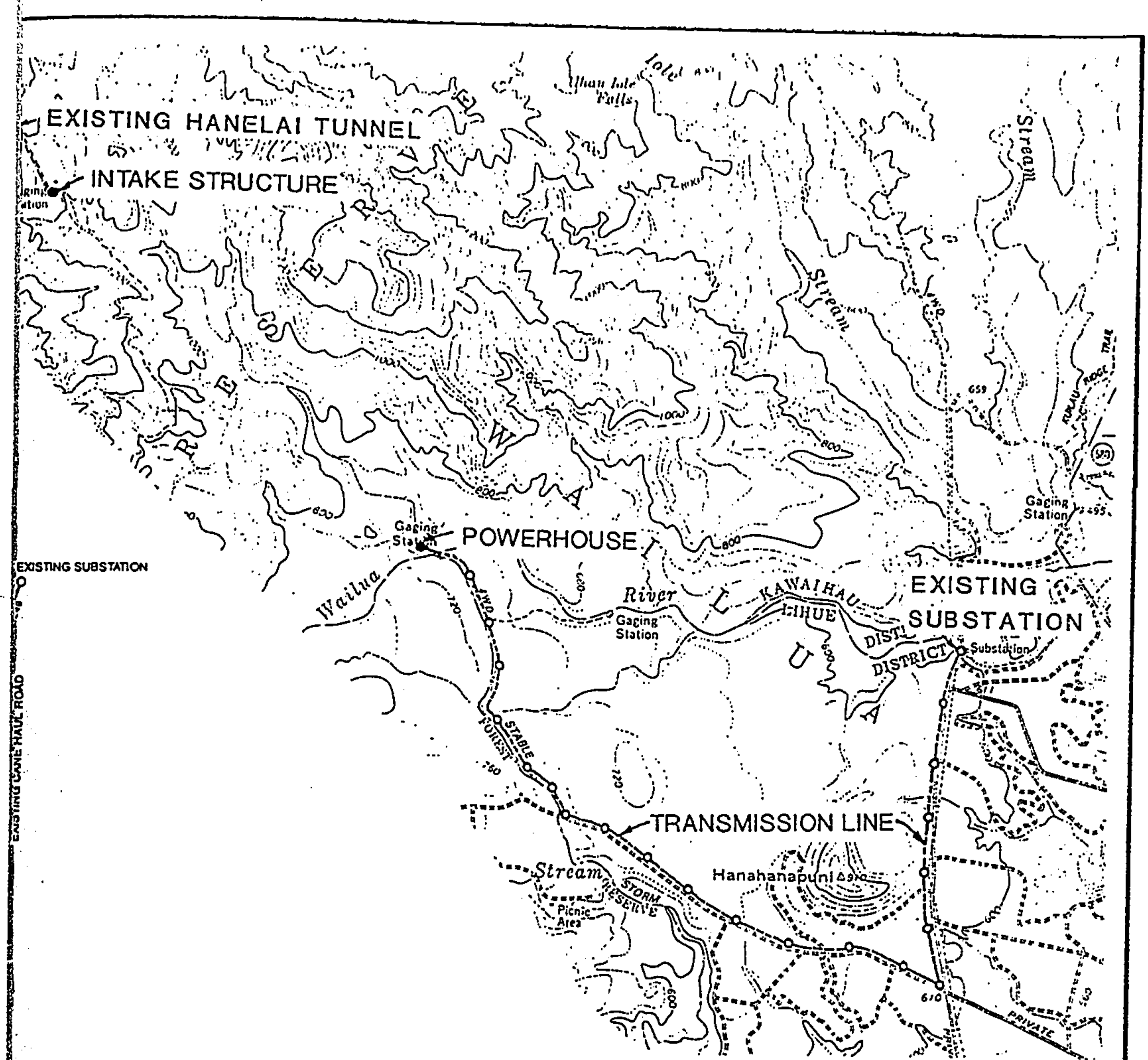
FIGURE 1.2-5. The foundation and footing plan for the Upper Wailua Hydroelectric Project.



LINE	BEARING	DISTANCE
1	S 33°28'53"E	781.33
2	S 40°35'27"E	270.45
3	S 69°33'38"E	451.11
4	S 58°09'28"E	456.86
5	S 42°20'53"E	258.10
6	S 29°08'53"W	80.44
7	S 41°07'43"E	303.56
8	S 31°24'06"E	729.33
9	S 63°18'41"E	1117.41
10	S 60°30'40"E	310.18
11	S 32°38'15"E	528.44
12	S 40°09'35"E	515.30
13	S 63°17'11"E	301.84
14	S 25°00'00"E	1191.01
15	S 25°00'00"W	258.98
16	S 36°09'39"E	901.39
17	S 66°29'52"E	229.73
18	S 34°05'22"E	727.29
19	S 75°57'00"E	830.38
20	S 55°00'09"E	1063.20
21	S 64°42'43"E	1343.77
22	S 87°36'51"E	1201.04
23	S 89°09'05"E	1375.03
24	S 59°07'02"E	775.22
25	S 86°10'21"E	1584.06
26	S 83°41'28"E	1418.59
27	S 88°01'32"E	901.56
28	S 74°27'42"E	1002.10
29	N 77°06'53"E	1569.52
30	S 49°21'44"E	1070.36
31	S 75°00'00"E	219.45
32	S 58°26'58"E	536.55
33	S 50°10'00"E	800.00
34	S 42°20'00"E	839.33
35	S 30°00'00"E	184.94
36	S 81°44'09"E	606.53
37	S 25°00'00"E	1510.81
38	S 25°00'00"W	795.79
39	S 38°39'38"E	1187.07
40	S 66°29'52"E	230.68
41	S 34°05'22"E	724.99
42	S 75°57'00"E	825.44
43	S 55°00'09"E	1965.70
44	S 64°42'43"E	1336.58
45	S 87°36'51"E	1200.04
46	S 89°09'05"E	1292.39
47	N 13°09'05"W	1183.84
48	N 06°50'55"E	1295.40
49	N 21°50'56"E	696.71
50	N 13°09'05"W	1200.00
51	N 06°50'55"E	1300.00
52	N 21°50'55"E	700.00

CURVE	DELTA	RADIUS	ARC	TANGENT
1	71°29'40"	150.00	187.18	107.98
2	70°18'37"	150.00	183.96	105.57
3	36°43'14"	200.00	128.18	66.38
4	50°00'00"	600.00	436.33	233.15
5	63°06'39"	500.00	551.18	307.37
6	25°36'18"	350.00	156.81	79.84
7	16°33'04"	350.00	101.10	50.91
8	12°30'00"	400.00	86.19	43.22
9	62°30'00"	300.00	327.26	182.04

FIGURE 1.2-6. A diagram of the transmission line from the powerplant to the existing substation.



ing substation.

The proposed project will total approximately 35.4 acres in size. The amount of land required for individual aspects of the project include the following:

Transmission Line	18.2 acres
Penstock	10.3 acres
Powerhouse	1.5 acres
Main Diversion Weir	.9 acres
Temporary Access Road (at distance from penstock)	3.8 acres
Permanent Access Road	.7 acres
TOTAL	35.4 acres

The Kauai Electric Division (KED) is required by the State Public Utilities Commission to maintain at least 22.2 megawatts (MW) of reserve capacity in the absence of any additional utility or purchasable capacity. Present reserve capacity decreases from 29.2 MW to 17.2 MW during the entire month of January when the 12.0 MW bagasse power plant is normally shutdown (bagasse is the unused remains of sugar cane burned to generate electricity). The possibility of simultaneous shutdown of both the 12.0 MW Lihue plant and the 22.2 MW gas turbine No. 2 plant, although remote, is of concern to KED officials. Hence, the construction of the proposed Upper Wailua Project will help alleviate this energy shortfall within the KED system.

The economic aspects of the project are significant and beneficial. The benefits are derived solely from dispersion of Kauai Electric's system energy and assumed fuel price escalation and a power-on-line effective date of 1989. The project would contribute significantly toward the goals of alleviation of oil dependence and increased energy self-sufficiency. The hydroelectric facility would supplant the need to import approximately 14,000 barrels of oil annually and service an equivalent of 1,500 households or 4,700 individuals, assuming the current rates of fuel oil utilization and household demands are maintained.

There will be a short term increase in employment opportunities for approximately one year for local laborers and construction companies as a result of construction of the proposed project. Local suppliers will also be used for concrete, backfill materials, and other major components of the project. Operation and maintenance of the project will also involve local personnel.

The project will cost approximately $5 million to construct, which includes all direct and indirect construction costs, easements and rights-of-way, land and agricultural damages, and interest during construction (Table 1.2-1). The following list is an itemization of the total project costs.

Direct Construction Cost. The basic assumptions for the construction cost estimates were as follows:

a. The contractor and laborers would be based on the Island of Kauai. Labor would be performed on six-8 hour shifts per week.

b. Construction period would be 12 months.

c. Escalation to mid-point of construction was included. Annual construction inflation would be 9 percent. Contingencies are 20 percent. However, for turbine/generator and related electrical/mechanical items, based on manufacturer's bid prices, contingencies are 10 percent. Transmission line contingencies are 15 percent.

d. Excavation 6-10 feet below the surface would require blasting for rock removal. Material at the surface would be composed of loose soil, cobbles and large boulders.

e. Mechanical and electrical equipment would be from continental United States. Installation labor from the mainland would be required for turbine/generator features. Itemized costs include delivery costs to site.

f. A suitable temporary diversion would be utilized to facilitate construction of the new diversion.

g. Price level for all work is as of July, 1989.

Indirect Costs. Indirect costs include technical and administrative costs associated with the design and construction of the project.

a. Engineering and Design. These indirect costs would be for engineering efforts in the preparation of design memoranda; construction plans and specification; and engineering during construction. All associated overhead amounts are included in the engineering and design totals.

b. Supervision and Administration. The construction contract would include contract administration and field inspection. Associated overhead amounts are included in the total.

c. Right-of-Way Indirect Costs. Indirect costs include the management of construction rights-of-way, easements and interagency coordination during construction.

d. Easements. The costs required to acquire construction rights-of-way would be borne by the developer.

TABLE 1.2-1. The project costs for the Upper Wailua Hydroelectric Site.

COST ESTIMATE

ITEM	
CONSTRUCTION	
Direct Construction Costs	$ 3,500,000
Indirect Costs	750,000
Subtotal	$ 4,250,000
LAND AND DAMAGES	
Lands, Easements & Rights-of-Way	150,000
TOTAL FIRST COSTS	$ 4,400,000
INTEREST DURING CONSTRUCTION	300,000
FINANCING COSTS	300,000
TOTAL PROJECT INVESTMENT COST	$ 5,000,000

e. Operational, Maintenance and Replacement Costs. These costs are annual costs required to keep all facilities in good working condition and repair.

f. 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. The turbine/generator procurement process is normally an independent contract. Hence, construction inflation was computed on the basis of 12 months and IDC was computed on the basis of 12 months.

1.3 DIVERSION AND INTAKE STRUCTURE

The diversion structure in the Hanalei drainage will be retrofitted with a fish screen which will prohibit downstream migrations of gobies and the adult Hawaiian opae kala'ole. The project proponent has prepared two alternatives for the diversion screen, both of which will mitigate entrainment. The first alternative (preferred) will use an Aqua Shear type device utilizing Johnson wedgewire (Figure 1.3-1). This alternative, however, requires a small bypass flow. Because the project does not control the water availability, a second alternative utilizing a more conventional fish screen has been prepared (Figure 1.3-2). Both screens will functionally protect downstream migrants.

The proposed intake structure at the outfall of the Hanalei tunnel will have the ability to divert 8 to 48 cfs. The channel leaving the tunnel will be 8 feet across at an elevation of 1210 feet above MSL. The diversion structure will contain a two foot high sluice gate which can drain the intake structure for cleaning. The 48 inch diameter penstock will be covered by a trashrack containing 2 inch by 1.25 inch bars at two inch centers. The diversion dam will be approximately 5 feet high and 30 feet wide. The overflow crest will be ten feet wide and two feet deep. The details of the diversion structure can be seen in Figure 1.3-3.

1.4 PENSTOCK

The penstock for the preferred alternative (Alternative 4) will be approximately 8,925 feet long and contain both 48 and 32 inch diameter pipe. The penstock will start at an elevation of 1210 feet above MSL. The flow will then be discharged from the powerhouse and returned to the natural channel of the Maheo Stream, 200 feet above its confluence with the North Fork Wailua River (Figure 1.2-2).

Along the length of the penstock, up to 80% of the penstock will be buried, depending on the availability of soil to cover the pipe. An example of a cross section of typical buried penstock can be seen

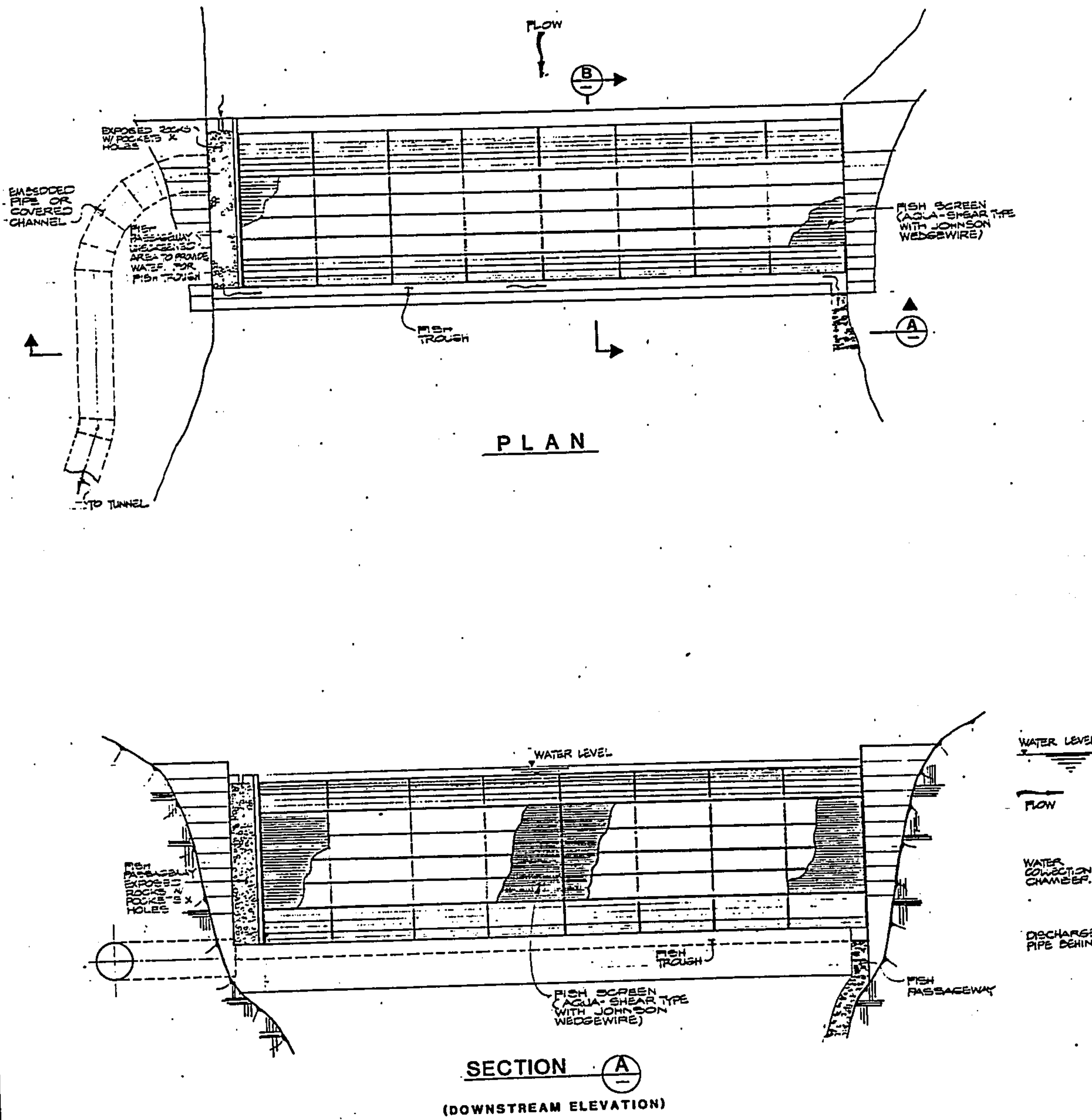
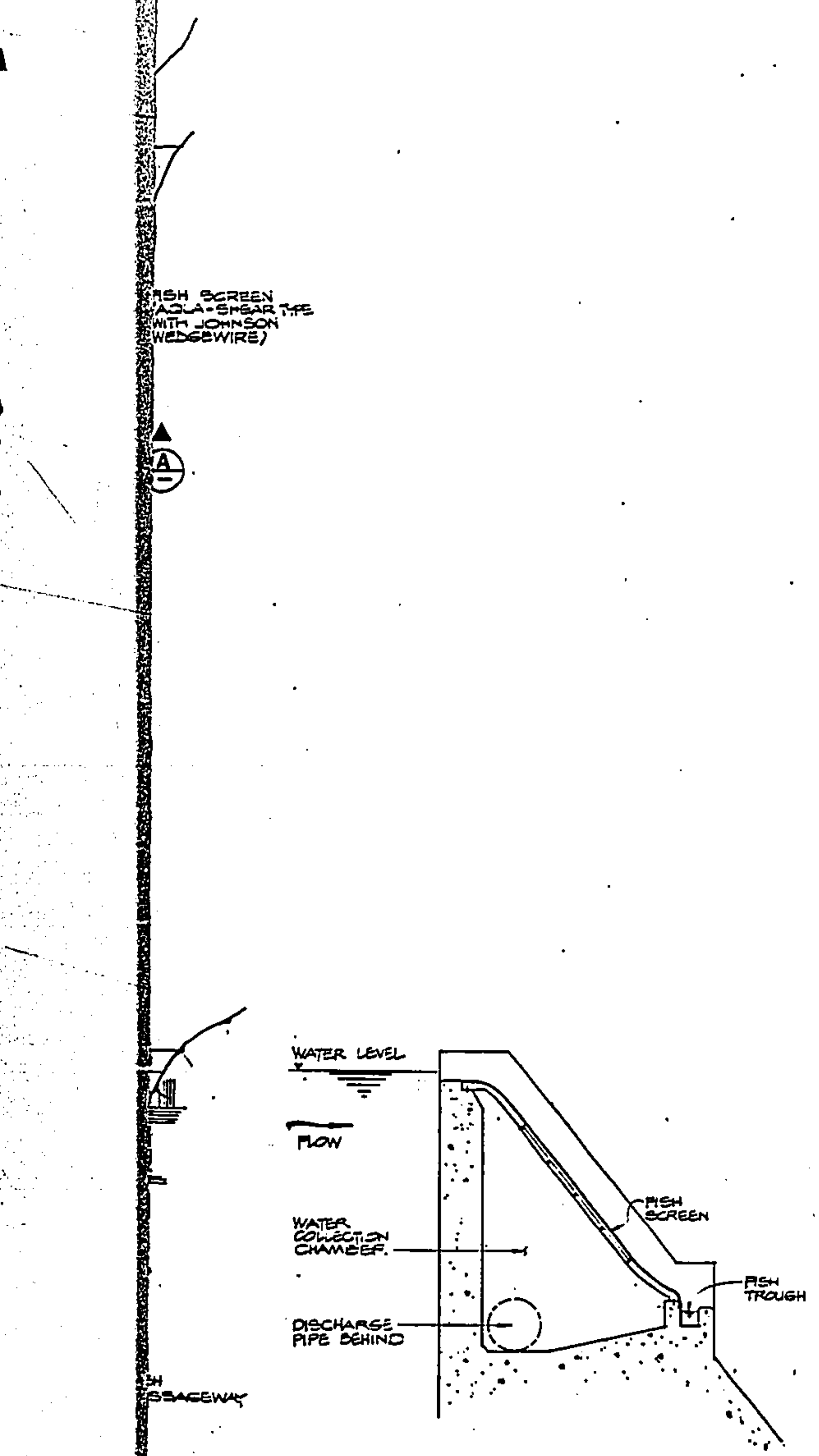


FIGURE 1.3-1. The detailed engineering drawing of the preferred diversion structure fish screen.



SECTION B

fish screen.

REVISION	DATE	DESCRIPTION	BY	APPD

UPPER WAILUA HYDROELECTRIC PROJECT

DIVERSION STRUCTURE WITH FISH SCREEN (PREFERRED)

ALPINE SAN JOSE CALIFORNIA

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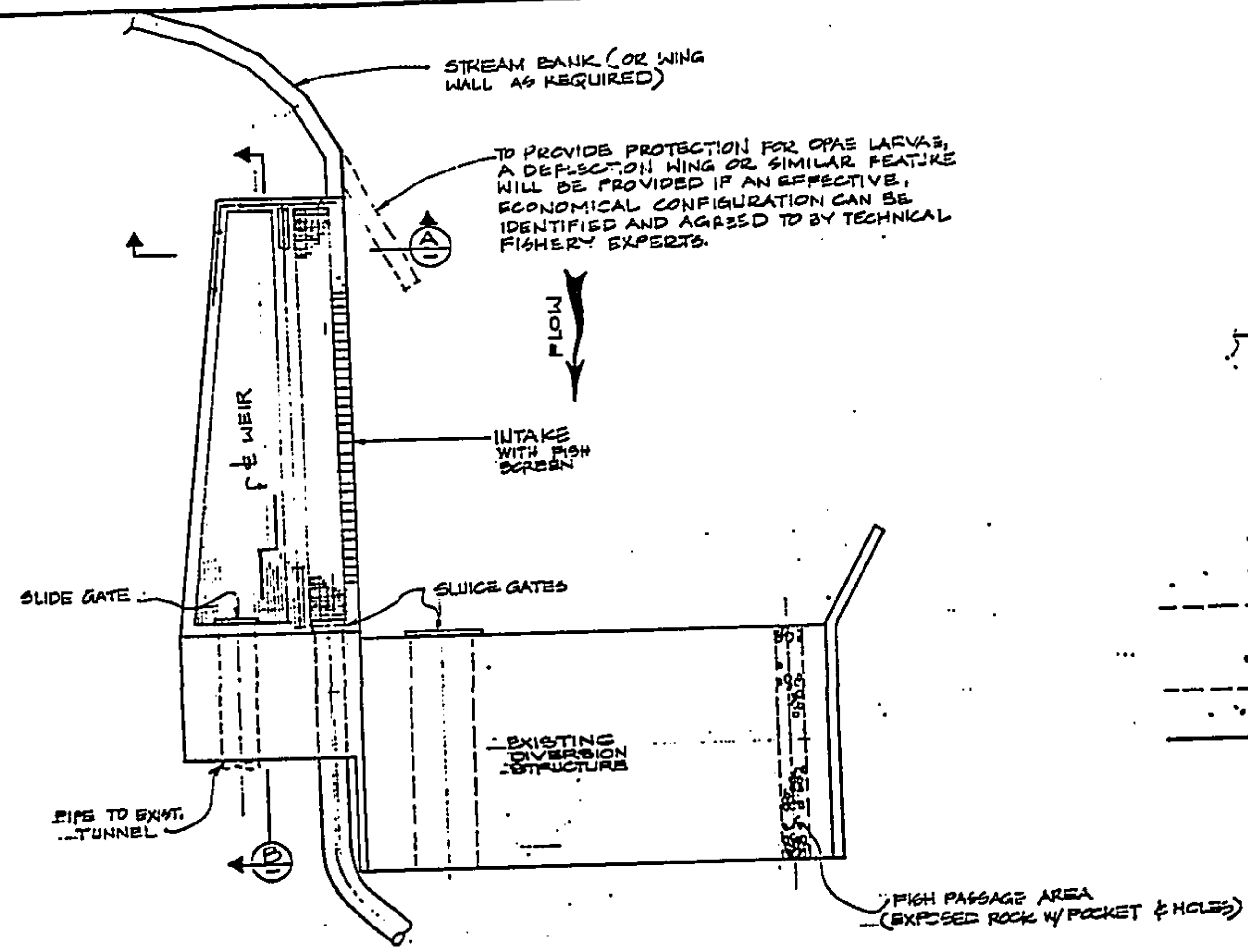

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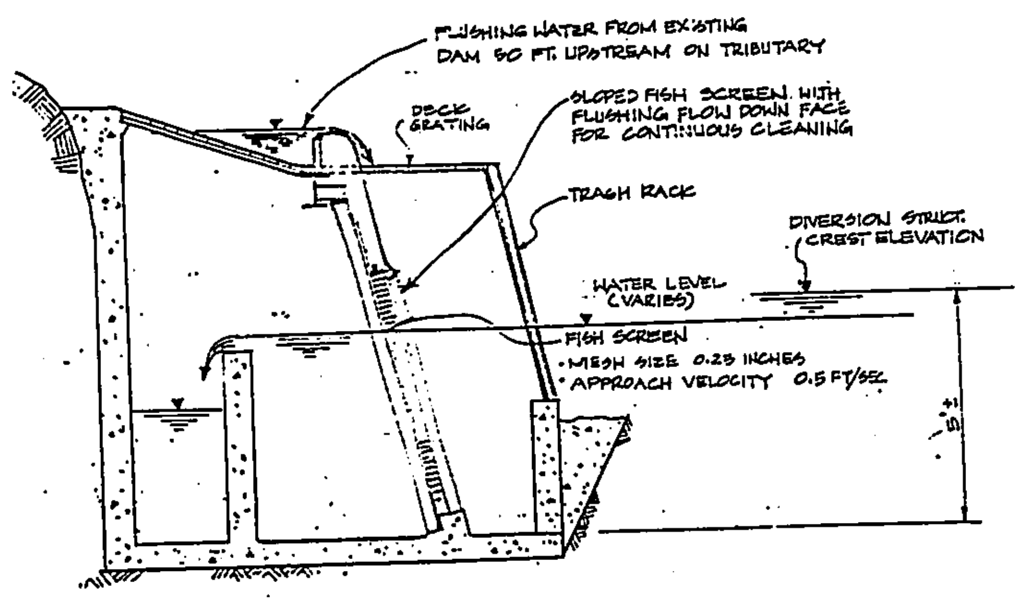

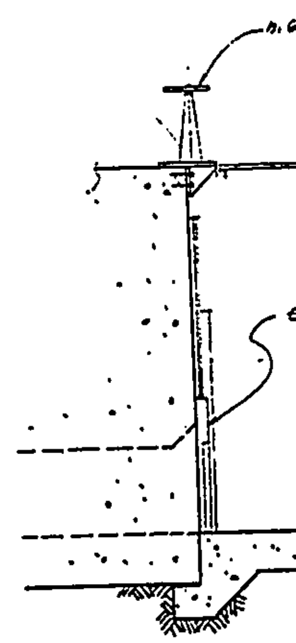

FIGURE 1.3-2. The detailed engineering
fish screen for the alternative de

SECTION A
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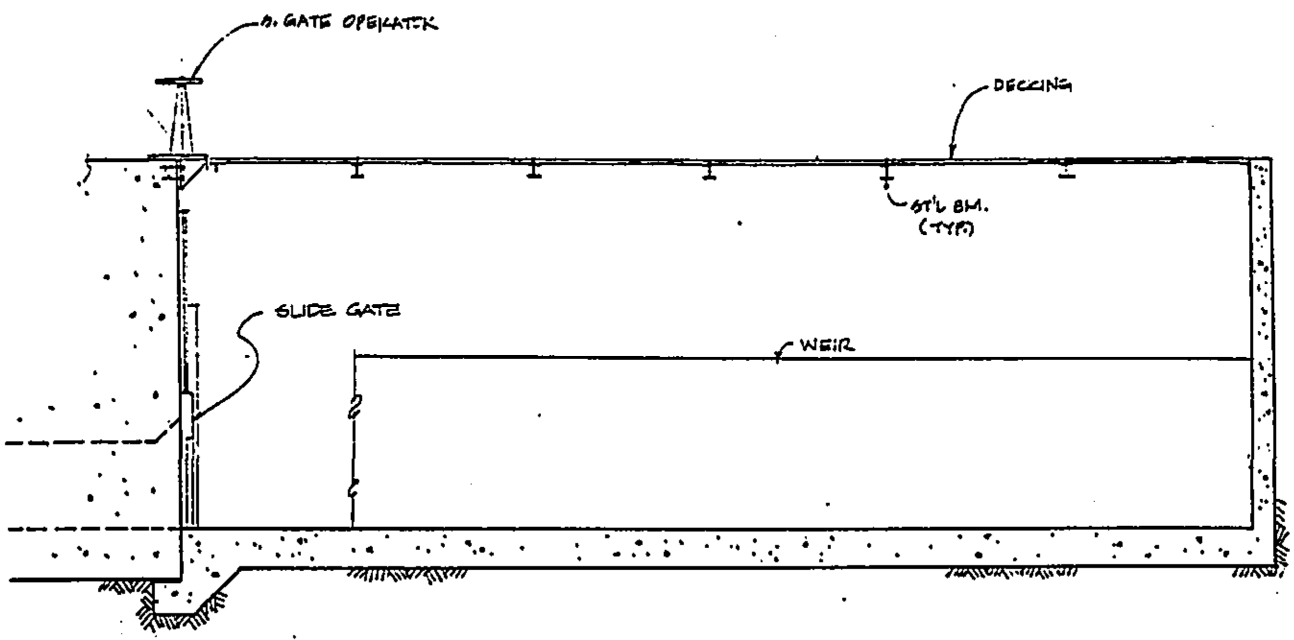

ET & HOLES)

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REVISION	DATE	DESCRIPTION	BY	APPD

UPPER WAILUA
HYDROELECTRIC PROJECT

DIVERSION STRUCTURE
WITH FISH SCREEN
(ALTERNATE)

ALPINE SAN JOSE CALIFORNIA

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etailed engineering drawing of the diversion structure with the alternative design.

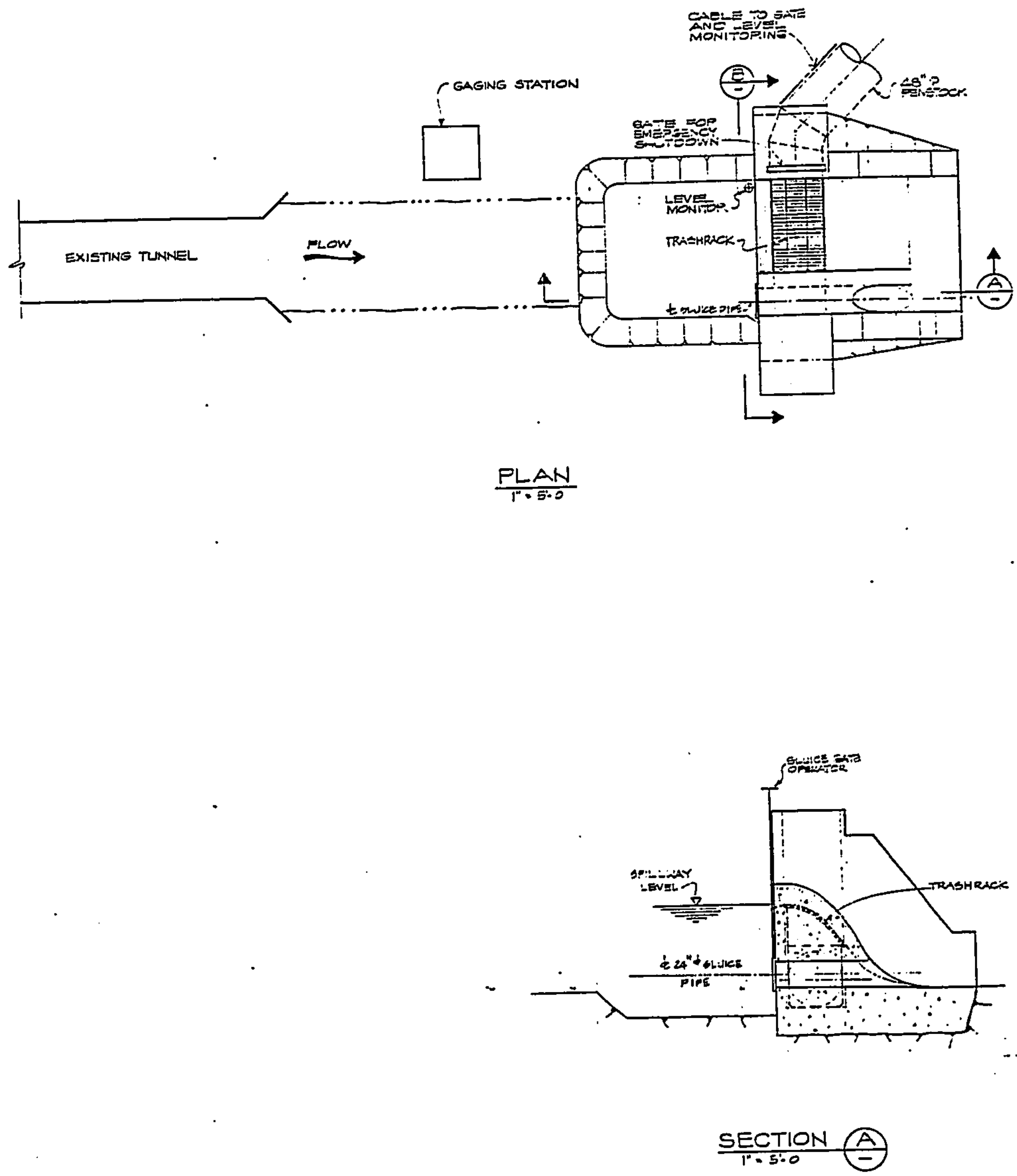
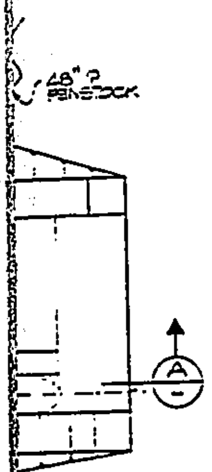
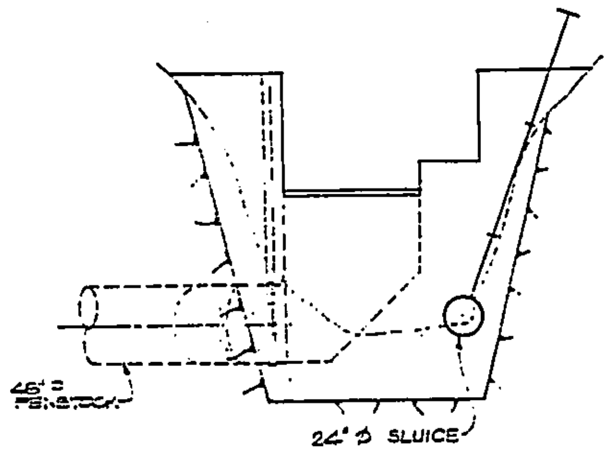


FIGURE 1.3-3. The engineering details of the diversion structure at the Hanalei Tunnel outlet.





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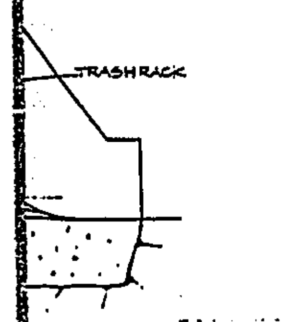
1" = 5'-0"



lei Tunnel outlet.

REVISION	DATE	DESCRIPTION	BY	APPD

UPPER WAILUA
HYDROELECTRIC PROJECT

PENSTOCK
INTAKE STRUCTURE

ALPINE · SAN JOSE CALIFORNIA

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DATE 3-1-89	SCALE AS SHOWN	DWG. NO.	

in Figure 1.4-1. Where possible, the slope above the penstock will be returned to original surface topographical contours. The above ground penstock will be supported in pre-made saddles. Along the penstock route, several stream crossings will be encountered. It is anticipated the penstock will either span these stream channels at a height sufficient to avoid extreme streamflows or be buried in a permanent gully crossing as depicted in Figure 1.4-2. Culverts will be sized and rockfill stabilized to cope with maximum foreseeable streamflows. Excavation into the bank will occur on each side of the stream. Care will be taken to remain out of the stream channel whenever possible during the construction phase of the project.

1.5 POWER PLANT

The proposed power plant will be 1.26 MW and generate 7.2 million MW hours of power annually. The plant will be located approximately 50 feet from Maheo Stream on the west bank. The plant will be 40 feet by 40 feet in surface area and twenty feet high. It will contain a pelton type turbine (Figures 1.2-4 and 1.2-5). The tailrace exit from the powerhouse will be below the structure (Figure 1.5-1). The tailrace exit will be lined with concrete, followed by riprap or gabions. The tailrace will be 9 feet wide at its base with 2 to 1 slopes. The total length of the tailrace will be approximately 50 feet and contain an average slope of 0.02. In addition, a one foot dry drop will be placed in the tailrace to inhibit upstream attraction of aquatic organisms.

1.6 ACCESS ROAD/POWER TRANSMISSION LINE

Access to the proposed project site from the Lihue area is gained from State Highway 583 and numerous private roads through property of the Lihue plantation. Access is above the site of the Lower Wailua hydroelectric project at Wailua Falls and above Aahoaka Reservoir and Hanahanapuni (Figure 1.6-1). Access to the proposed powerhouse site is further gained via the Stable Storm Ditch road. A permanent Irish crossing will be installed to provide access over the North Fork Wailua River (Figure 1.6-2).

The "Irish Crossing" concept was selected specifically because such crossings are designed to be overtopped by severe freshets without being washed out. Boulders stabilized by dental concrete will be used to cope with overtopping flows. Culverts for normal lower flows will be placed on the stream bed at upstream and downstream ends so that fish passage will not be impeded. The streamflow regime will be essentially unaltered. The crossing will be constructed during low flows as a matter of practicality, thus erosion will be minimized. This design concept is applied successfully at other road/stream crossings in

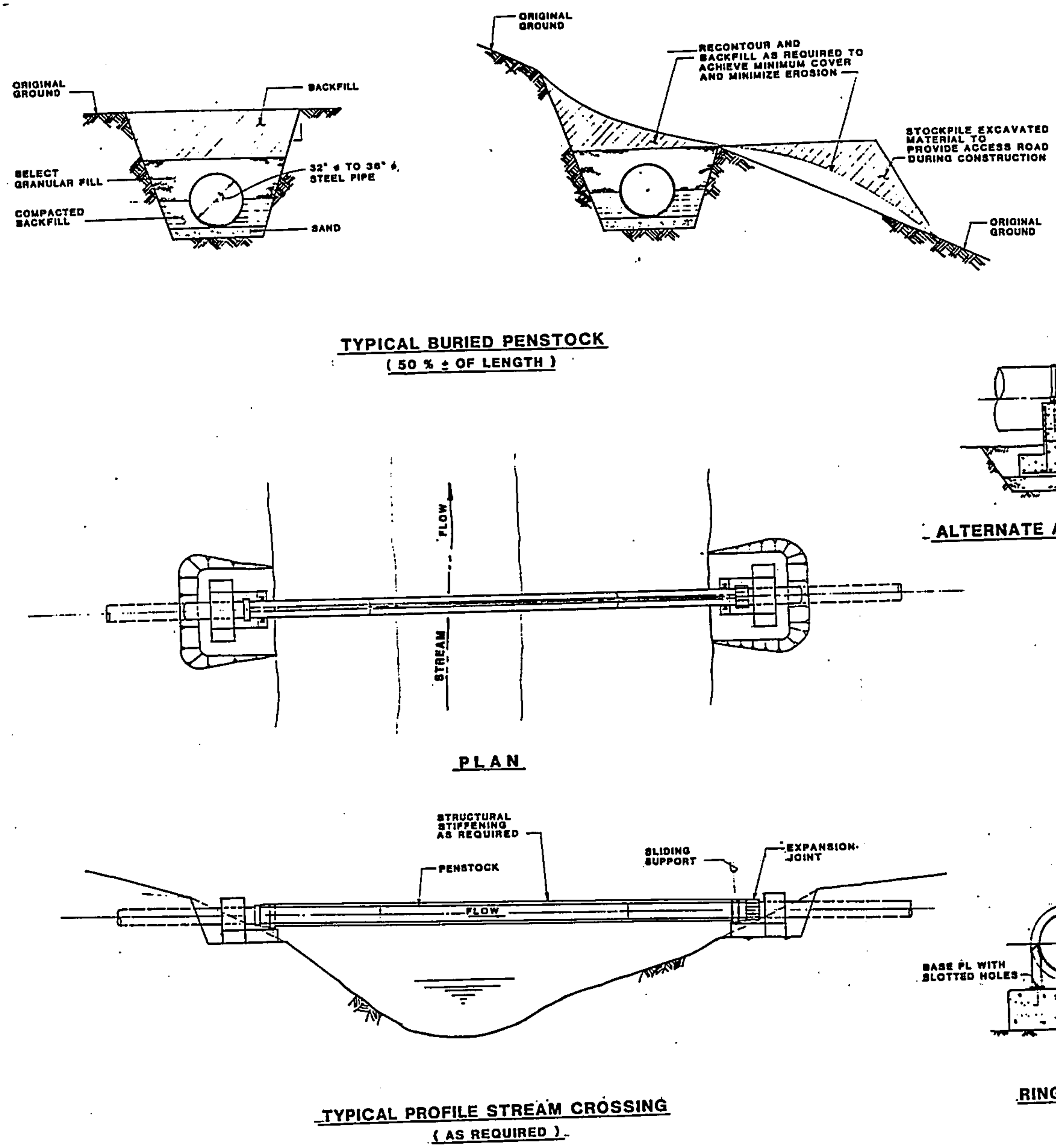
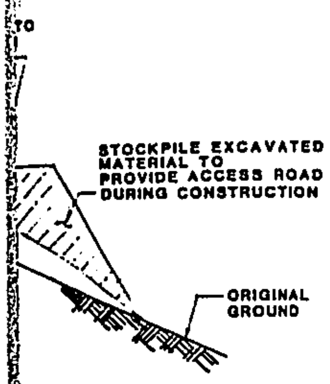
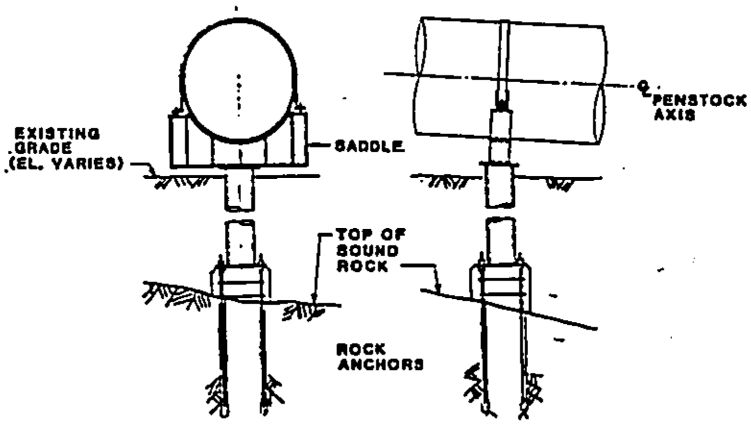
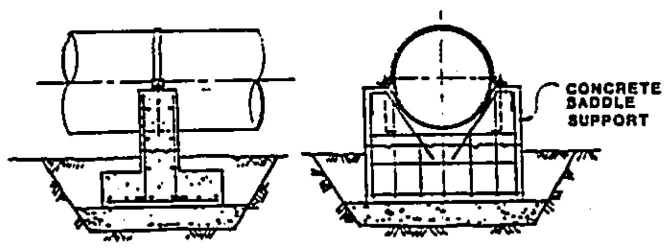


FIGURE 1.4-1. The typical cross-sections of the penstock to be used in the Upp

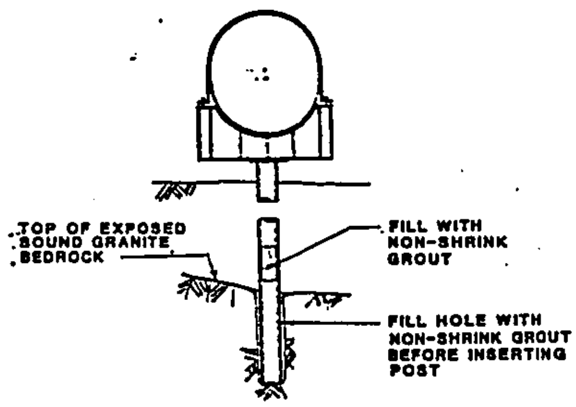




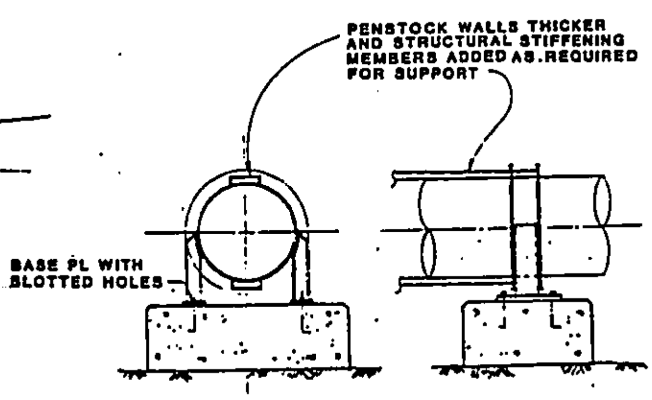
TYPICAL ABOVE-GROUND PENSTOCK SUPPORT
(50 % ± OF LENGTH)



ALTERNATE ABOVE-GROUND PENSTOCK SUPPORT



ALTERNATE ABOVE-GROUND PENSTOCK SUPPORT



RING GIRDER SLIDING SUPPORT

REVISION	DATE	DESCRIPTION	BY	APPD

UPPER WAILUA HYDROELECTRIC PROJECT

PENSTOCK SECTIONS AND STREAM CROSSING

ALPINE SAN JOSE CALIFORNIA

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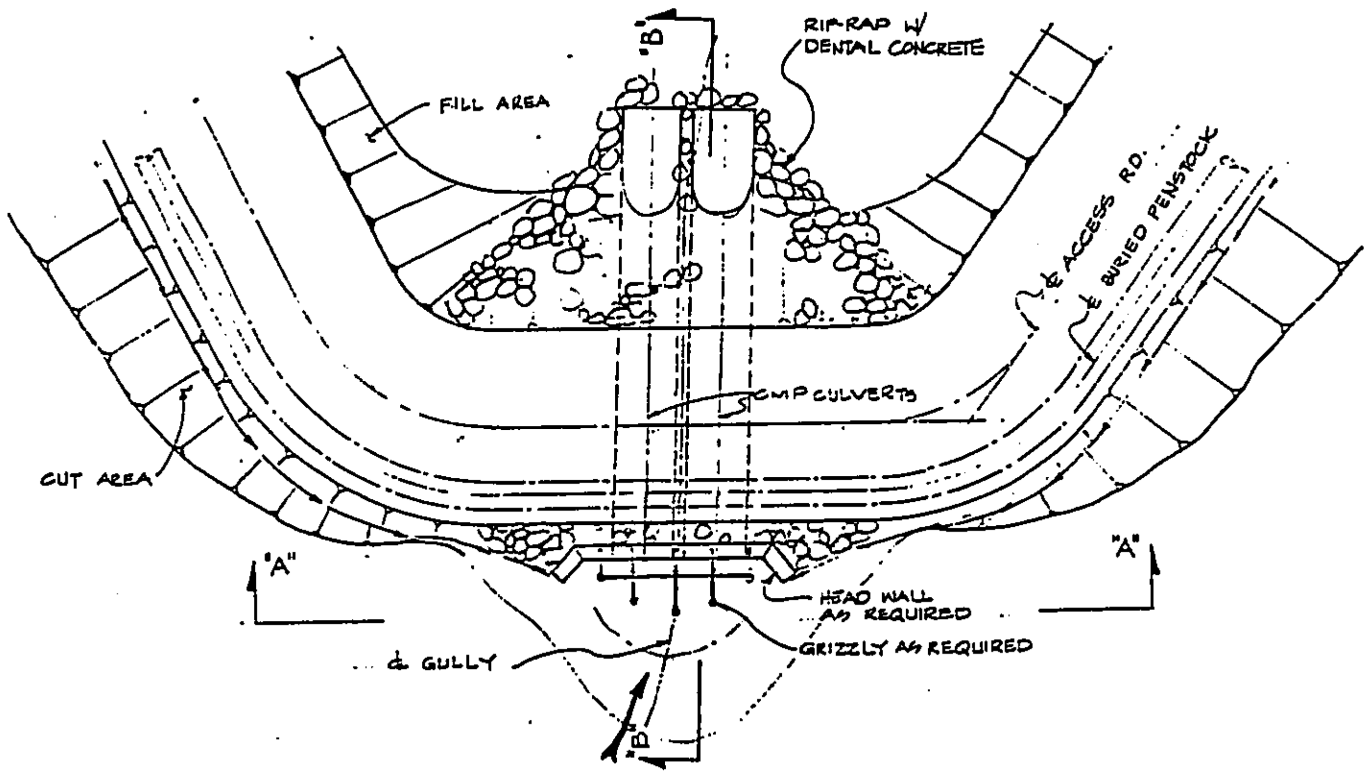
e used in the Upper Wailua project.



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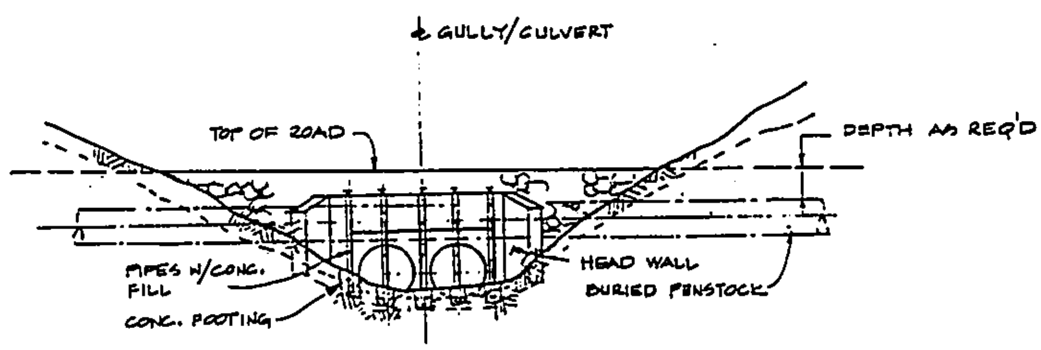

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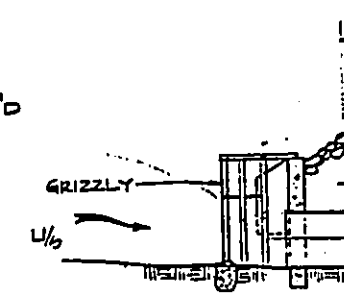

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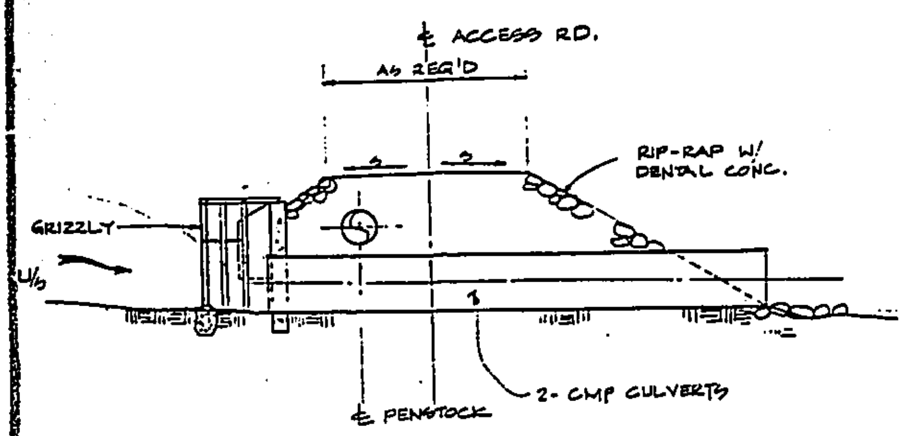
FIGURE 1.4-2. A diagram of a typical permanent penstock and road crossing.

NOTE:

CULVERT SIZING AND CROSSING DESIGN WILL BE CONSERVATIVE TO PREVENT PENSTOCK WASHOUT.



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ad crossing.

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UPPER WAILUA
HYDROELECTRIC PROJECT

PERMANENT PENSTOCK & ROAD
GULLY CROSSING

ALPINE — SAN JOSE CALIFORNIA

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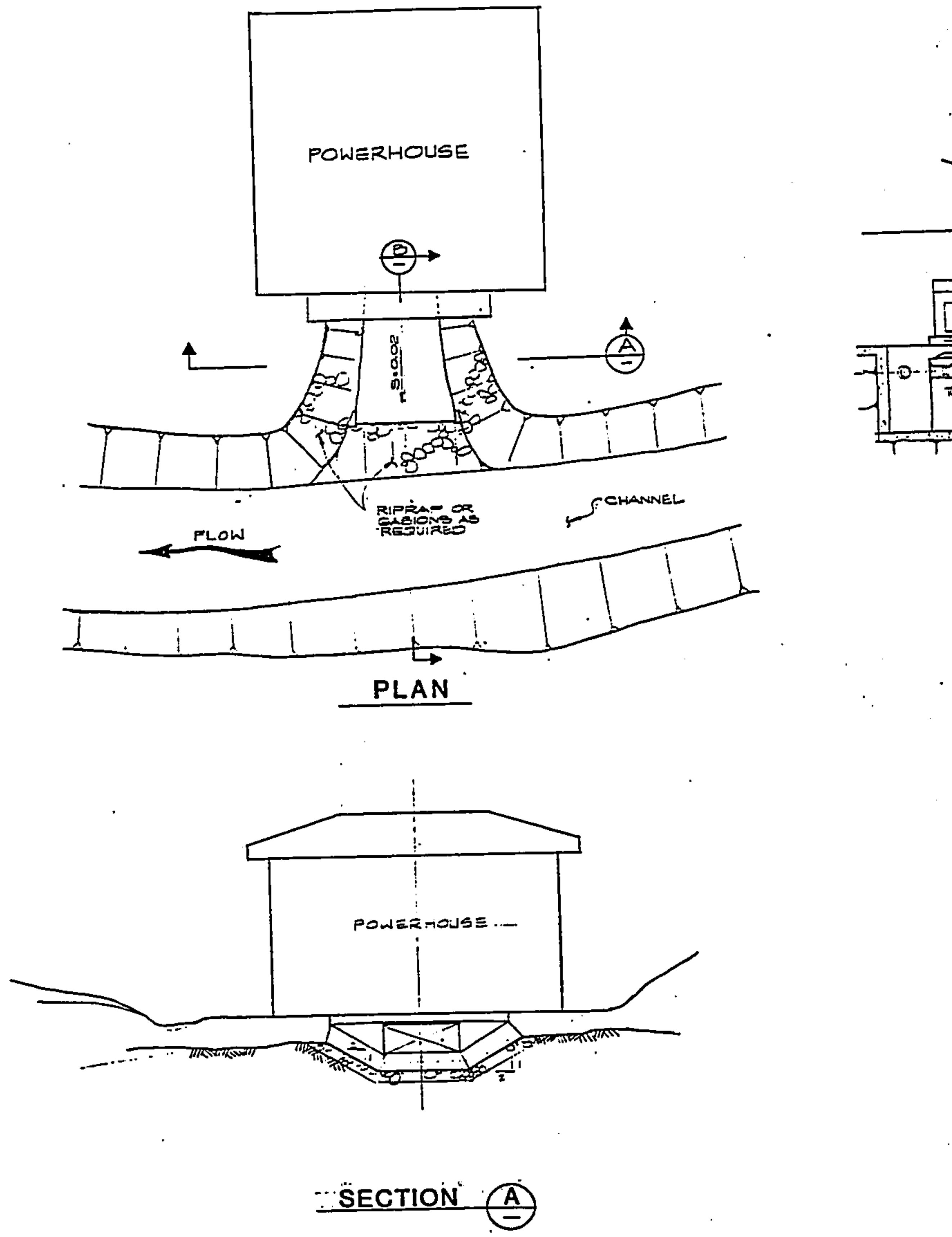
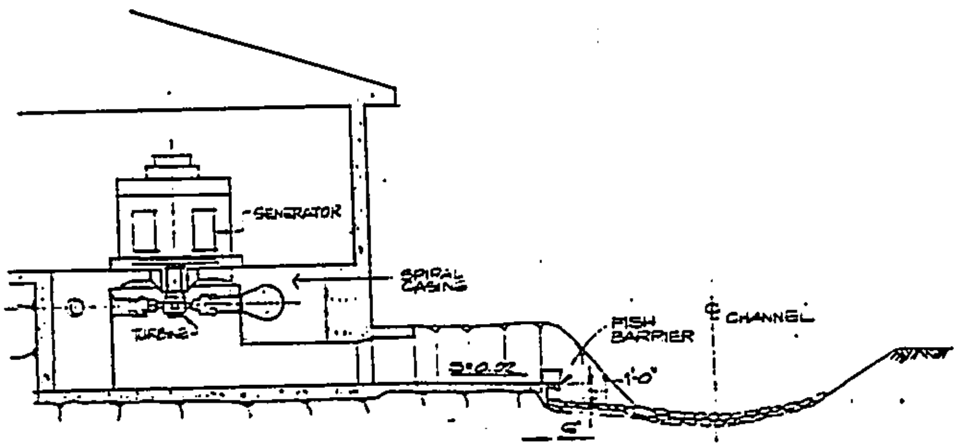


FIGURE 1.5-1. The tailrace plan and section for the Upper Wailua project.



SECTION B

NOTE:

FLOODPROOFING OF POWERHOUSE SHALL BE PROVIDED AS REQUIRED.

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UPPER WAILUA
HYDROELECTRIC PROJECT

TAILRACE
PLAN AND SECTIONS

ALPINE — SAN JOSE, CALIFORNIA

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pper Wailua project.

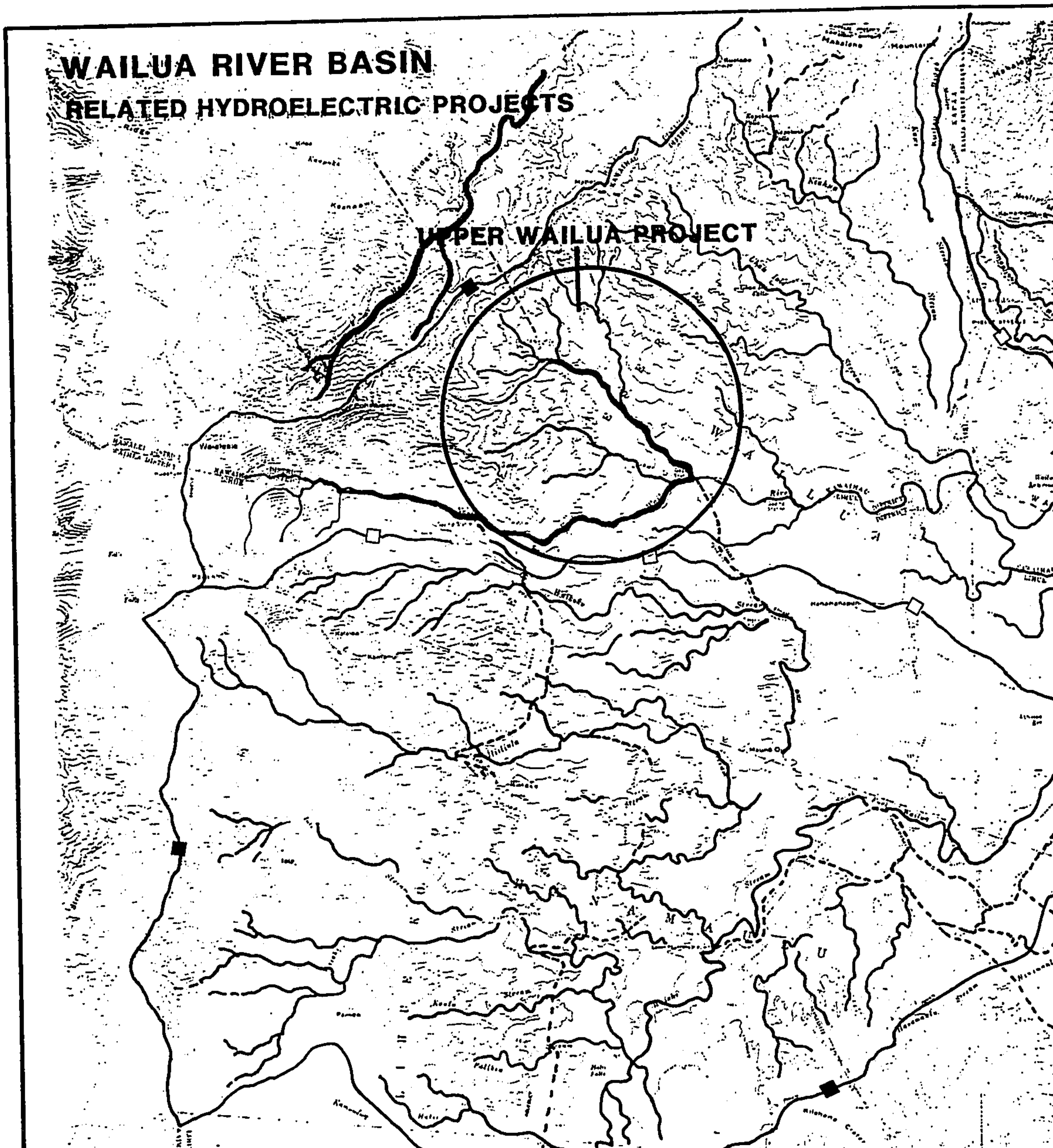
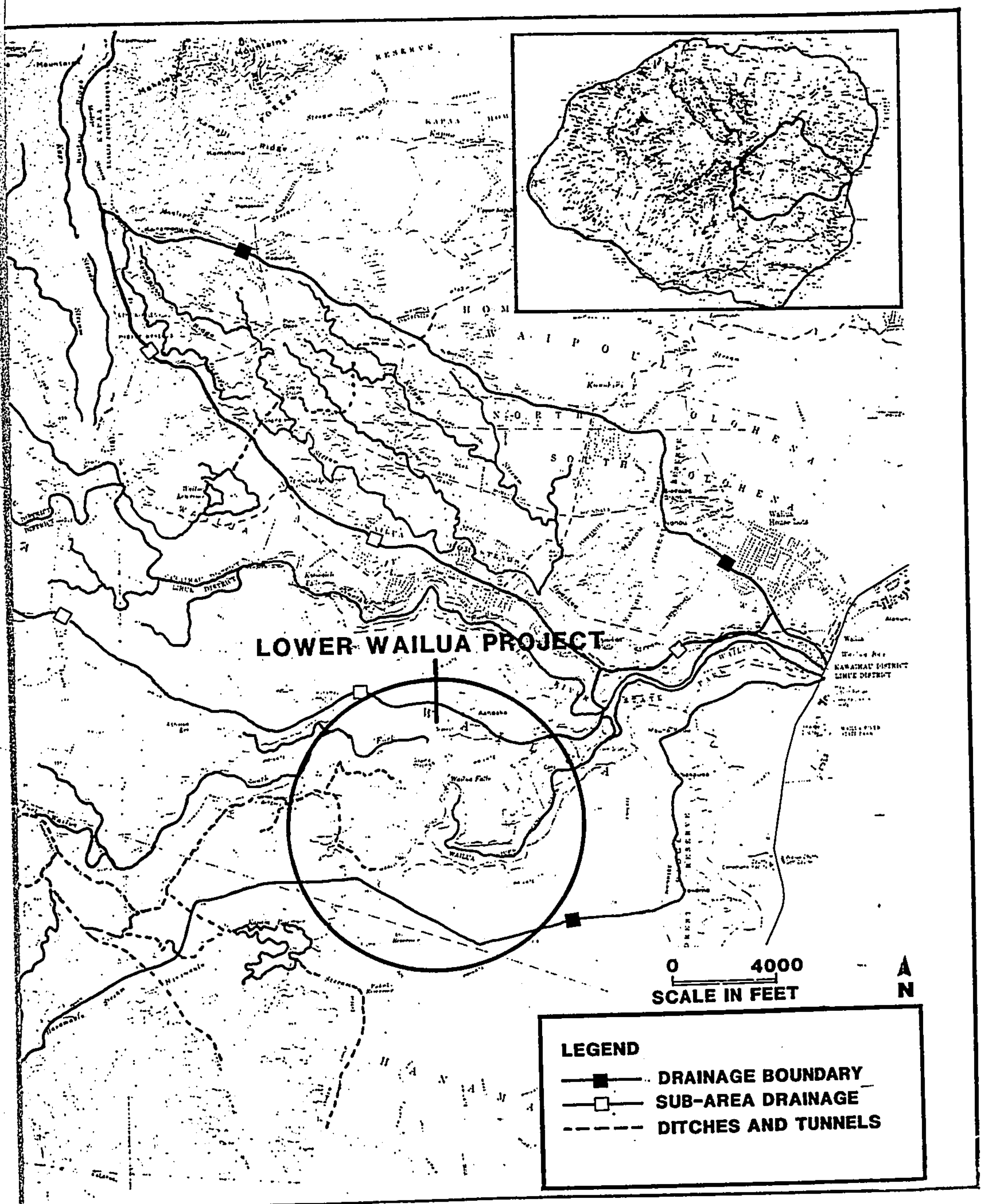


Figure 1.6-1. Location of Lower Wailua Project relative to Upper Wailua Project.


LOWER WAILUA PROJECT
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SCALE IN FEET
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SUB-AREA DRAINAGE
DITCHES AND TUNNELS

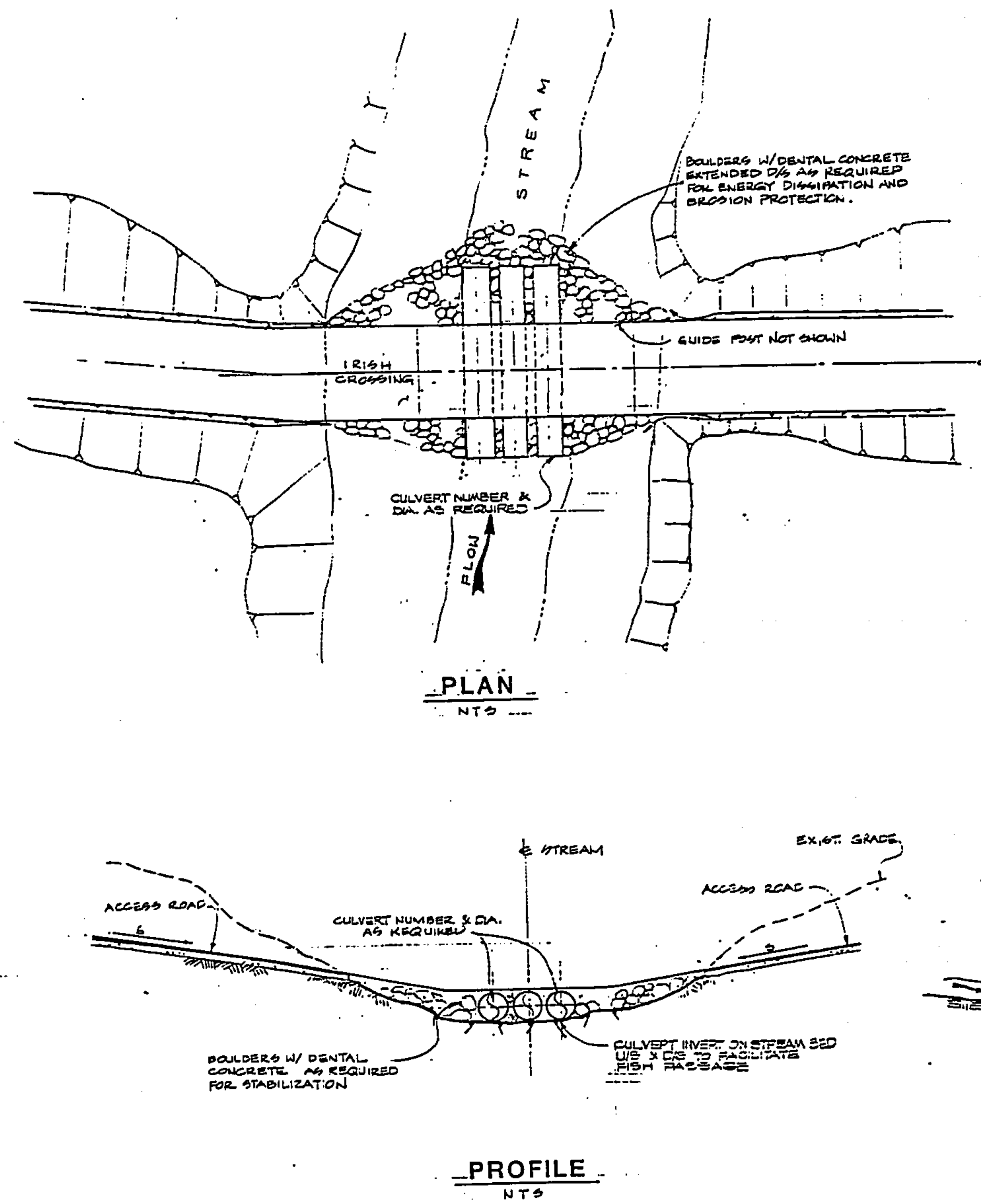
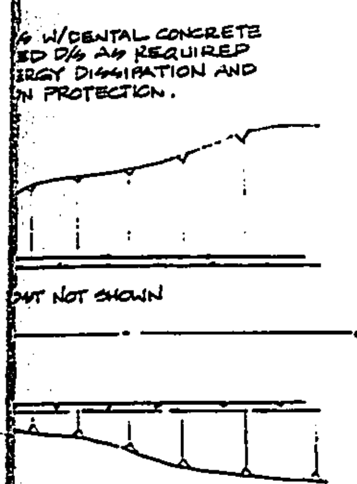
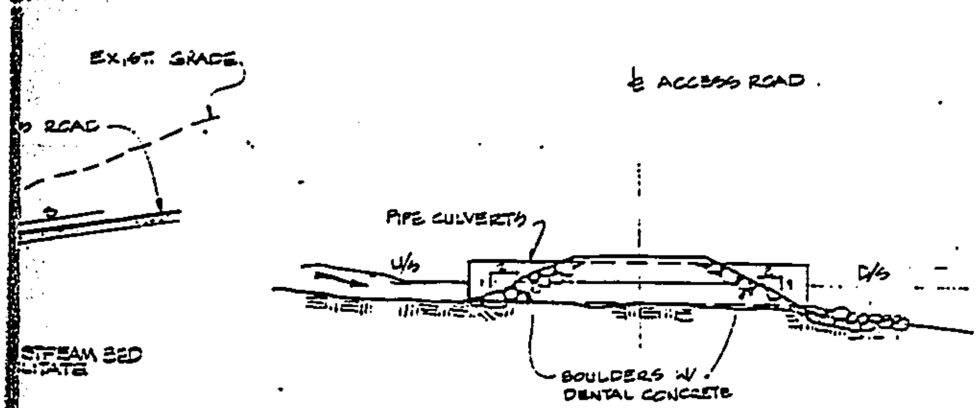


FIGURE 1.6-2. An engineering diagram of the stream crossing on the North Fork of the Wailua



NOTE:

IRISH CROSSING, DESIGNED TO COPE WITH OVERFLOW DURING HIGH FLOWS, WILL BE INSTALLED AT ALL PERMANENT ACCESS ROAD STREAM CROSSINGS AND AT MAJOR STREAM CROSSING (S) ON THE TEMPORARY ACCESS ROAD.



CROSS SECTION

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h Fork of the Wailua River.

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UPPER WAILUA HYDROELECTRIC PROJECT

IRISH CROSSING
PLAN & PROFILE

ALPINE — SAN JOSE CALIFORNIA

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the Wailua watershed and design details will be borrowed from those applications for adequacy of erosion protection and economy of construction.

For construction of the diversion weir and penstock, a new access road approximately 1 1/2 miles in length will be constructed from the confluence of Maheo Stream with the North Fork of the Wailua River to the outlet of the Hanalei Tunnel. This road will cross gullies and streams and over temporary or permanent stream crossings. Permanent crossings (Figure 1.4-2) will be designed and constructed to accommodate storm flows. Temporary crossings (Figure 1.6-3) will be removed following completion of construction and the crossing areas restored. The access road will likely be single lane and approximately 20 feet wide. The total disturbance zone of this road, however, could be as great as 50 feet wide due to construction impacts and deposition of graded material. The penstock will be buried within the access road right-of-way over up to 80% of its length (Figure 1.6-4). The entire road cut above the powerhouse location will be recontoured and revegetated following construction. The permanent access road from the Stable Storm Ditch to the powerhouse will be maintained for access to the project.

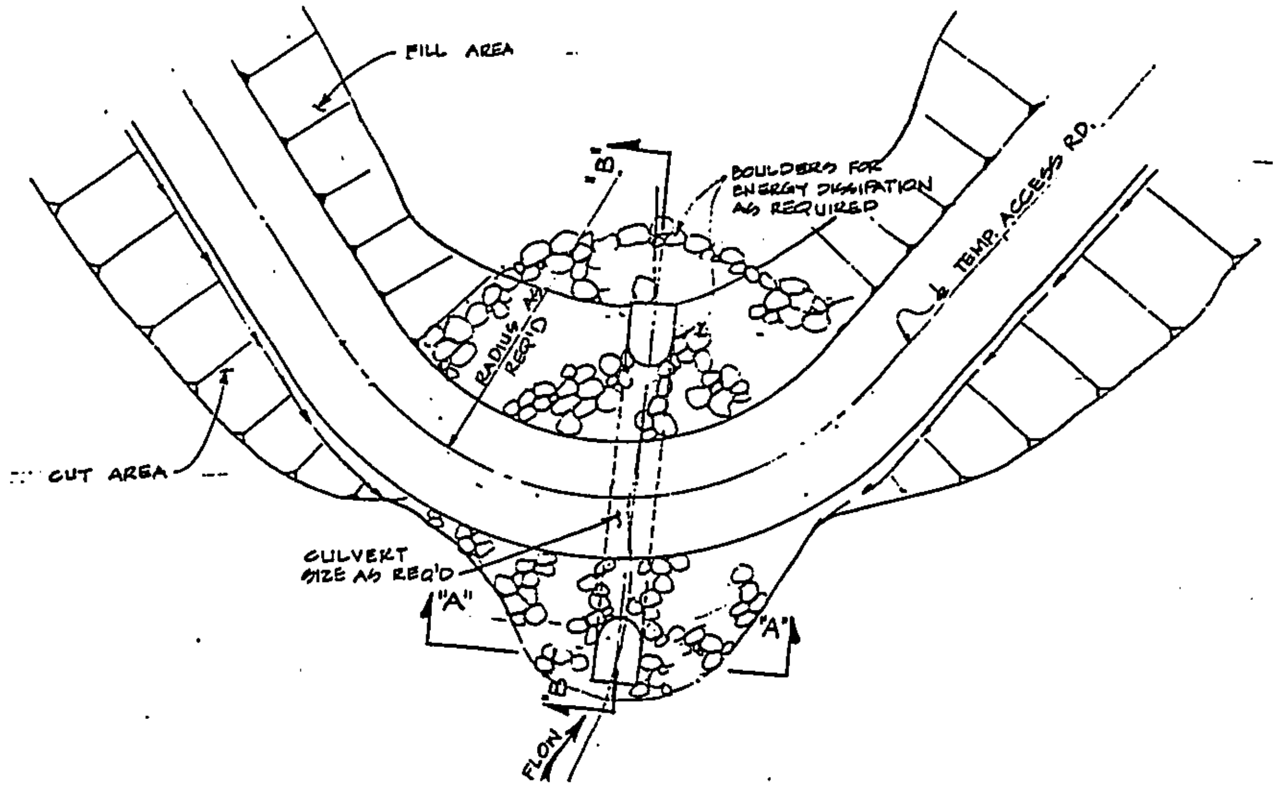
A new transmission line will be constructed from the powerhouse and will follow the existing corridor of the Stable Storm Ditch road. This transmission line will interconnect the existing KED system with the Upper Wailua Project near elevation 610 at the intersection of two private haul cane roads in the Lihue plantation (Figure 1.2-6). The new transmission line will be approximately 18,500 feet in length or approximately 3.5 miles long. Construction and subsequent maintenance of the transmission line will utilize the existing Stable Storm Ditch road.

1.7 STAGING AREA

The proposed staging area for Alternative #4 will be located at a site on the opposite side of the North Fork Wailua River from the project adjacent to the Stable Storm Ditch road. This site was cleared of vegetation by Lihue Plantation in February, 1989, and offers both a staging area close to the project, on an area that has already been disturbed. Figure 1.6-3 - Penstock and Access Road Plan and Profile - illustrates the proposed location of the staging area. In addition, a smaller area adjacent to the powerhouse location will also be utilized as a secondary staging area. Access to the powerplant location will be restricted by a locked gate at the North Fork Wailua River Irish crossing.

1.8 USE OF PUBLIC LANDS

The proposed Upper Wailua Project will be located on land owned by the State of Hawaii. Water utilized to generate electricity by the project is also owned by the State of Hawaii. The proposed project



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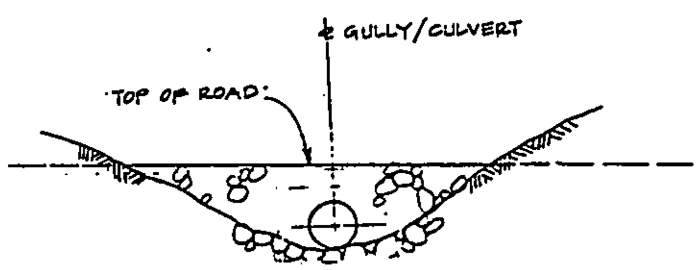

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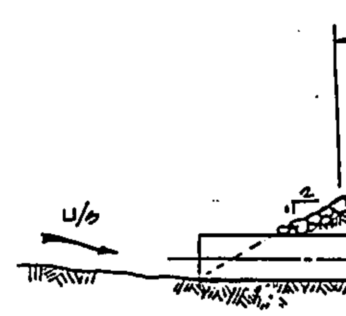

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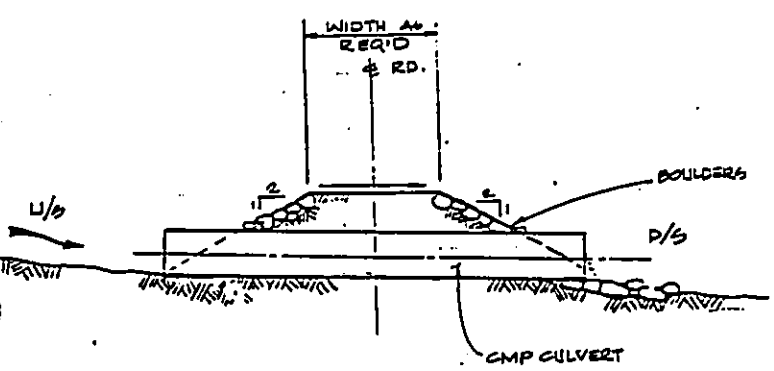
FIGURE 1.6-3. Engineering drawings of the temporary road crossings for gullies and stre

NOTE:
CROSSING WILL BE DEVELOPED FOR CONSTRUCTION SEASON ACCESS AND REMOVED UPON JOB COMPLETION.



SECTION "B-B"
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for gullies and streams.

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UPPER WAILUA HYDROELECTRIC PROJECT

TEMPORARY ROAD CROSSING OF GULLY/STREAM

ALPINE — SAN JOSE, CALIFORNIA

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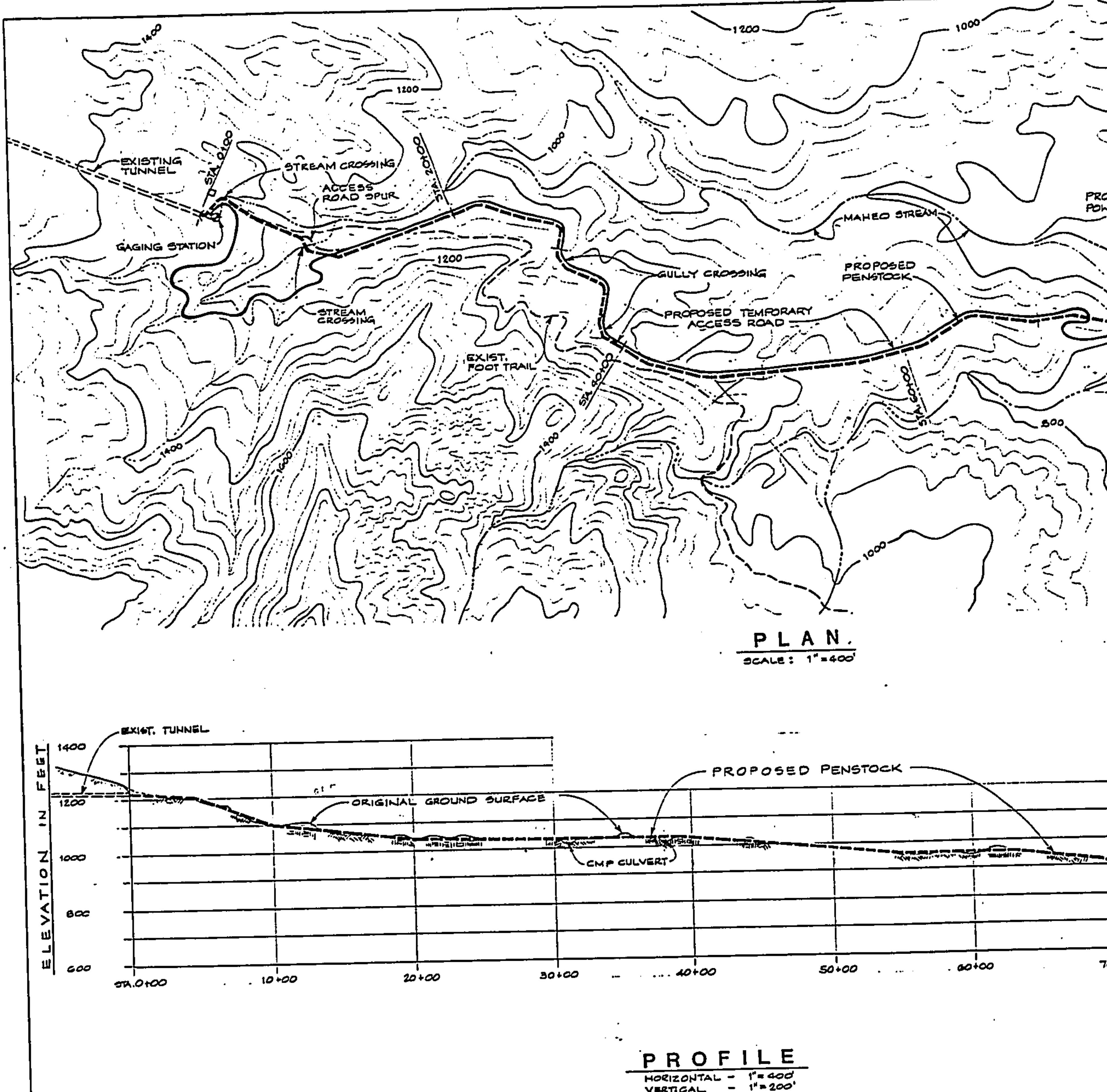
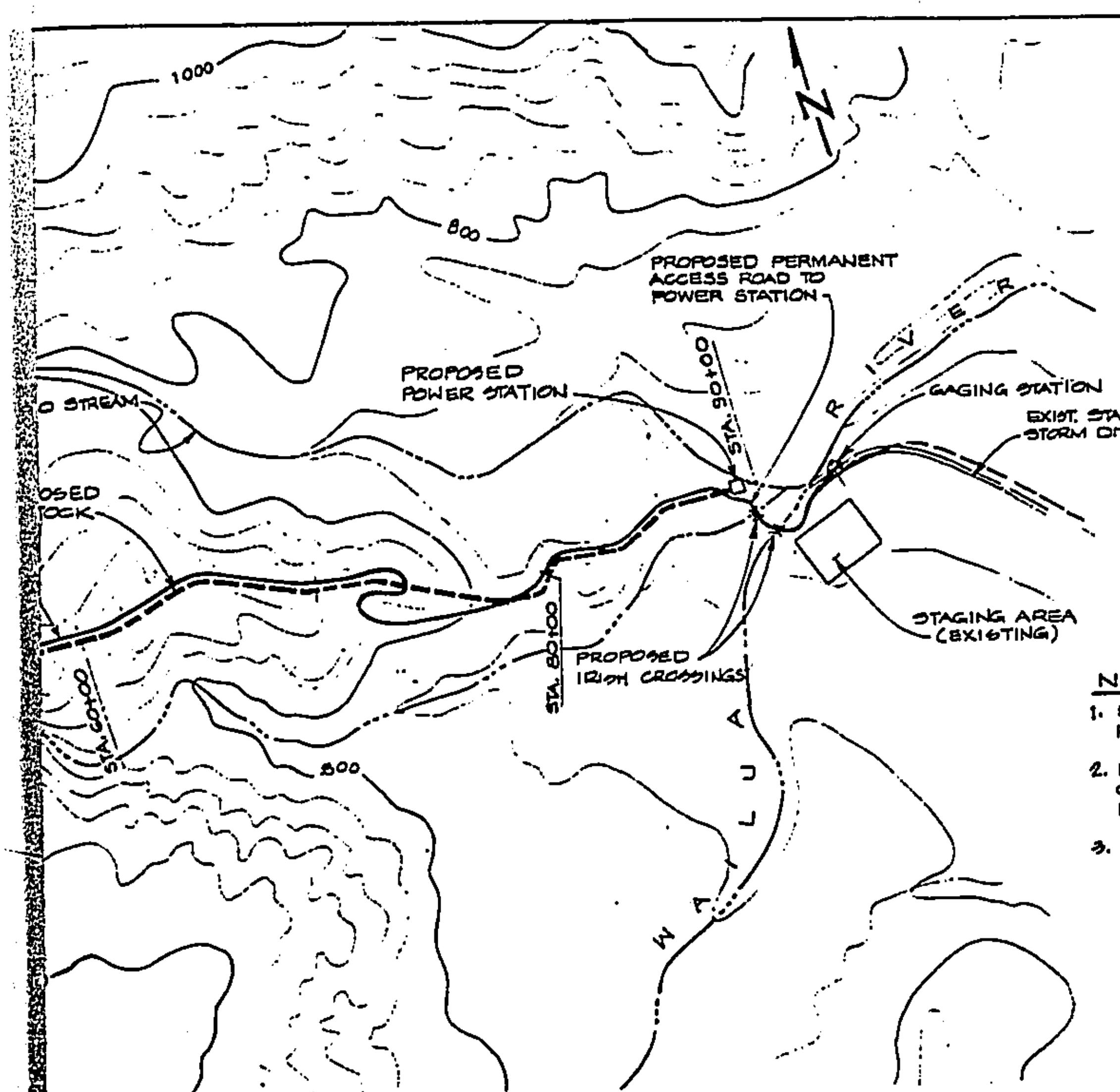
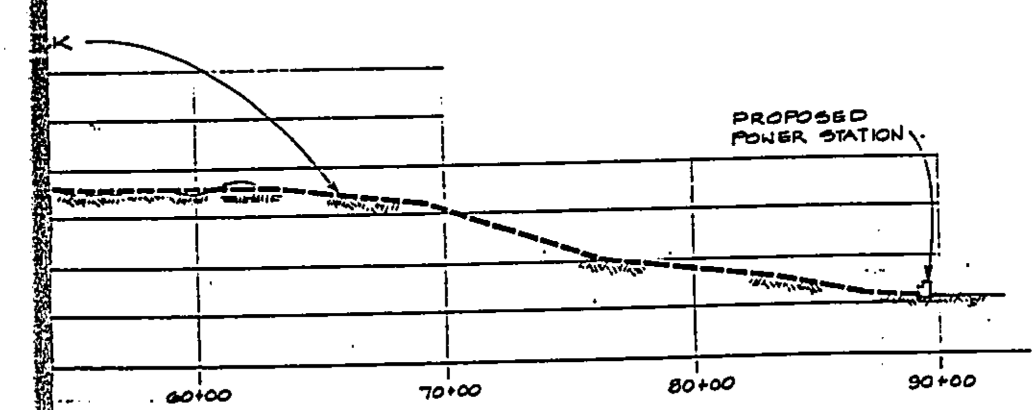


FIGURE 1.6-4. The penstock and access road plan and profile for Alternative 4 (preferred).



NOTES:

1. PERMANENT ACCESS ROAD WILL BE PROVIDED ONLY TO THE POWER STATION.
2. WHERE PENSTOCK AND ACCESS ROAD CROSS GULLIES TOGETHER, CROSSINGS WILL BE PERMANENT.
3. WHERE ONLY THE TEMPORARY ACCESS ROAD CROSSES STREAMS OR GULLIES, TEMPORARY CULVERT CROSSINGS WILL BE REMOVED AND THE SITE WILL BE RESTORED UPON COMPLETION OF CONSTRUCTION.



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UPPER WAILUA HYDOELECTRIC PROJECT

PENSTOCK & ACCESS ROAD PLAN & PROFILE

ALPINE SAN JOSE CALIFORNIA

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ternative 4 (preferred).

site is located within the Lihue-Koloa Forest Reserve Zone. A conditional use permit is required for the development of hydroelectric facilities within this zone. Recreation is the primary use of the Lihue-Koloa Forest Reserve. No Federal lands are needed for the project.

1.9 CONSTRUCTION SCHEDULING

The entire project, from initial planning to plant operation, is scheduled to proceed as follows:

1. Preliminary Planning -- This has been completed and is documented in this report.
2. Feasibility Study -- This phase includes preliminary engineering design, cost analysis, field studies, environmental analysis and applications for permits and approvals required to build the project. The products of this phase are a Feasibility Report, permit applications and an Environmental Impact Statement. This phase will conclude when the Final Environmental Impact Statement has been completed and the major required permits and approvals are obtained.
3. Design -- This phase includes preparing contract documents and specifications and ends when building and grading permits have been obtained and contracts are placed.
4. Financing -- This phase entails the completion of long-term financing agreements and the release of funds needed for the construction of the Project.
5. Construction -- This phase involves the actual building of the Project. Plant operation marks the end of the construction phase.

The approximate schedule, by phase, for this project is depicted in Figure 1.9-1.

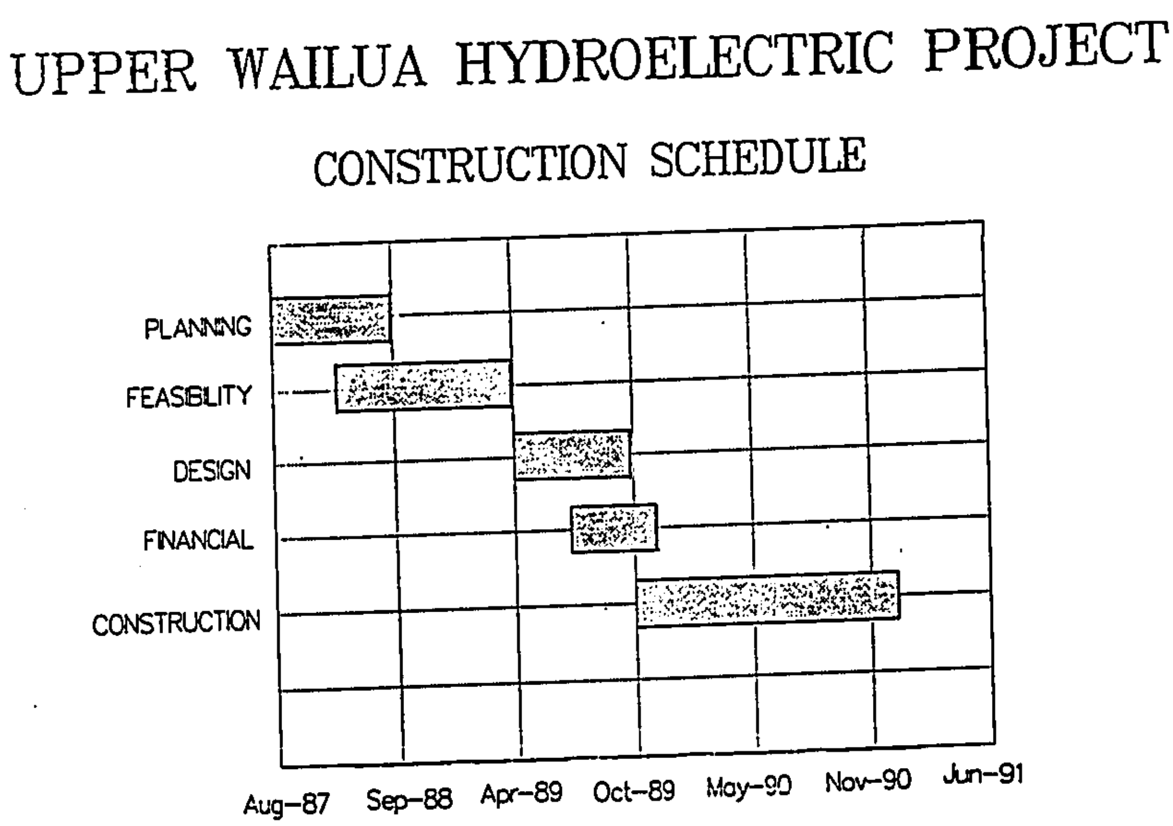


FIGURE 1.9-1. The construction schedule for the Upper Wailua Project.

2.0 DESCRIPTION OF ENVIRONMENTAL SETTING

2.1 PHYSICAL CHARACTERISTICS

2.1.1 Physical Setting

The island of Kauai is the summit of one of the primary volcanic peaks of the partially submerged Hawaiian range. This range extends for a distance of 1,500 miles across the floor of the Pacific Ocean. The topography of Kauai is complex, and is the result of past and present volcanic activity, severe erosion, and geologic faulting.

The Wailua River basin is on the 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 5,243 foot summit of Mt. Kawaikini in the central part of the island. The Wailua River watershed is located in what is known as the Lihue depression, a broad caldera formed by the collapse of the volcano's summit. Subsequent periods of volcanism covered the floor of the Lihue depression with moderately sloping lava aprons. Streams originating in the higher elevations of the depression, where annual rainfall reaches 450 inches, have since cut deep and relatively short gorges on their way to the ocean. The topography of the watershed is generally hilly and rugged in the upper section with a rolling plain in the central portion terminating in a small flat area at the coast.

Rainfall in the watershed flows into three principal tributaries to the Wailua River: North Fork Wailua River, South Fork Wailua River, and Opaekaa Stream. The North Fork has a drainage area of 18.5 square miles. The South Fork has a drainage area of 25 square miles, and Opaekaa Stream drains an area of 6.4 square miles. Stream flow on the Wailua River, recorded at Wailua Falls, varies from 2 cubic feet per second (cfs) to 89,000 cfs. The median flow is 36 cfs.

The project will bound the steep rugged terrain of the Maheo Stream channel and follow along the length of this stream down to the North Fork Wailua River. (See Figure 1.1-1 for a detailed illustration of the project area topography).

2.1.2 Geology and Seismic Potential

The island of Kauai was formed by the activity of one large shield volcano. The proposed project is located on the eastern flank of that volcano in what is known as the Lihue depression. The Lihue depression was formed when the summit of the volcano collapsed and formed the broad Lihue depression on its eastern side. The rim of the depression 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 5 to 6 million years old associated with the Waimea Canyon volcanic series.

During a period of time in which little volcanic activity occurred after the completion of the great Kauai shield, a long period of erosion formed a thick soil layer over much of the mountain. A new period of volcanism subsequently produced material that rests on this erosional unconformity. This period of volcanism is known as the Koloa Volcanic Series. Just before and during eruptions of the Koloa Volcanics, landslides and mud flows brought down large amounts of soil from the central island uplands. The Lihue basin floor consists of younger lava basalt, mud flows, and thick alluvium from the decay of basalt and accumulation of saprolitic and lateritic rock-soil mixtures. Rocks within the Lihue depression are estimated to be 1 to 1 1/2 million years old.

The Waimea Canyon Volcanic Series and the Koloa Volcanic Series are further classified into formations. The Upper Wailua project is in the vicinity of some of the formations from each unit (Figure 2.1-1).

With the close proximity of the project to the rim, the older Napali formation of the Waimea Canyon Volcanic Series is exposed at the higher elevations above the project drainage with the Pliocene age rocks of the Koloa Volcanic Series flanking the project and buried below the unconsolidated Quaternary deposits within the drainages. A thin ridge of sedimentary breccias and conglomerates is exposed in contact with the Waimea Canyon Volcanic series rocks. These rocks are part of the Palikea Formation (Qkp) which belongs to the Koloa Volcanic Series.

The Napali Formation (Twn) of the Waimea Canyon Volcanic Series consists of rocks accumulated on the flanks of the big shield volcano. The mineralogy of this unit is mainly olivine and picrite basalts which were put down in thin flows. There are also occasional sections of breccia in the Napali Formation. The lavas of the Koloa Volcanic Series (Qkl) are typically nepheline, olivine, picrite and melilite basalts which erupted from numerous large vents along the eastern portion of the island. It is also possible for thin flows of ash and occasional narrow vertical dikes to be exposed in this lava unit.

Within the drainage basin, unconsolidated materials (Qao) are typically non-calcareous Pleistocene age sediments which, in some areas, are very similar in age to the Koloa Volcanic Series. The majority of these units are graded to about the present day base level and are either "poised" or just beginning to cut into the parent rock in the drainages at the upper elevations. The alluvial material is consequently quite variable in its textural classification, ranging from very coarse cobbles and gravels to sands and silty sands. The older alluvial deposits have been re-worked to a significant degree and are distributed along

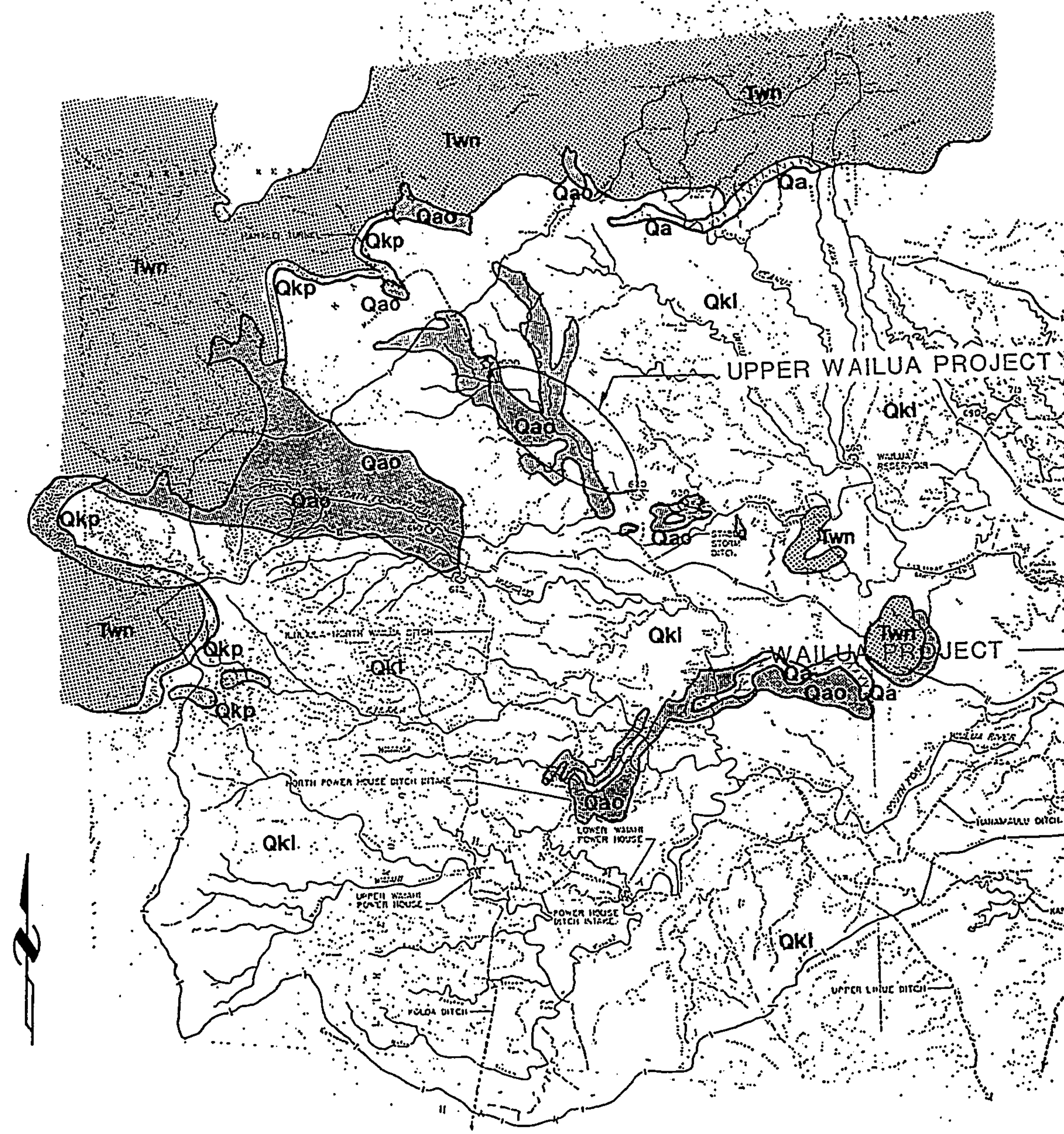
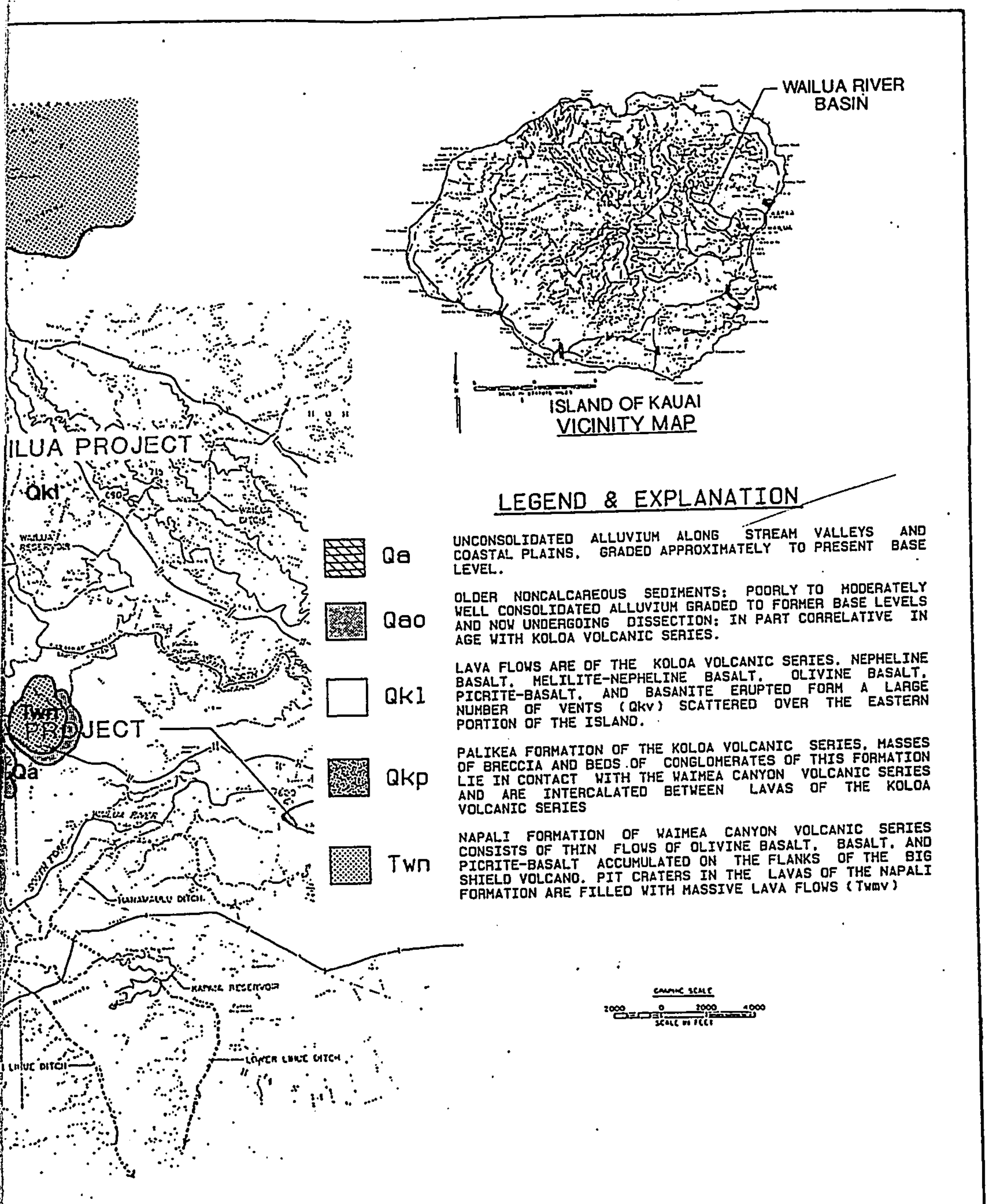


Figure 2.1-1. The geologic map for the Upper Wailu



for the Upper Wailua drainage basin.

the channels. The thickness of the soils in the alluvial segment can range from 60 inches to no cover at all over the basalt. The same is true of the soils on the terraces near the drainages. There are likely to be more well developed soils in the areas where the slope is less pronounced and the runoff potential is lower.

In understanding the alluvial and colluvial deposition of the island, it is important to understand that there existed a long period of time between eruption of the two major volcanic series rocks. This period allowed for the development of soil profiles, many of which became buried under or intercalated into the subsequent flows of the Koloa Series lavas. Extensive debris flow and landslide materials were deposited down slope and became part of the alluvial profiles which were in part covered up by the Koloa lavas.

<u>Seismicity</u>

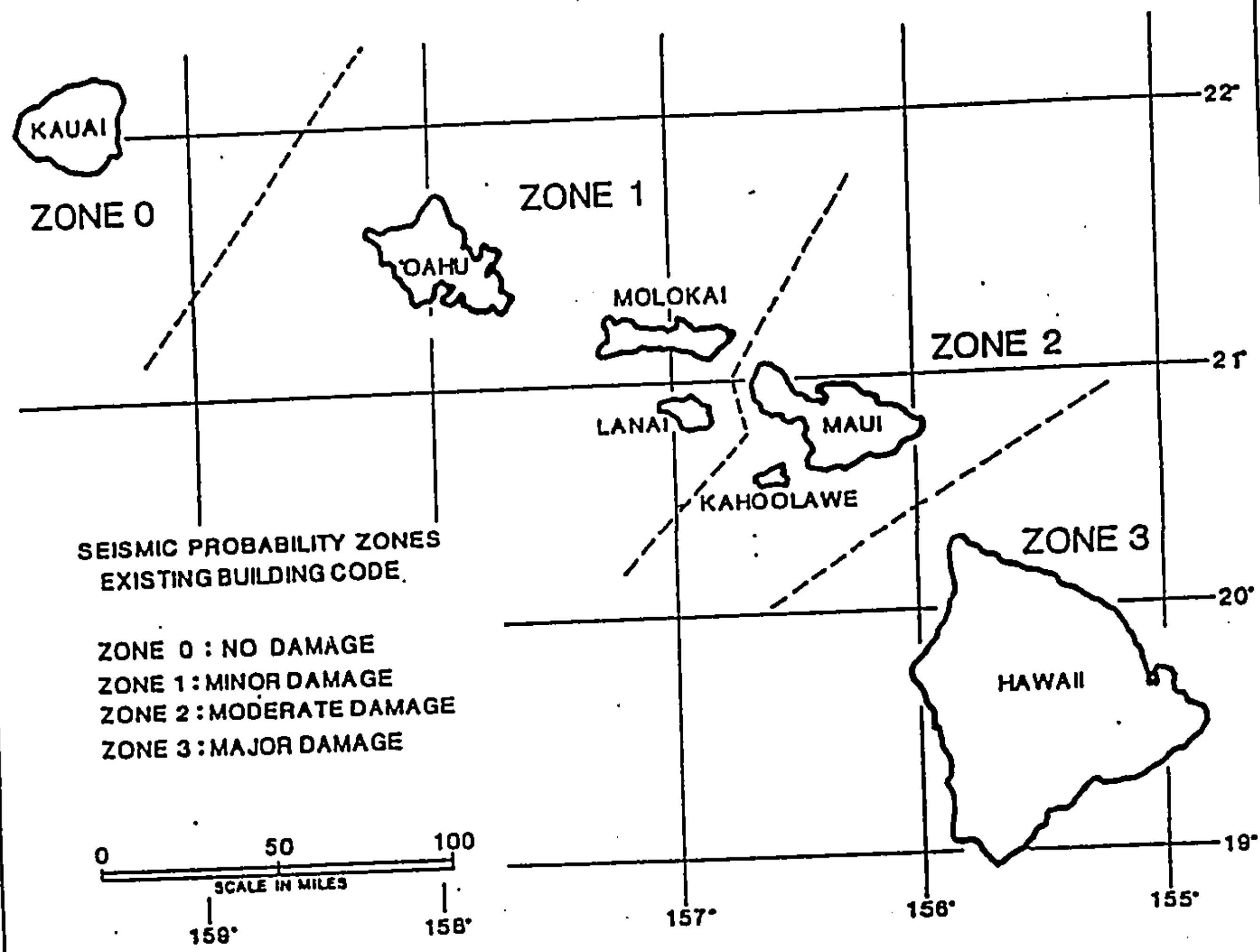
As would be expected, most seismic activity on the Hawaiian Island archipelago is typically associated with active volcanism. On Kauai, however, there are some effects known to be related to deep, regional tectonic activity. Geophysical mapping programs have confirmed the existence of a major series of faults and rifts in the vicinity of the island chain. Moreover, these zones have been identified as being branches of a major tectonic feature called the Molokai Fracture Zone. On Kauai, seismic activity is thought to be related almost totally to the fracture zone and not to reaction from localized events associated with the volcanic and seismic activity on or very near the big island of Hawaii.

According to the Uniform Building Code (UBC), the island of Kauai is in Seismic Risk Zone 0, where no damage is expected from an earthquake. This can be related to a Modified Mercalli Intensity of approximately IV. Figure 2.1-2 is a copy of the Seismic Risk Map of the Hawaiian Islands from the UBC.

2.1.3 <u>Soils</u>

Although the geology of Kauai is quite complex, the geology at the site of the Upper Wailua project is an expression of two basic types of material, basaltic bedrock, and the weathered by-product in the form of alluvial soils and colluvial material originating from the steep basalt ridges. Soil occurring on the slopes and in the numerous valleys is typically different from those exposed along the major drainages.

As proposed, the project would be constructed over an area encompassing seven different soil types (Figure 2.1-3) as classified by the U.S. Soil Conservation Service (USDA-SCS, 1972). Beginning from the diversion weir at the Hanalei Tunnel outlet, these soils include rough broken land associations (rRR),



Source: A Study of Past Earthquakes, Isoseismic Zones of Intensity and Recommended Zones for Structural Design for Hawaii, University of Hawaii, June 15, 1972.

UPPER WAILUA
HYDROELECTRIC PROJECT

SEISMIC ZONE MAP OF HAWAII

Figure 2.1-2. A seismic zone map for the Hawaiian Islands.

PROJECT AREA SOILS

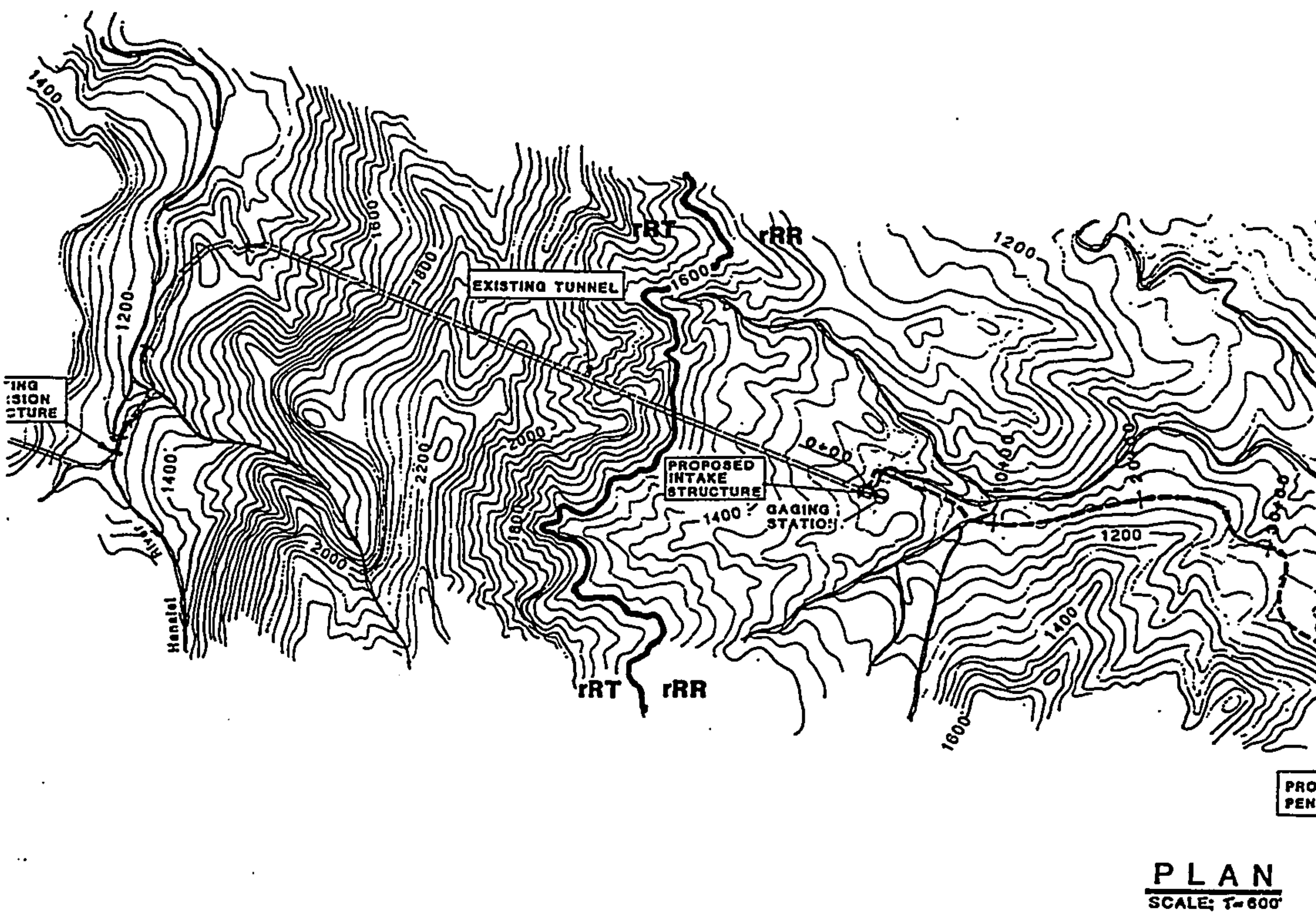
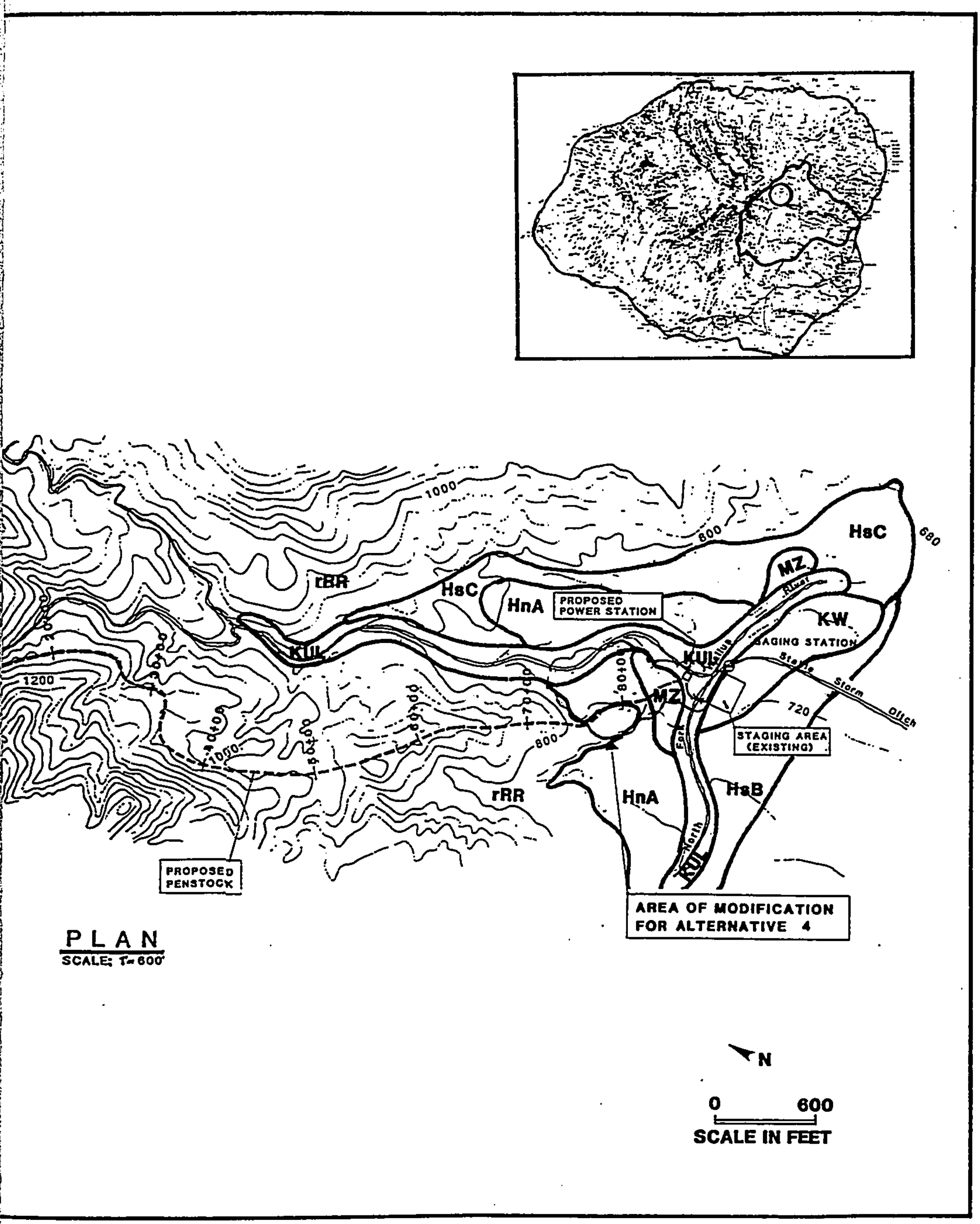


Figure 2.1-3. Soils found in project area (Alternative 4).



PROPOSED POWER STATION
HsC
HnA
rRR
KUL
MZ
KW
STAGING STATION
Stable Storm Ditch
River
North Fork
STAGING AREA (EXISTING)
HsB
1000
800
680
720
1200
PROPOSED PENSTOCK
AREA OF MODIFICATION FOR ALTERNATIVE 4
PLAN
SCALE: 1"=600'
N
0
600
SCALE IN FEET

Kolokolo extremely stony clay loam (KuL), Hanamaulu silty clay 8 to 15 % slopes (HsC), Hanalei silty clay (HnA), marsh land associations (MZ), Kolokolo clay loam (KW), and Hanamaulu silty clay 3 to 8% slopes (HsB).

The diversion weir and much of the penstock are located within the rough broken land (rRR) SCS Soil Classification. Rough broken lands consist of very steep areas with numerous drainage channels. In most places they are not stony. Elevations range from nearly sea level to approximately 5,200 feet statewide and slopes average 40 to 70 percent. Local relief is generally between 25 and 500 feet. Average annual rainfall ranges from 25 to over 200 inches in the highest elevations. Both surface runoff and soil erosion are rapid in these areas.

Soils within the rough broken land classification are generally 20 to more than 60 inches deep over soft, weathered rock. Weathered rock fragments are often mixed with the soil material. Areas of rock outcrops, stones, and eroded areas are common. The dominant uses of this land are for watershed and wildlife habitat. In places it is also used for woodland and pasture.

These soils appear in very steep to precipitous areas of mountains and gulches. The Soil Conservation Service classifies soils in rough broken lands as well-drained to excessively drained soils. SCS does not list any properties or engineering interpretations of these soils. Geotechnical studies of all project soils will be performed in conjunction with the final design to determine the potential for landslides and other necessary engineering properties not determined by the SCS soil survey.

Soils of the Kolokolo extremely stony clay loam series (KuL) are found along the stream bottom of both Maheo Stream and the North Fork Wailua River. It is expected the powerhouse, parking area, and tailrace will be located on these soils.

Soils of the Kolokolo extremely stony clay loam association (KuL) are found on nearly level lands and are developed in alluvial material. These soils are found at elevations from near sea level to 500 feet. Annual rainfall averages 25 to 150 inches. They are characterized as having a dark brown, friable silty clay loam, loam, or extremely stony clay loam at the surface. This surface layer is underlain by a layer of brown to dark brown, friable loam to silty clay loam. The bottom layer of soil is stratified alluvium. Kolokolo soils are used primarily for irrigated crops, pasture, and wildlife habitat.

Tables 2.1-1 and 2.1-2 illustrate specific properties of the soils found in the study area, as well as many engineering interpretations of these soils. Kolokolo extremely stony clay loam soils generally have a depth to bedrock greater than five feet, a depth to the seasonal high water table greater than five feet, a soil profile of 0-60 inches deep, a permeability rating of .63 - 2.0 inches per hour, and a moderate

TABLE 2.1-1. General physical and chemical properties of soils occurring in the project area.

SOIL	DEPTH TO BEDROCK	DEPTH TO HIGH WATER TABLE	DEPTH FROM SURFACE	CLASSIFICATION	PERMEABILITY	AVAILABLE WATER CAPACITY	REACTION	SHRINK-SWELL POTENTIAL	CORROSIVITY UNCOATED	CORROSIVITY CONCRETE
Hanalei (HnA)	> 5	0-5	0-13	Silty clay; peaty in places	0.63-2.0	0.16-0.18	4.5-6.5	Moderate	High	Moderate
			13-36	Silty clay loam	0.63-2.0	0.16-0.18	6.1-7.3	Moderate	High	Low
Hanamaulu (HsB,HsC)	> 5	> 5	0-72	Silty clay and silty clay loam	2.0 -6.3	0.13-0.15	4.0-5.5	Low	High	High
Kolokolo (Kw, KUL)	> 5	> 5	0-60	Silty clay loam and loam	0.63-2.0	0.12-0.14	6.6-7.3	Moderate	High	Low

TABLE 2.1-2. Engineering properties and interpretations of soils occurring in the project area.

SOIL SERIES AND MAP SYMBOLS	SUITABILITY AS A SOURCE OF-		SOIL FEATURES AFFECTING-									DEGREES AND KIND OF LIMITATIONS FOR SEPTIC TANK FILTER FIELDS
	TOPSOIL	ROAD FILL	HIGHWAY LOCATION	FARM PONDS		AGRICULTURAL DRAINAGE	IRRIGATION	TERRACES AND DIVERSIONS	GRASSED WATERWAYS	FOUNDATIONS FOR LOW BUILDINGS		
				RESERVOIR AREAS	EMBANKMENTS							
HANALEI (HnA)	Poor: always wet.	Poor: high water table; always wet.	High water table; subject to flooding.	High water table; subject to flooding.	Wetness; fair stability; subject to flooding.	High water table; moderate permeability; subject to flooding.	----------------	Wetness; high water table; subject to flooding.	High water table; wetness.	High water table; subject to flooding.		Severe: high water table; subject to flooding.
HANAMAULU (HsB, HsC)	Fair: low fertility.	Good---------------	Slopes as much as 40 percent.	Slopes as much as 40 percent; moderately rapid permeability.	Slopes as much as 40 percent.	----------------	All features favorable, except slopes as much as 40 percent.	All features favorable, except slopes as much as 40 percent.	Slopes as much as 40 percent.	Slopes as much as 40 percent.		Slight on slopes of 3 to 8%; moderate on slopes of 8 to 15%; severe on slopes of > 15%.
KOLOKOLO (Ko)	Fair: low fertility.	Good---------------	Subject to stream overflow.	Moderate permeability; subject to overflow.	----------------	----------------	----------------	Subject to stream overflow.	Subject to stream overflow and siltation.	Subject to stream overflow.		Severe: subject to stream overflow.
(KRL)	Fair: stony; low fertility.	Poor: stony--------	Stoniness; subject to stream overflow.	Moderate permeability; subject to stream overflow; stoniness.	Stoniness.	----------------	----------------	Subject to stream overflow; stoniness.	Subject to stream overflow; stoniness.	Subject to stream overflow; stoniness.		Severe: subject to stream overflow; stoniness.

shrink-swell potential. These soils are subject to stream overflow so the powerhouse will be flood-proofed.

Soils of the Hanalei silty clay series 0 - 2% slopes (HnA) are located within the project site on both sides of Maheo Stream approximately between elevation 800 and the North Fork Wailua River. A short portion of the temporary access road will be located on Hanalei silty clay.

These soils are deep, nearly level, poorly drained to well-drained soils. They have moderately fine textured to medium-textured subsoil or underlying material. They are located on bottom lands and have developed in alluvium. These soils are found at elevations ranging from sea level to 500 feet. The annual rainfall is 25 to 150 inches. The HnA soils are used primarily for agriculture.

Properties of the Hanalei soils indicate that there is a depth to bedrock greater than five feet, the seasonal high water table is 0 to 5 feet deep, the soil profile is 0-36 inches deep, permeability rating is .63 - 2.0 inches per hour, and shrink-swell potential is moderate. Soils of the Hanalei silty clay 0 to 2% slope association are limited in their development potential because of their constant wetness, high water table, and high flooding potential.

The lower portion of the temporary access road is located in an area classified by SCS as a marsh (MZ). The SCS describes these sites as wet, periodically flooded areas where water stands on the surface. There is a high probability that this site is wet year-round and subject to flooding conditions.

No soil properties or engineering interpretations for this classification are given by the SCS. However, the development potential of these areas is anticipated to be low because of wet soil conditions, a high water table, and high flooding potential. Precautions described in Section 8.2 will be taken to ameliorate these conditions during construction.

The principal staging area will be located on an existing cleared site on soils of the Kolokolo clay loam series (Kw) along the North Fork Wailua River near the Stable Storm Ditch and USGS gaging station No. 620. This soil is associated with stream bottoms and flood plains. The slope ranges from 0 - 2 percent.

Estimated properties of this soil indicate that the depth to bedrock is greater than five feet, the depth to the seasonal high water table is greater than five feet, the soil profile is 0 - 60 inches in depth, it has a permeability rating of .63 to 2.0 inches of water per hour, and a moderate shrink-swell potential. Engineering interpretations of Kolokolo clay loam series soils indicate a low development potential for these soils due to their association with flood plains. These soils are subject to stream overflow during high water events. Runoff is very slow, and the erosion hazard is slight. This soil type is used primarily for pasture.

Several additional soil types occur within the project area, but should not be directly affected by project activities. Soils of the Hanamaulu silty clay series (HsC) occur elevated above the east bank of Maheo Stream and the North Fork Wailua River. These soils occur on the opposite side of the stream from the proposed penstock. They occur on slopes ranging from 8 to 15 percent. Runoff is slow to medium and the erosion hazard is slight.

Estimated soil properties of the Hanamaulu silty clay series indicate that the depth to bedrock is greater than five feet, the seasonal high water table is deeper than five feet, the soil profile is from 0-72 inches deep, it has a permeability rating of 2.0 - 6.3 inches per hour, and it has a low shrink-swell potential. Engineering interpretations of these soils indicate no serious development constraints except that these soils can be found on slopes as great as 40 percent.

Soils of the Hanamaulu silty clay, 3 to 8% slope series (HsB), are present within the project area along the south bank of the North Fork Wailua River near the Stable Storm Ditch. These soils are associated with stream terraces.

The depth to bedrock associated with these soils is greater than five feet, the depth to the seasonal high water table is greater than five feet, the soil profile is 0 - 72 inches deep, they have a permeability rating of 2.0 to 6.3 inches per hour, and a low shrink-swell potential. Engineering interpretations of these soils indicate that the primary limitation to development is that slopes as much as 40 percent occur in some locations.

2.1.4 <u>Climate</u>

The island of Kauai is 33 miles long and 25 miles wide and has an area of 620 square miles. The eastern 1/3 of Kauai consists of broadly eroded valley lands; the western 2/3 is mostly mountainous. Mt. Kawaikini the highest elevation in the Wailua River Basin (5,243 feet msl) lies near the center of Kauai and is 20 miles northwest of Lihue.

The outstanding features of Kauai's climate are the extremely equable temperature conditions from day to day and from season to season, the persistent trade-wind flow of air from the northeast, and the marked variation in rainfall from the wet to the dry season.

The equable temperatures are associated with the location of Kauai in mid-ocean and to the small seasonal variation in the amount of energy received from the sun. The range in normal temperature from the coolest month, February, to the warmest month, August, averages less than 8°F. The daily range in temperature is also small, averaging less than 15°F at Lihue.

The trade winds blow across the island during most of each year and the dominance of these winds has a marked influence on the climate of the area. Completely cloudless skies are quite rare. On the average, 60 to 70% of the sky is covered by clouds during the daylight hour.

Kauai's rugged topography and high mountains, combined with moist trade winds sweeping across the island, result in large amounts of precipitation falling on the island. Orographic uplifting of storm clouds increases precipitation over the mountainous areas of Kauai. Generally, the highest elevations on the island receive the greatest amounts of precipitation. The frequency and intensity of the showers increase toward the mountains to the west. Average annual rainfall in the Wailua Basin varies between 50 inches near the coastline to over 480 inches at the summit of Mt. Waialeale. Normal annual precipitation at Mt. Waialeale is 486 inches, amongst the highest recorded averages in the world. The highest recorded annual rainfall on Mt. Waialeale is 624 inches. Average annual precipitation at the Upper Wailua project site ranges from 125 inches at the proposed powerhouse location to nearly 175 inches at the diversion weir at the Hanalei Tunnel (Figure 2.1-4).

Hurricanes and other severe windstorms are quite rare. However, Hurricane Ewa, which occurred in 1977 did extensive damage to the south shore. Strong winds do occur at times in connection with storm systems moving through the area.

Relative humidity, moderate to high in all seasons, is slightly higher in the wet season than in the dry. However, even during periods when the temperature and humidity are both high, the weather is seldom oppressive. This is due to the trade winds which provide a system of natural ventilation during most of each year.

2.1.4.1 Rainfall

Rainfall amounts have been recorded by Lihue Plantation at the North Wailua Ditch (Station 1051) from 1928 to present. This station is located at an elevation of 1,110 feet above sea level. Due to this station's close proximity to the project area, data from this rainfall station are used to represent a year with average precipitation, a year with above average precipitation, and a year with below average precipitation within the project area. Lihue Plantation records rainfall amounts at the North Wailua Ditch station daily. Figure 2.1-4 (precipitation amounts and rainfall stations in Wailua River Basin) illustrates the location of the North Wailua Ditch rainfall station (Station 1051).

Station 1051 records an average of 178 inches of precipitation annually. The year 1969 was the closest to an average year recorded at this location.

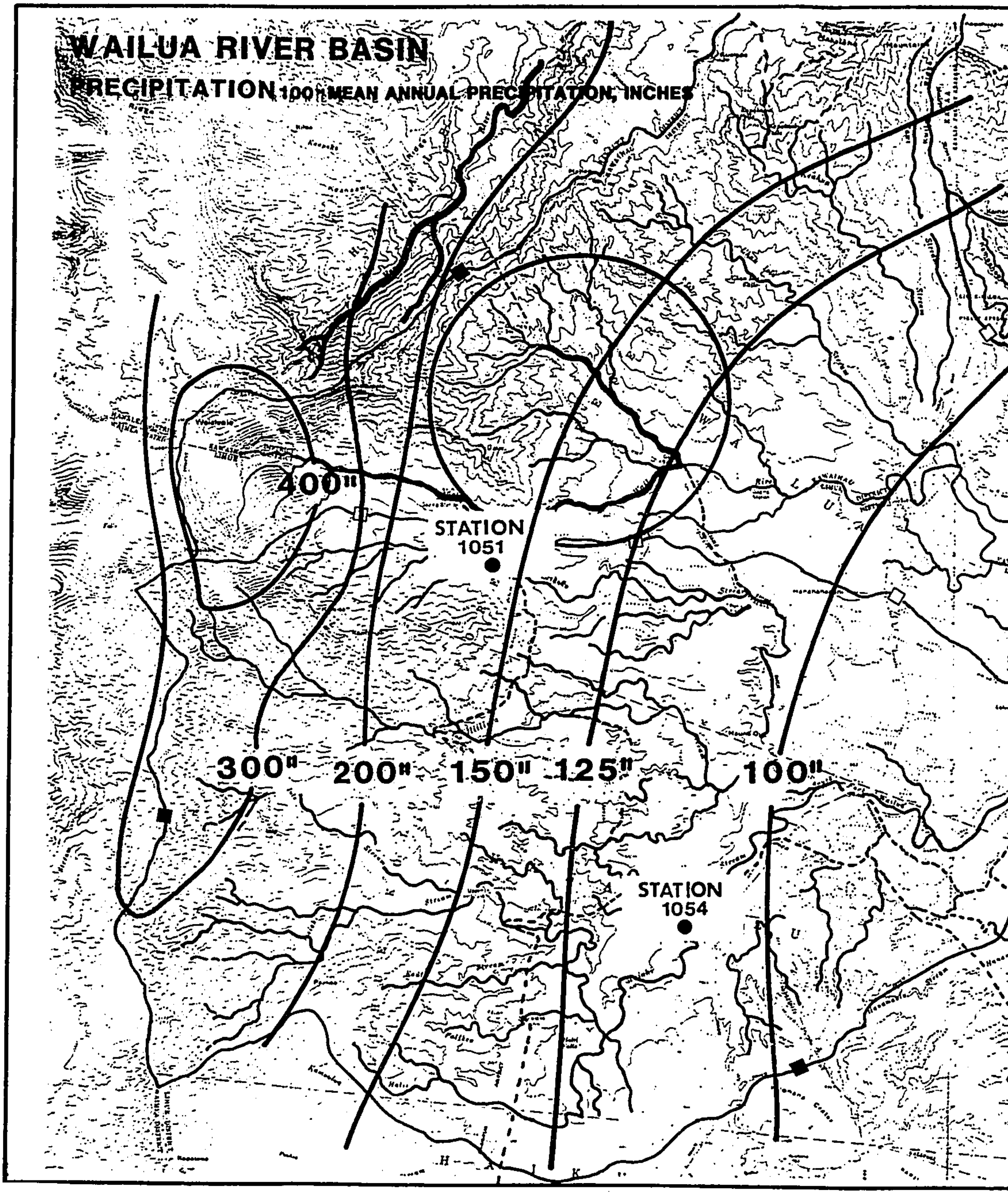
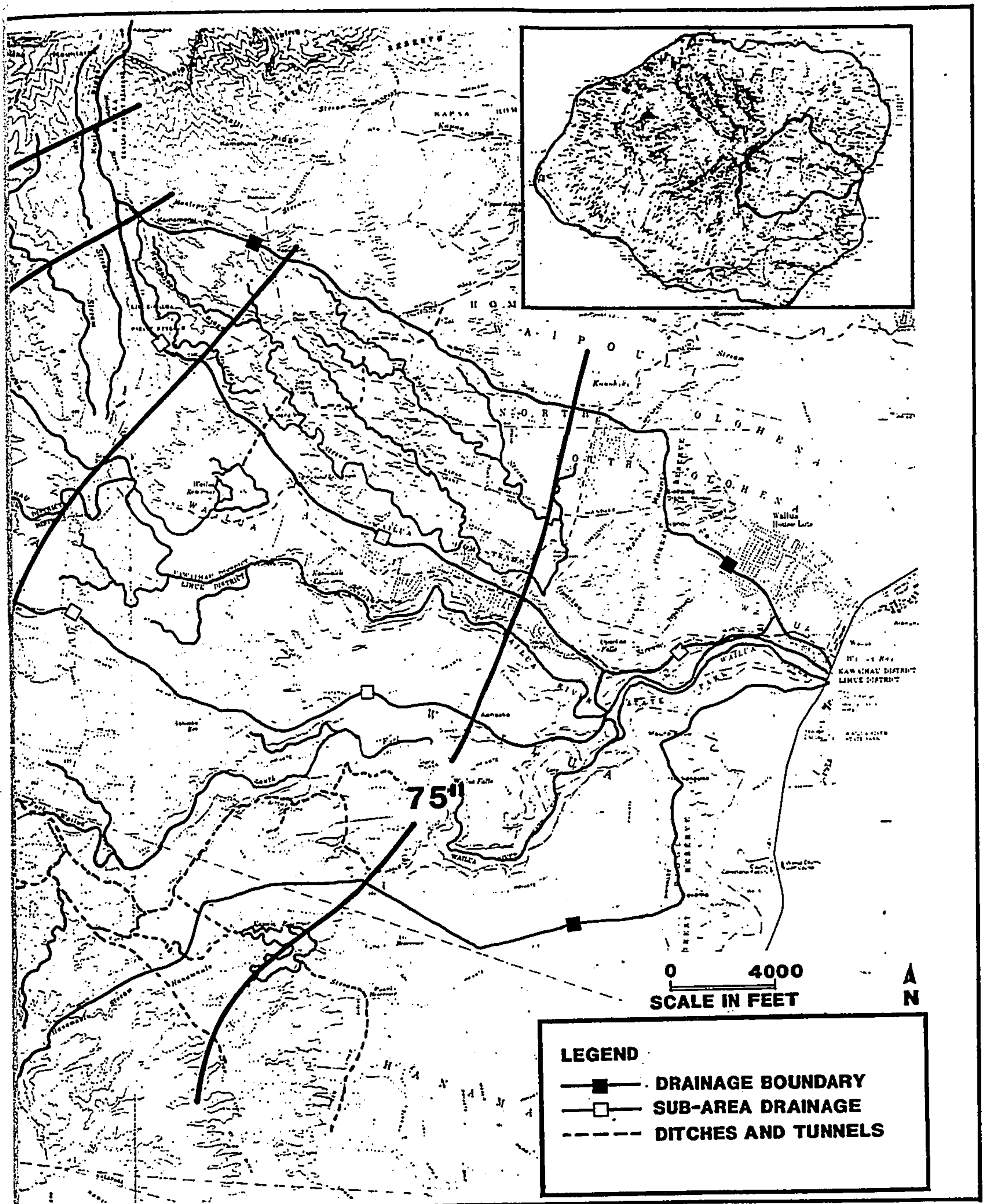


FIGURE 2.1-4. The precipitation amounts and precipitation stations in the Wailua Basin.


75"
0 4000
SCALE IN FEET
N
LEGEND
DRAINAGE BOUNDARY
SUB-AREA DRAINAGE
DITCHES AND TUNNELS

n the

The greatest amount of precipitation recorded at Station 1051 was 255 inches in 1967. The driest year recorded at this station was 1984, where 93 inches of precipitation was recorded (Figure 2.1-5).

Other years when significant amounts of precipitation have been recorded at Station 1051 include 1964 with 241 inches, and 1982 with 223 inches. It should be noted that in many years, precipitation amounts may be more than the recorded totals indicate due to gaps in the precipitation data sets where Station 1051 was either inoperative or the precipitation was not recorded on the missing date.

Unlike many other regions in the U.S., Kauai does not experience a noticeable or definite dry season. Rather, Kauai, and specifically Station 1051 at the North Wailua Ditch experiences a "dryer" season than what is found throughout the remainder of the year. This "dryer" time of the year represents the season when construction activities on the proposed project will be the greatest. Rainfall data from Station 1051 indicate this season to be from June 1st through October. The driest month of the year at Station 1051 is September with an average of 11 inches of precipitation.

The wettest months of the year at Station 1051 are November and January. November averages 18 inches of precipitation annually, while January averages 16 inches annually. Figure 2.1-6 illustrates total annual precipitation recorded at rainfall Station 1051 from 1958 to 1986.

2.1.4.2 Wind

Wind pattern data for the specific study area is unavailable. Information regarding wind speed and direction is available for Lihue approximately 10 miles to the southeast of the proposed project site. Data from the National Oceanic and Atmospheric Administration (NOAA) indicate the prevailing winds at Lihue are from the northeast. The average wind speed is 12 mph. The fastest wind speed recorded at Lihue was 73 mph in August, 1959.

2.1.4.3 Solar Insolation

Estimated solar insolation values for the island of Kauai (measured in calories per square centimeter per day) indicate a general pattern of higher values along the coasts and at lower elevations, and lower values at the highest elevations (Figure 2.1-7).

According to the Kauai Sunshine Map (Hawaii Department of Planning and Economic Development, 1985), the greatest solar insolation values on Kauai are found along the western coast at the Barking Sands Pacific Missile Range, and also along the southern coast in the Port Allen and Poipu areas. These areas receive an estimated 500 calories of solar insolation per square centimeter per day.

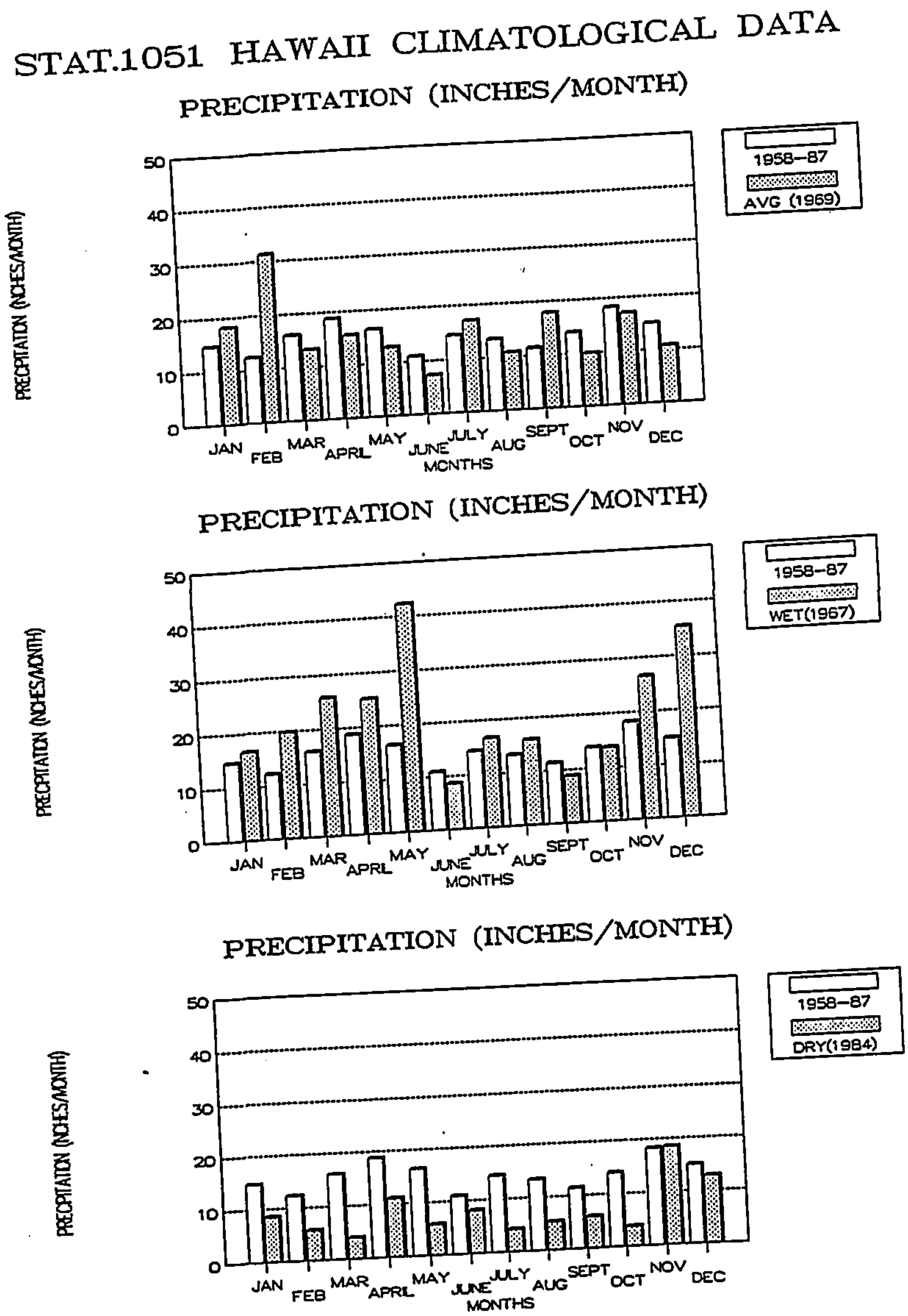


FIGURE 2.1-5. Precipitation by month for an average (upper), wet (center), and dry (lower) year at Station 1051. The open bars are the averages from 1958-1988.

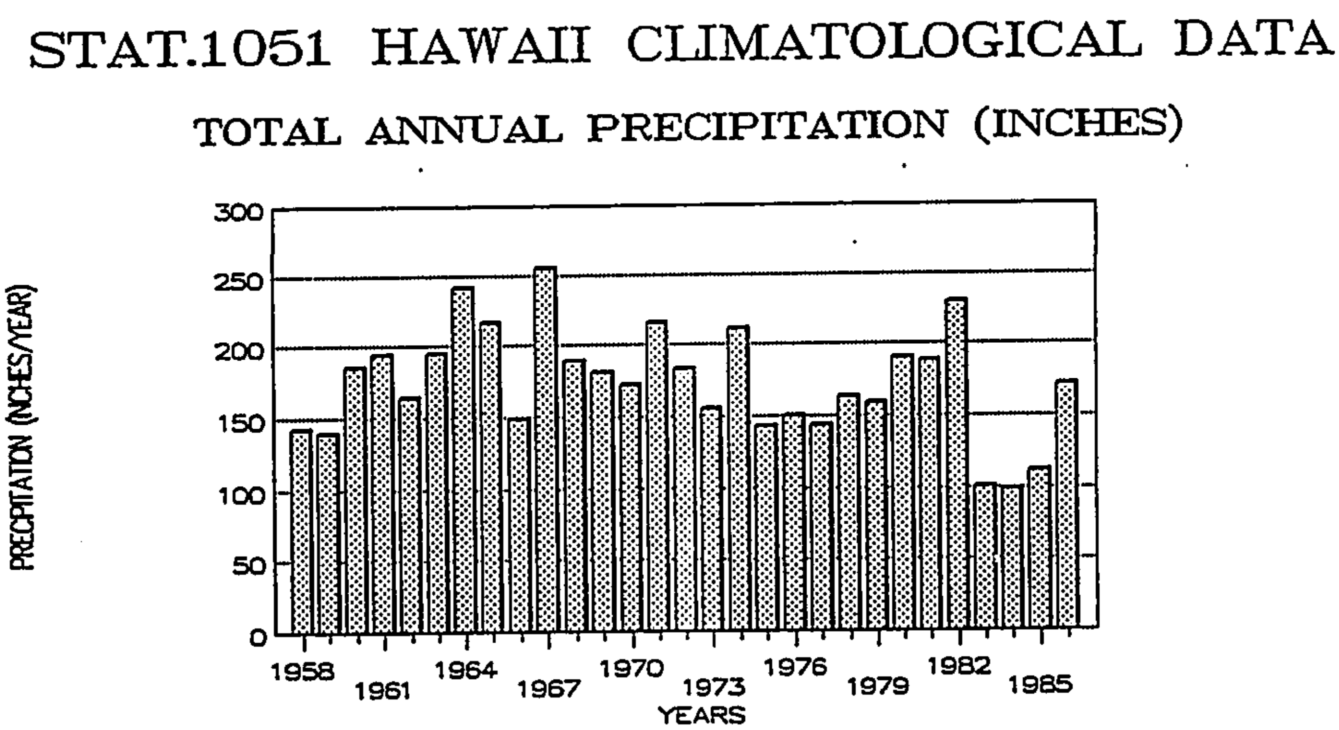


FIGURE 2.1-6. The total annual precipitation for the Station 1051 from 1958 to 1986.

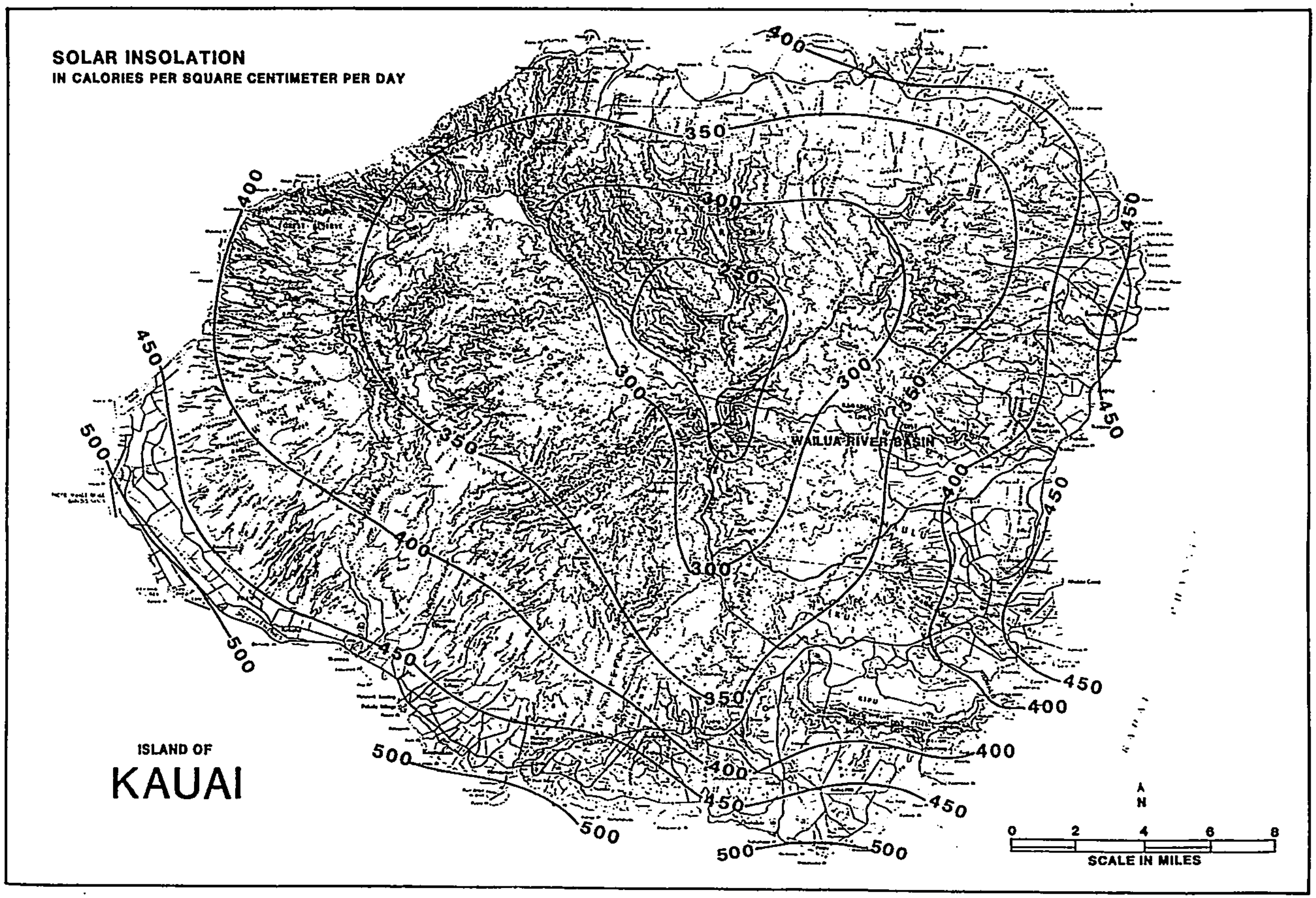


FIGURE 2.1-7. Solar Insolation on the Island of Kauai.

The lowest solar insolation values on Kauai are found near the summit of Waialeale. This area receives an estimated 250 calories per square centimeter per day of solar insolation.

Solar insolation values at the project site are estimated to be between 250-300 calories per square centimeter per day. Solar insolation values in the Lihue area are estimated to be approximately 450 calories per square centimeter per day.

2.1.4.4 Temperature

Temperature data representing the project area was retrieved from the Waiahi lower rainfall station (Station 1054) as illustrated in Figure 2.1-4. Available temperature data was limited, and not available from rainfall Station 1051. Station 1054 is located at 570 feet above sea level and approximately 3.5 miles south of the project area.

Temperatures at Station 1054, as on the entire island of Kauai, are relatively consistent throughout the year. The average annual high temperature at Station 1054 is 76 degrees. The average annual low temperature at Station 1054 is 63 degrees.

The warmest month at this location is usually September, where the average maximum expected high temperature is 87 degrees. The coolest month at this station is usually February, where the average minimum expected low temperature is 48 degrees.

Figure 2.1-8 illustrates the seasonal temperature variations at Station 1054. Figure 2.1-9 illustrates the mean annual temperature at Station 1054 for the available period of record.

2.1.5 Hydrology

The Wailua River represents one of the major surface water drainages on the island of Kauai, Hawaii. The river drains 51.6 square miles and is geographically located on the south east flank of Mt. Waialeale, starting at an elevation of 3500 ft and entering the Pacific Ocean near Kapaa. The principal watercourses and tributaries with the USGS gaging stations can be seen in Figure 2.1-10.

2.1.5.1 Streamflow

The specific stations used in the data analysis for this project (Table 2.1-3) have periods of record dating back to 1912 (Station 680) and 1932 (Station 1000). The most current 25 year records (1960-1985) were used in the analysis because it corresponds to a precipitation data set collected by Lihue Plantation which is located near the project (rainfall Station 1051). As noted in section 2.1.1, the project will divert water entering Maheo Stream at an elevation of 1210 ft via a transbasin diversion tunnel from Kaapoka

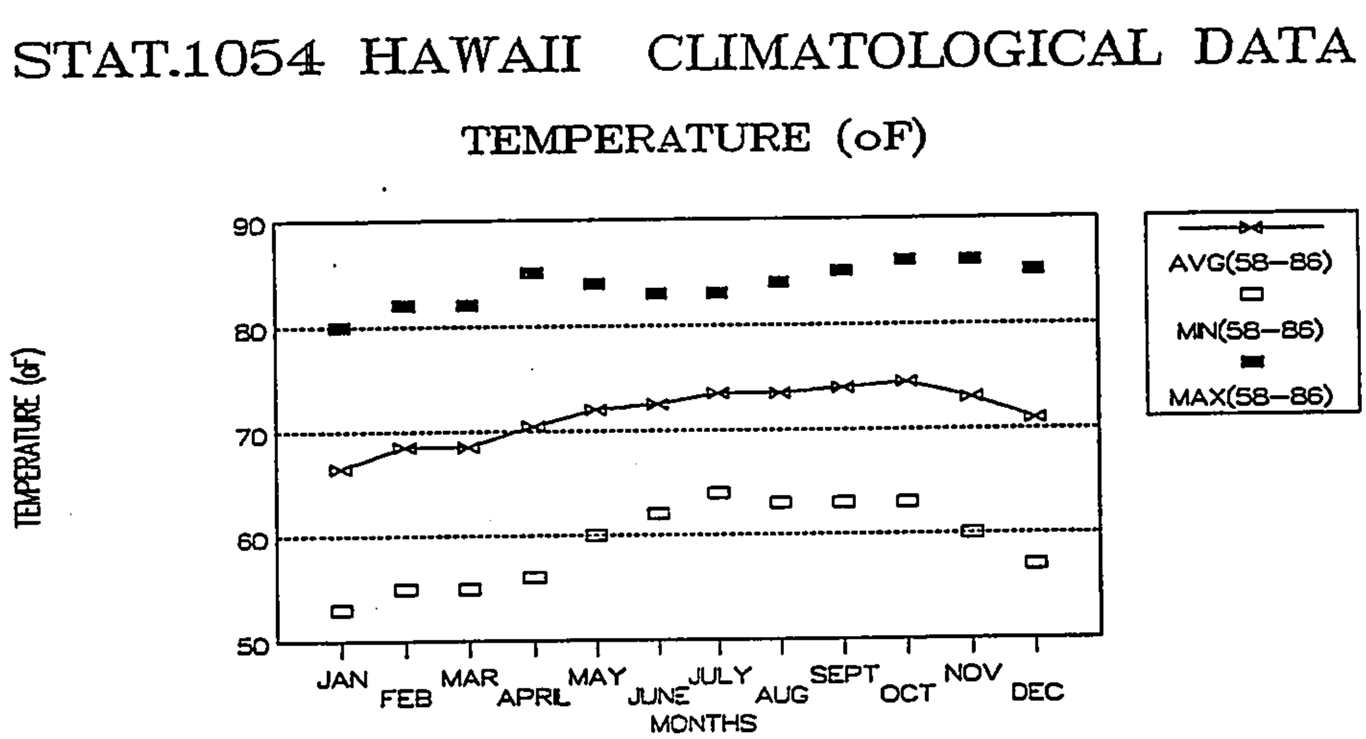


FIGURE 2.1-8. The seasonal temperature variations at Station 1054.

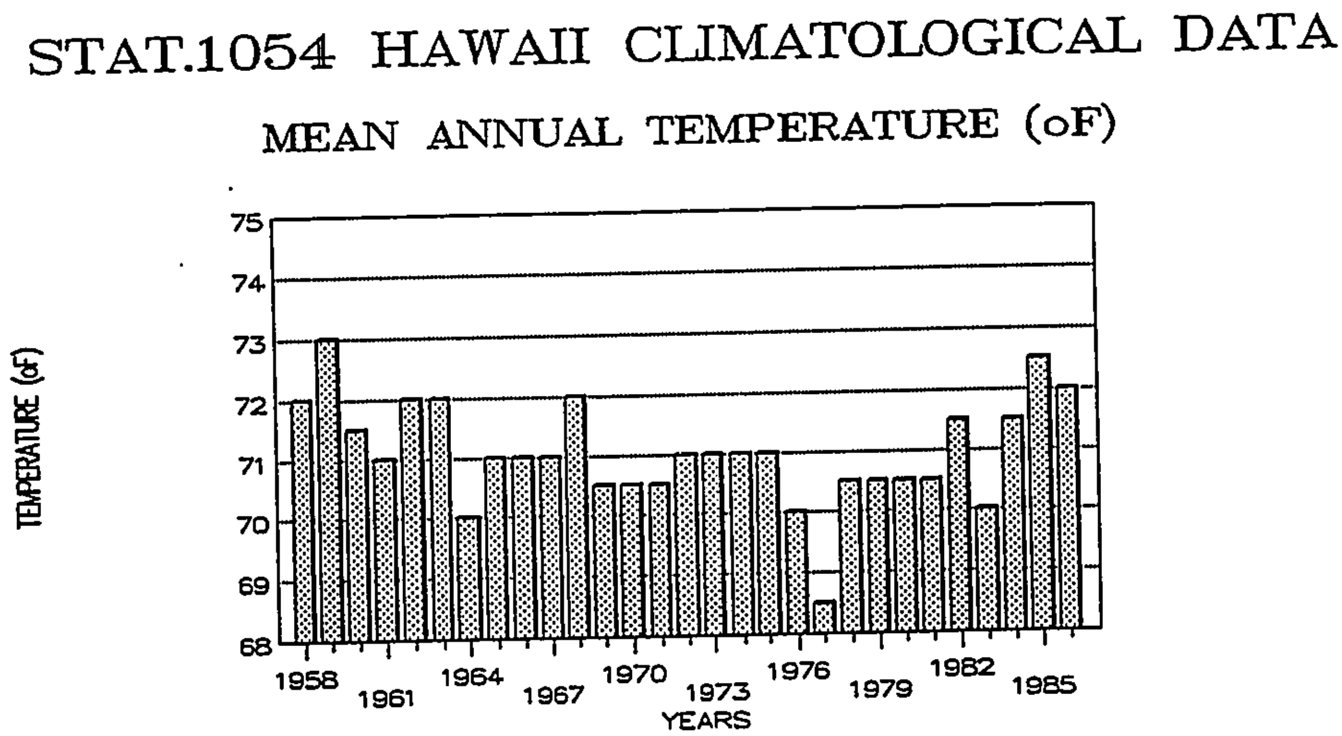


FIGURE 2.1-9. The mean annual temperature at Station 1054.

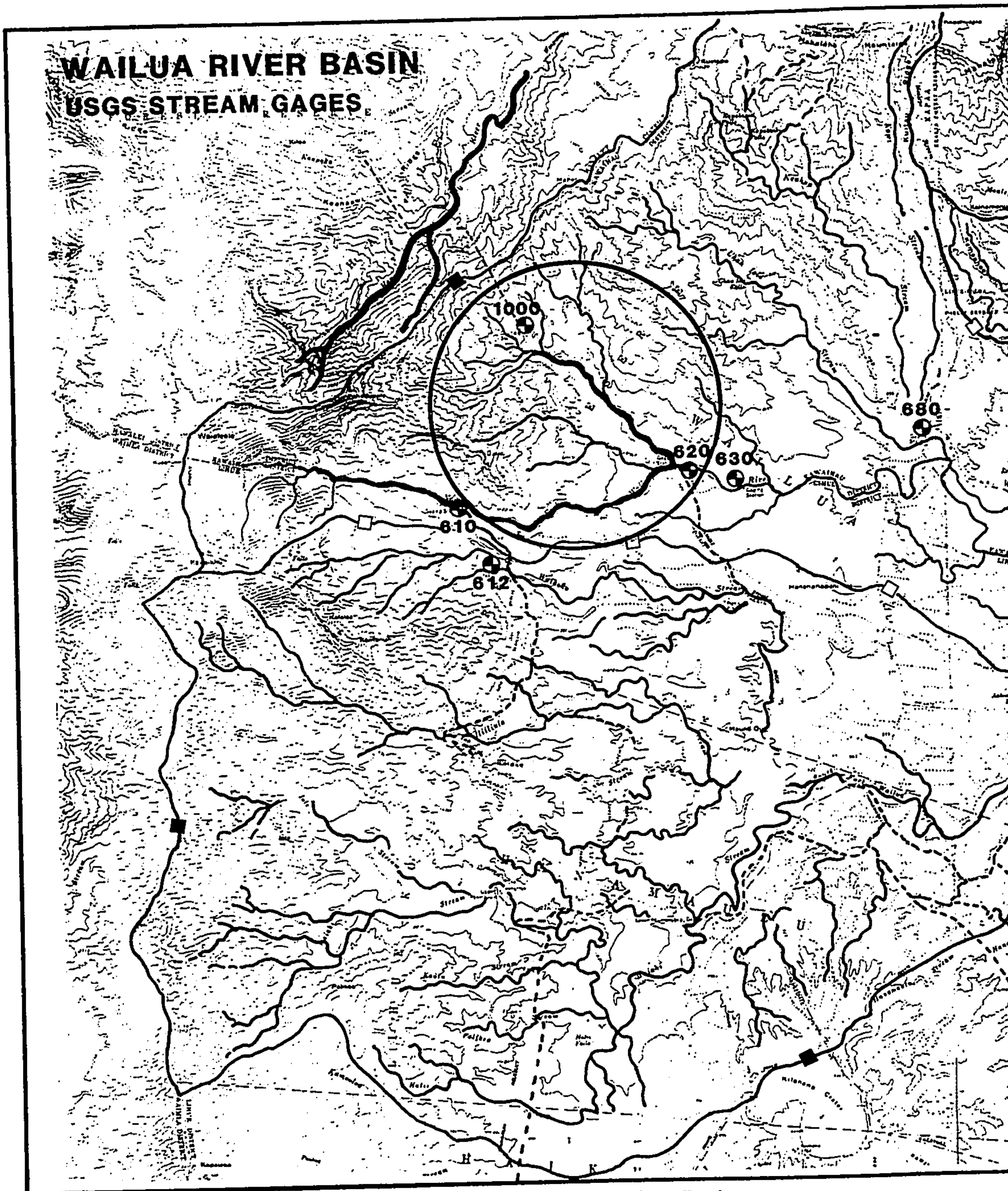
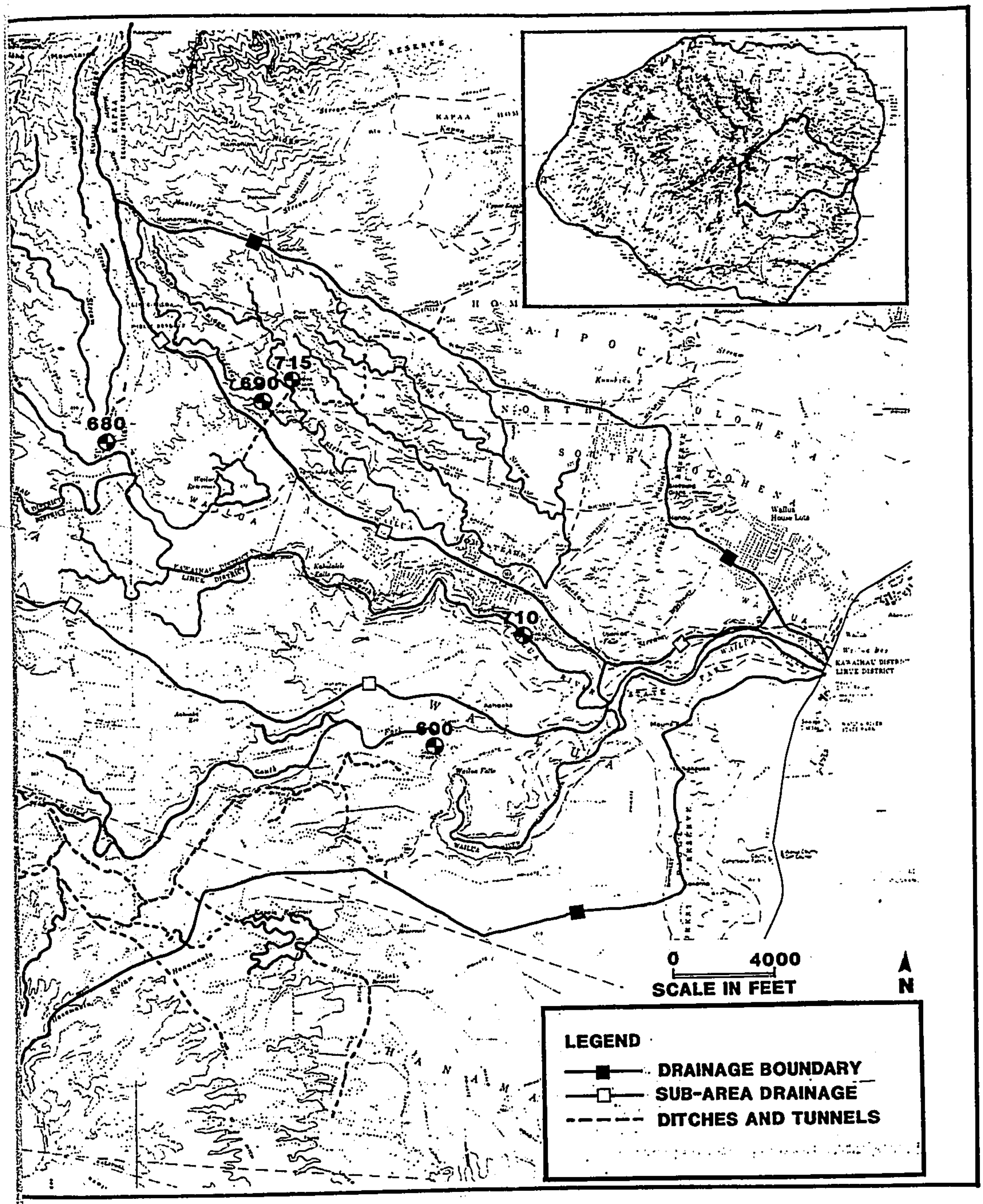


Figure 2.1-10. Location of USGS stream gages in Wailua River Basin.



715
690
680
710
600
0
4000
SCALE IN FEET
N
LEGEND
DRAINAGE BOUNDARY
SUB-AREA DRAINAGE
DITCHES AND TUNNELS

TABLE 2.1-3. A list of the USGS gaging stations on the island of Kauai, Hawaii[1].

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 Fork Wailua 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	--	1,120	1932-Current

(1) Source: U.S. Geological Survey.

Stream and the Hanalei River. The Hanalei Tunnel flows, from 1960 to 1985, can be seen in Figure 2.1-11. The average discharge at the tunnel station over a 52 year period was 26.0 cfs with a minimum of no flow. A flow duration curve can be seen in Figure 2.1-12.

A comparison was drawn between average, wet, and dry years for streams of interest. The determination was made based upon the bulk precipitation data at Station 1051 (Figure 2.1-6). The average annual flow pattern for the Hanalei Tunnel (Figure 2.1-13) indicates that peak flows occur between January and May, corresponding to the period of peak precipitation (Figure 2.1-5). Low flow periods (July-September) correspond to periods of low precipitation. A regression analysis comparing the annual discharge (Ac-ft/year) to bulk precipitation at Station 1051 indicated no relationship (Figure 2.1-14). It is apparent that on average 15,000 Ac-ft of flow is diverted annually into Maheo Stream regardless of precipitation conditions.

Several small tributaries enter the Maheo Stream below the Hanalei Tunnel. The total accrual from these tributaries is unknown. In order to estimate the conditions (flow and water quality) that would exist in Maheo Stream with the project in place at its point of entrance into the north fork, a second tributary to the Wailua River was used as a comparison. The East Branch of the North Fork drains a similar geographical area to that drained by the Maheo Stream without the Hanalei Tunnel and contains no water diversions (Station 680).

Flows for this tributary over the 1960 to 1985 period can be seen in Figure 2.1-15. The drainage area of 6.27 square miles has an average discharge of 48.1 cfs with a maximum of 18,400 cfs and a minimum of 6.8 cfs. In an average year (Figure 2.1-16), peak average monthly flows (40-80 cfs) occur during November to January, while low flows (10-20 cfs) occur in February and March. During a dry year (1984-1985), flows did not exceed 60 cfs. The major difference in the wet year compared to the average and dry year was the extremely wet spring (January to May).

A regression analysis between annual flow (Ac-ft/year) in the East Branch and bulk precipitation at Station 1051 was found to be significant at the $P=.05$ level (Figure 2.1-17) with an r^2 of 0.81. This would indicate that the flows from the drainage area are responding directly to atmospheric precipitation.

2.1.5.2 Water Quality

There is only a limited amount of water quality data available for the Hanalei diversion tunnel and no information on the Maheo Stream at its confluence with the North Fork Wailua River. A summary of the water quality data for the Hanalei tunnel (1975-1984) can be seen in Table 2.1-4. The temporal distribution of temperature, pH, and conductivity over an annual time period can be seen in Figure 2.1-

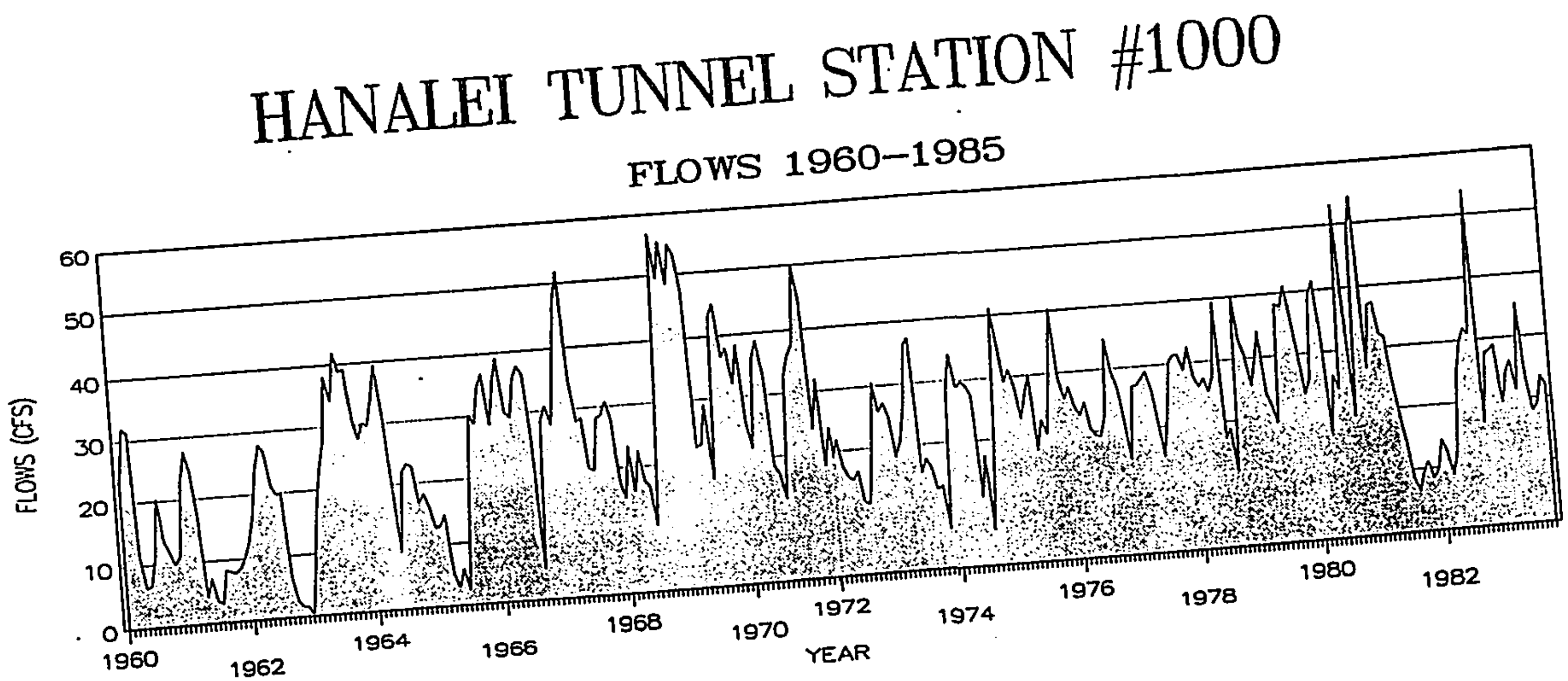


Figure 2.1-11. The flows from the Hanalei Tunnel (1960-1985).

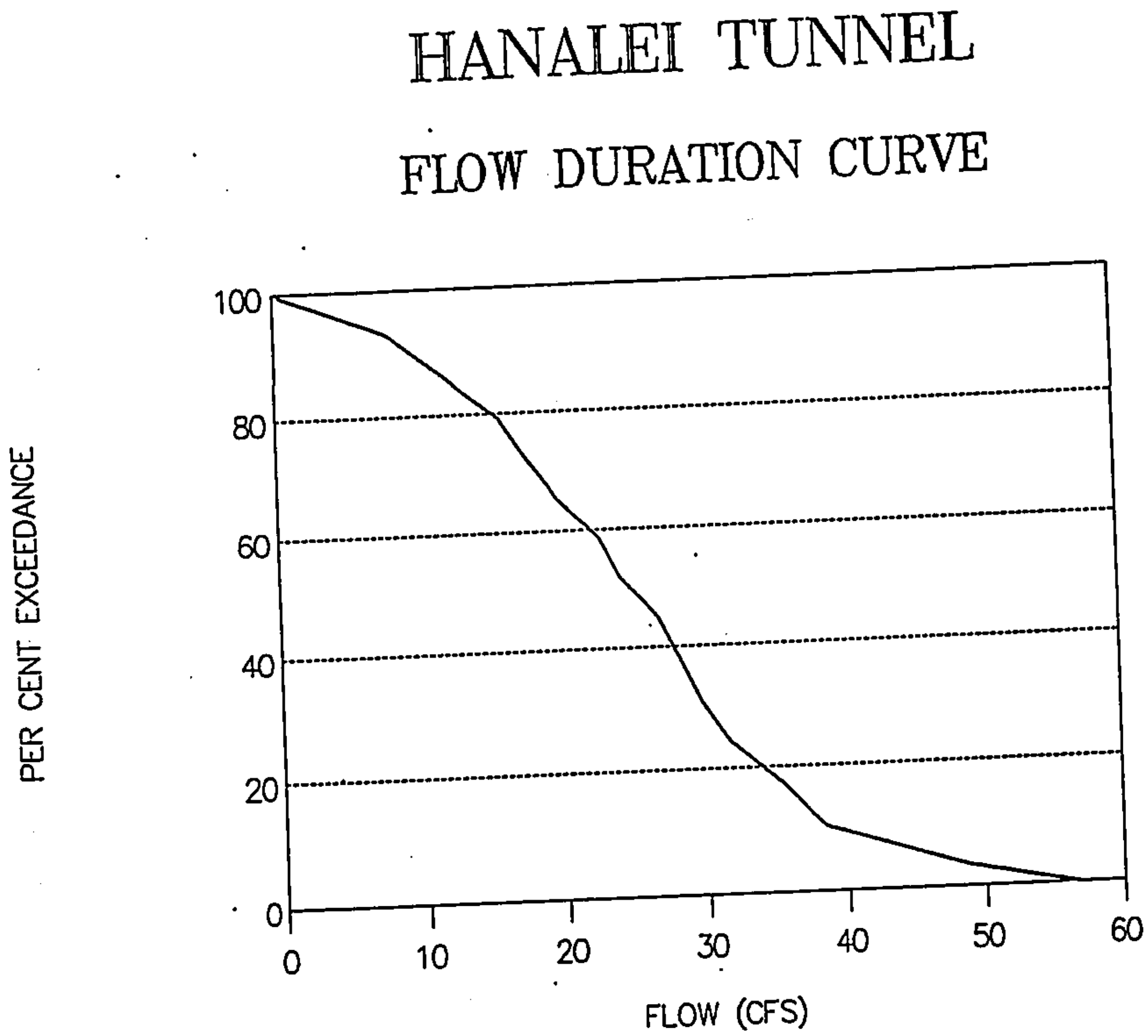


FIGURE 2.1-12. The flow duration curve for the Hanalei Tunnel USGS Station #1000 for the years 1960 to 1985.

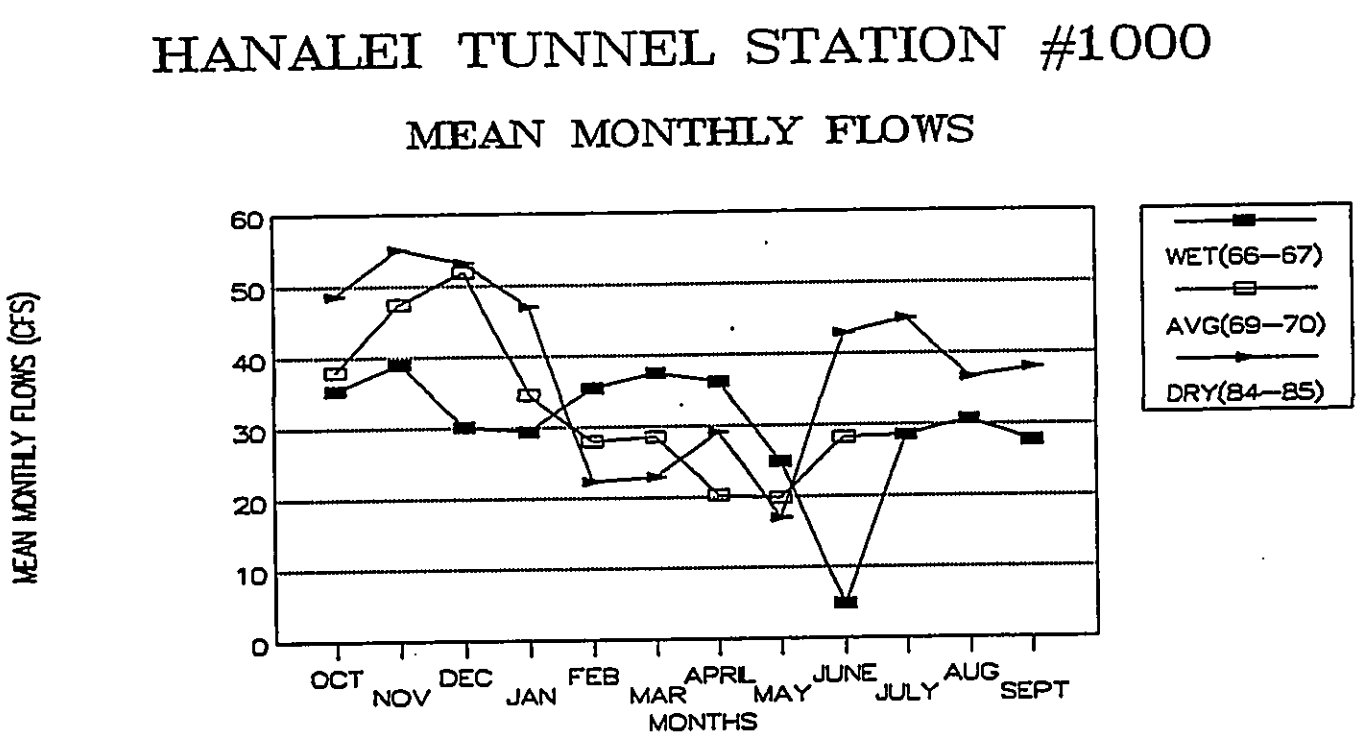


FIGURE 2.1-13. The annual flow pattern at the Hanalei Tunnel for an average (1969-1970), wet (1966-1967), and dry (1984-1985) water year.

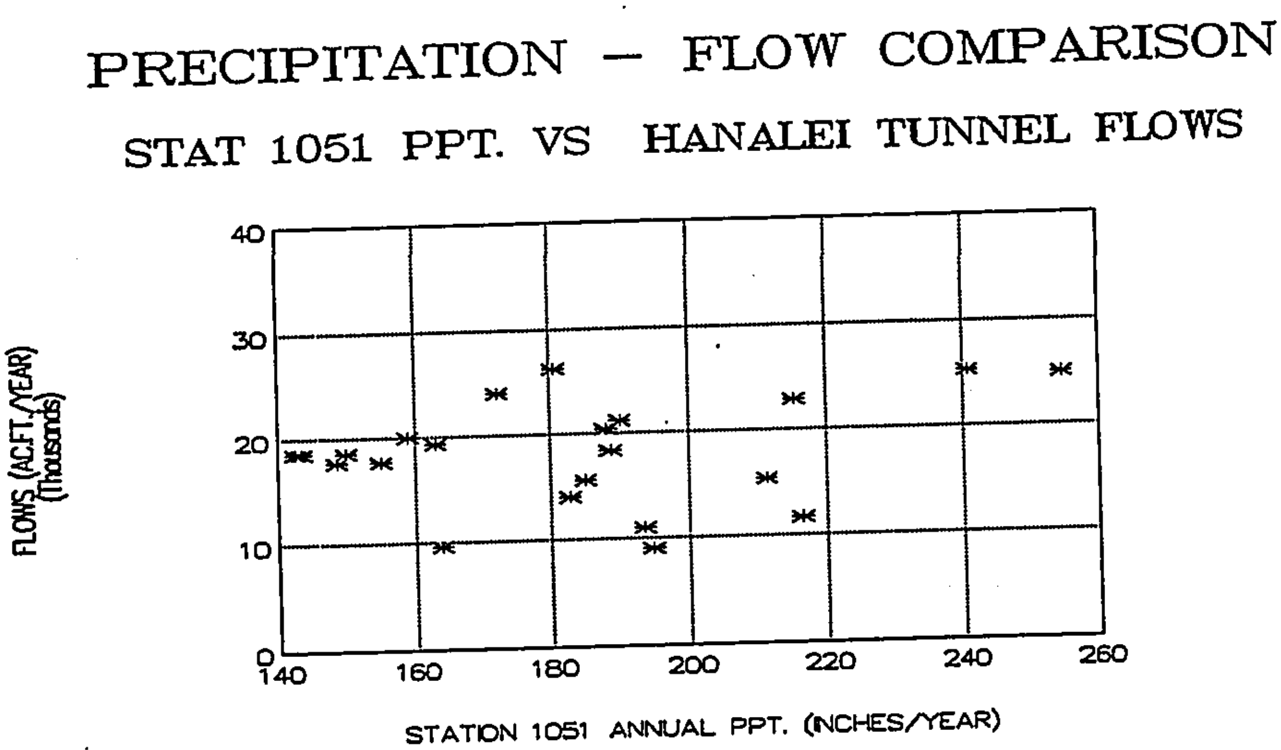


FIGURE 2.1-14. A regression between bulk precipitation at Station 1051 and annual discharge at the Hanalei Tunnel (Station 1000) for the years 1958 to 1985.

EB OF NORTH FORK WAILUA RIVER

FLOWS 1960–1985

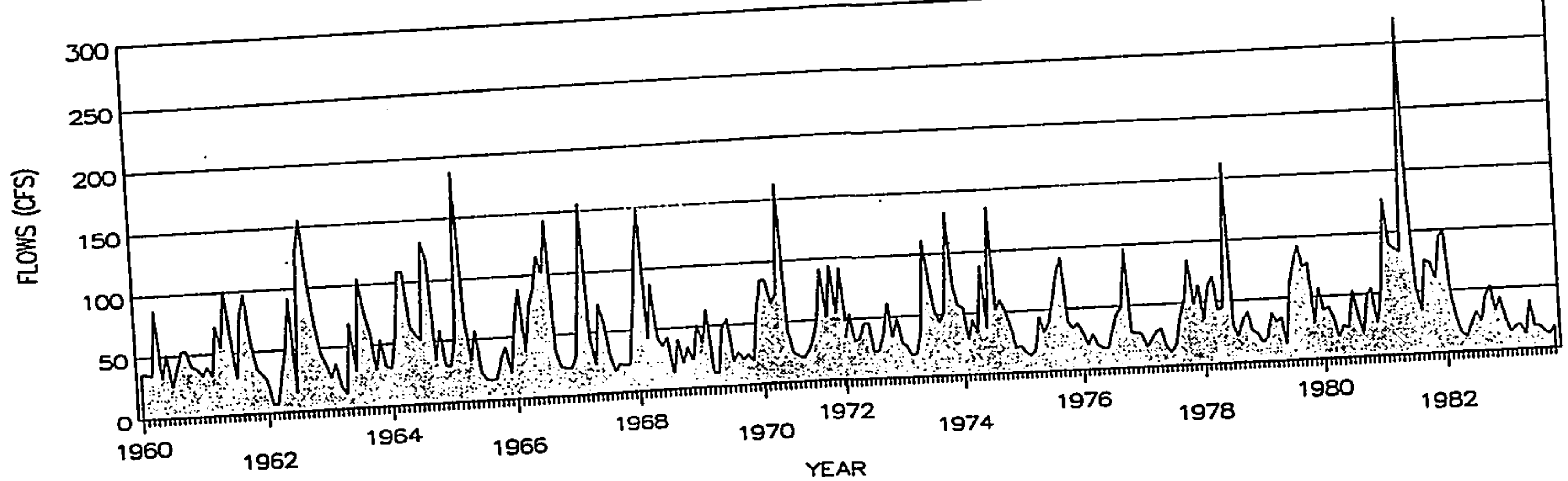


Figure 2.1-15. The flows for the East Branch of the North Fork Wailua River for the period 1960 to 1985.

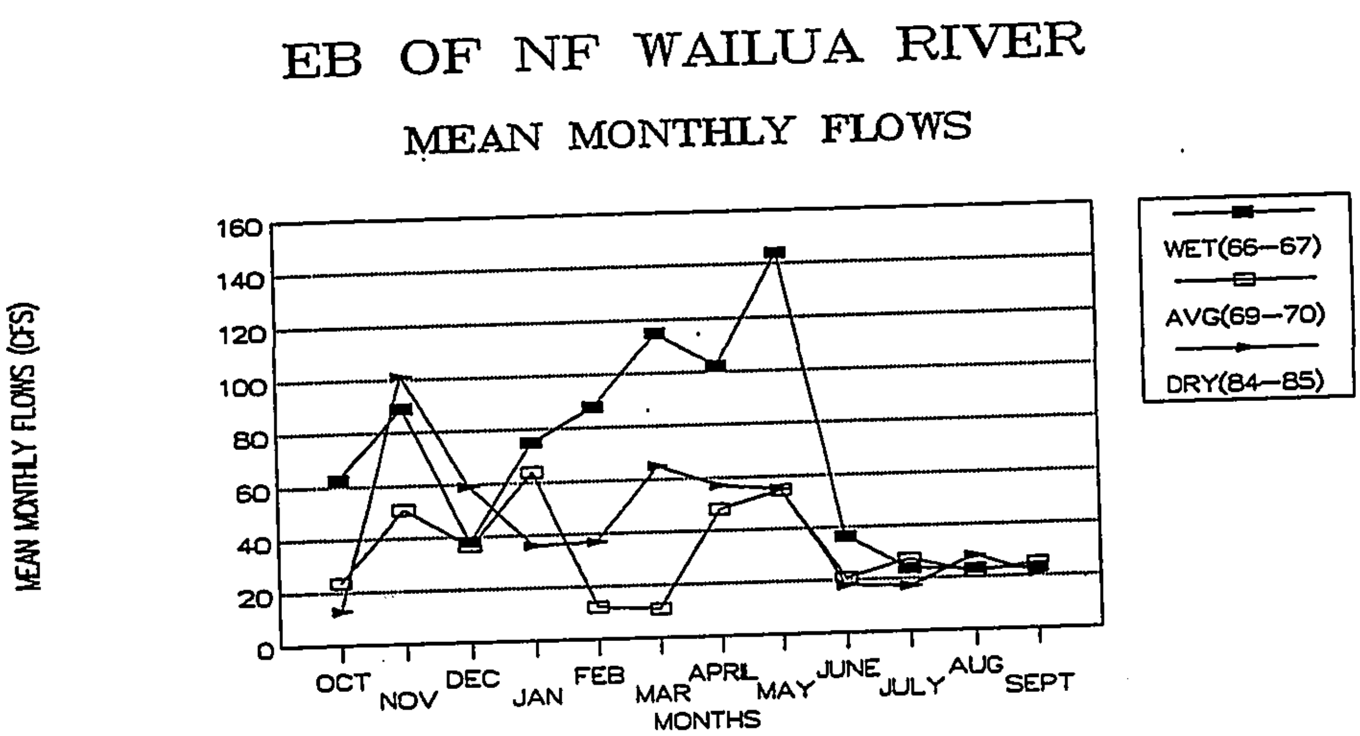


FIGURE 2.1-16. The annual flow pattern of the East Branch of the North Fork Wailua River for an average (1969-1970), wet (1966-1967), and dry (1984-1985) water year.

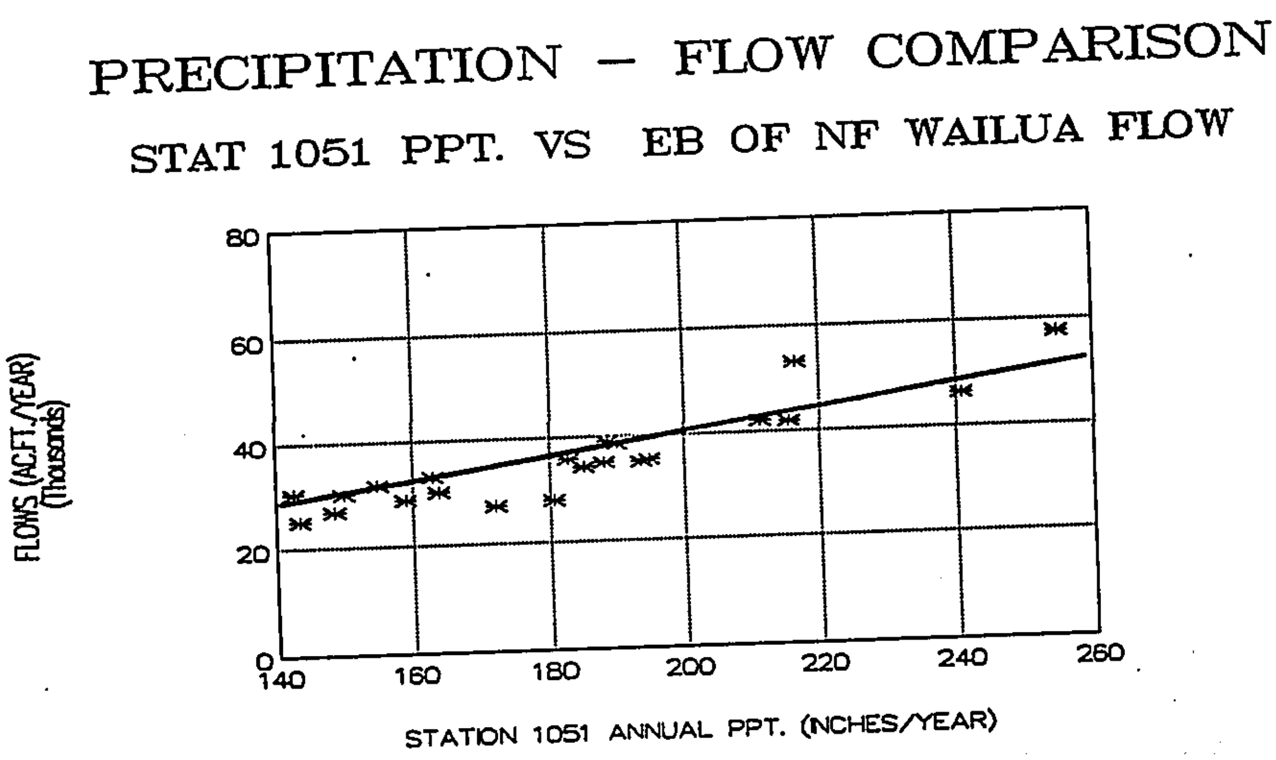


FIGURE 2.1-17. A regression between bulk precipitation at Station 1051 and annual discharge at the East Branch of the North Fork Wailua River for the years 1958 to 1985.

TABLE 2.1-4. A summary of available water quality data for the Hanalei Tunnel. Station No. 1000[1].

Parameter	N	Mean	STD	Min	Max
Alkalinity (mg/l $CaCO_3$)	4	26.5	3.1	24.0	31.0
Ca^{++} Diss. (mg/l Ca^{++})	4	4.4	0.4	4.1	5.0
Cl Diss. (mg/l Cl)	4	7.3	1.3	5.6	8.5
Color (PL-Co Units)	4	4.0	2.9	1.0	8.0
F (mg/l F)	3	0.1	0.0	0.1	0.1
Hardness (mg/l $CaCO_3$)	4	27.5	2.63	25.0	30.0
MG Diss. (mg/l MG)	4	4.0	0.38	3.6	4.5
MN Diss. (mg/l MN)	4	12.5	5.0	10.0	20.0
NO_3 + NO_2 (mg/l N)	3	0.057	0.045	0.01	0.10
pH (units)	46	7.2	0.44	6.0	7.9
K (mg/l K)	4	0.47	0.15	0.30	0.60
Si (mg/l SiO_2)	3	14.66	0.58	14.0	15.0
Na Diss. (mg/l Na)	4	5.45	0.82	4.6	6.2
TDS (mg/l)	3	52.6	2.51	50	55
Conductance (umhos/cm^2)	46	76.5	11.13	49	120
SO_4 (mg/l SO_4)	4	1.125	0.26	0.90	1.50
Temperature (°C)	47	17.96	1.2	15.5	21.0
Turbidity (JTU)	4	1.25	0.95	0.0	2.0

[1] Source: USGS Water Quality records.

18. Water temperatures (at an elevation of 1210 ft.) reach a minimum between January and March (15°C) and a maximum during the summer months of July and August (21°C). In order to determine how temperatures might change with changes in elevation, a relationship was drawn for all water temperature data collected in July and August, 1986 at USGS stations on Kauai. The data indicates (Figure 2.1-19) that at the site, temperatures can be expected to increase naturally about 2°C.

Both conductivity and pH have their highest values on an increasing limb of the hydrograph, with minimum values occurring during baseflow conditions (July-October). The low levels of conductivity (less than 80 umhos/cm^2) and large fluctuations in pH indicate that the waters entering the Wailua drainage from the Hanalei basin are not well buffered.

The water quality from the East Branch of the North Fork Wailua River was found to be different from the Hanalei tunnel waters. The temperature was significantly higher at this station although the seasonal pattern was the same (Figure 2.1-20). An elevational difference of 710 ft could account for this difference. Conductivity was significantly higher at the East Branch Station (an average of 95 umhos/cm^2). These higher values, combined with a more constant pH, indicate more buffering capacity in the Wailua drainage in comparison to the Hanalei basin.

2.2 BIOLOGICAL CHARACTERISTICS

2.2.1 Aquatic Environment

Topographically and hydrologically, Maheo Stream can be divided into three zones: (1) a 4700 foot lower gradient segment with a 3.4 percent slope beginning at the confluence of the North Fork and ending at a small tributary entering from the north at elevation 860 feet, (2) a 4200 foot higher gradient segment with an 8.6 percent slope beginning at elevation 860 feet and ending at the mouth of the existing Hanalei River diversion tunnel, and (3) an upstream watershed above the point where water from the Hanalei tunnel enters the tributary. The two downstream sections are augmented by the Hanalei tunnel flows (with an average of 26 cfs) while the upper watershed retains a natural flow regime. Upon completion of the project, flows within the lower two segments of Maheo Stream would revert to the pre-diversion regime present before the construction of the Hanalei tunnel. Below the proposed project, the North Fork Wailua River is extensively diverted to serve as a water supply for the main island industry of sugar cane production.

Three separate field investigations were undertaken to define the aquatic environment. The primary producers (periphyton and detritus levels) and macroinvertebrates were sampled at 10 locations (Figure

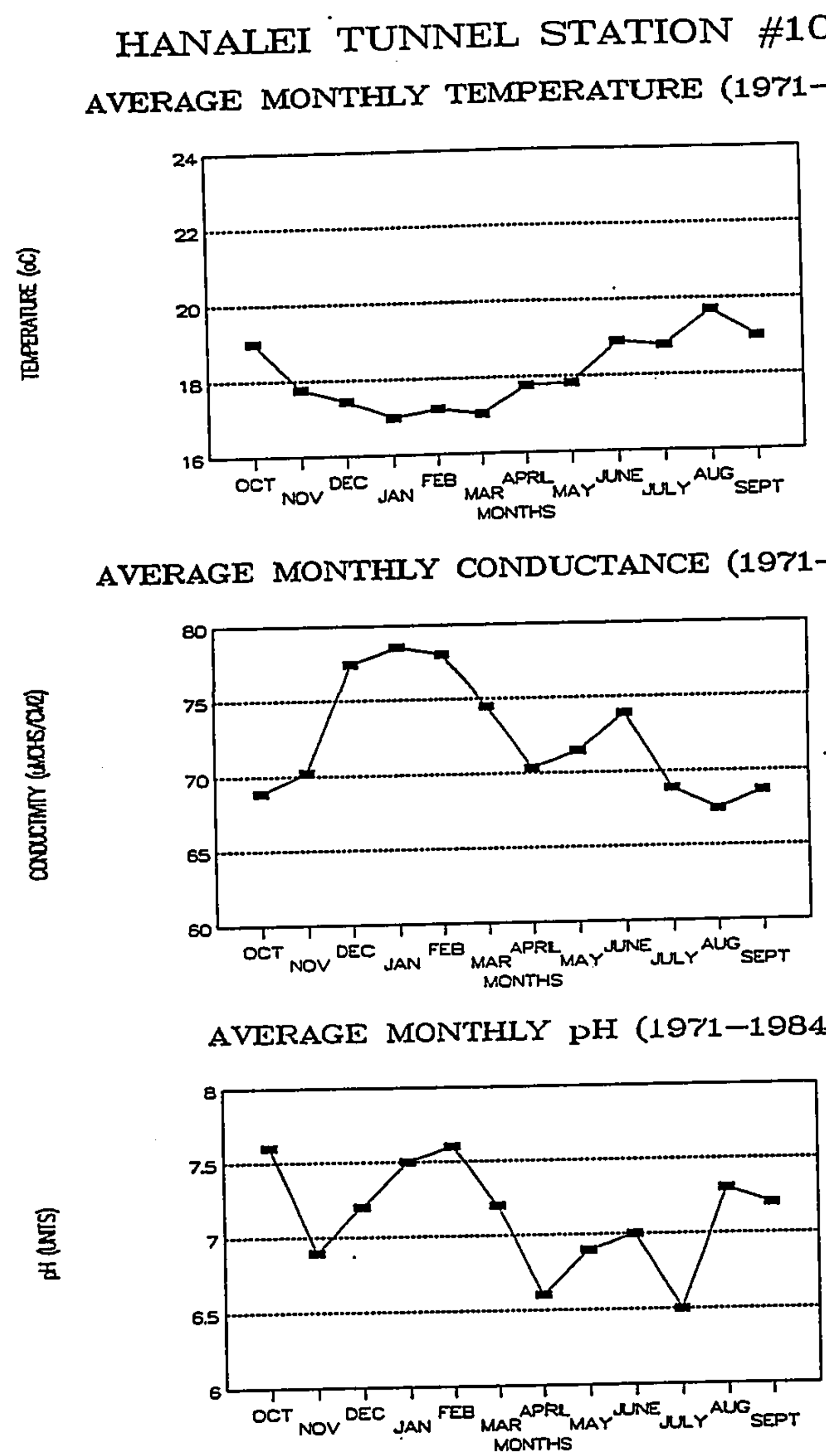


Figure 2.1-18. The annual patterns of temperature (upper), conductivity (center), and pH (lower) in the Hanalei Tunnel for the period 1971 to 1984.

KAUAI SURFACE WATERS

JULY—AUGUST 1986 STREAM TEMPERATURES

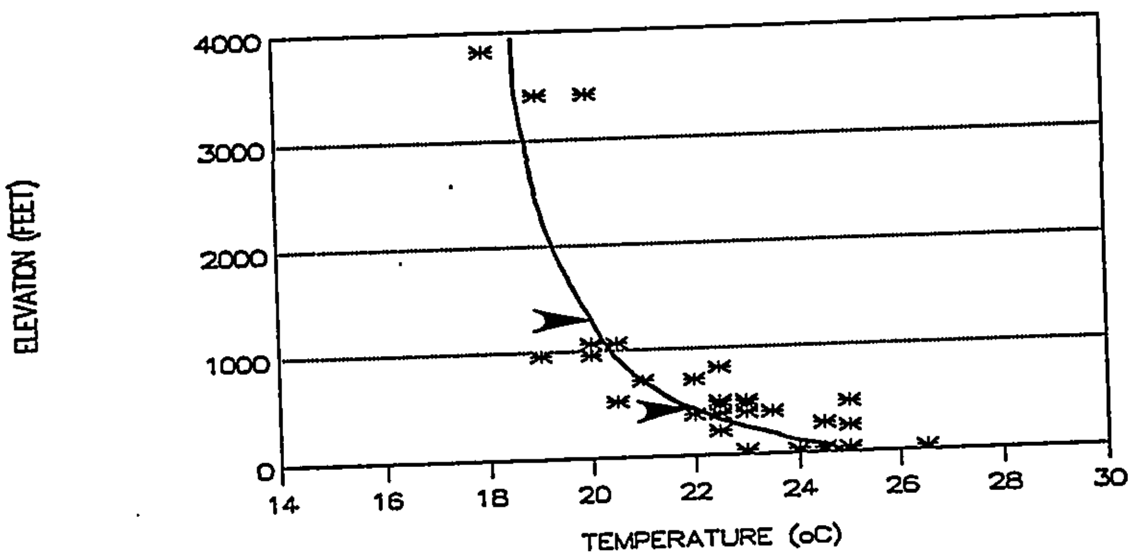


FIGURE 2.1-19. A comparison of all surface water temperatures collected at USGS stations during July and August, 1986. Arrows denote the discharge elevation of the Hanalei Tunnel into the Maheo Stream (1210 ft MSL) and the elevation of the Maheo Stream at its confluence with the North Fork Wailua River (710 ft MSL).

EB OF NORTH FORK WAILUA RIVER

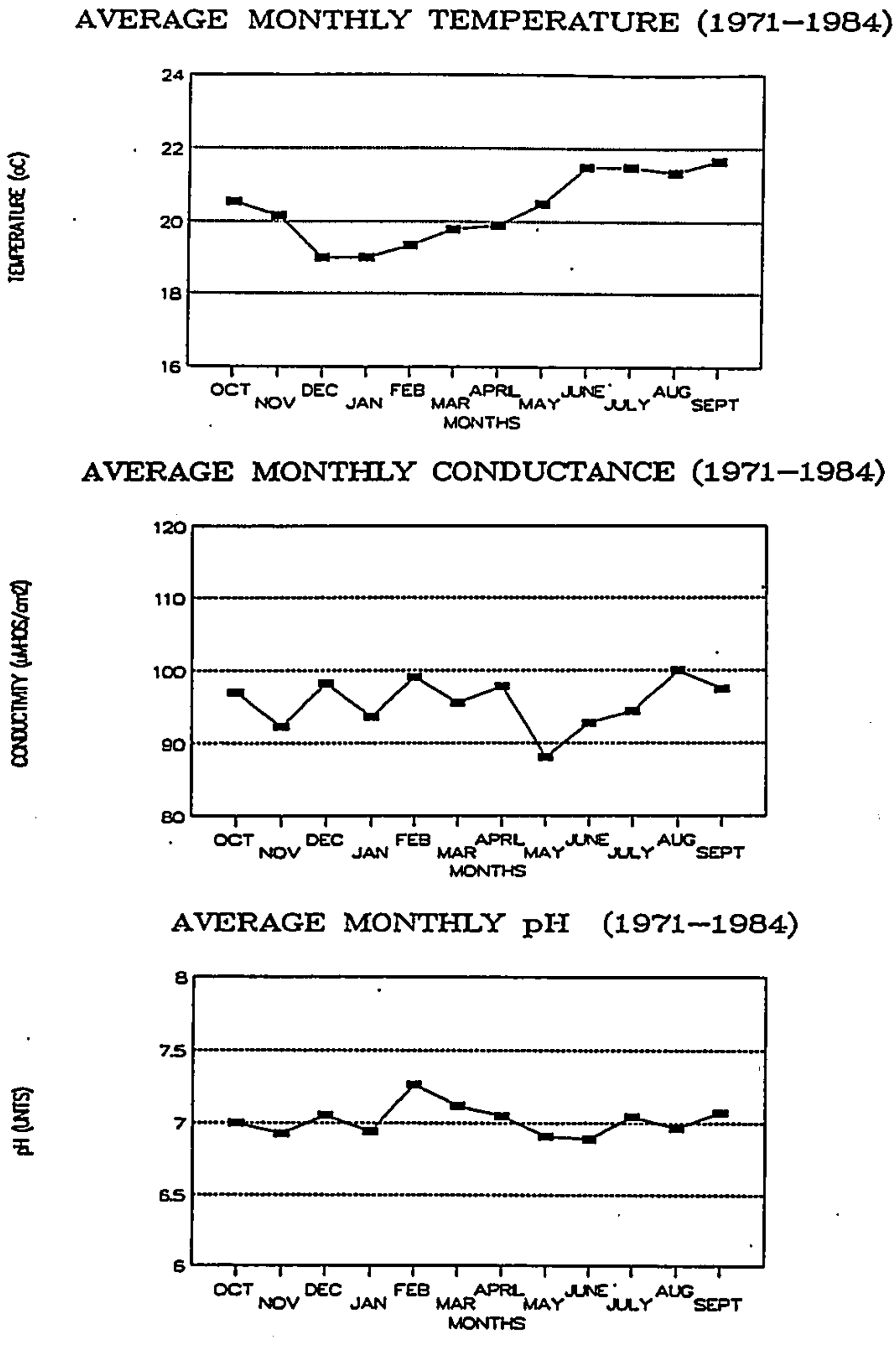


FIGURE 2.1-20. The annual patterns of temperature (upper), conductivity (center), and pH (lower) in the East Branch of the North Fork Wailua River.

2.2-1) within the Maheo Stream in October, 1988. The data for this investigation can be seen in Tables 2.2-1, 2 and 3. These data indicate that the periphyton/detritus complex was abundant, ranging from 9 gms/m^2 at Station 10 to 972 at Station 2. In general, the lower stations on the two tributaries to the North Fork (stations 1 and 2) had the highest periphyton/detritus levels, while the North Fork and Stable Storm Ditch stations tended to be an order of magnitude lower (stations 10, 3, and 4). The highest macroinvertebrate levels (12-29 gm/m^2) were found at stations 5, 6 and 7 near the headwaters. With increased distance downstream, invertebrate densities decreased to less than 1 gm/m^2. The highest biomass of Atya shrimp were found at the same locations as those of high invertebrate densities.

In January, 1988, Thomas R. Payne and Associates sampled the project site at 10 locations for macrofauna (Fig. 2.2-1). Their data showed that the distribution, species composition, and abundance of the fisheries resources in Maheo Stream largely correlate with topographic and hydrologic patterns (Table 2.2-4). The downstream, lower gradient section contains variable platyfish, green swordfish, and smallmouth bass (Payne 1988). These three species are among the numerous introduced fishes that have become established within the Hawaiian Islands (Kanayama 1968, Timbol and Maciolek 1978). None were found to be very common, although smallmouth bass are reported to be more abundant in the middle sections of Maheo Stream not covered by the surveys (Heacock, personal communication, 1988). Over most of the project reach, Maheo Stream flows in a confined channel with steep banks that offers little of the quiet, sheltered habitat preferred particularly by the swordtails and platyfish. These fish were located only in the restricted areas of backwaters protected by the roots of the introduced California grass. The abundance of all three exotic species combined is estimated to be less than 10 individuals per 100 feet of stream, and no native species were found in this downstream section of the Maheo (Payne 1988).

Higher in the watershed, within the steeper section of the project reach, the exotic fishes are replaced by three species of native diadromous fauna. Most of this reach is composed of exposed bedrock and large boulders. A freshwater shrimp known by its Hawaiian name of opae kala'ole, is relatively common. Populations of the 2-3 inch crustacean are estimated at approximately 100 per 100 feet of stream (Payne, 1988). The life history and behavior of opae kala'ole has been described by Edmondson (1929) and Couret (1976). They feed either by filter feeding, trapping detritus on fan-like setae attached to extended chelipeds, or by grazing on filamentous algae and diatom mats growing on the substrate. As noted previously, periphyton and detritus were abundant at locations where shrimp were found. The shrimp can be found in mountain streams at elevations up to 3600 feet and have been used as a food source and fish bait by native islanders. Breeding occurs in the streams and eggs are carried by the females, after which the hatched larvae drift to the ocean to develop into juveniles. This diadromous life cycle then

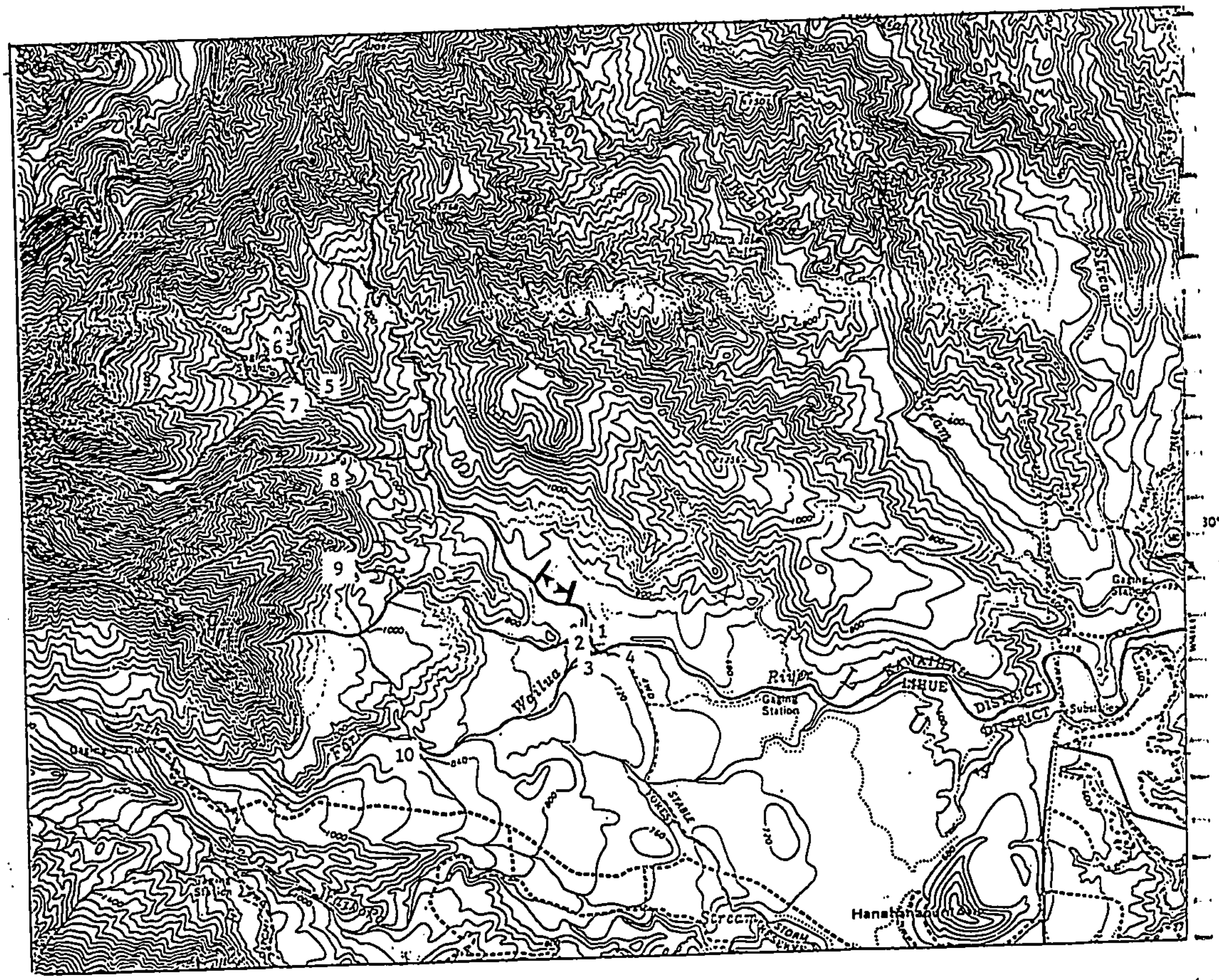


FIGURE 2.2-1. A location map of the sampling locations for aquatic life collected in January and October, 1988. Arrows denote the location of the February, 1989 IFIM study reach.

TABLE 2.2-1. A list of the biomass estimates of periphyton/dentritus and macroinvertebrates collected in the Maheo Stream complex in October, 1988.

Station	Periphyton/ Detritus gm/m²	Total Wt. of Invertebrates gm/m²	Total Wt. of Atya gm/m²	Atya plus Invertebrates gm/m²	Total # of Invertebrates	Total# of Opae kala'ole
1	732	9.0	0.00	9.0	900	0
2	972	0.45	0.00	0.45	126	0
3	22	0.63	Fragments	0.63	225	0
4	16	1.71	0.00	1.71	198	0
5	109	11.79	7.47	19.26	1017	2
6	245	25.2	19.71	44.91	117	6
7	159	29.70	19.89	49.59	315	2
9	695	6.30	23.67	29.97	1944	3
10	9	9.27	0.00	9.27	351	0

TABLE 2.2-2. Aquatic fauna collected at each sampling station in January 1988 and October 1988.

Site Location	Fish[1]	Invertebrates & Fish[2]
SITE 1 - Upper Wailua above Stable Storm Ditch, 300 m	Smallmouth bass Green swordtail Variable platyfish	Damselfly* Caddisfly Microcaddisfly Earthworm
SITE 2 - Trail Stream above Stable Storm Ditch, 300 m	Smallmouth bass Green swordtail Variable platyfish	Caddisfly
SITE 3 - North Fork Wailua above Stable Storm Ditch, 100 m	No Species Found	Midge Damselfly* Caddisfly Opae kala'ole*
SITE 4 - Stable Storm Ditch below USGS Streamgage, 100 m	Smallmouth bass Variable platyfish	Brinefly larvae Caddisfly Microcaddisfly Earthworm
SITE 5 - Upper Wailua below tunnel confluence, 100 m	Opae kala'ole* O'opu nakea* O'opu nopili*	Midge Damselfly* Caddisfly Microcaddisfly Opae kala'ole (Atya)
SITE 6 - Hanalei Tunnel, 10 m	Opae kala'ole*	Damselfly (megalagrion)* Opae kala'ole (Atya)*
SITE 7 - Upper Wailua above tunnel confluence, 100 m	Opae kala'ole* O'opu nakea*	Midge Damselfly* Caddisfly Opae kala'ole Leach

TABLE 2.2-2 (continued). Aquatic fauna collected at each sampling station in January 1988 and October 1988.

Site Location	Fish[1]	Invertebrates & Fish[2]
SITE 8 - Small tributary at trail, 10 m	Opae kala'ole*	No Water at Time of Sampling
SITE 9 - Trail stream at trail, 10 m	Opae kala'ole*	Damselfly* Caddisfly
SITE 10 - North Fork Wailua at trail, 50 m	Variable platyfish Opae kala'ole*	Midge Brinefly Damselfly* Caddisfly Microcaddisfly Mosquito fish

(1) Payne - January, 1988.

(2) Lamarra - October, 1988.

* Endemic = occurring naturally in Hawaii only.

TABLE 2.2-3. Scientific names for aquatic fauna collected from the project site.

Scientific Name	Common Name
ANNELIDS *(Worms)*	
Hirudinea	Leach
Oligochaeta	Earthworm
INSECTS	
Diptera	
Chironomidae	Midge larvae
Ephydridae	Brinefly larvae
Odonata	
Megalagrion heterogamius*	Damselfly larvae
Trichoptera	
Cheumatopsyche analis	Caddisfly larvae
Oxyetura maya	Microcaddislfy larvae
CRUSTACEANS	
Atya bisulcata*	Opae kala'ole
FISHES	
Micropterus dolamieui	Smallmouth bass
Xiphophorus nelleri	Green swordtail
Xiphophorus variatus	Variable platyfish
Awaous stamineus	O'opu nakea
Sicyopterus stimpsoni	O'opu napili
Gambusia affinis	Mosquito fish
MOLLUSKS	
Unidentified Snails	

* Endemic = occurring naturally in Hawaii only.

TABLE 2.2-4. Results of Upper Wailua River Survey, listed by site location, length of site, species, size, and estimated abundance (Payne, 1988).

Site Location	Length of Site	Species	Species Size	Estimated Abundance
SITE 1 - Upper Wailua above Stable Storm Ditch	300 m	Smallmouth bass Green swordtail Variable platyfish	10-30 cm 4- 6 cm 4- 6 cm	Rare Rare Rare
SITE 2 - Trail stream above Stable Storm Ditch	100 m	Smallmouth bass Green swordtail Variable platyfish	10-30 cm 4- 6 cm 4- 6 cm	Uncommon Uncommon Uncommon
SITE 3 - North Fork Wailua above Stable Storm Ditch	100 m	NO SPECIES FOUND		
SITE 4 - Stable Storm Ditch below USGS streamgage	100 m	Smallmouth bass Variable platyfish	8-10 cm 1- 4 cm	Rare Abundant
SITE 5 - Upper Wailua below tunnel confluence	100 m	Opae kala'ole O'opu nakea O'opu nopili	5- 7 cm 6-16 cm 8 cm	Common Rare Rare
SITE 6 - Hanalei tunnel	10 m	Opae kala'ole	5- 7 cm	Rare
SITE 7 - Upper Wailua above tunnel confluence	100 m	Opae kala'ole O'opu nakea	5- 7 cm 8-16 cm	Abundant Rare
SITE 8 - Small tributary at trail	10 m	Opae kala'ole	5- 7 cm	Uncommon
SITE 9 - Trail stream at trail	10 m	Opae kala'ole	5- 7 cm	Uncommon
SITE 10- North Fork Wailua at trail	50 m	Variable platyfish Opae kala'ole	1- 6 cm 5- 7 cm	Common Rare

Rare = 1 to 3 per site

Uncommon = 4 to 10 per site

Common = 10 to 100 per site

Abundant = >100 per site

requires the juveniles to migrate back upstream, ascending rapids and vertical waterfalls by means of minute hooks on their chelipeds.

The other two aquatic species collected in Maheo Stream are the diadromous gobies: the common goby (o'opu nakea) and Stimpson's goby (o'opu nopili). Densities were found to be very low. The January intensive survey found only a few in several hundred feet of sampling towards the upper end of the reach (Payne 1988). The o'opu nakea inhabit freshwaters and descend downstream in mass migrations after fall rains to spawn near estuaries, where deposited eggs quickly hatch and the larvae are swept out to sea (Ego 1956). After a four to seven month period in the marine environment, the fry migrate into rivers where they stay until they reach sexual maturity. Upstream migration and movement within the river environment is assisted by a ventral sucking disk formed by the union of the pelvic fins (Tinker 1978). Habitat assessment work done in the Lumahai River on the north shore of Kauai (TRPA 1987) found two size classes of nakea, indicating that they spend at least two years in freshwater.

The common goby often reaches nine to ten inches in length and have been documented to take a baited hook on their spawning migration, making them popular as a food fish to the native islanders (Ego 1956). The o'opu nopili has a life history similar to the o'opu nakea (Tomihama 1972) but they reach only an average size of two to three inches and are less attractive to fishermen.

The uppermost end of the project reach is on a short spur leading to the exit of the diversion tunnel from the Hanalei River. Here the stream is very narrow and swift, flowing through a void in old lava flows.

The portion of Maheo Stream upstream of the confluence with the tunnel water is less confined than immediately downstream. The substrate is composed of boulders, cobbles, and gravels instead of lava bedrock and the stream contains more pools, riffles, glides, and undercut bands. 'Opae kala'ole are very abundant in this section, approaching some of the densities reported in other Hawaiian streams of about four or five animals per square foot (Couret 1976, Kinzie and Ford 1982, TRPA 1988), or 6,000 to 7,500 per 100 feet. The two gobies remain uncommon and are present in approximately the same abundance as below the confluence (Payne 1988). The rarity of gobies is probably related to the distance of the area from the ocean (8 miles), predators in the lower river through which the gobies must migrate, and extensive intervening irrigation diversions. It is possible that the gobies may have moved through the tunnel from the Hanalei River where they are more common (Timbol 1986). However, the opae kala'ole are too abundant for them all to have moved through the tunnel, so they must be fecund and hardy enough to continue migrating through the lower Wailua.

There are other species of macrofauna that were not observed in the investigations but occur in the Hanalei drainage above the Hanalei tunnel. These species were collected in 1986 in the Hanalei River (Timbol 1986) and are summarized in Table 2.2-5.

In order to evaluate the potential effect on aquatic organisms and habitat of a reversion to natural flow in Maheo Stream, a third investigation was undertaken in February, 1989. This investigation was conducted using the Instream Flow Incremental Methodology (IFIM). Study site areas were selected with the assistance of DLNR/DAR and hydraulic data collected to calibrate computer models for physical habitat simulation (Figure 2.2-1). The entire affected reach of Maheo Stream (7600') was mapped on foot by habitat type in 100' intervals to assign weights to ten individual transects located in the middle portion of the reach. Habitation use criteria for opae were taken from data collected in similar habitat on Maui (TRPA, 1988), and smallmouth bass curves were acquired from publications of the U.S. Fish and Wildlife Service (juvenile, adult, and spawning; Edwards, et al. 1983) and Pacific Gas & Electric Company (fry; Studley, et al. 1986).

Results of this study confirm that aquatic habitat in Maheo Stream is relatively insensitive to flow alteration, that is, there are no strong peaks in habitat area that occur at particular flows. Total weighted usable area (the IFIM index to habitat suitability) for 'opae kala'ole is at its highest level at flows between 5 and 10 cfs (Figure 2.2-2), which is the range of discharge that would be normally present in the stream under post-project conditions. The addition of the average flow of 26 cfs from the Hanalei River diversion reduces habitat area for opae by about 20 percent. Smallmouth bass habitat area for fry, juvenile, and adult fish is also shown to be somewhat decreased at higher flows than at lower flows (Figure 2.2-2). Fry habitat is almost doubled under post-project conditions, while juvenile and adult habitat remain relatively the same, although they are also increased at flows in the post-project range of 10 cfs. Spawning habitat is shown to increase slowly as flow is increased up to the limits of the study.

The physical habitat simulation of the IFIM indicates that the flows added to Maheo Stream from the Hanalei diversion are generally detrimental to both native opae and introduced smallmouth bass. Removal of this water and reversion to natural conditions would act to increase habitat area, probably by lowering the high velocities created at higher flows. Data on wetted area from the instream flow study shows that Maheo Stream does have steep sidewalls that prevent water from expanding into a wider channel and increasing suitable habitat area (Figure 2.2-3). Discharges greater than average natural conditions provide very little increase in wetted area, so flow increases translate into higher depth and velocities to the point where the habitat becomes less suitable for existing aquatic species.

TABLE 2.2-5. Aquatic fauna observed in the Hanalei River above diversion, but not observed in the Wailua drainage.

Scientific Name	Common Name	Origin	Listing
MOLLUSKS			
Erinna aulacospira	Pond snail	endemic	none
Neritina granosa	Hihiwai	endemic depleted on Oahu[1]	none
CRUSTACEANS			
Macrobrachium grandimanus	Opae-'oeha'a	endemic	none
FISHES			
Awaous genivittatus	O'opu-nanida	indigenous	none
Eleotis sandwicensis	O'opu-okuha	endemic	none
Kuhlia sandwicensis	Aholehole	endemic	none
Lentipes concolor	O'opu'alamo'o	endemic	special concern[2]
Mugie cephalus	Ama'ama, mullet		

[1] Maciolek, 1978.

[2] Deacon et al., 1979.

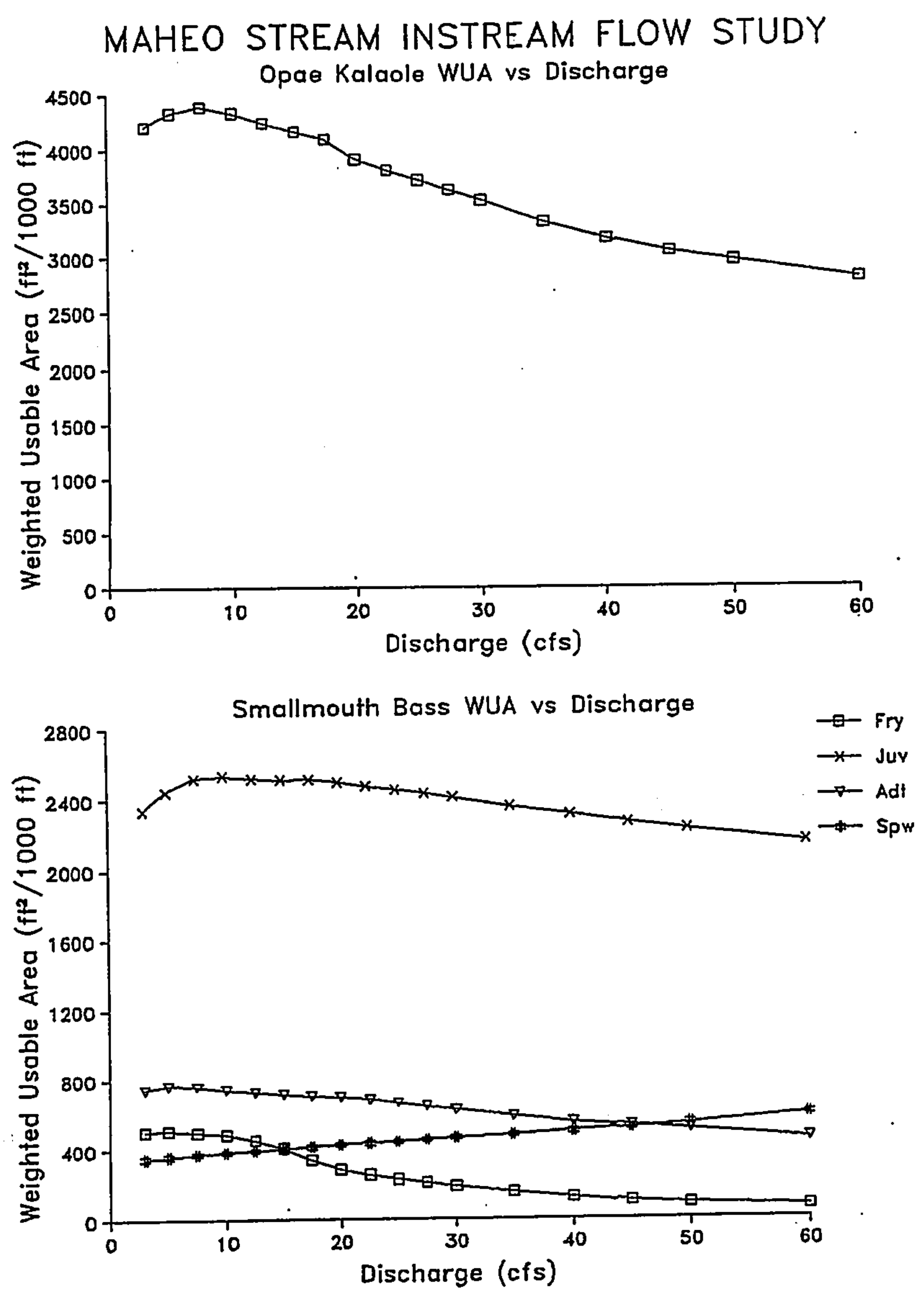


FIGURE 2.2-2. The weighted usable area vs. discharge for opae and smallmouth bass in the Maheo Stream.

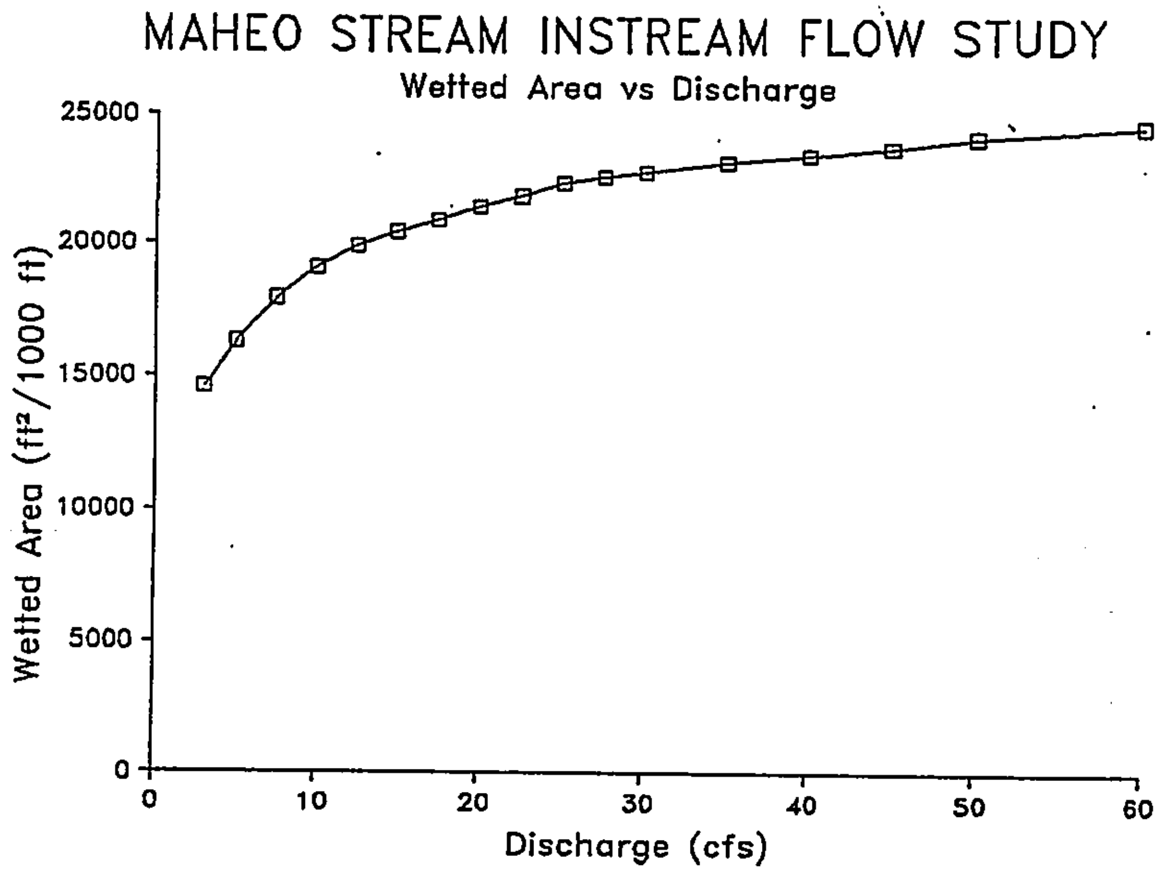


FIGURE 2.2-3. The wetted area vs. discharge curve for the Maheo Stream.

In addition to the above IFIM Study, opae densities were quantitatively determined. A sample site was selected with the assistance of DLNR/DAR, blocked at both ends with nets, and shocked with two backpack units using the three-pass removal depletion technique. Only opae were captured within the reach, which contained shallow pool, cascades, riffle, run-glide, and a small section of deep pool. A sub-sample of 100 opae was counted and measured to determine numbers per volume, and the remainder were counted by volumetric displacement. The length-frequency distribution of the sub-sample is presented in Figure 2.2-4. Population estimates made with the computer program CAPTURE (White, et al. 1978) from a total of 696 opae generated a point estimate of 1025 opae and a 95 percent confidence interval of 881 to 1169. Measurement of the sample area (1853' sq.) and calculation of opae density resulted in an estimate of 1 opae per 1.8 square feet.

Additional surveys on the abundance and distribution of the smallmouth bass in Maheo Stream were conducted at a flow near 8 cfs over the entire length of stream to be affected by the project. Sampling methods included visual observation from streambanks, hook-and-line, and direct underwater observation with mask and snorkel. All pools with depths greater than 4 feet were recorded, along with habitat types where fish were sampled or sighted. Within the 6800 feet of stream below an impassable falls, there were 20 deep pools capable of containing adult smallmouth bass (greater than 20 cm). The number of large bass in these pools was estimated to average about 10, giving a total population estimate of approximately 200 adult fish in the reach. Juvenile bass abundance could not be determined, even when electroshock sampling was attempted, but they are estimated from observations to be about three times as numerous as the adults.

Access to the stream from the road at the lower end required hiking predominantly within the channel over rocky substrate and only occasionally along the banks. Fifteen bass were actually caught that averaged 24 cm in length, with the largest at 31 cm. This level of success means that a single fisherman is capable of harvesting 10 percent or more of the entire adult bass population in one day. While the access conditions will limit utilization of the resource to robust fishermen wearing good footgear, the low abundance of large fish and the ease of capture will soon require either strict harvest limits or catch-and-release regulations if the populations are to be maintained. Providing better access to fishermen will quickly result in the depletion of adult bass and the elimination of the fishery.

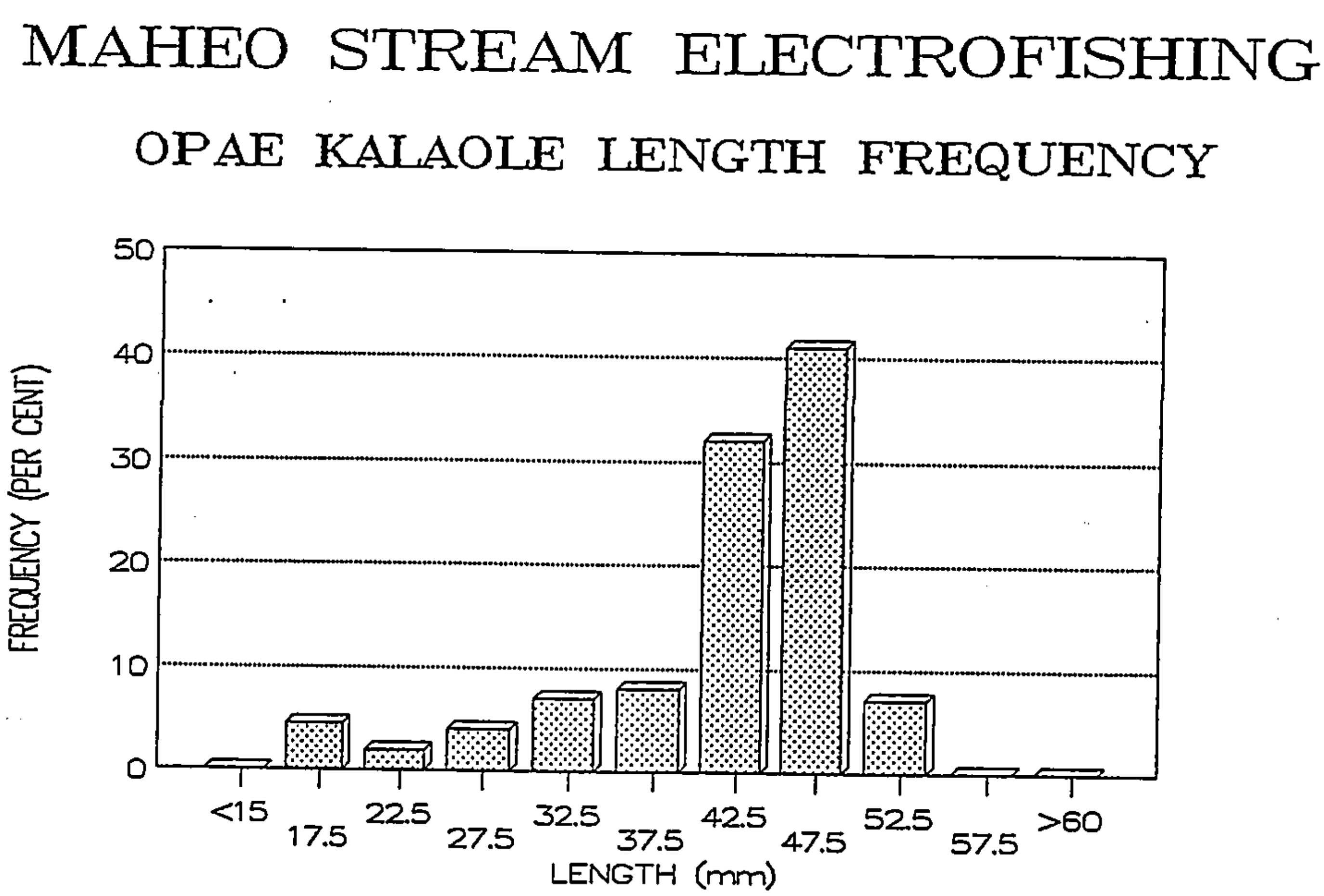


FIGURE 2.2-4. The length/frequency distributions of opae kalaole in the Maheo Stream collected in February, 1989.

Threatened and Endangered Species

No individuals of the candidate endangered species o'opu alamo'o (Lentipes concolor), have been observed in or near the project area. The full text of the fisheries survey report is included as Appendix B.

2.2.2 Terrestrial Environment

2.2.2.1 Flora

Description of Existing Vegetation

The proposed intake structure, penstock, and power plant for the Upper Wailua project are situated on state forest reserve land. The lower half of the proposed project, from the powerhouse site to the existing substation (transmission section), is covered by sugar cane fields and forestry plantings. The forestry plantings are found in the area between Hanahanapuni and the powerhouse site (near the lower gaging station at the end of the Stable Storm Ditch 4-WD road, ±700 ft. elevation) and are composed of such species as Eucalyptus, paper bark, Paraserianthes (formerly Albizia), tropical ash, etc. There are patches of native trees such as 'ohi'a, hame, and 'ohi'a-ha and the mat-forming uluhe fern scattered among the forestry plantings.

The proposed permanent access road, the lower penstock route and the intake site are situated in open areas near the stream. Unfortunately, most of the riparian system, especially at mid to lower elevations, has been disturbed and, in many places, guava scrub has replaced much of the native vegetation. Over these areas of the project, the vegetation is composed largely of guava shrubs, dense mats of California grass, and scattered clumps of Job's tears. Where the penstock is located on the steeper slopes and ridge areas above the stream, the native taxa dominate and a vegetation consisting of an open 'ohi'a forest with large areas occupied by uluhe fern is found.

Three vegetation types are described in detail below. A checklist of all the plant species found during an on-site survey is provided in Table 2.2-6. Plant families are arranged alphabetically within each of three groups: Ferns and Fern Allies, Monocots, and Dicots. Taxonomy and nomenclature of the Ferns and Fern Allies follow Lamoreux (1984); the flowering plants (Monocots and Dicots) are in accordance with Wagner et al. (in press). In most cases, common English and/or Hawaiian names given follow St. John (1973) or Porter (1972). The full text of the botanical survey report is included as Appendix A.

Guava/California Grass Association -- Vegetation on the area near the outlet to the Hanalei Tunnel (proposed intake structure site), and on the proposed powerhouse site is composed almost exclusively of a guava (Psidium guajava)/California grass (Brachiaria mutica) association. Guava is one of

TABLE 2.2-6. List of plant species observed on the project site.

Scientific Name	Common Name
FERNS AND FERN ALLIES	
ADIANTACEAE (Maiden-hair Fern Family)	
Adiantum hispidulum Sw.	maiden-hair fern
ATHYRIACEAE (Athyrium Family)	
Athyriopsis japonica (Thunb.) Ching	
Diplazium sandwichianum (Presl) Diels	ho'i'o
BLECHNACEAE (Blechnum Family)	
Blechnum occidentale L.	blechnum
DICKSONIACEAE (Tree Fern Family)	
Cibotium splendens (Gaud.) Krajina ex Skottsb.	hapu'u pulu
ELAPHOGLOSSACEAE (Elaphoglossum Family)	
Elaphoglossum crassifolium (Gaud.) Anders. & Crosby	'ekaha, hoe-a- Maui
GLEICHENIACEAE (False Stag-horn Fern Family)	
Dicranopteris linearis (Burm.) Underw.	uluhe
Diplopterygium pinnatum (Kunze) Nakai	uluhe-lau-nui
GRAMMITACEAE (Grammitis Family)	
Adenophorus hymenophylloides (Kaulf.) Hook. & Grev.	pai, palai-huna
Adenophorus tamariscinus (Kaulf.) Hook. & Grev.	wahine-noho-mauna
Grammitis tenella Kaulf.	kolokolo, mahina-lau
HEMIONITIDACEAE (Gold Fern Family)	
Pityrogramma calomelanos (L.) Link	gold gern
HYMENOPHYLLACEAE (Filmy Fern Family)	
Gonocormus minutus (Blume) v. d. Bosch.	gonocormus
Mecodium recurvum (Gaud.) Copel.	'ohi'a-ku
LINDSAEACEAE (Lace Fern Family)	
Sphenomeris chinensis (L.) Maxon	pala'a, palapala'a
LYCOPODIACEAE (Club Moss Family)	
Lycopodium phyllanthum Hook. & Arnott	wawae-'iole

TABLE 2.2-6 (continued). List of plant species observed on the project site.

Scientific Name	Common Name
FERNS AND FERN ALLIES (continued)	
NEPHROLEPIADACEAE (Sword Fern Family)	
Nephrolepis exaltata (L.) Schott	ni'ani'au, kupukupu
Nephrolepis multiflora (Roxb.) Jarrett ex Morton	hairy sword fern
OPHIOGLOSSACEAE (Adder's-tongue Fern Family)	
Ophioglossum pendulum subsp. falcatum (Presl) Clausen	puapua-moe
POLYPODIACEAE (Common Fern Family)	
Phlebodium aureum (L.) J. Sm.	laua'e-haole
Phymatosorus scolopendria (Burm.) Pic.-Serm.	laua'e, lauwa'e
Pleopeltis thunbergiana Kaulf.	'ekaha-'akolea, pakahakaha
PSILOTACEAE (Psilotum Family)	
Psilotum nudum (L.) Beauv.	moa, pipi
SELAGINELLACEAE (Small Club Moss Family)	
Selaginella arbuscula (Kaulf.) Spring	lepelepe-a-moa
THELYPTERIDACEAE (Downy Woodfern Family)	
Christella dentata (Forsk.) Brownsey & Jermy	downy woodfern
Christella parasitica (L.) Levl.	woodfern
Cyclosorus interruptis (Willd.) H. Ito	neke
Pneumatopteris sandwicensis (Brack.) Holtt.	
MONOCOTS	
AGAVACEAE (Agave Family)	
Cordyline fruticosa (L.) A. Chev.	ti, ki
ARACEAE (Arum Family)	
Colocasia esculenta (L.) Schott	taro, kalo
COMMELINACEAE (Spiderwork Family)	
Commelina diffusa N.L. Burm.	honohono

TABLE 2.2-6 (continued). List of plant species observed on the project site.

Scientific Name	Common Name
MONOCOTS (continued)	
CYPERACEAE (Sedge Family)	
Cyperus difformis L.	
Cyperus halpan L.	
Cyperus rotundus L.	nutgrass, nut sedge
Cyperus sp.	
Eleocharis geniculata (L.) Roem. & Schult.	eleocharis
Eleocharis cf. radicans (Poir) Kunth	
CYPERACEAE (Continued)	
Fimbristylis dichotoma (L.) Vahl.	tall fringe rush
Kyllinga brevifolia Rottb.	kyllinga, kili-o-opu
Machaerina mariscoides subsp. meyenii (Kunth) T. Koyama	'uki, 'ahu-niu
Mariscus cf. cyperinus (Retz.) Vahl	
Pycreus polystachyos (Rottb.) P. Beauv.	
Rhynchospora rugosa subsp. lavarum (Gaud.) T. Koyama	kuolohia, pu'uko'a
Schoenoplectus juncoides (Roxb.) Palla	
DIOSCORIACEAE (Yam Family)	
Dioscorea bulbifera L.	bitter yam, pi'oi
Dioscorea pentaphylla L.	pi'ia
LILIACEAE (Lily Family)	
Astelia menziesiana Sm.	pa'iniu
MUSACEAE (Banana Family)	
Musa X paradisiaca L.	banana, maia
ORCHIDACEAE (Orchid Family)	
Phaius tankarvilleae (Banks ex L'Her) Blume	phaius
Spathoglottis plicata Blume	Chinese ground orchid
PANDANACEAE (Screw Pine Family)	
Freycinetia arborea Gaud.	'ie'ie
POACEAE (Grass Family)	
Axonopus fissifolius (Raddi) Kuhlm.	carpetgrass
Brachiaria mutica (Forssk.) Stapf	California grass, paragrass
Cenchrus echinatus L.	common sandbur
Chloris barbata (L.) Sw.	swollen fingergrass
Chloris radiata (L.) Sw.	radiata fingergrass
Coix lachryma-jobi L.	Job's tears

TABLE 2.2-6 (continued). List of plant species observed on the project site.

Scientific Name	Common Name
POACEAE (continued)	
Cyonodon dactylon (L.) Pers.	Bermuda grass, manienie
Digitaria ciliaris (Retz.) Koeler	large crabgrass
Digitaria cf. horizontalis Willd.	
Digitaria radicosa (Presl) Miq.	crabgrass
Digitaria setigera Roth	itchy crabgrass
Digitaria violascens Linke	kukai pua'a-uka
Echinochloa colona (L.) Link	jungle rice
Echinochloa crus-galli (L.) P. Beauv.	barnyard rice
Eleusine indica (L.) Gaertn.	wiregrass
Eragrostis sp.	
Melinis minutiflora P. Beauv.	molassesgrass
Oplismenus compositus (L.) P. Beauv.	
Paspalum conjugatum Bergius	Hilo grass
Paspalum dilatatum Poir	paspalum grass
Paspalum scrobiculatum L.	rice grass
Paspalum urvillei Steud.	Vasey grass
Saccharum officinarum L.	sugar cane, ko
Sacciolepis indica (L.) Chase	Glenwood grass
Schizostachyum glaucifolium (Rupr.) Munro	bamboo, ohe
Setaria gracilis Kunth	foxtail
Sporobolus africanus (Poir) Robyns & Tournay	African dropseed
PONTEDERIACEAE (Pickerelweed Family)	
Monochoria vaginalis (N.L. Burm.) K. Presl	cordata monchoria
SMILACACEAE (Smilax Family)	
Smilax melastomifolia Sm.	hoi-kuahiwi
ZINGERBERACEAE (Ginger Family)	
Zingiber zerumbet (L.) Sm.	shampoo ginger, 'awapuhi kuahiwi
DICOTS	
ACANTHACEAE (Acanthus Family)	
Thunbergia fragrans Roxb.	white thunbergia
AMARANTHACEAE (Amaranth Family)	
Amaranthus spinosus L.	spiny amaranth
ANACARDIACEAE (Mango Family)	
Mangifera indica L.	mango, manako

TABLE 2.2-6 (continued). List of plant species observed on the project site.

Scientific Name	Common Name
APIACEAE (Carrot Family)	
Centella asiatica (L.) Ruban	Asiatic pennywort
Ciclospermum leptophyllum (Pers.) Sprague	fir-leaved celery
Cryptotaenia canadensis (L.) DC	wild celery, honeywort
Hydrocotyle sibthorpioides Lam.	marsh pennywort
APOCYNACEAE (Periwinkle Family)	
Alyxia oliviformis Gaud.	maile
AQUIFOLIACEAE (Holly Family)	
Ilex anomala Hook. & Arnott	kawa'u, ka'awa'u
ASTERACEAE (Daisy Family)	
Adenostemma lavenia (L.) Kuntz	kamanamana
Ageratum conyzoides L.	ageratum, maile-hohono
Ageratum houstonianum Mill.	ageratum
Bidens pilosa L.	Spanish needle
Conyza bonariensis (L.) Cronq.	hairy horseweed, ilioha
Conyza canadensis var. pusilla (Nutt.) Cronq.	Canada fleabane
Crassocephalum crepidioides (Benth.) S. Moore	crassocephalum
Eclipta alba (L.) Hassk.	false daisy
Elephantopus mollis Kunth	elephant's-foot
Emilia coccinea (Sims) G. Don	red pua-lele
Emilia fosbergii Nicolson	purple fireweed
Erchtites valerianifolia (Wolf) DC	Indian pluchea
Pluchea indica (L.) Less.	pluchea
Pluchea symphytifolia (Mill.) Gillis	synedrella
Synedrella nodiflora (L.) Gaertn.	iron weed
Vernonia cinerea (L.) Less.	oriental hawksbeard
Youngia japonica (L.) DC	
BIGNONIACEAE (Bignonia Family)	
Spathodea campanulata P. Beauv.	African tulip tree
CAMPANULACEAE (Bellflower Family)	
Cyanea cf. fauriei H. Lev.	cyanea
CARYOPHYLLACEAE (Carnation Family)	
Drymaria cordata var. pacifica Mizush.	drymaria pilipili
CASUARINACEAE (Casuarina Family)	
Casuarina equisetifolia L.	ironwood

TABLE 2.2-6 (continued). List of plant species observed on the project site.

Scientific Name	Common Name
CELASTRACEAE (Bittersweet Family)	
Perottetia sandwicensis A. Gray	olomea
COMBRETACEAE (Terminalai Family)	
Terminalia myriocarpa Van Heurck & Mull. Arg.	
CONVOLVULACEAE (Morning-glory Family)	
Ipomoea alba L.	moonflower, koali-pehu
Ipomoea indica (J. Sm.) Merr.	koali-'awania
Ipomoea triloba L.	little bell
EUPHORBIACEA (Spurge Family)	
Aleurites moluccana (L.) Willd.	kukui, tutui
Antidesma platyphyllum var. hillebrandii Pax & K. Hoffm.	hame, mehamehame
Chamaesyce hirta (L.) Millsp.	hairy spurge
Chameasyce hypericifolia (L.) Millsp.	spurge
Chamaesyce prostrata (Aiton) Sm.	prostrate spurge
Euphorbia heterophylla L.	fire plant
Phyllanthus debilis Klein ex Willd.	phyllanthus weed
Ricinus communis L.	castor bean, koli
FABACEAE (Pea Family)	
Chamaecrista nictitans (L.) Moench	partridge pea, lauki
Crotalaria incana L.	fuzzy rattlepod
Desmanthus virgatus (L.) Willd.	virgate mimosa
Desmodium incanum DC	Spanish clover
Desmodium sandwicense E. May.	ka'imi
Desmodium tortuosum (Sw.) DC	Florida beggarweed
Desmodium triflorum (L.) DC	three-flowered beggarweed
Desmodium sp.	
Indigofera suffruticosa Mill	indigo, 'iniko
Leucaena leucocephala (Lam.) deWit	koa-haole
Macroptilium lathyroides (L.) Urb.	wild bush-bean
Mimosa piduca var. unijuga (Duchass. & Walp.) Griseb.	sensitive plant, pua-hilahila
Paraserianthes falcataria (L.) I. Nielsen	
HYDRANGEACEAE (Hydrangea Family)	
Broussaisia arguta Gaud.	kanawao
LAMIACEAE (Mint Family)	
Leonotis nepetifolia (L.) R. Br	lion's-ear

TABLE 2.2-6 (continued). List of plant species observed on the project site.

Scientific Name	Common Name
LAURACEAE (Laurel Family)	
Persea americana Mill.	avocado
LYTHRACEAE (Loosestrife Family)	
Cuphea carthagenensis (Jacq.) Macbf.	Colombian cuphea, puakamoli
MALVACEAE (Hibiscus Family)	
Hibiscus tiliaceus L.	hau
MELASTOMATACEAE (Melastome Family)	
Heterocentron subtriplinervium (Link & Otto) A. Braun & C. Bouche	pearl flower
Melastoma candidum D. Don	Malabar melastome
MYRTACEAE (Myrtle Family)	
Eucalyptus robusta Sm.	swamp mahogany
Eucalyptus sp.	eucalyptus
Melaleuca quinquenervia (Cav.) S. T. Blake	paper bark
Metrosideros polymorpha Gaud.	'ohi'a-lehua, 'ohi'a
Psidium cattleianum Sabine	strawberry guava, waiawi
Psidium guajava L.	guava, kuawa
Psidium littorale Raddi	
Rhodomyrtus tomentosa (Aiton) Hassk.	downy myrtle, rose myrtle
Syzygium cumini (L.) Skeels	Java plum, palama
Syzygium sandwicensis Gray	'ohi'a-ha
NYCTAGINACEAE (Four O'clock Family)	
Pisonia sandwicensis Hillebr.	papala-kepau
OLEACEAE (Olive Family)	
Fraxinus uhdei (Wenzig) Ligelsh	tropical ash
ONAGRACEAE (Evening Primrose Family)	
Ludwigia octovalvis (Jacq.) Raven	primrose willow, kamole
OXALIDACEAE (Wood Sorrel Family)	
Oxalis corniculata L.	yellow wood sorrel, ihi
Oxalis corymbosa DC	pink wood sorrel

TABLE 2.2-6 (continued). List of plant species observed on the project site.

Scientific Name	Common Name
PASSIFLORACEAE (Passion Fruit Family)	
Passiflora edulis Sims	passion fruit, lilikoi
PIPERACEAE (Pepper Family)	
Piper methysticum G. Forster	'awa, kava
PLANTAGINACEAE (Plantain Family)	
Plantago major L.	broad-leaved plantain, lau-kahi
POLYGALACEAE (Polygala Family)	
Polygala paniculata L.	polygala
POLYGONACEAE (Buckwheat Family)	
Polygonum glabrum Willd.	knotweed, kamole
PRIMULACEAE (Primrose Family)	
Anagallis arvensis L.	scarlet pimpernel
ROSACEAE (Rose Family)	
Rubus rosifolius Sm.	thimbleberry
RUBIACEAE (Coffee Family)	
Hedyotis terminalis (Hook. & Arnott) W.L. Wagner & Herbst	manono
Psychotria kaduana (Cham. & Schlechtend.) Fosb.	kopiko
Spermacoce assurgens Ruiz & Pav.	buttonweed, spermacoce
SAPOTACEAE (Sapodilla Family)	
Chrysophyllum oliviforme L.	satin leaf
SOLANACEAE (Tomato Family)	
Solanum americanum Mill.	popolo
URTICACEAE (Nettle Family)	
Boehmeria grandis (Hook. & Arnott) A. Heller	akoka
Pilea peploides (Gaud.) Hook. & Arnott	pilea
Pipturus albidus (Hook. & Arnott) A. Gray	mamaki

TABLE 2.2-6 (continued). List of plant species observed on the project site.

Scientific Name	Common Name
VERBENACEAE (Verbena Family)	
Lantana camara L.	lantana, lakana
Stachytarpheta dichotoma (Ruiz & Pav.) Vahl	Cayenne vervain
Stachytarpheta urticifolia (Salisb.) Sims	nettle-leaved vervain
Verbena litoralis Kunth	weed verbena

the most common shrubs in drainage areas which have been disturbed (Fosberg, 1972) and is spread primarily by feral pigs in such areas. California grass, a large coarse perennial grass with hairy stems, forms dense patches to 7 feet tall.

Along the penstock route, the occurrence of native species is more common, especially in the areas of ridge tops and steeper slopes (from about 1,220 feet to 800 feet elevations). Trees and shrubs of 'ohi'a (Metrosideros polymorpha), papala-kepau (Pisonia sandwicensis), kawa'u (Ilex anomala), mamaki (Pipturus albidus), olomea (Perottetia sandwicensis), hame (Antidesma platyphyllum), and kopiko (Psychotria kaduana) are occasional. Other natives include a number of ferns such as ho'i'o (Diplazium sandwichianum), hapu'u pulu (Cibotium splendens), 'ekaha (Elaphoglossum crassifolium), wahine-noho-mauna (Adenophorus tamariscinus), kolokolo (Grammitis tenella), etc.; and a few climbers such as ieie (Freycinetia arborea), maile (Alyxia oliviformis), and hoikuahiwi (Smilax melastomifolia). Over much of the penstock route, the matted uluhe fern (Dicranopteris linearis) is abundant; less frequently observed is uluhe-lau-nui (Diplopterygium pinnatum).

Locally common in places along the stream sides are clumps of Job's tears (Coix-lachryma jobi), a robust erect grass to 6 feet tall. Other species found occasionally along the stream or in the shallow water areas include such species as taro (Colocasia esculenta), primrose willow (Ludwigia octovalvis), honohono (Commelina diffusa), drymaria (Drymaria cordata), Pycreus polystachyos, and cuphea (Cuphea carthagenensis).

Mixed Forests -- From the proposed powerhouse site, just above the Stable Storm Ditch diversion on the North Fork Wailua River, to the cane fields located south (makai) of Hanahanapuni, the vegetation consists of large blocks of forestry plantings. The taller specimens such as Paraserianthes (Albizia) falcataria and various Eucalyptus species may be 50 to 70 feet tall while paper bark (Melaleuca quinquenervia), the most abundant of the plantings, may vary in height from 12 to 18 feet tall in open, scrubby plantings to 25 to 35 feet tall in the denser, older stands. Other forestry plantings include a few trees of tropical ash (Fraxinus uhdei), Terminalia myriocarpa, ironwood (Casuarina equisetifolia), satin leaf (Chrysophyllum oliviforme), etc. In the open scrubby paper bark plantings, uluhe fern (Dicranopteris linearis) commonly forms a dense cover between the trees. Also found in this area are scattered trees of 'ohi'a (Metrosideros polymorpha), hame (Antidesma platyphyllum), and 'ohi'a-ha (Syzygium sandwicensis).

In almost all parts of the mixed forest with the exception of the hau forests, the shrub layer is dense and almost impenetrable. The common components of the shrub layer are Malabar melastome (Melastoma candidum), strawberry guava (Psidium cattleianum), and downy rose myrtle (Rhodomyrtus tomentosa). Because of the dense shrub layer, ground cover consists of more shade-tolerant species such as ni'ani'au (Nephrolepis exaltata), wood ferns (Christella parasitica, Christella dentata), thimbleberry (Rubus rosaefolius), and blechnum (Blechnum occidentale). Where there is more available light, as along the jeep road through the forested area, an assortment of various weedy grasses, sedges, and herbs can be found.

Hau (Hibiscus tiliaceus) forms dense forests, 18 to 25 feet tall, on the lower slopes of Hanahanapuni where the proposed transmission line will run. Common associates of this forest type are bitter yam (Dioscorea bulbifera), pi'ia (Dioscorea pentaphylla), shampoo ginger (Zingiber zerumbet), hairy sword fern (Nephrolepis multiflora), Hilo grass (Paspalum conjugatum), elephant's-foot (Elephantopus mollis), and Oplismenus compositus.

Cane Fields -- Almost one-half the length of the transmission line will be located along or adjacent to existing haul cane roads. A number of weedy species commonly associated with agricultural lands are found along the roadsides and margins of fields. These include nutgrass (Cyperus rotundus), broad-leaved plantain (Plantago major), Bermuda grass or manienie (Cynodon dactylon), several crabgrass (Digitaria) species, radiate fingergrass (Chloris radiata), spurges (Chamaesyce spp.), and California grass (Brachiaria mutica). Within the fields themselves, weed numbers are low due to the dense stands of cane which tend to shade out the lower growing weedy plants.

Threatened and Endangered Species

No officially listed threatened or endangered plant species designated by the federal and/or state governments (U.S. Fish and Wildlife Service 1985; Herbst 1987) were found on the project site; nor are any plants proposed or candidate for such status. None of the native plants inventoried during the field survey are considered rare (Fosberg and Herbst 1975).

Previous field studies of the flora in drainage areas such as along the Hanalei River (Char 1986), Makaleha Stream (Linney and Char 1986), and the South Fork of Wailua River (Department of the Army 1982) have also resulted in similar findings. Generally such drainage areas are dominated by introduced species such as guava, hau, and California grass. Native species are commonly those which are widespread throughout the islands in similar environmental habitats.

2.2.2.2 Fauna

Terrestrial vertebrate fauna within the project area contains members of the four major orders: birds, mammals, reptiles and amphibians. The majority of species found within the project area are exotic with only a small number of native species present. A wildlife survey was conducted in the project area, February 12 to 17, 1989, to investigate the potential for endangered species and to determine the species composition of forest birds.

Avian Fauna

The birdlife of the Hawaiian Islands is a moderately rich mixture of nesting seabirds and terrestrial birds with a small number of waterbirds and raptors. Prior to the arrival of the Polynesians (between A.D. 500 and 750), the native birdlife was particularly rich with at least 110 endemic species and subspecies present. As few as 15 original colonist species are believed to account for at least 70 species and subspecies, with a single species from the Fringillidae family responsible for the subsequent evolution of more than 50 of these (Shallenberger 1986).

Large scale extinctions and population reductions of these endemic bird species have occurred since the arrival of the Polynesians with at least 40 species disappearing before Europeans arrived on the islands in 1778 (Olson and James 1982). Since that time, an additional 23 species and subspecies have gone extinct and another 28 have been listed as endangered (27) or threatened (1) under the Federal Endangered Species Act (Shallenberger 1986).

Habitat destruction, weather, hunting, and the introduction of exotic plants, livestock, predators, competing species of birds, disease and disease vectors have all been hypothesized to have contributed to the extinction of these unique species and subspecies (Pratt et al. 1987; Scott et al. 1986; Shallenberger 1986; Carothers et al. 1983; Olson and James 1982; Berger 1981; Warner 1968). Widespread habitat destruction through clearing (for farming, logging and human settlement) and grazing and trampling by feral livestock, the introduction of the predatory small Indian mongoose (Herpestes auropunctatus) and rats (Rattus rattus, R. norvegicus, R. exulans) and the accidental introduction in 1826 of the night-biting mosquito (Culex quinquefasciatus), a vector for avian malaria, are considered to be the major factors in these extinctions. The confining of most native forest birds to elevations above 1970 ft (600 m) may be in part the result of the upper elevational limit of these malaria-carrying mosquitoes (Warner 1968).

Introduction of exotic birds to the Hawaiian Islands began with the arrival of the red jungle-fowl (Gallus gallus) with the Polynesians. Since the arrival of the Europeans, over 170 species of birds have been introduced, including 78 potential game birds (Berger 1981). While many of these species did not become established, several have become among the most abundant land birds on the islands.

The island of Kauai presently has 72 regularly occurring bird species (Shallenberger 1986; DLNR 1984; Berger 1981) with the band-rumped petrel hypothesized to breed there (Berger 1981). This includes 22 species indigenous to the Hawaiian Islands, 20 species and subspecies endemic to the Hawaiian Islands and 31 exotic species including 12 game species (Table 2.2-7). Of the endemic species, five occur only on Kauai. Kauai is unique among the main Hawaiian Islands in that all the native bird species recorded since the arrival of the Europeans were still present in the 1960's, perhaps because Kauai is the only main island to have avoided the introduction of the mongoose (Berger 1981). However, the Kauai 'akialoa was last observed in 1965 and is possibly extinct and only one individual of the Kauai 'O'o has been seen since 1984 (Scott et al. 1986). In addition, most of the other native forest birds have declined in abundance and have been restricted in distribution to mountainous regions above 600 m while many of the nesting seabirds and waterbirds have been dramatically reduced in abundance (Shallenberger 1986; Berger 1981; Warner 1968).

The avifauna within the project area reflects these rather complex changes in birdlife in the Hawaiian Islands. Only a few native species occur with the majority of species being introduced.

As part of the wildlife survey conducted in February 1989, a survey of forest birds was conducted within the project area. The object of the survey was to determine if native forest birds occurred in the project area. Systematic methods were used to enumerate birds along the proposed penstock line as this is the only section of the project area that would be exposed to disturbance that might contain these species. Observations of birds were also recorded within the lower portions of the project area (plant site, staging area and transmission line corridor) and along Maheo Stream.

The variable circular-plot method (Reynolds et al. 1982) was used to systematically sample forest birds along the proposed penstock route. Sampling stations were located roughly every 250 m along the proposed route (Figure 2.2-5). Additional stations were located along the lower portion of the trail leading up to the Hanalei diversion tunnel to increase the sample size for the survey within similar habitat. Twenty stations were sampled during the survey.

Six (6) species of birds were identified during the systematic sampling (Table 2.2-8). No native forest birds were located during the survey. This is consistent with the findings of Scott et al. (1986) as the project area is outside the known range of all native forest birds on the island (Figure 2.2-6). The Hawaiian duck and white-tailed tropic bird were also seen during the survey but flying at distances of 200 to over 1000 m. No other species of forest birds were recorded in this area during other activities.

Japanese white-eye was the most abundant species recorded with a mean density of 2027 km^{-2}. This was not unexpected as this species is probably the most abundant forest bird in Kauai (Pratt et al. 1987). The large number of Japanese bush warblers (494 km^{-2}) was unexpected as this species was only hypothesized to be on Kauai (Pratt et al. 1987). This species has apparently recently spread from Oahu (where is was originally introduced from Japan) and undergone a population explosion within this region.

TABLE 2.2-7. Species list of birds that regularly inhabit Kauai. Federal status relative to the Endangered Species Act, occurrence status on Kauai, life history status on Kauai and status relative to the project area are indicated. Species names and taxonomy are the most recent from the American Ornithological Union. Classification into groups reflects DLNR (1984).

Common Name	Scientific Name	Hawaiian Name	A[1]	B[2]	C[3]	D[4]
SEABIRDS						
Family DIOMEDEIDAE (Albatrosses)						
Laysan Albatross	Diomedea immutabilis	Moli		I	B	
Family PROCELLARIIDAE (Shearwaters, Petrels)						
Wedge-tailed Shearwater	Puffinus pacificus chlororhynchus	'Ua'u-kani		I	B	
Newell's Shearwater	Puffinus newelli	'A'o	T	E	B	P
Dark-rumped (Hawaiian) Petrel	Pterodroma phaeopygia sandwichensis 'Ua'u	E	E	H	?	
Family HYDROBATIDAE (Storm-Petrels)						
Band-rumped (Hawaiian) Storm-Petrel	Oceanodroma castro cryptoleucura	'Oeoe	E	I	B	?
Family PHAETHONTIDAE (Tropicbirds)						
White-tailed Tropicbird	Phaethon lepturus dorotheae	Koa'e-kea		I	B	U
Family SULIDAE (Boobies)						
Red-footed Booby	Sula sula rubripes	'A		I	B	
Family FREGATIDAE (Frigatebirds)						
Great Frigatebird	Fregata minor palmerstoni	'Iwa		I	V	
Family LARIDAE (Gulls, Terns, Noddies)						
Black Noddy	Anous minutus melanogenys	Noio		I	R	
MIGRATORY SHOREBIRDS						
Family CHARADRIIDAE (Plovers)						
Black-bellied Plover	Pluvialis squatarola			I	W	
Lesser Golden Plover	Pluvialis dominica	Kolea		I	W	F
Family SCOLOPACIDAE (Sandpipers, Waders)						
Wandering Tattler	Heteroscelus incanus	'Ulili		I	W	O
Bristle-thighed Curlew	Numenius tahitiensis	Kioea		I	W	
Ruddy Turnstone	Arenaria interpres	'Akekeke		I	W	
Sanderling	Calidris alba	Huna-kai		I	W	
Pectoral Sandpiper	Calidris melanotos			I	W	
Sharp-tailed Sandpiper	Calidris acuminata			I	W	
MIGRATORY WATERFOWL						
Family ANATIDAE (Geese, Ducks)						
Mallard	Anas platyrhynchos			I	W	
Northern Pintail	Anas acuta	Koloa-mapu		I	W	
Green-winged Teal	Anas crecca			I	W	
Northern Shoveler	Anas clypeata	Koloa-moha		I	W	
American Widgeon	Anas americana			I	W	
Lesser Scaup	Aythya affinis			I	W	

TABLE 2.2-7 (continued). Species list of birds that regularly inhabit Kauai. Federal status relative to the Endangered Species Act, occurrence status on Kauai, life history status on Kauai and status relative to the project area are indicated. Species names and taxonomy are the most recent from the American Ornithological Union. Classification into groups reflects DLNR (1984).

Common Name	Scientific Name	Hawaiian Name	A[1]	B[2]	C[3]	D[4]
RESIDENT WATERFOWL						
Family ANATIDAE						
Hawaiian Duck	Anas wyvilliana	Koloa	E	E	R	F
WATERBIRDS						
Family ARDEIDAE (Herons, Egrets)						
Cattle Egret	Bubulcus ibis			X	R	F
Black-crowned Night Heron	Nycticorax nycticorax hoactli	'Auku		I	R	F
Family RALLIDAE (Rails, Gallinules, Coots)						
Common Moorhen (Hawaiian Gallinule)	Gallinula chloropus sandvicensis	'Alae-'ula	E	E	R	O
American (Hawaiian) Coot	Fulica americana alai	'Alae-ke'oke'o	E	E	R	O
Family RECURVIROSTRIDAE (Stilts)						
Black-necked (Hawaiian) Stilt	Himantopus mexicanus knudseni	Ae'o	E	E	R	
FOREST BIRDS						
Family MUSCICAPIDAE (Old World Warblers, Thrushes)						
Japanese Bush Warbler	Cettia diphone			X	R	C
'Elepaio	Chasiempis sandwichensis sclateri	'Elepaio		E	R	O
White-rumped Shama	Copsychus malabaricus			X	R	C
Kama'o (Kauai Thursh)	Myadestes myadestinus	Kama'o	E	E	R	
Puaiohi (Small Kauai Thrush)	Myadestes palmeri	Puaiohi	E	E	R	
Greater Necklaced Laughing-thrush	Garrulax pectoralis			X	R	O
Melodious Laughing-thrush	Garrulax canorus			X	R	C
Red-billed Leiothrix	Leiothrix lutea			X	R	O
Family MELIPHAGIDAE (Honeyeaters)						
Kauai 'O'o	Moho braccatus	'O'o'a'a	E	E	R	
Family ZOSTEROPIDAE (White-eyes)						
Japanese White-eye	Zosterops japonicus			X	R	C
Family FRINGILLIDAE (Old World Finches and Allies)						
'O'u	Psittirostra psittacea	'O'u	E	E	R	
Common 'Amakihi	Hemignathus virens stejnegeri	'Amakihi		E	R	O
'Anianiau	Hemignathus parvus	'Anianiau		E	R	
Kauai 'Akialoa	Hemignathus procerus	'Akialoa	E	E	R	
Nuku-pu'u	Hemignathus lucidus hanapepe	Nuku-pu'u	E	E	R	

TABLE 2.2-7 (continued). Species list of birds that regularly inhabit Kauai. Federal status relative to the Endangered Species Act, occurrence status on Kauai, life history status on Kauai and status relative to the project area are indicated. Species names and taxonomy are the most recent from the American Ornithological Union. Classification into groups reflects DLNR (1984).

Common Name	Scientific Name	Hawaiian Name	A[1]	B[2]	C[3]	D[4]
FOREST BIRDS *(continued)*						
Family FRINGILLIDAE (Old World Finches and Allies) *(continued)*						
Kauai Creeper	Oreomystis bairdi	'Akikiki		E	R	
'Akepa	Loxops coccineus caeruleirostris	'Akeke'e				
		'O'u-holo-wai		E	R	
'I'iwi	Vestiaria coccinea	'I'iwi		E	R	
'Apapane	Himatione sanguinea sanguinea	'Apapane		E	R	O
FIELD BIRDS						
Family ALAUDIDAE (Larks)						
Eurasian Skylark	Alauda arvensis			X	R	
Family MIMIDAE (Mockingbirds, Thrashers and Allies)						
Northern Mockingbird	Mimus polyglottos			X	R	
Family EMBERIZIDAE (Warblers, New World Finches, Blackbirds and Allies)						
Northern Cardinal	Cardinalis cardinalis			X	R	C
Western Meadowlark	Sturnella neglecta			X	R	
Family ESTRIDIDAE (Waxbills, Mannikins and Allies)						
Nutmeg Mannikin	Lonchura punctulata			X	R	C
Chestnut Mannikin	Lonchura malacca			X	R	C
URBAN BIRDS						
Family COLUMBIDAE (Pigeons, Doves)						
Rock Dove	Columba livia			X	R	
Family STURNIDAE (Mynas)						
Common Myna	Acridotheres tristis			X	R	C
Family EMBERIZIDAE (Warblers, New World Finches, Blackbirds and Allies)						
Red-crested Cardinal	Paroaria coronata			X	R	O
Family FRINGILLIDAE (Old World Finches and Allies)						
House Finch	Carpodacus mexicanus			X	R	C
Family PASSERIDAE (Old World Sparrows)						
House Sparrow	Passer domesticus			X	R	O
BIRDS OF PREY						
Family TYTONIDAE (Barn-Owls)						
Common Barn-Owl	Tyto alba			X	R	U
Family STRIGIDAE (Typical Owls)						
Short-eared Owl	Asio flammeus sandwichensis	Pueo		E	R	U

TABLE 2.2-7 (continued). Species list of birds that regularly inhabit Kauai. Federal status relative to the Endangered Species Act, occurrence status on Kauai, life history status on Kauai and status relative to the project area are indicated. Species names and taxonomy are the most recent from the American Ornithological Union. Classification into groups reflects DLNR (1984).

Common Name	Scientific Name	Hawaiian Name	A[1]	B[2]	C[3]	D[4]
GAME BIRDS						
Family PHASIANIDAE (Quail, Pheasants, Francolins)						
Black Francolin	Francolinus francolinus			X	R	
Gray Francolin	Francolinus pondicerianus			X	R	
Erckel's Francolin	Francolinus erckelii			X	R	
Chukar	Alectoris chukar			X	R	
Japanese Quail	Coturnix japonica			X	R	
Red Jungle-fowl	Gallus gallus	Moa		X	R	
Ring-necked Pheasant	Phasianus colchicus	Kolo-hula		X	R	F
Common Peafowl	Pavo cristatus			X	R	
Wild Turkey	Meleagris gallopavo	Pelehu		X	R	
California Quail	Callipepla californicus	Manu-kapalulu		X	R	
Family COLUMBIDAE (Pigeons, Doves)						
Spotted Dove	Streptopelia chinensis			X	R	F
Zebra (Barred) Dove	Geopelia striata			X	R	C

[1] FEDERAL STATUS
- E = Endangered
- T = Threatened

[2] OCCURRENCE STATUS
- E = Endemic
- I = Indigenous
- X = Exotic

[3] LIFE HISTORY STATUS ON KAUAI
- B = Breeds but not permanent resident
- H = Hypothesized breeder
- R = Perminant resident
- V = Non-breeding visitor
- W = Winter visitor

[4] PROJECT AREA STATUS
- C = Common resident
- F = Fairly common resident
- U = Uncommon resident
- V = Uncommon visitor
- O = Occassional visitor
- P = Possible breeder but no records
- ? = Unlikely but unknown breeding locations on Kauai
- = Not likely to occur

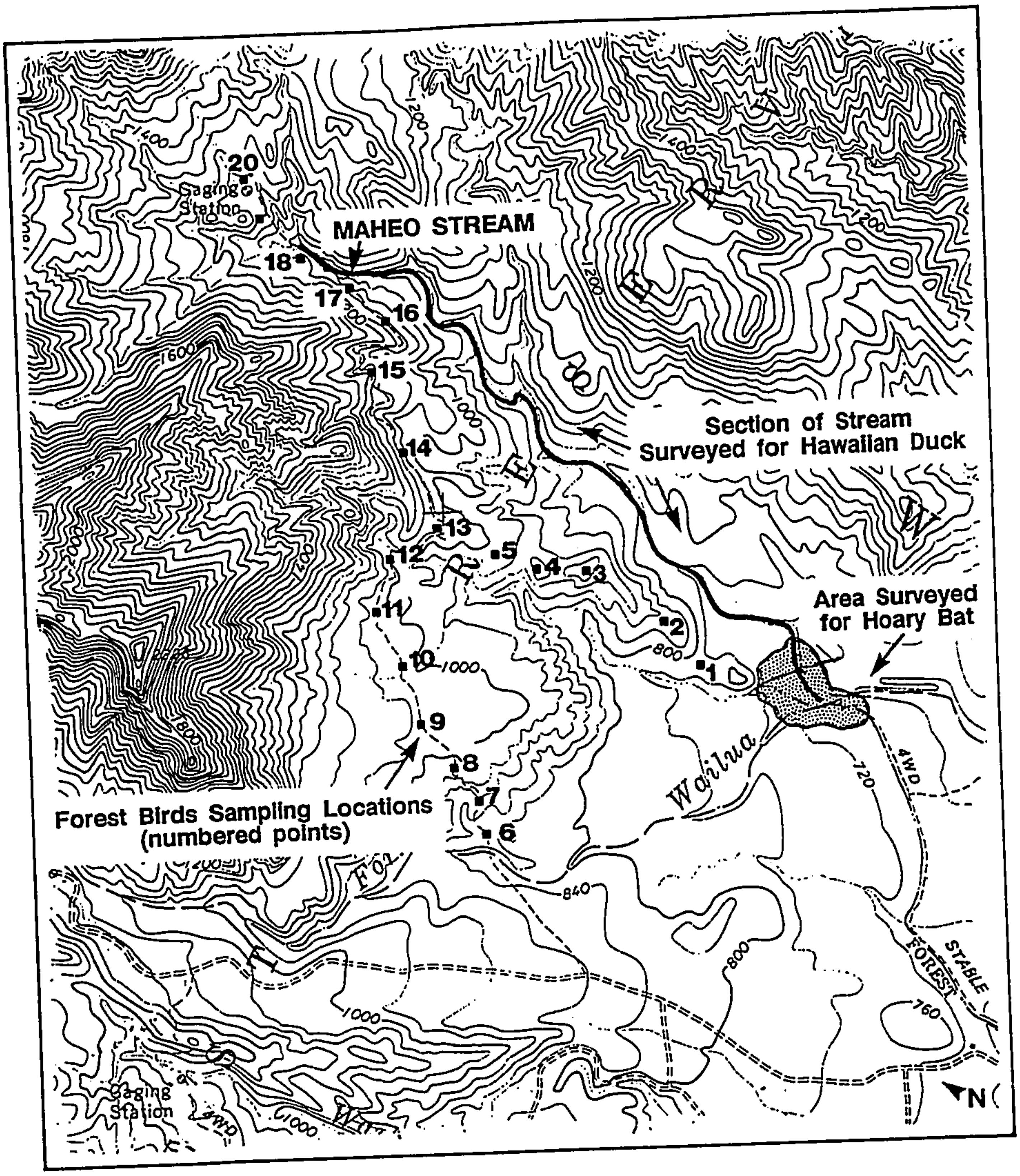


FIGURE 2.2-5. Locations of bird sampling stations, Hawaiian duck survey and hoary bat survey.

TABLE 2.2-8. Estimated densities of forest birds in forest areas near proposed penstock route. The variable-circular plot method with 20 sample locations was used to estimate densities. Numbers of singing males were doubled to obtain estimates of density for all species except Japanese white-eye and house finch. Densities are in numbers per km^{-2}.

Species	Mean	Std. Error
Japanese White-eye	2026.8	388.0
Japanese Bush Warbler	493.8	86.6
House Finch	105.2	51.8
Melodious Laughing-thrush	37.4	11.2
Northern Cardinal	26.4	10.6
White-rumped Shama	4.2	4.2

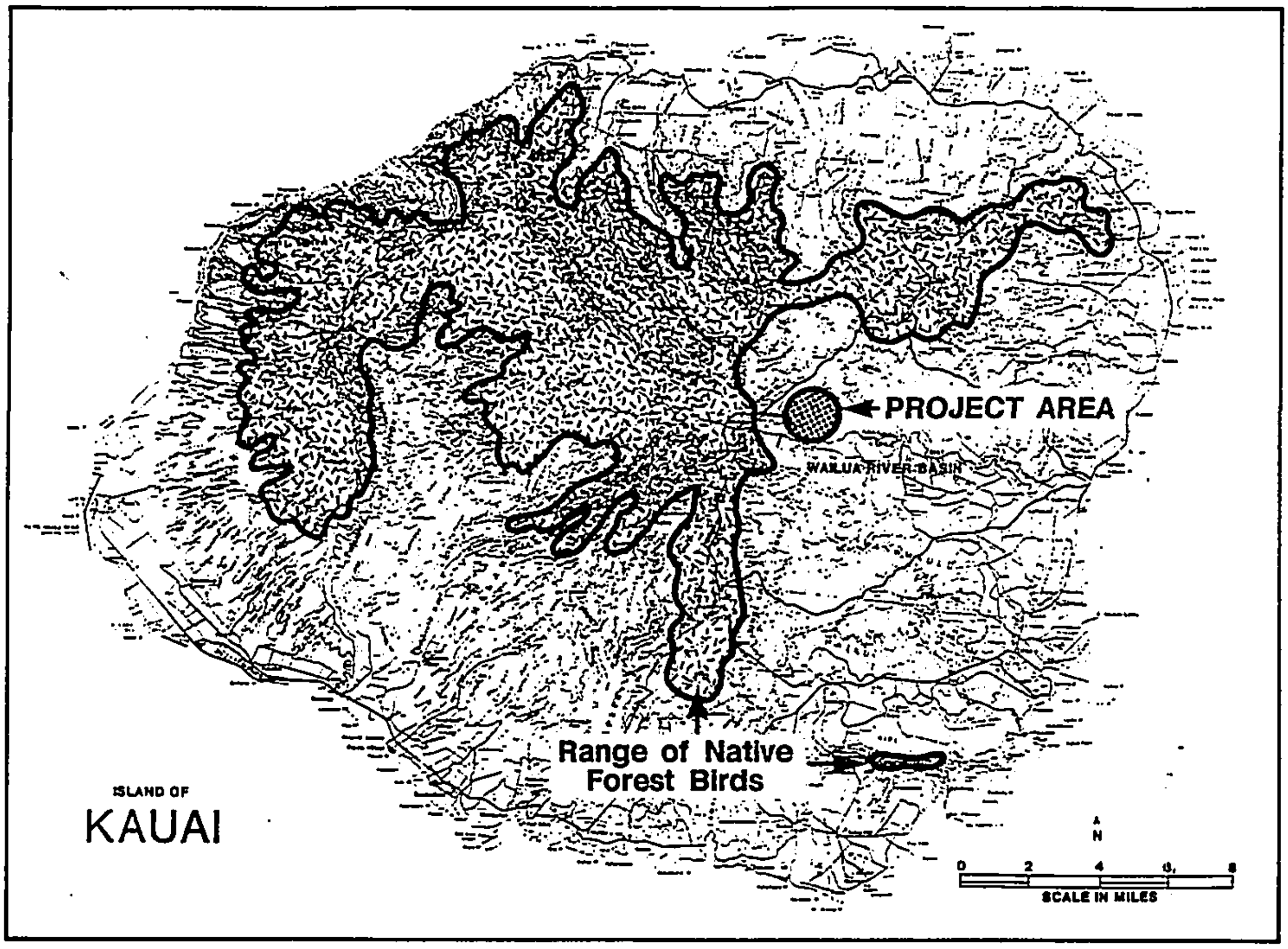


FIGURE 2.2-6. Maximal range for all native forest birds in Kauai (modified from Scott, et al. 1986). The Upper Wailua project area is also shown.

Both the white-eye and bush warbler as well as the house finch and cardinal were found spread over most of the survey area. White-rumped shama was recorded only in the low forest regions (stations 1 and 7) while melodious laughing thrush was largely restricted to the denser forest and brush areas.

Observations in the vicinity of the proposed power plant and staging area included 12 species (Table 2.2-9). A total of 7 species were recorded along the portion of the transmission line corridor from the staging area to the cane fields while 13 were recorded in the cane fields along the proposed corridor. Hawaiian duck, lesser golden plover and black crowned night heron were recorded within the channel of Maheo Stream. Of the birds observed within the vicinity of the project area only the black-crowned night heron, Hawaiian duck, lesser golden plover, white-tailed tropicbird and short-eared owl are native species with the rest being introduced species.

An additional 10 species of birds not observed during this survey may be occasional visitors to the study area, but are unlikely to breed there (Table 2.2-7). While not observed, the barn owl is expected to be uncommon in the study area and may breed. Newell's shearwaters nest in cliff areas similar to that near the project area but have not been recorded there. Band-rumped storm-petrels and dark-rumped petrels are postulated to breed on Kauai (Berger 1981; T. C. Telfer, DLNR, personal correspondence October, 1988) but very unlikely in the project area. The potential for game-bird hunting within the project area is very low as only three game birds (ring-necked pheasant, zebra dove and spotted dove) are likely to be found within the study area and primarily in the cane fields (T. C. Telfer, DLNR, personal correspondence October, 1988).

Mammalian Fauna

The Hawaiian Islands have only two native species of mammals, the hoary bat (Lasiurus cinereus semotus), and the Hawaiian monk seal (Monachus schauinslandi) with only the former occurring on the main islands (van Riper and van Riper 1982). A variety of species introductions by the Polynesians and Europeans, both intentional and accidental, have increased the number of mammal species to at least 19 (DLNR 1984). On the island of Kauai, 10 species are present (Table 2.2-10), including 3 species considered as game species (DLNR 1984).

Within the project area, 8 species of mammals may occur (Table 2.2-10), with feral pigs and feral goats being game species (T. C. Telfer, DLNR, personal correspondence October, 1988). Feral pigs are common within the study area and are an important game species within this region of Kauai (Figure 2.2-7). Feral goats are likely to be infrequent visitors with small numbers occurring regularly in the upper reaches of Hanalei Valley on Makaleha Peak (T. C. Telfer, DLNR, personal communication October, 1988)

TABLE 2.2-9. Species of birds observed within the project area during the wildlife survey, February 12-17, 1989.

Species	Section within Project Area[1] A	F	M	P	T	C
Cattle Egret				X		X
Black-crowned Night Heron			X	X		
Hawaiian Duck			X	X		
Ring-necked Pheasant						X
Lesser Golden Plover			X	X		X
White-tailed Tropicbird	X					
Spotted Dove						X
Zebra Dove						X
Short-eared Owl				X		
Japanese Bush Warbler		X		X	X	
White-rumped Shama		X		X	X	X
Melodious Laughing Thrush		X		X	X	X
Common Myna				X	X	X
Japanese White-eye		X		X	X	X
Northern Cardinal		X		X	X	X
House Finch		X		X	X	X
Nutmeg Mannikin						X
Chestnut Mannikin						X
Total by Area	*[2]	6	3	12	7	13

[1] Section within Project Area
A = Forested area on hillside above Hanalei diversion tunnel
F = Forested area along penstock route
M = Within Maheo Stream channel
P = Area near proposed power house and staging area
T = Forest area along proposed transmission line
C = Sugar cane fields along proposed transmission line

[2] A comprehensive survey was not conducted in this section.

TABLE 2.2-10. Species list of mammals that inhabit the island of Kauai. Federal status relative to the Endangered Species Act, occurrence status on Kauai, and status relative to the project area are indicated. Species names, taxonomy and classification are from DLNR (1984).

Common Name	Scientific Name	Hawaiian Name	A[1]	B[2]	C[3]
GAME MAMMALS					
Family SUIDAE (Old World Swine)					
Feral Pig	Sus scrofa	Pua'a		X	C
Family CERVIDAE (Antlered Ruminants)					
Mule Deer	Odocoileus hemionus columbianus	Kia		X	
Family BOVIDAE (Hollow-horned Ruminants)					
Feral Goat	Capra hircus	Kao		X	P
PREDATORY MAMMALS					
Family CANIDAE (Wolves, Jackals and Allies)					
Feral Dog	Canis familiaris	Ilio		X	
Family FELIDAE (Cats)					
Feral Cat	Felis catus	Popoki		X	C
RODENTS					
Family MURIDAE (Old World Rats and Mice)					
Roof Rat	Rattus rattus	'Iole-nui		X	C
Norway Rat	Rattus norvegicus	'Iole-po'o-wai		X	U
Polynesian Rat	Rattus exulans hawaiiensis	'Iole		X	C
House Mouse	Mus musculus	'Iole li'ili'i		X	C
OTHER MAMMALS					
Family VESPERTILIONIDAE (Common Bats)					
Hoary (Hawaiian) Bat	Lariurus cinereus semotus	Pe'a	E	E	P

[1] FEDERAL STATUS
E = Endangered
T = Threatened

[2] OCCURRENCE STATUS
E = Endemic
I = Indigenous
X = Exotic

[3] PROJECT AREA STATUS
C = Common
F = Fairly common
P = Possible occurrence
= Not likely to occur

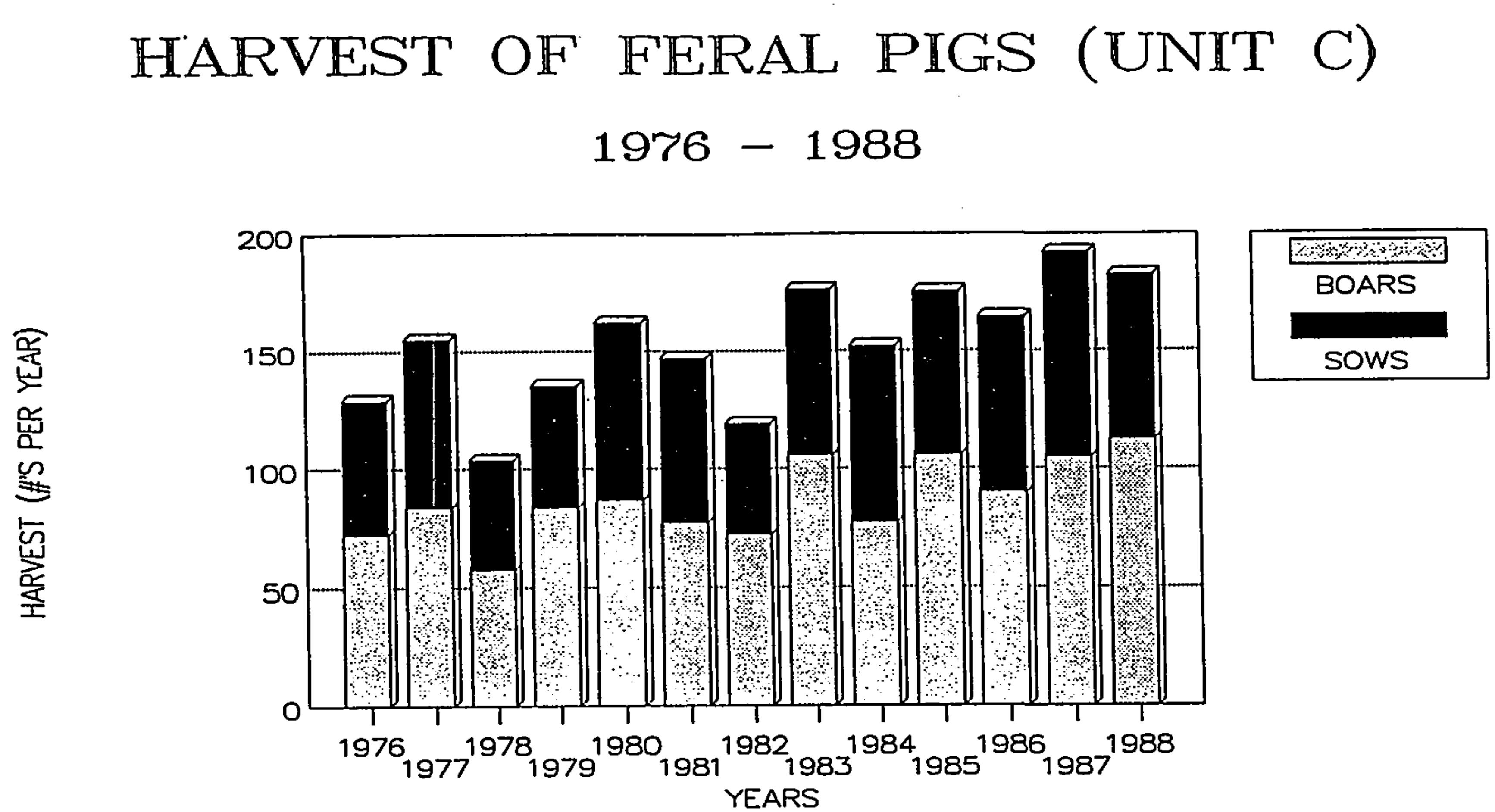


FIGURE 2.2-7. Summary of feral pig harvest on Kauai in Game Management Unit C from 1976 to 1988 (from DLNR).

and are also hunted within the region (Figure 2.2-8). The native hoary bat may occur in low numbers within the dense forests of the project area (T. C. Telfer, DLNR, personal communication October, 1988). The predatory feral cat and the four species of rodents that are likely to occur within the project area are generally considered undesirable but removal methods are costly and largely ineffective (DLNR 1984).

Reptiles and Amphibians

No species of reptiles or amphibians are native to the Hawaiian Islands. As with birds and mammals, several species of these vertebrates have been introduced and become established on the islands. On Kauai, 9 species of reptiles and 3 species of amphibians have been introduced (DLNR 1984) (Table 2.2-11).

Within the project area, three lizards, two frogs and one toad may occur (Table 2.2-11) (T. C. Telfer, DLNR, personal communication October, 1988). These are not considered to be a problem to native vegetation or crops (DLNR 1984) but bullfrogs have been observed to feed on young of the endangered Hawaiian Duck (Berger 1981). A survey of the reptiles and amphibians was not conducted, however, the following species were observed during the wildlife survey: metallic skink, giant neotropical toad, bullfrog and wrinkled frog.

Endangered Species

The status of six species of vertebrates listed as endangered and one listed as threatened by the Federal Endangered Species Act were considered relative to the proposed project. This includes six species of birds and one mammal.

Newell's Shearwater: This is a small slender shearwater with short wings and short rounded tail. It was formerly considered a race of the Manx shearwater (Puffinus puffinus) and recently classified as conspecific with the Townsend's shearwater (P. auricularis) before being given full species status in the mid-1980's (Shallenberger 1986). It is listed as threatened by the U. S. Fish and Wildlife Service.

Newell's shearwaters were thought to be common nesting birds on Hawaii, Maui, Molokai and Kauai (Munro 1944) but have not been reported from Maui since 1894 and Molokai since 1908 (King and Gould 1967) and only a small population may exist on the island of Hawaii (Berger 1981). Extermination on these islands is hypothesized to be largely due to mongooses (Berger 1981). Kauai presently is thought to be the primary and possibly only breeding locality of this species (King and Gould 1967).

The first documented nesting site of Newell's shearwater was found on Kauai in 1967 in the Makaleha Mountains at an elevation of 1500 feet where a nesting colony of 500 birds was estimated.

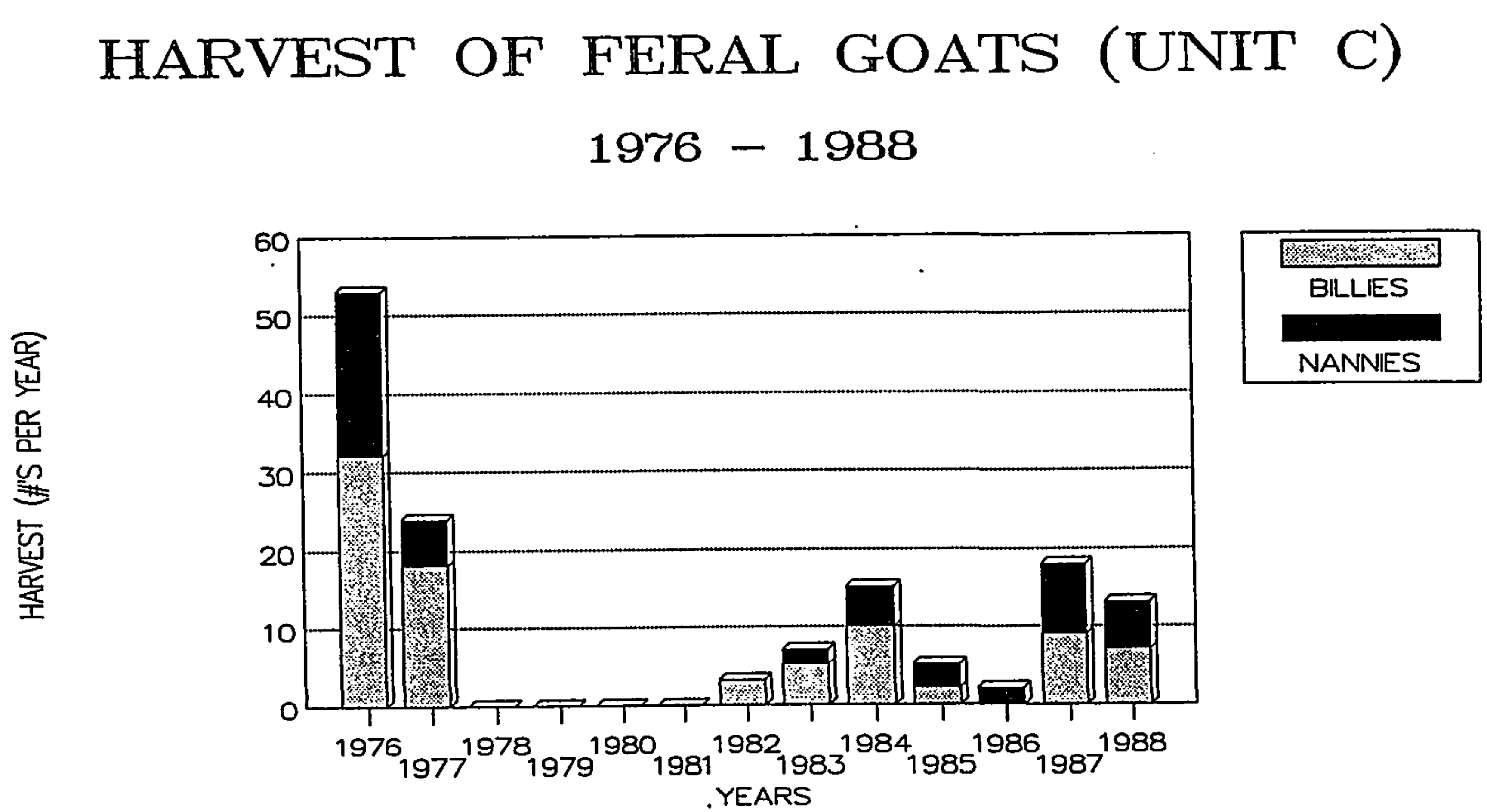


FIGURE 2.2-8. Summary of feral goat harvest on Kauai in Game Management Unit C from 1976 to 1988 (from DLNR).

TABLE 2.2-11. Species list of reptiles and amphibians that inhabit the island of Kauai. Federal status relative to the Endangered Species Act, occurrence status on Kauai and status relative to the project area are indicated. Species names, taxonomy and classification are from DLNR (1984).

Common Name	Scientific Name	A[1]	B[2]	C[3]
REPTILES				
Family TRIONYCHIDAE (Softshell Turtles)				
Chinese Softshell Turtle	Trionyx sinensis sinensis		X	
Family TYPHLOPIDAE (Blind Snakes)				
Hawaiian Blind Snake	Typhlina bramina		X	
Family GEKKONIDAE (Geckos)				
Mourning Gecko	Lepidodactylus lugubris		X	P
Tree Gecko	Hemiphilodactulus typus typus		X	
Stump-toed Gecko	Gehyro mutilata		X	P
Indo-Pacific Gecko	Hemidactylus garnoti		X	
House Gecko	Hemidactylus frenatus		X	
Family IGUANIDAE (Iguanids)				
Snake-eyed Skink	Cryptoblepharus boutoni poecilopleurus		X	
Metallic Skink	Leiolopisma metallicum		X	F
AMPHIBIANS				
Family BUFONIDAE (True Toads)				
Giant Neotropical Toad	Bufo marinus		X	C
Family RANIDAE (True Frogs)				
Wrinkled Frog	Rana rugosa		X	C
Bullfrog	Rana catesbeiana		X	C

[1] FEDERAL STATUS
E = Endangered
T = Threatened

[2] OCCURRENCE STATUS
E = Endemic
I = Indigenous
X = Exotic

[3] PROJECT AREA STATUS
C = Common
F = Fairly common
P = Possible occurrence
= Not likely to occur

Other nesting locations are speculated to be at other sites in the Makaleha Mountains, in the upper reaches of the Hanalei River, in the Haupu range, above Kahili Mountain Park and in Waimea Canyon. Most of these suspected nesting sites are between 1500 and 2000 ft (450 and 600 m) and are covered with uluhe fern (Dicranopterus linearis) (Berger 1981).

Newell's shearwaters begin arriving in April for breeding with the bulk of these birds arriving in May. Egg laying probably begins in early June (King and Gould 1967) with hatching in mid-July to early August (Sincock and Swedberg 1969). Nesting adults are nocturnal in their activities around the nesting areas. Adults leave the nesting areas for winter feeding areas in early October while the chicks fledge in October and November. The young are noted for "raining down" on highways, parks, football fields and buildings during this fledging period. More than 390 were found in the Lihue area in 1978 (Berger 1981).

No records of nesting Newell's shearwaters have been made within the project area. The closest suspected nesting location is in the upper Hanalei River canyon, above the upper end of the existing water diversion tunnel between the Hanalei River and the North Fork Wailua River. Portions of the project area are located within the 1500 to 2000 ft elevation range and support extensive patches of uluhe fern, suggesting favorable potential locations for nesting colonies. These areas, however, are generally above the locations of proposed construction activities. A survey will be conducted for this species within the project area in late April or May 1989.

Dark-rumped (Hawaiian) Petrel: This is a large petrel with a wing-span of 36 inches. The species has two subspecies, one nesting in the Hawaiian Islands (Pterodroma phaeopygia sandwichensis), the other in the Galapagos Islands (P. p. phaeopygia) (Harrison 1983). The Hawaiian subspecies is listed as endangered by the U. S. Fish and Wildlife Service.

The Hawaiian subspecies formerly nested on all the major islands of the Hawaiian chain (Munro 1944) but is now restricted to a few locations on Maui, Lanai and Hawaii, with evidence of remnant breeding populations on Kauai (Shallenberger 1986). Mongooses, rats and feral cats are suspected to be the major contributors to the reduction in the populations of this subspecies.

The major nesting location is within the Haleakala Crater on Maui where a minimum of 800 adults was estimated in 1965 and 1966. Recent nesting locations range from 2800 ft on Lanai to near 10,000 ft on the Haleakala Crater (Berger 1981). Munro (1944) reported nesting elevations from 1500 to 5000 ft. Low elevation nest sites are under the roots of trees and stones while the higher elevation nest sites are burrows dug in either old lichen covered lava (on Hawaii) or in soil or ash deposits overlain by bedrock lava (Maui) (Berger 1981).

On Maui, adults return to the nesting areas during March and April. Egg laying occurs in early May with incubation lasting 50 to 55 days (Berger 1981). Adults leave the nesting area for winter feeding north and west of the Hawaiian islands (Harrison 1983) by October and the young leave by the end of the month (Berger 1981).

Confirmation of breeding in recent years on Kauai has not been made despite speculation that the species breeds there. The project area is within the elevational range where nesting occurs. The habitat within the project area, however, is much different than that used in the Maui and Hawaii nesting sites.

Band-rumped Storm-petrel: This sooty brown storm-petrel, (also known as the Harcourt's, Madeiran or Hawaiian storm-petrel) breeds in scattered locations within the tropical Atlantic (e.g., Madeira, Azores, Cape Verde Islands, St. Helena) and Pacific (Galapagos Islands, Hawaiian Islands, some islets off Japan) Oceans (Harrison 1983; Berger 1981). The Hawaiian subspecies (Oceanodroma castro cryptoleucura) is listed as endangered by the U. S. Fish and Wildlife Service.

. Little is known about the Hawaiian subspecies of this storm-petrel. Immature birds have been found on Kauai and Maui in the past and breeding is now assumed to be restricted to Kauai and possibly Maui and Hawaii. Nests and eggs have never been found in the Hawaiian Islands (Berger 1981). Breeding at other locations occurs throughout the year. In Japan, adults return in May with egg-laying in June and fledging and dispersal to winter feeding areas beginning in October (Harrison 1983). Two distinct breeding populations of this storm-petrel occur in the Galapagos Islands with egg laying periods from November to January and May to June. The birds are colonial nesters laying one egg in holes in sea cliffs or under boulders. The adults are nocturnal around the nesting sites (Harris 1974).

Nesting areas on Kauai have not been located despite the speculation that the species nests there. Significant habitat differences between the project area and the known breeding sites on the Galapagos indicate that nesting within or near the project area is probably unlikely.

Hawaiian Duck: This is a small duck that resembles the closely related Mallard. The Hawaiian duck, listed by the U. S. Fish and Wildlife Service as endangered, was originally found on all the major Hawaiian Islands except Lanai (Shallenberger 1986). Hunting, draining of marshes, and predation contributed to the demise of this species on all the islands until the 1960's when the species survived only on Kauai. Captive breeding programs initiated in 1972 have been successful in reintroducing the Hawaiian duck to Hawaii and Oahu (Berger 1981) where small, naturally breeding populations now occur (Shallenberger 1986).

The Hawaiian duck has adapted to a variety of ecological settings. On Kauai, this species has been found to breed from sea level to 3500 feet using marshes, reservoirs, taro patches, pastures, drainage ditches and agricultural lands in lowland areas and stream and river valleys in densely wooded areas at higher elevations (Berger 1981). They appear to tolerate some types of human disturbance and rapid changes in water levels (Berger 1981) but flash flooding during periods of heavy rains may cause some mortality of ducklings (Swedberg 1967). Individuals may use different areas depending on their needs and will readily leave an area if these needs are not met (Swedberg 1967). The breeding season extends throughout at least 11 months of the year (Swedberg 1967) although the main breeding season is from December through May (Berger 1981).

The Hawaiian duck population on Kauai was estimated to be approximately 3,000 in the mid-1960's (Swedberg 1967). Most of the individuals on Kauai are found in remote, mountainous stream habitat and protection of this habitat along perennial streams is considered important in the recovery of this species (USFWS 1985). Nesting locations observed on Kauai between 1962 and 1966 include areas near and similar to those within the project area (Figure 2.2-9). The nearest documented nesting locations to the project area were located in Kawi Stream, a tributary of the North Fork of the Wailua River and in the central portion the South Fork of the Wailua River (Swedberg 1967), both within 4 miles of the project area. Adults and very young ducklings have been seen along Maheo Stream in the project area since 1982 (D.E. Heacock, DLNR, personal communication June 1988 and February 1989) indicating possible nesting within the project area.

As part of the wildlife survey, Maheo Stream was searched for Hawaiian ducks and nests. The stream was walked twice (February 13 and 16) from the confluence with North Fork Wailua to the confluence with the short channel below the Hanalei diversion tunnel (Figure 2.2-5). Flows within the stream were 7.5 and 18.9 cfs for the first and second surveys, respectively. Seven (7) ducks were recorded during the first survey in 4 different groups with the flow representing post-project base flows. A single group of 7 individuals was also observed by another party a few hours after the survey in a pool in the lower portion of Maheo Stream. The second survey located 6 ducks in 4 groups with the flow at pre-project base flow levels. Three was the maximum number of birds observed during the second survey in one group. Duplicate counting of the same duck was possible during this survey. The maximum group count represents the minimum number of individuals observed. Numerous other sightings of Hawaiian ducks were also made during other portions of the wildlife and fisheries investigations. No nests or ducklings were located during the surveys or other activities.

These observations as well as numerous observations made prior to this survey (T. Telfer and D. Heacock, DLNR, personal communication) indicate that the Hawaiian duck uses Maheo Stream on a regular basis. Individuals were observed using the stream at flows representing both pre- and post-project

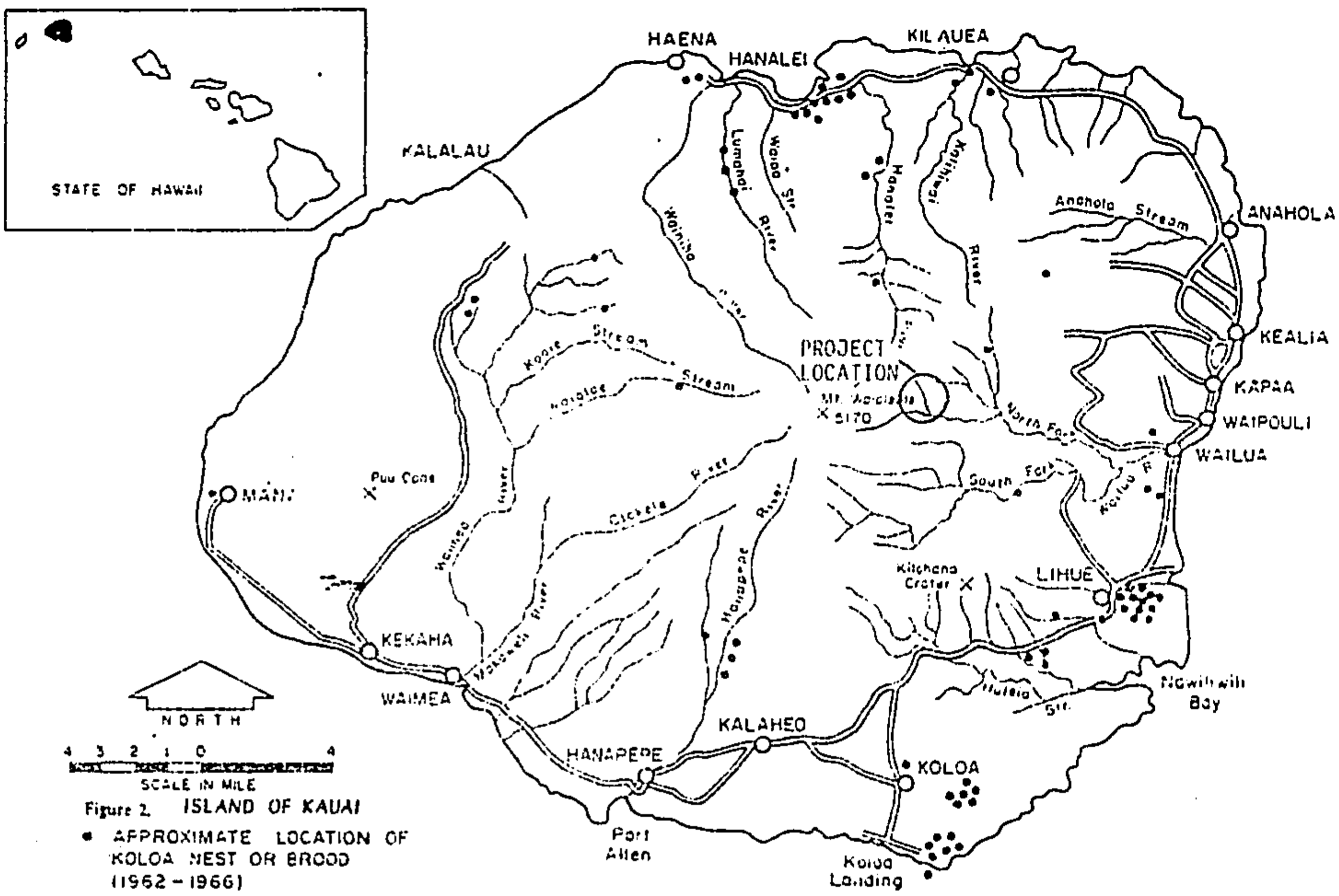


FIGURE 2.2-9. Nesting locations of the Hawaiian Duck (Anas wyvilliana) on Kauai during 1962 to 1966 (from Sedberg, 1967).

levels, however, no information exists on flow preferences for this species. Maheo Stream may not be a regular nesting area as evidence of nesting (presence of young ducklings in lower Maheo Stream) has been found only in 1983 (D. Heacock, DLNR, personal communication, February 1989). Its primarily importance may be as a feeding and loafing area for individuals breeding elsewhere in the Upper Wailua River drainage.

Common Moorhen (Hawaiian Gallinule): The Hawaiian subspecies of the common moorhen is listed as endangered by the U. S. Fish and Wildlife Service. Unlike its North American and Eurasian counterpart, it is nonmigratory. This bird originally was found on all the main Hawaiian Islands except Lanai and Niihau but is now found only on Kauai and Oahu. Reestablishment attempts on Maui and Hawaii have been unsuccessful. Habitat destruction (filling and draining of wetlands), illegal shooting and predation by mongooses, rats, and cats have all contributed to the population reductions (Berger 1981).

The moorhens inhabit the lowlands and are widely dispersed in freshwater ponds, marshes, irrigation ditches, reservoirs, taro patches and, formerly, rice fields. They require dense vegetation along the edges of bodies of water and are seldom seen in deeper, more open bodies of water (Shallenberger 1986; USFWS 1985; Berger 1981). The preference for lowland bodies of water would likely preclude the common moorhen from using waters within the project area on a regular basis. A survey of water habitats within the project area failed to locate any moorhens nor did it locate apparently favorable habitat as described by USFWS (1985).

American (Hawaiian) Coot: This subspecies of the American coot is nonmigratory, unlike its North American counterpart. It is listed as endangered by the U. S. Fish and Wildlife Service. The coot still occurs on all the main Hawaiian Islands except Lanai but the populations have been greatly reduced. The largest populations occur on Maui, Oahu and Kauai and the 1983 population was estimated to be 2000 birds (Shallenberger 1986). As with the common moorhen, habitat destruction (filling and draining of wetlands), hunting and predation by various introduced animals are likely the cause of the population declines (Berger 1981).

Habitat for the coot is similar to that for the common moorhen but they prefer more open water and often use brackish water (Shallenberger 1986; USFWS 1985; Berger 1981). As with the common moorhen, preference for lowland bodies of water would likely preclude the American Coot from using waters within the project area on a regular basis. A survey of water habitats within the project area failed to locate any coots nor did it locate apparently favorable habitat as described by USFWS (1985).

Hoary (Hawaiian) Bat: This endemic bat subspecies was listed as endangered by the U. S. Fish and Wildlife Service in 1970. Little is known about its past but it is known to be a resident on Hawaii and Kauai and a sporadic migrant to Maui and Oahu. It is unknown from Lanai and Molokai. The largest population appears to be on the island of Hawaii (Kepler and Scott, undated).

The hoary bat appears to favor forest edges or open canopy forests with spacing between trees. Studies on Hawaii from 1976 to 1981 found that bats were most frequently associated with exotic vegetation, with relatively few in native vegetation. They have been found from sea level to 10,000 ft, although the majority of sightings have been from below 3300 ft. The bats occur in reduced numbers in the wettest portions of Hawaii. While considered solitary for part of the year, the hoary bat may be seasonally gregarious and may hibernate in caves during portions of the winter months (Kepler and Scott, undated).

On Kauai, 15 records exist for this species, all over the period May through February (Table 2.2-12). A pregnant female with two fetuses was found at the National Guard Radar Station near the Kalalau Lookout which established that breeding occurs on the islands (Kepler and Scott, undated). While much is unknown about this species on Kauai, the project area may provide habitat for low numbers of this species (T. C. Telfer, DLNR, personal correspondence October 1988).

A survey for hoary bats was conducted during the wildlife survey. Two to three observers were stationed in the vicinity of the proposed power plant and staging area (Figure 2.2-5) for two hours each of three evenings. Observations were made beginning one hour before sundown and continuing one hour after sundown on February 15, 16 and 17. The weather was mostly clear each of these evenings and a bright moon aided in observing after dark. The survey location was an open area bordered on all sides by largely exotic forests. This location was selected as it is the most likely feeding area within the proposed project area based on the findings of Kepler and Scott (undated). No bats were sighted during this survey. Also no bats were observed during any other portions of the wildlife survey. The results of the survey suggest that the project area does not provide habitat for large concentrations of bats on a regular basis.

2.3 HISTORICAL/ARCHAEOLOGICAL SITES

2.3.1 History

The project area is located within the ahupua'a of Wailua. An ahupua'a is the largest land unit within a district. These land units, which were marked by a cairn of stone on which a pig or other tribute was laid as a tax to the ruling chief, were self-sufficient economic entities extending from the mountains to the outer reef in the sea.

TABLE 2.2-12. Records of sightings of the Hoary bat (Lasiurus conereus semotus) on Kauai (from Kepler and Scott, undated).

DATE	LOCATION	ELEVATION	HABITAT	OBSERVER	COMMENTS
07/01/64	Kokee National Guard Radar Station		Building lights	S. Au	Found "half dead", died two days later.
06/23/71	Princeville		Exotic vegetation	William Dias	Immature bat found impaled on barbed-wire fence.
11/24/75	Anahola Bay	Sea Level		Dr. W. J. Schrenk Dr. W. Bennert	One individual observed at dusk.
11/28/75	Kalalau Lookout			Dr. W. J. Schrenk	One individual observed at dusk.
11/17/76	Kalaheo		Exotic vegetation	Alphonso Martin	One bat found hanging on a fence was collected by Mr. Alphonso Martin. Identification was confirmed by Tom C. Telfer.
10/15/77	Kokee Hunter Checking Station		Highway corridor		One bat was observed at dusk feeding along the highway corridor.
10/78	Nomilu Fishpond southern Kauai coastline	Sea Level	Open ocean 100 ft offshore	Tom C. Telfer	
10/78			Exotic vegetation trees	Tom C. Telfer	
10/80			Exotic vegetation trees	Tom C. Telfer	Observed up to 4 bats every Saturday.
10/81			Exotic vegetation trees	Tom C. Telfer	Observed up to 4 bats every Saturday.
06/14/82	National Guard Facility near Kalalau Lookout			K. Fujii verified by Tom C. Telfer	Found in mechanics shed. Pregnant female, 2 near full-term fetuses.
09/05 to 10/30/82	Kokee Hunter Checking Station		Trees	Tom C. Telfer	Three to five bats reportedly seen along highway corridor.
02/03/70	Pohakea Ridge	1097-1250 m	Ohia forest	J. Sincock	One flying from 0045-1010, in valley below campsite.
09/25/78	Kokee			G. Anderson & F. O. Hay	Picked up, released in good condition on 09/26/78.
05/78	Kokee		Building lights, Missile tracking station	F. Howarth	Up to 25 bats circling the powerful lights.

In addition to the records, mummified remains, skeletons or carcasses of hoary bats have been deposited with the B. P. Bishop Museum in Honolulu, Hawaii. The specimen numbers for each island are: Hawaii, BBM 9009; 9129; 9130; 9201; BBM-X 145,164; 145,165; 145,170; 145,763; 147,035; 147,123; 147,124; 147,125; 147,126; 155,005; 156,911; 156,912; 156,913; Kauai; BBM-X 148,202, Maui 159,266; 159,268; 159,280; Oahu BPBM 159,287; 159,287; 159,288; 159,289; 159,290; 159,291.

Wailua Ahupua'a is located in the district of Puna between Hanama'ulu to the south and Olohena and Hanalei to the north. The name Wailua is generally considered to refer to the 2 main forks of the Wailua River (wai = water, lua = two). However, if the name is translated as one word, it means spirit, ghost, remains of the dead (Pukui and Elbert, 1981). This meaning would be more appropriate to the traditionally sacred nature of the place.

The area along the river mouth between the confluence of the North and South Forks and the Pacific Ocean was known as Wailua-nuiho'anu or "great sacred Wailua", and was kapu, or forbidden to all but ali'i (Dickey, 1917). Wailua is therefore comparable to similarly sacred localities on other islands, such as Waipio, Kahalu'u, and Holualoa on the Big Island or Kualoa on O'ahu. All of these places were used for training of young chiefs and residence for ruling ali'i. From legendary through historic times, Wailua was a residence of great chiefs such as Moikeha Monokalani po, Palila and Kaumualii (Salisbury, 1936). The importance of Wailuanuiho'anu is underlined by the presence of eight major heiau.

There are virtually no substantial written accounts or descriptions of Wailua. This, in part, can be traced to the fact that no Protestant mission station was established in or close to the area, a condition that has benefited the reconstruction of history in other locales through the use of journals, diaries, letters, etc.

A check of land awards as a result of the Great Mahele (1848) shows only a total of approximately 75 acres of Wailua awarded to 25 individuals, among the D. Kapule and Iosia Kaumuali'i, wife and son of Kaumuala'i, the last chief of Kaua'i. None of these awards were near the present study area. The rest of this large ahupua'a was kept as Crown Lands or the private lands of Kamehameha III (Kauikeaouli), another testament of the importance and value of the area at that time.

Handy, in 1935, studied the ahupua'a as an agricultural area. He found extensive agricultural terracing along the lower two miles of the river. However, by 1935 little of the original Hawaiian agricultural staples were being cultivated. Most of the terraces, once in taro, were given over to rice grown by Chinese farmers along with limited areas in sweet potato and pasture (Handy, 1940).

Handy described the agricultural terraces of the upper North and South forks of the Wailua River as follows:

> There are terraces in the canyon of the North Fork of the Wailua River; presumably there are terraces also in the flatlands along Kawi, Keahua and Iole Streams which form the head waters of this fork of the river above the junction with the north fork. Extensive areas of terraces fill the valley immediately above Wailua Falls and along the river of 3 miles above Waikoko. Ilii̇ula, Waiaka , Waiahi, Kaulu, Palikea and Halii Streams undoubtedly all had small terraces along their lower courses. (Handy 1940:67-68)

The archaeological implications of Handy's comments are that flat lands along both forks of the Wailua River and presumably many of the headwater tributaries were developed into irrigated taro terraces of loi and that the Wailua River valley was a major taro-growing area of Kaua'i. However, Bennett (1931) makes no mention of these terraces in his island-wide survey of major sites, although he recorded heiau near the mouth of the valley. This lack of mention is worthy of note, considering that he explored other valleys, such as Hanalei, and noted taro terraces and house sites far back in the valleys (Bennett, 1931).

There are two previous studies which cover portions of the riverbanks mauka of Wailuanuiho'anu (great Sacred Wailua). Ching conducted a survey covering the North and South forks of the river from Koholalele Falls and Waiehu (Wailua Falls) to the confluence of the North and South forks (Ching, 1968). Four archaeological sites were recorded including taro terraces (lo'i) and irrigation ditches (auwai) along the alluvial flats. This area is still far downstream from the present project area.

In 1981 Ching conducted another survey for the Wailua River Hydropower study for the Army Corps of Engineers (Ching, 1981). Nine separate areas were surveyed, mostly along the South Fork of the Wailua River, and lo'i, terrace complexes, auwai, and a rice mill were recorded in three of these areas. Of greatest interest to the present study was a survey of the mauka most area (Area I) which includes the portion of the proposed transmission line paralleling the Stable Storm Ditch. The description of this area is as follows:

> Area I is the most mauka of the study areas and contains a man made ditch that collects water from the north fork of Wailua River and delivers it to the Hanama'ulu ditch intake on the south fork via Waikoko Stream. A gaging station access road runs along the northeast side of this ditch (except the southernmost 2,000 to 3,000 feet) providing access to the study area.
>
> No evidence of cultural remains was found in Area I aside from the ditch, gaging station and road, two (2) stands of 'ohe (probably Melocanna baccifera), two (2) large stands of palepiwa (Eucalyptus spp. or Melaleuca leucadendra (paper bark) of the family Myrtaceae). These stands are located on the north side of the downstream end of the ditch and on the south side of the upstream end near the gaging station. They are planted in straight rows, probably by forestry personnel experimenting with various introduced trees for industry. The 'ohe noted above is located near the gaging station at the north end of the area and is of the Hawaiian variety in that nodes are about 18 inches apart and the walls of the stalk, thin. This is the type of 'ohe used in making pu'ili (bamboo rattle) and 'ohehanoihu (nose flute) (Ching, 1981:33).

The recommendations concerning this area were for no further archaeological investigation, considering the modern modifications of the landscape. The closest archaeological sites to the present project area were located by Ching along the South Fork of the river below the Hanama'ulu Ditch. Here were a few surviving terraces in disturbed condition (Ching, 1981:5).

The R.B. Marshall U.S.G.S. 1910-1916 map does have coverage of the project area, but shows no roads, houses or settlements of any kind for the North Fork of the Wailua River above the Kanaha Ditch intake.

It is of interest to note that the Hanalei-Wailua Water Tunnel does not seem to appear on this map, but does appear on the 1939 map. This would date the construction of the tunnel and improvement of the trail leading to the tunnel to the late 1920's or the 1930's.

The W.E. Wall Map of 1923 (Reg. No. 2698) extends mauka only to the forest reserve and does not show the present project area. The map does show Land Court Awards below and slightly above the junction of the North and South Forks of the Wailua River.

The 1939 Map (CSF 7106-A) labeled "License - Waters in the drainage basins of north Wailua and Kapa'a Rivers and the Drainage basins of the Hanalei River" is shown as *Figure 4 in Appendix C*. This map shows no settlement in the project area, but does not show the Hanalei-Wailua Tunnel and the Stable Storm Ditch connecting the North Fork of the Wailua River to Waikoko Stream.

2.3.2 Archaeological Sites

The archaeological site survey area consists of two segments. The main section is the approximately 8,000 foot-long segment of Maheo Stream, running from the outlet of the Hanalei-Wailua Tunnel to the confluence of the north fork of the Wailua River. The proposed pipeline route is along the west bank of the stream bed.

The upper reaches of the stream valley consist of steep bedrock slopes and cliffs with high gradient tributaries, joining a fairly straight stream course. Vegetation is an extremely thick mix of native and exotic species of trees, shrubs, and grasses with steep slopes covered with uluhe fern. Hawaiian cultigens such as ti, banana and wild taro occur intermittently along the stream banks. The only reasonable access for the survey was along the streambanks and in the streambed itself.

At approximately 900 feet elevation, a major tributary enters on the northeast side of the stream and 1,000 feet below this, the valley broadens to include flat alluvial meander bars on both sides of the stream. The largest of these alluvial flats is located on the southwest side of the stream directly above the confluence with the North Fork. Here, a small tributary enters from the west at the upper end of the flat. All of these alluvial bars are covered with dense growth of California grass with intermittent areas of Guava forest along the edges.

One day was spent surveying the 8,925 foot-long proposed pipeline route. Clearly, the survey was hampered by difficult access to the areas above the streambank and the lack of visibility due to dense cultigens such as ti, banana and wild taro occur intermittently along the stream banks. The only reasonable access for the survey was along the streambanks and in the streambed itself.

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One day was spent surveying the 8,925 foot-long proposed pipeline route. Clearly, the survey was hampered by difficult access to the areas above the streambank and the lack of visibility due to dense vegetation. However, the author was able to locate archaeological remains in a previous survey of upper Hanalei Valley under similar conditions of terrain and vegetation (Hammatt and Borthwick, 1986). For comparative purposes no archaeological remains were located in Hanalei Valley where the valley was as steep sided as the upper reaches of the present project area and it is the opinion of the author that this area would have been unsuitable for traditional irrigated agriculture. The occurrence of ti, banana and wild taro in isolated patches would indicate some Hawaiian planting in former times.

The most likely area for archaeological sites along the proposed pipeline route is on the flat lands at the confluence of Maheo Stream with the North Fork of the Wailua River. This area was surveyed thoroughly on the second day of fieldwork for this reason and also because it is the location of the proposed powerhouse.

The unforested portions of the alluvial flats were covered with extremely thick California grass. The surveyors walked on top of the grass which mantled the ground to a thickness of 2-3 feet. Stone or earthen terraces would have been impossible to see or even feel under these conditions. However, the edges of the flat area were forested and the bare ground was visible. No terraces or archaeological remains were observed. It was thought that the most obvious place for a water source and irrigation ditch for the large alluvial flat would have been upstream along the small tributary entering the North Fork a few hundred feet west of the main confluence. The tributary was followed upstream to the mauka end of the alluvial flat where the ground was searched carefully to find traces of an auwai and terracing. However, no signs of former human modification were found.

The entire length of the proposed powerline route is within 100 feet or less of existing roads and there are two sections which are not in cane cultivation. The first section runs from the North Fork confluence along the edge of a road parallelling the Stable Storm Ditch through Eucalyptus forest. This area appears to have been previously bulldozed before planting. The other section runs north through hau forest paralleling a cane haul road on the east side of the Hanahanapuni. This hau forested section was surveyed and no archaeological remains were found.

The results of this reconnaissance survey show that the 8,000-foot length of Maheo Stream was not modified by ancient or historic Hawaiians for settlement or traditional agriculture. This conclusion appears surprising for the following reasons:

1. The confluence area at the base of the proposed pipeline route is definitely suitable for development of irrigated agriculture, considering the availability of flat land and water source;
2. Similar areas in Hanalei Valley and other valleys were developed by ancient Hawaiians (see Hammatt & Borthwick, 1986);
3. The Wailua Ahupua'a was definitely of great political importance in ancient Hawaii, as evidenced by heiau and other sites in the makai areas of the river valley. It would appear that the upper reaches would be developed accordingly for wetland agriculture and procurement of forest resources for the high status communities in the makai areas (bird feathers, wood for canoes, medicinal plants, etc.).

However, on present evidence, it appears that the stream valley in the project was not agriculturally developed and its almost certain use for procurement of forest resources apparently left no tangible archaeological evidence.

The full text of the archaeological survey is included as Appendix C.

2.4 SOCIO-ECONOMIC CHARACTERISTICS

2.4.1 Population

The 1986 population of Kauai was 46,300 persons. The 1986 populations of the Lihue and Kawaihau Districts of the county of Kauai, the two districts where the proposed project will be located, were 9,500 and 12,700 persons, respectively. The 1980 population of Lihue City was recorded at 4,000 persons.

The total population of Kauai increased by 31 percent in the period 1970-1980, and increased by 18.5 percent in the period 1980-1986. Total population in the Lihue District increased by 27 percent during the period 1970-1980 and by 10.3 percent from 1980-1986. The Kawaihau District increased in population by 42 percent from 1970-1980, and by 21 percent for the period 1980-1986 (Hawaii State Department of Business and Economic Development, The Population of Hawaii, 1980-1986, 1987).

In 1980 there were 1,181 homes in census tract 404 (Lihue District), 1,389 homes in census tract 405 (Lihue city), and 1,829 homes in census tract 402 (Kawaihau District). Kauai County is 620 square miles in size, of which 608 square miles is considered rural and 12 square miles is characterized as urban.

2.4.2 Demographic Characteristics

2.4.2.1 Ethnicity

Kauai's population is ethnically diverse. Major races represented on Kauai include, in order of their representative size, Filipino, Japanese, Caucasian, Hawaiian, Chinese, and Puerto Rican. In 1986, 10,208 residents of Kauai claimed themselves a part Hawaiian, while 5,465 residents claimed themselves as non-Hawaiian in their ethnicity.

2.4.2.2 Age Distribution

In 1984, Kauai's population consisted of 22,962 males and 21,193 females. The median age was 31.3 years. Of the population, 31 percent was under 18 years of age, 58 percent was between 18 and 64 years, and 11 percent of the population was 65 years old and over.

2.4.3 Employment and Income

2.4.3.1 Employment

In 1980, the existing labor force in Kauai numbered 19,000 persons. The unemployment rate in 1980 was 3.0 percent. However, in 1986 the unemployment rate had risen to 6.0 percent.

Most residents on Kauai in 1986 were employed in non-agricultural fields, including trade (5,050 persons), services and miscellaneous (5,000 persons), government (2,800 persons), transportation, communication, and utilities (1,950 persons), finance, insurance, and real estate (1,000 persons), and manufacturing (1,200 persons).

Agriculture employed 1,250 persons in Kauai in 1986. The sugar industry employed 1,050 people, and 200 additional people were employed in other agricultural industries on Kauai.

There were 1,800 persons self-employed in non-agricultural fields, as well as 200 persons self-employed in agricultural fields on Kauai in 1986.

2.4.3.2 Income

Kauai's residents are employed in a number of fields. There were approximately 1,150 employers on the island of Kauai in 1986. Total wages paid by these employers in 1986 was $322,720,000. The average annual wage earned in Kauai in 1986 was $16,210.

2.4.4 Transportation

Inter-island transportation facilities to Kauai are good. There is one commercial airport on the island, located at Lihue, population 4,000. There is one general aviation airport, one military airport, one semi-private airport, as well as three heliports also located on Kauai (Figure 2.4-1).

During 1986, there were 143,905 movements of aircraft (arrivals or departures) at Lihue airport. Of these movements, 41,750 were commercial flights. Lihue airport is located approximately ten miles to the southeast of the proposed project site.

Kauai has two state operated commercial harbors. These include Nawiliwili on the southeast coast near Lihue, and Port Allen on the south coast near Hanapepe. Total arrivals at Nawiliwili Harbor in 1985 were 677 vessels. Total arrivals at Port Allen Harbor for the same year were 12 vessels (these figures exclude domestic fishing vessels).

Honolulu Harbor and airport handle the greatest amount of both shipping and air traffic in the state. Honolulu Harbor handled 8,604 inbound vessels in 1985, and Honolulu International Airport handled 368,049 aircraft movements in 1986.

Highways provide the primary means of transportation on Kauai. A network of 390 miles of roads on the island connects the towns, other transportation facilities, and other points of interest.

Surface transportation to the project location from Lihue is provided via Highway 56, Highway 583, and a series of private roads belonging to the Lihue Plantation Company. The project applicants will have to secure access rights to the site with Lihue plantation to make construction of the project feasible.

There is one electrical transmission line with a service road near the project area. This line and road will be used to interconnect the project to the Kauai Electric System. The proposed project will utilize or modify existing haul cane roads for access to the proposed project for both construction and operation purposes.

The proposed project will not displace, alter or interrupt any existing structures, transportation facilities, or utilities of any significance in the immediate project area.

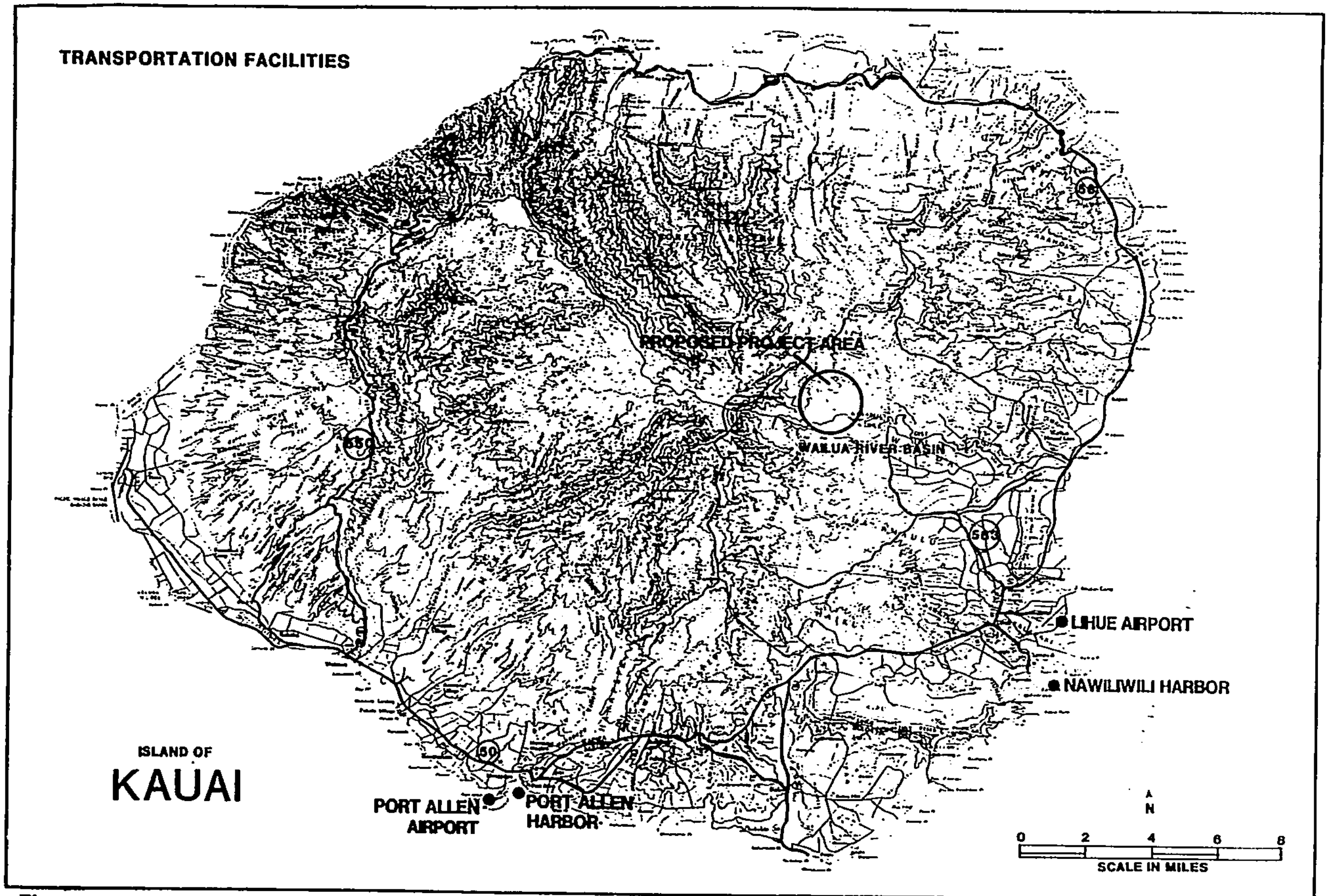


Figure 2.4-1. Project area transportation facilities.

2.4.5 Recreation and Scenic Resources

The primary recreational area within the boundaries of the proposed project is the Lihue-Koloa Forest Reserve. This forest reserve is administered by the State Division of Forestry and Wildlife. Recreational opportunities within this area include hiking, nature trails, bird watching, hunting, fishing, and swimming. There are no developed recreation opportunities within the proposed project boundaries.

The closest area for developed recreation is at Wailua River State Park, approximately 6 miles to the east. Wailua River State Park is easily reached from Kauai's eastern coast via Highways 56 and 580. Scenic resources within the park include Wailua Falls on the South Fork of the Wailua River, Opaekaa Falls on Opaekaa Stream and Fern Grotto near Wailua Bay. In 1979, an estimated 2.5 million visitors toured the Park.

Approval of the proposed project is not expected to increase or decrease recreational opportunities or use within the area.

3.0 RELATIONSHIP OF THE PROPOSED PROJECT TO LAND USE PLANS, POLICIES, AND CONTROLS

The proposed Upper Wailua Hydroelectric Project is consistent with all state, county, and local land use plans, policies, and controls. Figure 3.1-1 is a generalized land use map of the Wailua River Basin, and Figure 3.1-2 is a generalized land ownership map of the river basin.

3.1 STATE LAND USE DESIGNATION

The proposed project is located within the Lihue-Koloa Forest Reserve in a State Conservation District. Hydroelectric projects are permitted uses in conservation districts with the issuance of a conditional use permit. The preparation of this environmental impact statement is required by the State of Hawaii Department of Land and Natural Resources for the issuance of this permit.

3.2 RELATED HYDROELECTRIC STUDIES

In December, 1982, the U.S. Army Corps of Engineers (COE) released their report on the potential for hydroelectric power development on the Wailua River. The COE's report, entitled "Wailua River Hydropower - Final Interim Survey Report and Environmental Statement", was utilized as a source for some of the baseline environmental data appearing in the Final Environment Impact Statement for the Lower Wailua River Hydroelectric Project prepared for Island Power Company, Inc., in May 1986. Only a small amount of this information was utilized as a data source for the preparation of this environmental document.

The hydroelectric project proposed for the Lower Wailua River is almost identical in concept and design to the project proposed by the COE in 1982 (see Figure 1.6-1 for location of the Lower Wailua Hydroelectric Project).

3.3 KAUAI PARKS AND RECREATION MASTER PLAN

The proposed Upper Wailua Hydroelectric Project is located in the Anahola-Kapaa-Wailua Recreation Planning District. According to the Kauai Parks and Recreation Master Plan, there are no

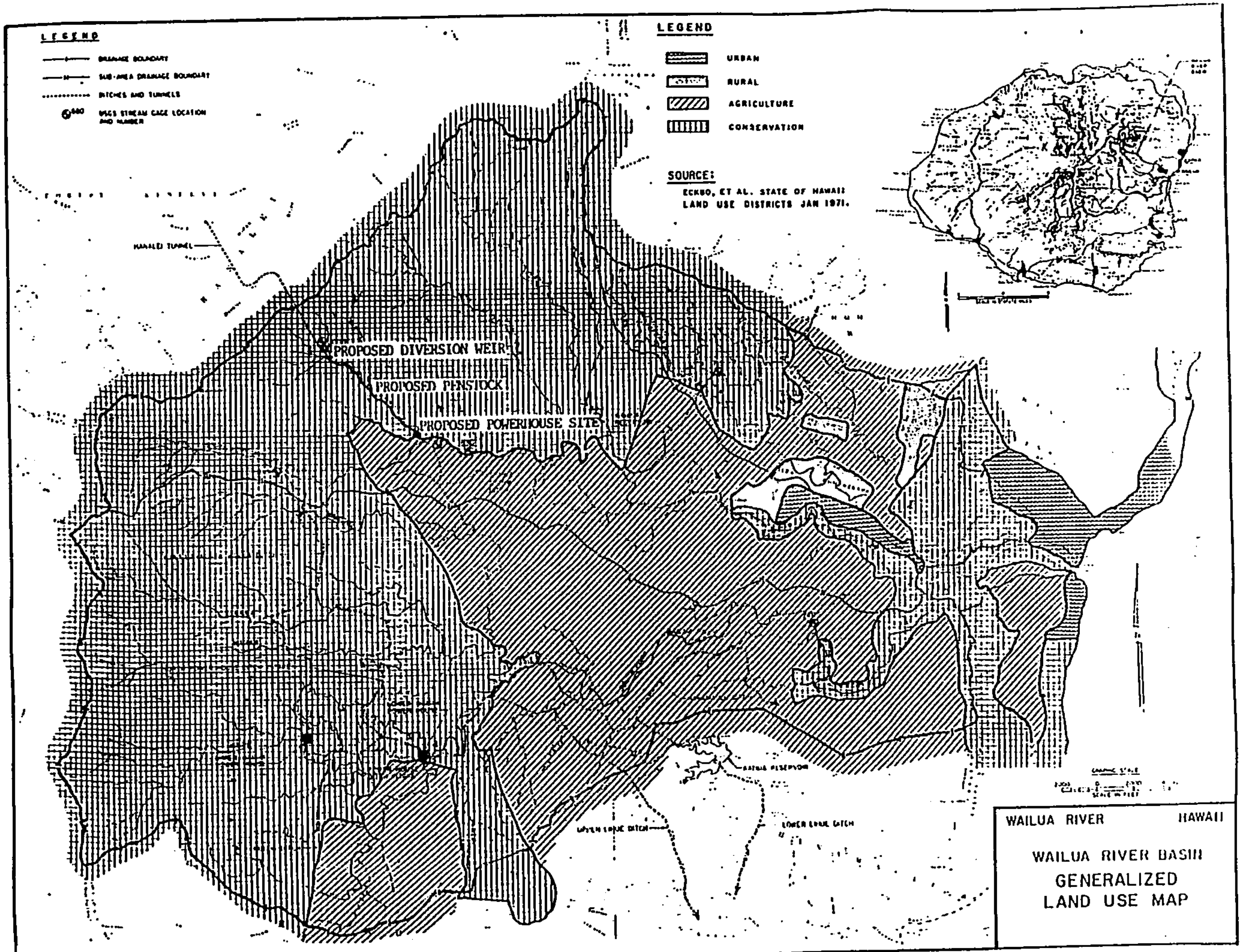


Figure 3.1-1. The generalized land use map of the Wailua River Basin.

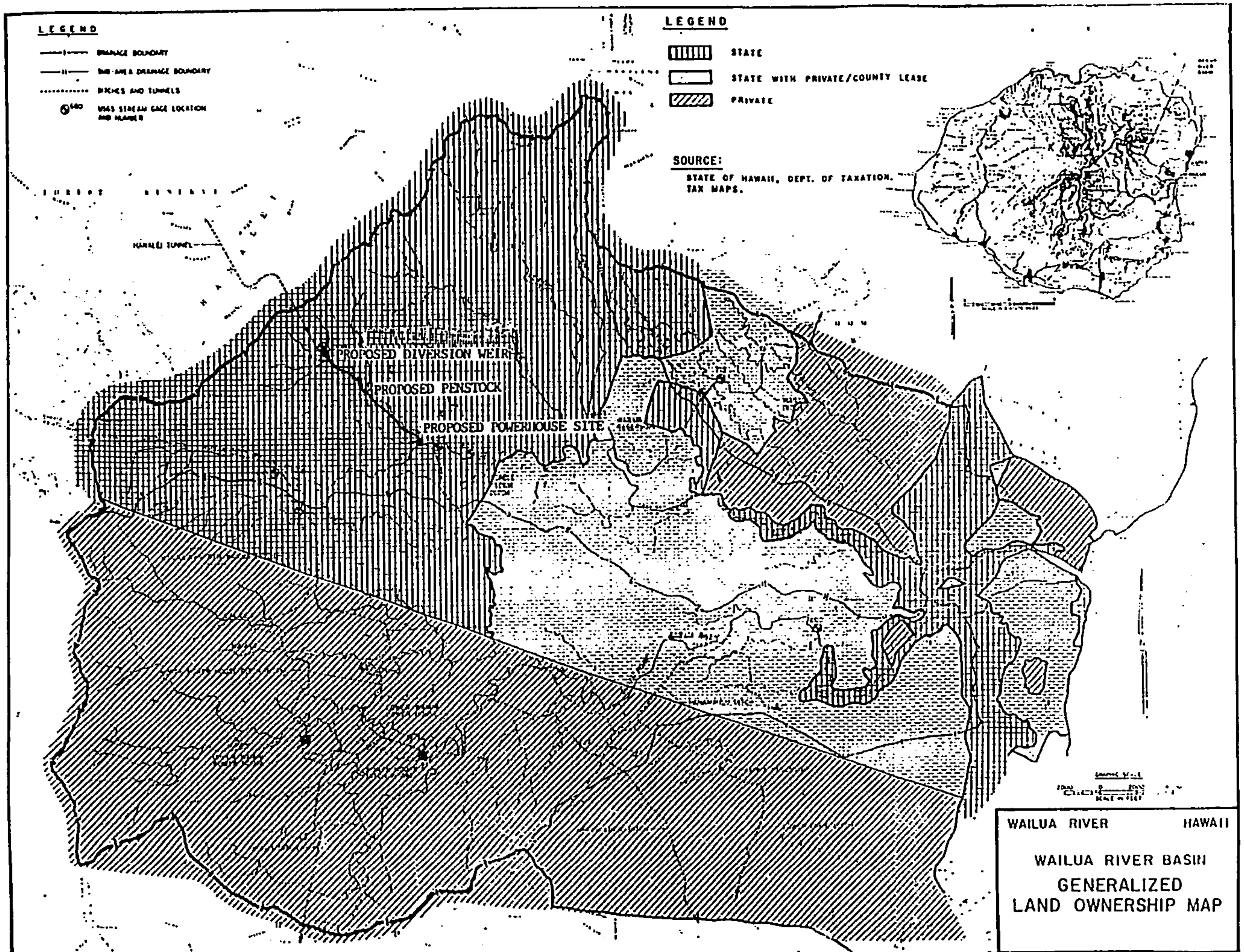


Figure 3.1-2. The generalized land ownership map of the Wailua River Basin.

developed recreation sites within the proposed project area.

The proposed project is not expected to hinder any future development of recreational facilities within the project area. Future development of recreational facilities in the project area will be limited by the lack of public access.

3.4 KAUAI GENERAL PLAN

The proposed project is consistent with the goals and objectives of the Kauai General Plan. Specifically, the Kauai general plan states that future growth and development on Kauai should take place in an environmentally sensitive manner. Reducing Kauai's dependence on imported, air polluting petroleum energy resources, and increasing Kauai's reliance on island based, renewable energy resources, is a move in the proper direction.

The proposed project is not located within a special management area.

4.0 PROBABLE EFFECTS OF THE PROPOSED PROJECT ON THE ENVIRONMENT

4.1 CONSTRUCTION

4.1.1 Aquatic Environment

The following section addresses the construction impacts of the preferred alternative on the aquatic environment.

4.1.1.1 Hydrology

During the construction phase of the project, the hydrology of the Maheo Stream should not be interrupted. The actual penstock construction and placement will not interfere with the stream discharge. The flow from the Hanalei Tunnel will be interrupted during the placement of the intake structure noted in Section 1.3 of this report.

4.1.1.2 Water Quality

The water quality in the Maheo Stream will be unaffected during construction. A sedimentation and soil erosion control plan as described in Section 8.2 will be implemented in such a manner that there will be no water quality degradation in the Maheo Stream. There will be a substantial one-time pulse of sediment to the Maheo Stream when water is first released through the tunnel upon completion of construction, but the impact will be temporary. However, during construction, the North Fork Wailua River and several small tributaries will be directly impacted due to the construction of stream crossings and culverts. These impacts will occur over a short period of time near the beginning of access road construction. These short-term increases should have very little effect on the aquatic species of the Maheo Stream or North Fork Wailua River, principally because Hawaiian streams regularly experience large, temporary increases in turbidity following the intense rain showers that are common on the islands (U.S.G.S. Stream Gaging Records). The introduction of feral pigs and their proliferation over the years has resulted in large populations that are capable of seriously disturbing a watershed and accelerating soil erosion (Kepler 1986). Turbidity due to construction should be small compared to the background levels normally experienced by the resident aquatic species, particularly after implementation of sediment control procedures designed as mitigation. The diadromous life history of the species also minimizes their susceptibility to impacts from temporary turbidity increases during their more vulnerable reproductive phases. No other water quality impacts are expected during construction.

4.1.1.3 Flora and Fauna

As stated previously, construction will not affect the organisms in the Maheo Stream or the Hanalei tunnel outfall except where the intake structure is installed. In the North Fork Wailua River and several small tributaries, benthic habitat will be destroyed and replaced by stream crossing structures. This loss of stream habitat will be permanent and represent about a 1,000 ft^2 area. Some of this disturbance will be temporary as the temporary stream crossings will be removed following construction (Figure 1.4-2). An alternative to the permanent gully and stream crossings would be to build bridges. This alternative will be considered for feasibility and availability of materials at the time of construction for the gully crossings. The bridge alternative for the major streams has been rejected due to the greater vulnerability of bridges to washout by flood waters.

4.1.2 Terrestrial Environment

4.1.2.1 Topography

Project construction will result in minimal changes to topography. Some cut and fill activity will be necessary to provide a relatively level corridor for the temporary access road and penstock alignment. The penstock will then be buried within the road alignment over up to 80% of its length and the disturbed corridor will be recontoured to the original contours wherever possible (Figure 1.4-1). If it is impossible to re-establish the original contours, the disturbed area will be reshaped to conform to undisturbed landforms in the vicinity. Over 20% or more of its length, the penstock will remain on the ground surface which represents an alteration of the landscape but will not change the level of the ground surface.

4.1.2.2 Soil

The diversion structure and penstock will be located on soils classified as rough broken land (rRR) (Figure 2.1-3). No engineering interpretations are available for this soil but foundation conditions on basalt bedrock and weathered basalt are anticipated to be suitable (Bingham Engineering 1988). Proper preparation methods will be followed if loose gravels or soils are encountered.

Removal of vegetation and excavation of soil material will result in the exposure of the disturbed soils to erosion by wind and water. The total area to be affected by project development through vegetation removal is estimated to be 16.51 acres. Area of disturbance in each soil type will be:

Rough broken land (rRR)	14.3 acres
Kolokolo extremely stony clay loam (KuL)	1.56 acres
Hanalei silty clay, 0-2% slope (HnA)	.20 acres
Marshland (MZ)	1.07 acres

The two acres of Kolokolo clay loam (KW) supporting the permanent staging area have already been cleared and are maintained by Lihue Plantation independently of this project.

The Universal Soil Loss Equation (USLE) was used to calculate the potential soil loss by water erosion from the areas disturbed by project construction (Wischmeier and Smith 1978). The USLE is A=RKLSCP where:

A - Computed Soil Loss

A is the computed soil loss derived from sheet and rill erosion in tons per acre per year. This represents on-site erosion from a defined parcel of ground rather than sediment delivered to some point on the stream system.

R - Rainfall Erodibility Factor

The energy of moving water detaches and transports soil material. The energy-intensity (EI) parameter measures the total energy of a storm. The sum of the Annual EI units from all storms serves as the R factor.

K - Soil Erodibility Factor

The soil erodibility factor is the erosion rate per unit of erosion index for a specific soil cultivated in continuous fallow, on a 9% slope, 72.6 feet long.

LS - Slope/Length Factor

These two factors combine to represent: (1) L, the slope length factor, is the ratio of the soil loss from the field slope length to that from a 72.6 foot length on the same soil type and gradient, and (2) S, the slope gradient factor, is the ratio of soil loss from the erodible surface gradient to that from a 9% slope.

C - Cropping Management Factor

The vegetative management factor is the ratio of soil loss from disturbed forest areas to that from a fallow condition of a comparable soil.

P - Erosion Control Practice Factor on Cropland

The erosion control factor P is the ratio of soil loss of the support practice to the soil loss with up and down hill culture (Bennion, 1987).

Soil loss was calculated using a value of 400 for the rainfall erodibility factor (Figure 4.1-1). Soil erodibility factors, K, for the soils on the project site are as follows (USDA-SCS, 1981):

Rough broken land	.28
Kolokolo extremely stony clay loam	.28
Hanalei silty clay, 0-2% slope	.17
Marsh	.00

These erodibility factors differ somewhat from those used in the Draft EIS which were obtained by telephone from the SCS office in Honolulu. Soil loss was calculated separately for the area of disturbance on each soil type using the K factor specific to that soil type.

The slope/length factor, LS, was also calculated separately for areas of disturbance corresponding to different structures to be installed. At the diversion, the maximum length in the slope direction was estimated to be 50 feet and the average slope over that area was calculated to be 10%. Along the penstock corridor, the maximum length of disturbance in the slope direction was measured to be 600 feet with a slope of 10% over the stretch of road below the diversion weir on rough broken land soils. Water bars will reduce the slope lengths over the entire temporary and permanent access road to approximately the distances recommended by the U.S. Forest Service for wooded areas (USDA-Forest Service, 1978):

ROAD GRADE	WATER BAR SPACING
2%	300 ft
4%	200 ft
6%	167 ft
10%	140 ft
20%	120 ft

With the water bars in place, maximum slope angle and length of disturbed areas on rough broken land were estimated to be 10% and 150 feet. Maximum slope angle and length in the lower

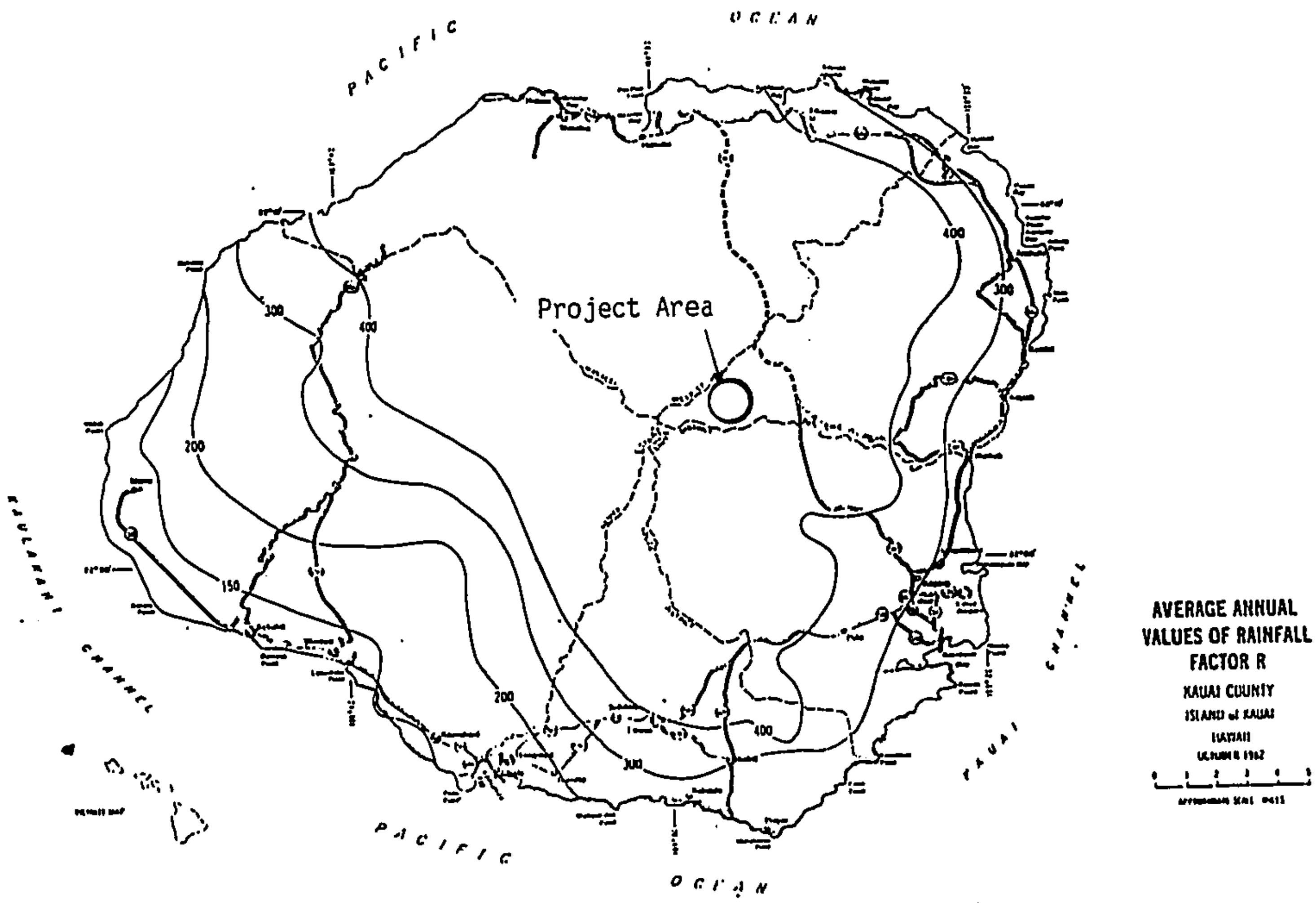


Figure 4.1-1. Map of average annual values of rainfall factor, R, for the island of Kauai.

penstock/powerhouse area were estimated to be 10% and 150 feet over Hanalei silty clay, 6% and 175 feet over Marshland, and 5% and 75 feet over Kolokolo extremely stony clay loam. The permanent access road slope length and angle were estimated to be 200 feet and 5%. In the powerhouse area, the maximum slope length and angle on the area to be disturbed were estimated to be 250 feet and 5% on both Kolokolo extremely stony clay loam and marsh.

The cropping management factor, C, was derived from Table 4.1-1. During construction of the diversion structure, the maximum amount of area would be exposed with no vegetational erosion control. As the diversion structure and penstock are completed, portions of the area will be mulched and revegetated, reducing the C factor. Thus, the value calculated for soil loss is the maximum rate and represents losses occurring during only a part of the construction period. The value of the erosion control practice factor, P, was adjusted to values reflecting contouring practices because the access road is routed across steeper slopes rather than straight down them.

Values for all of the factors used in the calculation of soil loss during construction are listed in Table 4.1-2. Table 4.1-2 also presents the predicted maximum amount of soil to be lost on a monthly basis during construction of the diversion weir, the penstock, the powerhouse, and the access road to the powerhouse.

The maximum amount of soil loss from unvegetated areas of maximum slope length and angle on the project site during a one month period during construction would be approximately 141 tons. The largest contributor to this soil loss total appears to be the penstock corridor with 90% of the total. This level of soil loss would only be possible at the start of construction when the entire project area to be disturbed is exposed to wind and water erosion. Subsequent months would show decreased soil loss due to gradual revegetation of the disturbed areas. In addition, because maximum values for slope angle and length were used in these calculations, it can be assumed that actual soil loss will be somewhat less than the figures presented in Table 4.1-2 over the entire construction period. Erosion control practices described in Section 8.2 will be implemented and will minimize the impact of sediment on the surrounding vegetation and on water quality.

Construction of the transmission line will affect an additional 18.2 acres. Complete vegetation removal and soil disturbance will only be necessary at the locations of the power poles. The transmission line will follow an existing ditch and haul cane roads which will eliminate the need for construction of an additional access road. The area of temporarily exposed soil and soil erosion resulting from power pole installation will be insignificant relative to the sedimentation associated with the existing road.

TABLE 4.1-1. Values of the cropping factor, C, to be used in the USLE. Pre- and post-project conditions were assumed to be appreciable brush canopy with 95-100% forb coveer except for 95-100% grass cover with no canopy on Hanalei silty clay and marsh soils.

Vegetal canopy			Ground cover (See footnote 5/)					
			Percent					
Type and height 2/	Percent Canopy 3/	Type 4/	0	20	40	60	80	95-100
No appreciable canopy		G	0.45	0.20	0.10	0.042	0.013	0.003
		W	.45	.24	.15	.090	.043	.011
Canopy of tall weeds or short brush (0.5 m fall ht.)	25	G	.36	.17	.09	.038	.012	.003
		W	.36	.20	.13	.082	.041	.011
	50	G	.26	.13	.07	.035	.012	.003
		W	.26	.16	.11	.075	.039	.011
	75	G	.17	.10	.06	.031	.011	.003
		W	.17	.12	.09	.067	.038	.011
Apppeciable brush or bushes (2 m fall ht.)	25	G	.40	.18	.09	.040	.013	.003
		W	.40	.22	.14	.085	.042	.011
	50	G	.34	.16	.08	.038	.012	.003
		W	.34	.19	.13	.081	.041	.011
	75	G	.28	.14	.08	.036	.012	.003
		W	.28	.17	.12	.077	.040	.011
Trees, but no appreciable low brush (4 m fall ht.)	25	G	.42	.19	.10	.041	.013	.003
		W	.42	.23	.14	.087	.042	.011
	50	G	.39	.18	.09	.040	.013	.003
		W	.39	.21	.14	.085	.042	.011
	75	G	.36	.17	.09	.039	.012	.003
		W	.36	.20	.13	.083	.041	.011

1/ All values shown assume: (1) random distribution of mulch or vegetation, and (2) mulch of appreciable depth where it exists.

2/ Average fall height of waterdrops from canopy to soil surface: m = meters.

3/ Portion of total-area surface that would be hidden from view by canopy in a vertical projection (a bird's-eye view).

4/ G = cover at surface is grass, grasslike plants, decaying compacted duff, or litter at least 2 inches deep.

W = cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface) and/or undecayed residues.

5/ The Percent Ground Cover is that portion of the soil surface that is hidden from aerial view by the G and W cover types with a fall height of less than 0.5 m.

TABLE 4.1-2. Values of factors used in calculation of pre-project, post-project and construction soil loss. Maximum soil loss rates and monthly totals are also included.

Construction Area	Soil Type	Acres	R	K	L	S	LS	C			P	Maximum Monthly Soil Loss (Tons per Month)		
								Pre-Project	During Construction	Post-Project		Pre-Project	During Construction	Post-Project
Diversion Weir	Rough broken land (rRR)	.90	400	.28	50	10%	.968	.001	1.00	.005	0.60	.005	4.88	.024
Penstock & Temporary Access Road	Rough broken land (rRR)	13.40	400	.28	150	10%	1.68	.001	1.00	.005	0.60	.130	126.07	.630
	Hanalei silty clay (HnA)	.20	400	.17	150	10%	1.68	.001	1.00	.005	0.60	.001	1.14	.006
	Marsh (MZ)	.32	400	.00	175	6%	.888	.001	1.00	.005	0.50	.000	0.00	.000
	Kolokolo extremely stony clay loam (KuL)	.09	400	.28	75	5%	.464	.001	1.00	.005	0.50	.0002	0.19	.001
Permanent Access Road	Kolokolo extremely stony clay loam (KuL)	.72	400	.28	200	5%	.758	.001	1.00	.005	0.50	.003	2.55	.013
Powerhouse	Kolokolo extremely stony clay loam (KuL)	.75	400	.28	250	5%	.843	.001	1.00	.005	1.00	.006	5.90	.030
	Marsh (MZ)	.75	400	.00	250	5%	.843	.007	1.00	.005	1.00	.000	0.00	.000
										TOTAL:		.145	140.73	.704

4.1.2.3 Flora

A maximum of 17.13 acres of vegetation will be removed from the site during construction. This vegetation includes no threatened or endangered species of plants or native plant species considered to be rare. Surrounding undisturbed vegetation will be protected from encroachment of sediment from the disturbed areas by mitigation measures outlined in Section 8.2. Revegetation efforts also described in Section 8.2 will be implemented during the construction period and will proceed down the disturbance corridor from the diversion to the powerhouse as the penstock is buried. The entire disturbed area will have been planted by the end of the construction period with the exception of areas directly under the penstock where it is located above the ground surface and areas beneath the powerhouse, tailrace, and permanent access road.

The power transmission line will affect an additional 18.2 acres. Vegetation will be completely removed only in small areas around power poles. Trees will be removed from the entire corridor under the power lines. Since the transmission line will be located along an existing road, the effect of construction on vegetation will involve primarily weedy vegetation growing along those roads. No threatened or endangered plant species will be impacted.

4.1.2.4 Fauna

Effects on the terrestrial vertebrate fauna within the project area during project construction will result from 1) habitat destruction in the construction of the access road, penstock, powerhouse and equipment staging area and 2) from increased human activity within the project area.

Avian Fauna

The project area does not contain critical habitat specified for any species of birds, and adverse impacts on the abundance or distribution of these species on Kauai during construction are not expected. There will, however, be localized disturbances to the avifauna. Habitat destruction during construction will likely cause disruption of breeding, feeding and resting of individuals that have territories within the impacted area. These disruptions would be expected to last only until post-construction reclamation of the area is complete.

Mammalian Fauna

The project area does not contain critical habitat specified for any species of mammals, and adverse impacts on the abundance and distribution of these species on Kauai are not expected. Individuals of some species are likely to vacate the immediate construction area until post-construction reclamation is complete. Such movement is not expected to significantly affect hunting of feral pigs or goats in game unit C.

Reptiles and Amphibians

The project area does not contain critical habitat for any species of reptiles or amphibians and adverse impacts on the abundance and distribution of these species are not expected. Effects to individuals in the immediate construction area are expected, but post-construction reclamation should allow these species to repopulate to pre-project levels.

Endangered Species

Adverse impacts from project construction are not expected on the seven species of vertebrates listed as endangered or threatened that have the potential to inhabit the project area. Only the Hawaiian duck is likely to inhabit the project area on a regular basis.

Newell's Shearwater: Newell's shearwaters are not known to inhabit the project area, however, they are suspected to nest nearby in the Hanalei River canyon. Project construction is not expected to impact this probable breeding population as construction activities should be sufficiently distant from the suspected nesting area.

While not known to use the Upper Wailua River basin for breeding, the possibility does exist for such a breeding population to occur as suitable habitat (slopes between 1500 and 2000 ft elevation covered with uluhe fern) is found in the project area and is widespread in the upper Wailua River basin. If such a breeding area is located within or near the construction area, adverse impacts might be expected. A survey will be conducted in late April or May (or other time as deemed necessary by the U. S. Fish and Wildlife Service) to determine the presence of this species in the project area. If the project will impact nesting Newell's shearwaters, project modifications will be made in consultation with the U. S. Fish and Wildlife Service to minimize these impacts.

Dark-rumped (Hawaiian) Petrel: This endangered subspecies is suspected to nest on Kauai, however, nesting areas have not been located. Habitat used on Maui and Hawaii for nesting locations is quite different from that found in or near the project area and nesting within the project area is highly unlikely. If the species were to nest within or near the construction area, adverse impacts during construction might occur.

Band-rumped Storm Petrel: This endangered subspecies is assumed to breed on Kauai but nest locations have never been found. Little is known about this subspecies but nesting locations of the Galapagos subspecies indicate a preference for nesting habitat dissimilar to that found in or near the project area suggesting that breeding within or near the project area is highly unlikely. If the species were to nest within or near the construction area, adverse impacts during project construction might occur.

Hawaiian Duck: Adults and ducklings of this endangered species have been observed within or near the project area since 1982. Maheo Stream and the North Fork of the Wailua River contain suitable habitat for nesting of this species and these areas within the project area are considered as part of the "essential" habitat necessary for the recovery of the species. The project area does not contain critical habitat for this species and project construction is not expected to adversely affect the status and distribution of this species on Kauai.

Construction may cause minimal disturbance to individuals of this species that currently use the area. Increased human activity, altered flows in Maheo Stream, and increased sedimentation and turbidity in Maheo Stream may cause individuals of this species to vacate parts of the immediate project area during portions of the construction phase although the species is known to be quite tolerant of disturbances and fluctuating flows (Berger 1981). This disturbance should cease once successful reclamation is completed. To minimize impacts on the Hawaiian duck during nesting, heavy construction activities will be limited during the peak nesting period (December through May) in the area of the proposed powerhouse.

Common Moorhen (Hawaiian Gallinule): The project area does not contain critical habitat for this endangered subspecies. Use of the project area by this species is likely to be very infrequent and not for nesting purposes. Construction activities should have no impact on the abundance and distribution of this species on Kauai.

American (Hawaiian) Coot: The project area does not contain critical habitat for this endangered subspecies. As with the Common Moorhen, the use of the project area by this species would be infrequent and unlikely for nesting. Construction activities should have no impact on the abundance and distribution of this species on Kauai.

Hoary (Hawaiian) Bat: Little is known of this species on Kauai and it has not been recorded within the project area and was not located during the wildlife survey. However, the hoary bat may still occur within the project area as low numbers and nocturnal habits make the species difficult to observe. The project area contains no critical habitat for this species but may contain suitable habitat, especially where there are forests bordering open areas.

Should individuals frequent the immediate construction areas, they may vacate the project area until post-construction reclamation is complete. As a mitigative measure, the initial clearing of trees in the forested sections along the penstock route will not be done during mid-May through July to minimize impacts to the flightless young. Construction activities should have no impact on the abundance and distribution of this species on Kauai.

4.1.3 Archaeological Sites

An archaeological reconnaissance survey was conducted for the proposed Upper Wailua hydropower project along Maheo Stream on Kauai. The survey report appears in Appendix C of the Final EIS. The proposed project includes an approximately 8,925 foot long penstock running from the outlet of the Hanalei Water Tunnel to an area 200 feet from the confluence with the North Fork Wailua River. In addition, a power line is planned to parallel existing roads and ditches to an Electric Substation near the North Fork Wailua River.

No archaeological remains were located within the project area, but the area near the confluence of the two streams, which will be used as a staging area and access road, is a potential site for traditional irrigated agricultural terraces. Land clearing and grading at this location could damage or destroy the archaeological significance of this site if it is present. Although this locality was carefully examined for sites, terraces may lie under a thick mat of California grass. Some historic evidence suggests Hawaiian terracing of the upper tributaries of the Wailua River. For these reasons, archaeological monitoring is recommended during vegetation clearing before construction in the confluence area. If ancient terraces are present at this location, they can be found and mapped. No further archaeological research or field work is recommended for other areas of the proposed project. Section 8.3 discusses mitigative measures proposed to minimize impacts to potential archaeological sites.

4.1.4 Socio-Economic Factors

4.1.4.1 Recreation

During construction, the corridor of disturbance will represent a visual impact on recreationists in the project area. The impact, however, will be temporary as revegetation will take place immediately following completion of construction.

The above ground sections of the penstock over 20+ percent of its length may impede movement of feral pigs, dogs, and hunters. However, up to 80% of the penstock will be buried and passage over the penstock in these areas or under the penstock where it crosses gullies will provide freedom of movement on most of the project area.

4.1.4.2 Economy

There will be no adverse effects on the economy associated with construction of the proposed project. In fact, any effects on the economy will tend to be positive. Although short-term, the local economy in the Lihue-Wailua area will improve as a result of the project. Construction jobs will increase, as will the need for contract labor, heavy equipment, and aggregate materials. Much of the labor required for construction of the proposed project will be hired from the local area.

4.1.5 Air Quality

Effects of project construction on air quality will be the result of dust and exhaust fumes produced by the heavy equipment operating at the site, and by the private vehicles driven by construction workers to and from the site. Dust abatement practices, such as grading and watering the road during dry periods, will minimize the amount of dust produced by construction of the project.

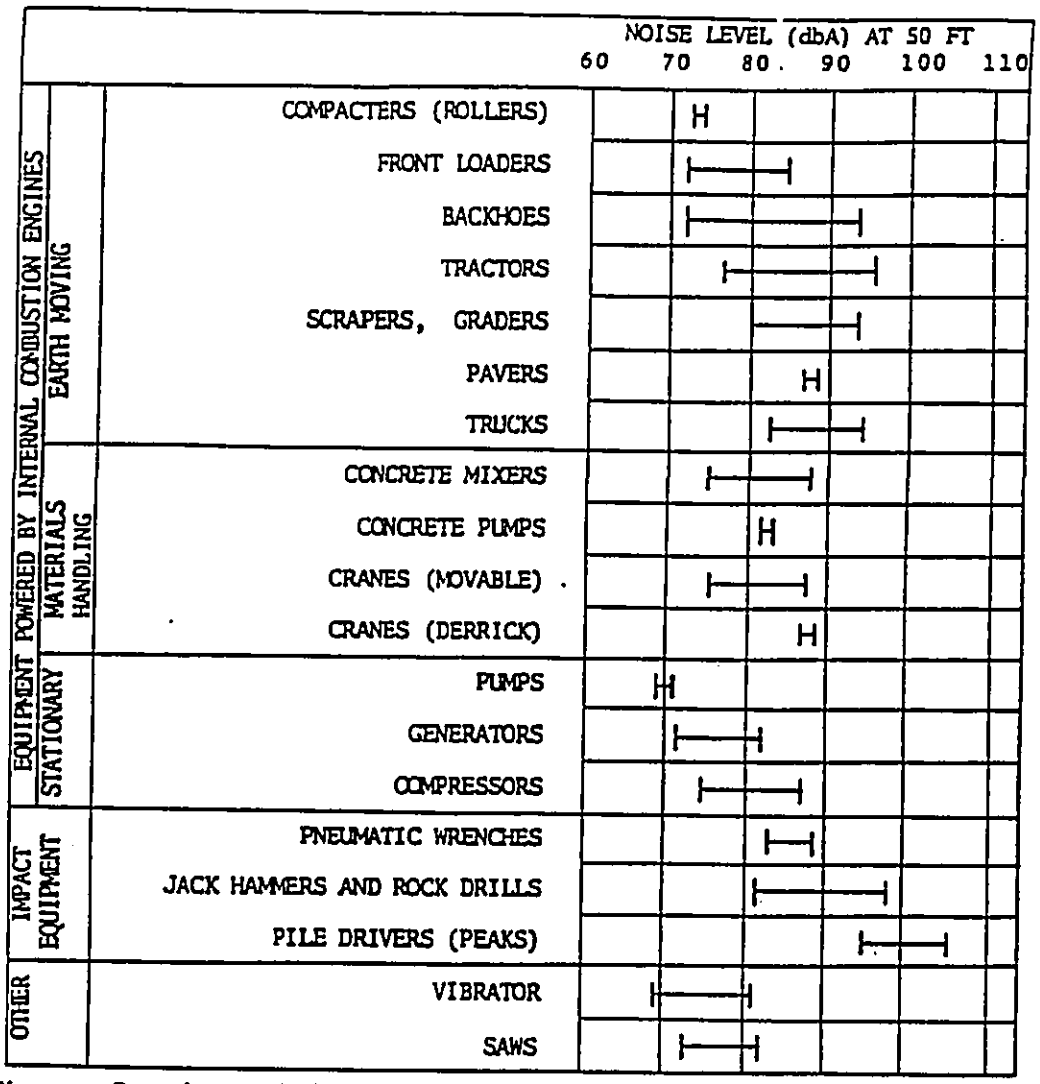
4.1.6 Noise

Construction of the proposed project will generate significant noise impacts in the project area. The primary source of this noise will be from the operation of construction equipment. Figure 4.1-2 illustrates some estimated noise levels produced by common construction equipment that may be found at the project construction site. For comparison, the noise level humans perceive in conventional speech is 60 decibels (dB).

Noise produced during construction of the project will reduce the recreational value of the area during the construction period. Noise produced during construction of the project may also have an adverse effect on mammalian and avian wildlife in the project area by disturbing them and causing them to relocate on at least a temporary basis. The construction period is estimated to be at least one year in time.

4.1.7 Traffic

Construction of the proposed project will increase traffic significantly within the local area. It is not known at this time how many vehicles will be in use for construction. Because of the rural nature



Note: Based on Limited Available Data Samples

Figure 4.1-2. The estimated noise levels produced by common construction equipment. Source: Noise From Construction Equipment and Operations, Building Equipment, and Home Appliances (EPA, 1971).

of the project area and present light vehicle use, the increased number of construction vehicles in the area will have a significant impact on traffic volume and flow patterns.

Many of the vehicles needed for project construction will be large trucks and heavy equipment including cement mixers, dump trucks, land graders, cranes, backhoes, front loaders, and numerous other tractors. These vehicles are slow and hard to transport. They can also be expected to produce noise levels that are greater than what could be expected to occur within the project area at present, as well as decrease air quality within the area due to increased exhaust emissions. It should be noted, however, that similar equipment and construction activities occur on a continuous basis (sugar cane harvesting) adjacent to the Forest Reserve.

The majority of the vehicles and equipment required for project construction will travel from the Wailua and Lihue urban areas. Access to the project area is gained utilizing a network of private roads through lands owned by the Lihue Plantation.

4.2 OPERATION

4.2.1 Aquatic Environment

The following section addresses the operational impacts of the preferred alternative on the aquatic environment.

4.2.1.1 Hydrology

The natural flows within the Maheo Stream have not been gaged. In order to estimate these flows, a similar watershed which has no upstream diversions was used as a template. The data from this watershed (East Branch of the North Fork Wailua River) have been previously discussed in Section 2.1.5. The surface area of the watershed within the Maheo Stream was determined to be 53% of the East Branch North Fork Wailua River watershed. A direct proportion of flows based upon watershed surface area resulted in a hydrograph of estimated flows in Maheo Stream without the Hanalei Tunnel additions (Figure 4.2-1). This can be done because of the significant relationship found between precipitation and flow. The maximum estimated natural flow was 140 cfs with a minimum flow of 5 cfs. If the Hanalei tunnel diversions as measured at the USGS Station #1000 are included, the flows are increased substantially (Figure 4.2-2). The maximum estimated flow was 165 cfs, with no flows lower than 15 cfs. A frequency distribution of these two sets of flows can be seen in Figure 4.2-3. Without the Hanalei tunnel, the most frequent flows which were estimated to occur were 10 to 15 cfs (17.9% occurrence) and 15 to 20 cfs

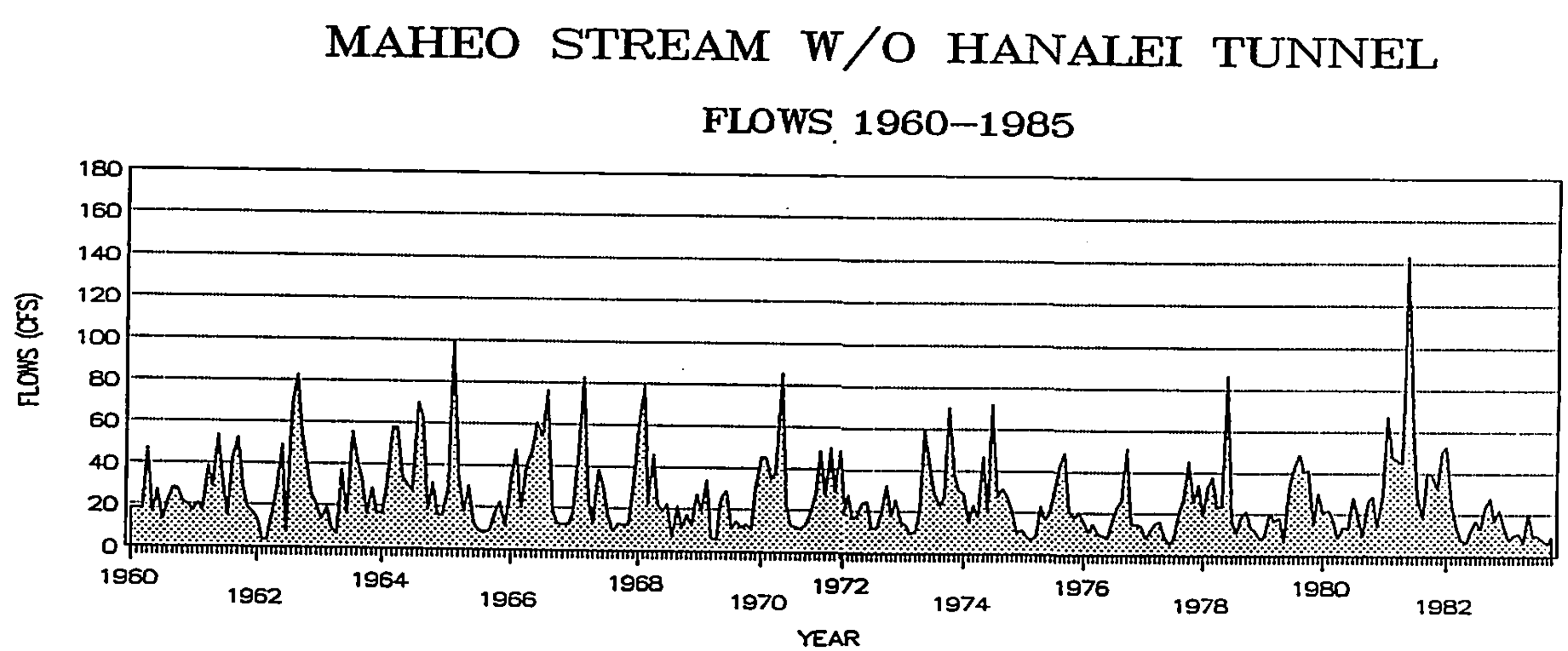


FIGURE 4.2-1. The estimated flows using 53% (based upon watershed surface area) of USGS Station #680. Data are for 1985 without the Hanalei Tunnel diversions.

MAHEO STREAM

FLOWS 1960–1985

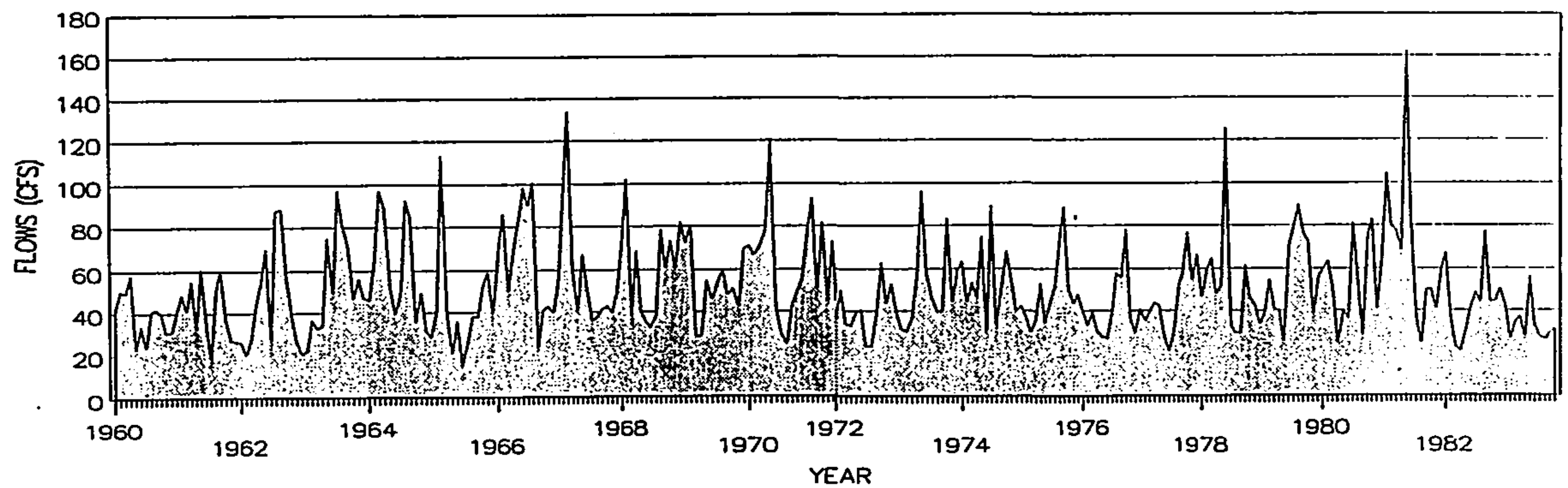


FIGURE 4.2-2. The estimated flows of the Maheo Stream using 53% (based on watershed surface area) of USGS Station #680. Data are for 1960 to 1985 with Hanalei Tunnel diversions.

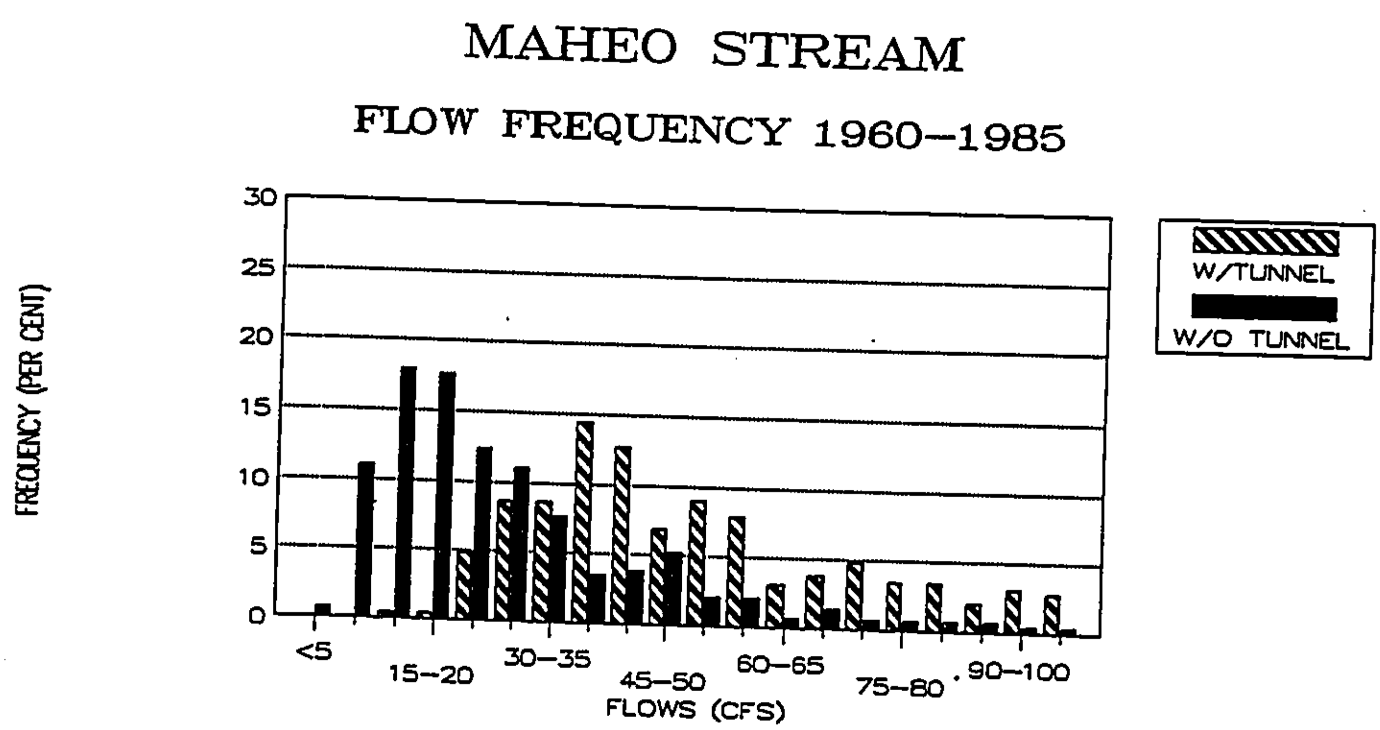


Figure 4.2-3. The frequency distributions of the Maheo Stream flows with and without the Hanalei diversion flows.

(17.5% occurrence). With the Hanalei diversion added to the Maheo system, the most frequent flows were in the range of 35 to 40 cfs (14.4% occurrence).

Under the current operational plan, the Hanalei tunnel flows will be diverted from the Upper Maheo Stream within a range of 8 to 48 cfs. Flows below 8 cfs and above 48 cfs will be bypassed into the stream. These unused flows will combine with the naturally occurring flows at their present confluence. An estimated hydrograph for these unused flows and the Maheo Stream are shown in Figure 4.2-4. The flows which will be returned to the Maheo Stream approximately 200 feet upstream from its confluence with the North Fork Wailua River, can be seen in Figure 4.2-5. The flows represent the estimated discharge from the hydroelectric plant. The frequency distribution of the flows immediately upstream of the tailrace and the tailrace discharges can be seen in Figure 4.2-6. The most commonly occurring flow above the powerplant during operation will be 10 to 15 cfs (17.9% occurrence). Flows less than 5 cfs will occur only 0.5% of the time. The 50% exceedance flows were estimated to be 21 cfs (Figure 4.2-7). The most frequent flows from the powerplant will be 25 to 30 cfs (20% occurrence).

In summary, the flows in the Maheo Stream will be returned to their natural pattern with an augmentation of flows from the Hanalei tunnel when tunnel flows are less than 8 cfs and greater than 48 cfs.

4.2.1.2 Water Quality

The key water quality parameters of concern are suspended sediments, temperature, and dissolved oxygen. No information exists on the existing changes in these parameters with distance downstream in the Maheo Stream. However, the operational effects of the powerplant on the turbidity in the Maheo Stream should be negligible. The proposed soil erosion control plan and revegetation plan will mitigate any potential long-term impacts.

Water temperatures, and therefore dissolved oxygen concentration, change with decreases in altitude. A comparison of stream water temperatures on Kauai with elevational differences for the July-August period (1986) indicates that changes as great as 2°C per 500 foot drop in elevation have occurred naturally. Because the penstock will be buried 50% of the time, temperatures, and therefore dissolved oxygen, are not anticipated to change outside the naturally occurring ranges presently experienced at similar elevations.

4.2.1.3 Flora and Fauna

As stated previously, the principal feature of project operation will be the removal of flow added to the Maheo Stream by the irrigation diversion from the Hanalei River. Existing flows between the mouth

MAHEO STREAM

FLOWS 1960–1985 WITH PLANT

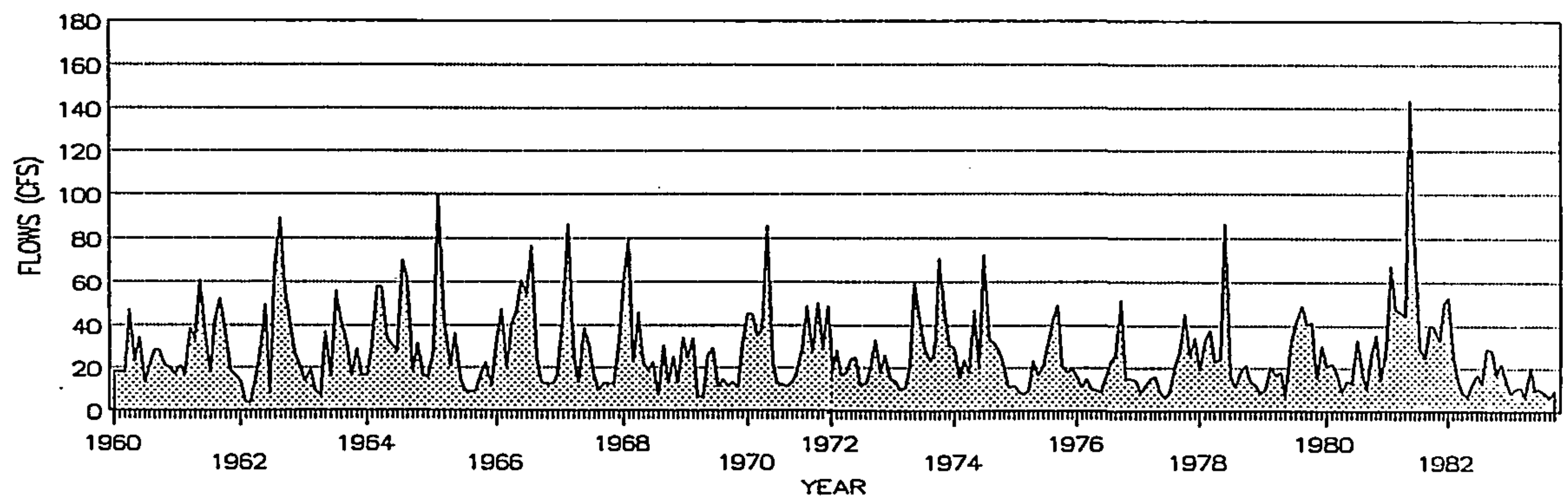


Figure 4.2-4. The flows in the Maheo Stream under the operational criteria of 8 to 48 cfs use.

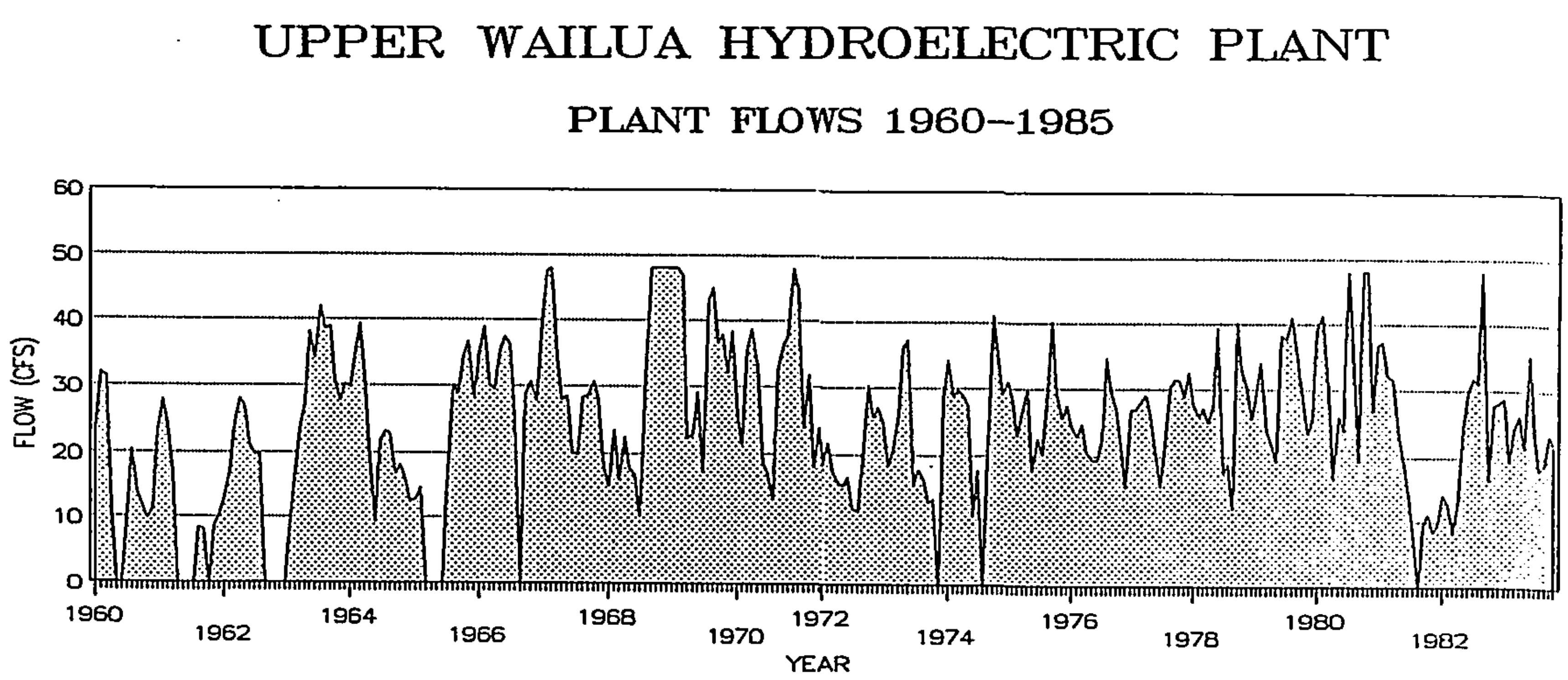


Figure 4.2-5. The estimated flows discharged from the Upper Wailua Power Plant.

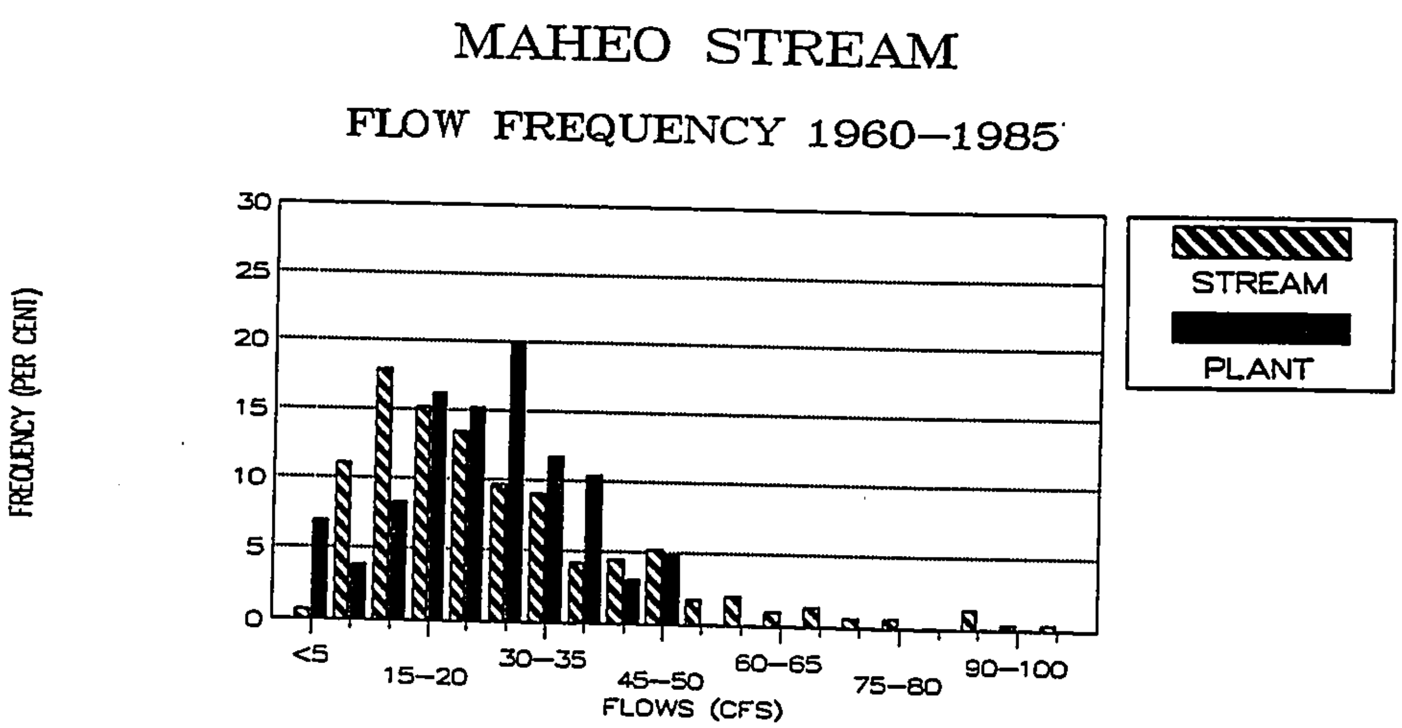


Figure 4.2-6. The frequency distributions of flows in the Maheo Stream immediately above the powerplant and the powerplant discharge.

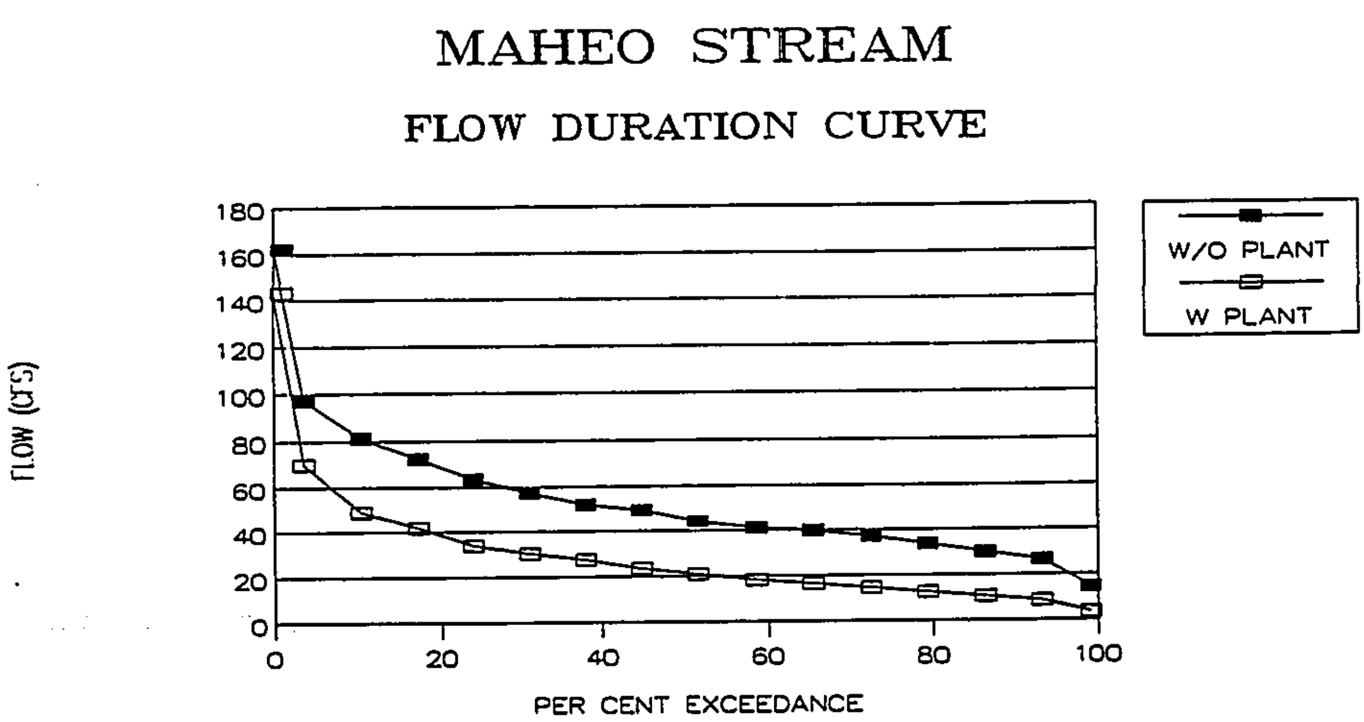


Figure 4.2-7. The flow duration curve for the Maheo Stream with and without the power plant in operation.

of the tunnel and the confluence with the North Fork Wailua River will be reduced by a nearly constant 26 cfs and the drainage will revert to natural flow volumes. An instream flow study to quantify potential changes in aquatic habitat has been conducted. Reversion to natural flow is expected to have no negative effects on existing aquatic habitat and may possibly result in an improvement. This conclusion is based on the present pattern of species abundance and distribution within the watershed, and on the physical character of the stream and its response to changing streamflow (see Section 2.2.1).

The large change in the abundance of opae above and below the confluence of the Maheo Stream with the tunnel water is most likely due to a combination of a difference in flow volume and in the character of the stream substrate. Above the confluence, the substrate in Maheo Stream is mostly boulder and cobble, which offers abundant cover for the opae, while below the confluence, the stream substrate is mostly lava bedrock with little cover. The addition of 26 cfs from the Hanalei tunnel increases water velocity and turbulence without increasing wetted area because of the steep sidewalls of the stream. Removal of the 26 cfs will reduce velocity and turbulence and provide conditions more similar to those above the confluence, although the natural change in geology will still create differences. While opae are described as a "torrential" species (Edmondson, 1929), they have been found to be most abundant in velocities less than 0.5 feet per second (TRPA 1987, 1988), and the reduction in flow to natural levels should improve the suitability of the habitat. The artificial addition of flow from the Hanalei River has not increased habitat, as might be assumed, because opae are less abundant below the confluence than they are above. No change is expected in the abundance of the o'opu because there is currently no apparent difference above and below the tunnel water confluence.

Reduction in flow by 26 cfs will lower the average depths and velocities of the downstream section of the Maheo Stream, probably to the benefit of the exotic species such as the swordtails and platys which occupy quieter, low velocity water. Increases in these species, the prey base for smallmouth bass, may result in greater numbers of the sportfish and a small improvement in fishing opportunity. Unfortunately, the presence of bass (a very effective piscivorous predator) and the continuation of flow and water quality problems downstream in the North Fork and mainstem Wailua River will strongly inhibit any re-establishment of the native species within the lower project area. Because the tailrace for the project will discharge into the Maheo Stream 200 feet above its confluence with the North Fork Wailua River, no change in the ecology of this lower reach of the stream is anticipated.

Operation of the project may also affect the recruitment of native diadromous species by entraining downstream migrants in the diversion flow or by falsely attracting upstream migrants to the tailrace of the powerhouse. As noted in Section 1.3 of this report, the project proponent has proposed a small bypass flow at the Hanalei diversion structure using an Aqua Shear Screen. However, if bypass flows are not available, an alternative screening method will be employed. This alternative can be seen in Figure 1.3-1. Although it will not remove opae larvae, it will prevent opae and o'opu adults from migrating through the tunnel.

The preferred design of the water diversion structure on the Hanalei River includes a screening system that will act to protect o'opu migrating downstream to spawn, larval opae drifting with the current, and all aquatic species migrating upstream to rear. The Aqua Shear Screen manufactured by Aquadyne, Inc., operates with a combination of flow shear and the Coanda effect to separate particulates from water with very high efficiency and little or no maintenance (Strong and Ott, 1988). Constructed of stainless steel wedgewire and standard slot openings of 1 mm, the screen will separate 90% of solids larger than 0.5 mm and everything greater than 1 mm, and will work at all flows.

In operation, water will pass over the crest of the diversion weir, flow through the screen slots, and enter a collection chamber for conveyance to the Wailua River watershed (Figure 1.3-1). Particulate matter, including any aquatic organisms, will be separated from the diverted water and deposited into a trough running laterally to the weir at the base of the screen. Water that originates from a notch cut in the top of the weir next to the screen will be flowing through the trough to carry screened material below the diversion. O'opu or opae moving upstream can reverse this path (which will be roughened with embedded stones) back up the base of the weir, through the trough, and up the side of the screen to the pool above the weir.

This screen design will provide complete protection for large o'opu migrating downstream to spawn by not having any openings larger than 1 mm, plus being smooth and non-abrasive. Fish passing over the weir and past the screen will be collected in the trough and carried safely downstream. Opae larvae, which are about 2 mm in size, will also follow this route and be excluded from possible diversion to the power facility and the Wailua River.

Water leaving the powerhouse will be conveyed to Maheo Stream through a tailrace that will be elevated above the normal water surface level of the stream by about 1 foot (Figure 1.5-1). The lip of the tailrace will be extended on a shelf and will remain dry underneath. The drop to the stream and the dry shelf will combine to create an impassable barrier to aquatic organisms migrating upstream by not providing a wet surface for them to ascend. With no means to reach the tailrace, they will not be able to reach the powerhouse.

4.2.2 Terrestrial Environment

4.2.2.1 Topography

Recontouring of the land surface during penstock burial should leave few permanent alterations to the topography. Some areas over the penstock corridor may be more level than prior to construction but will be contoured to conform to natural landforms in the vicinity. The 30 foot by 5 foot diversion weir, the 40 foot by 40 foot by 20 foot tall powerhouse, the approximately 50 foot long tailrace, and sections of exposed penstock will be the only significant changes to the landscape that will persist during operation of the project.

4.2.2.2 Soil

Following revegetation, all soils disturbed by project construction other than the permanent access road below the powerhouse and the parking area at the powerhouse will no longer be exposed to erosion by wind and water. After less than a year following construction, ground cover by vegetation should be complete and soil loss from areas above the powerhouse should quickly approach levels observed on adjacent undisturbed areas (Table 4.1-2). Soil erosion control by vegetation was projected to be slightly less effective on revegetated areas than on undisturbed areas. With proper construction and mitigation practices, there will be a very slight effect of the project on soils above the powerhouse during operation.

Soil loss rates from the powerhouse parking area and the road below the powerhouse will remain the same as during construction. Continued maintenance of sediment control structures and continued implementation of soil erosion control practices should minimize the amount of soil material lost as well as its impact on adjacent vegetation and water quality.

In the unlikely event of penstock rupture, the potential exists for major soil loss from the area around the rupture and the subsequent development of gullies. Mitigation practices described in Section 8.2 should minimize the amount of soil lost and the impact of sediment on the surrounding environment.

4.2.2.3 Flora

Vegetation will be eliminated permanently on areas covered by the permanent access road, the exposed penstock, the powerhouse, and the tailrace. In all other locations, vegetation similar to the undisturbed condition will be re-established. Complete ground cover should be restored within a year following completion of construction. Shrubs and trees will become established over time. There will be no further impacts to the vegetation associated with project operation.

4.2.2.4 Fauna

Effects of project operation on the terrestrial vertebrate fauna will result primarily from increased human activity within the project area once post-construction reclamation is completed. This increased activity, which is likely to be infrequent, will be confined generally to an area from the access road to the powerhouse and in the immediate vicinity of the powerhouse. Successful reclamation will return the penstock corridor to near pre-project status and should facilitate recolonization of this area by terrestrial vertebrate fauna.

Avian Fauna

Post-construction operation of the project should have very little effect on birdlife within the project area. Human activities and the powerhouse may make habitat adjacent to the access road and powerhouse slightly less desirable than that prior to the project. This will have only minimal impact on the local populations of birds and no impact on the abundance and distribution of these species on Kauai.

Mammalian Fauna

Operation of the proposed project should have no significant effect on mammalian populations within and near the project area and would have no effect on the abundance and distribution of these species on Kauai. Human activity along the access road and near the powerhouse may have an effect on the immediate distribution of feral pigs as they tend to avoid disturbance.

Reptiles and Amphibians

Operation of the project should have minimal impact on populations of these species and would have no effect on the abundance and distribution of these species on Kauai. Reduced flows in Maheo Stream should have little effect on populations of bullfrogs in this stream as habitat change would be minimal.

Endangered Species

Reduced construction activity near Maheo Stream after project completion will return disturbances to the Hawaiian duck to pre-project levels except in the vicinity of the powerhouse. Activities during routine maintenance and caretaking of the powerhouse will likely cause some disturbance to this species along the lower 600 feet of Maheo Stream. This, however, should have little effect on the usage of the rest of Maheo Stream by this species.

The effect of reduced flows in Maheo Stream on the suitability for Hawaiian duck is not known. Instream flow analyses conducted for the fisheries portion of this report indicate that the wetted perimeter and depth of pools change very little in Maheo Stream between flows of 7.5 and 35.0 cfs (see Figure 2.2-3). Velocities with in pools, however, increase by approximately 4 times over the same range of flows. The lower base flow may actually make the stream somewhat more suitable for feeding due to the reduced velocities in pool habitats. Disturbances caused by increased access to Maheo Stream for fishing would likely adversely affect the Hawaiian Duck. Providing better access to this stream for fishing as a mitigative measure is therefore not recommended.

Project operation will have no effect beyond those incurred during construction relative to the other endangered species.

4.2.3 Archaeological Sites

No adverse environmental effects to archaeological sites will be associated with the operation of the proposed project. Section 8.3 discusses the proposed mitigation plan addressing the potential to locate archaeological sites near the proposed powerhouse location.

4.2.4 Socio-Economic Factors

4.2.4.1 Recreation

Maheo Stream will experience decreased water flows from the operation of the Upper Wailua Hydroelectric Facility. These decreased water flows will have little or no impact on the recreational opportunities available along Maheo Stream due to the dewatering effect of the project (see Section 4.2.1.3). During operation of the project, Maheo Stream will flow 8-48 cubic feet per second (cfs) less than before the project began operation. It should be noted, however, that the dewatering of Maheo Stream serves to reduce the flows of this stream back to a more natural flow pattern for this stream since the water being utilized for the project is imported via a water tunnel from the Hanalei watershed.

The diversion weir, sections of the penstock, and the powerhouse will also create visual impacts to recreationists in the project area.

4.2.4.2 Economy

Operation of the proposed project will have no direct adverse effect on the local economy. It is possible, however, that construction of the project will decrease recreational use of the Maheo watershed, resulting in a loss of tourism and recreation in this particular location for a period of approximately 1 year.

At this time, laborers needed for construction of the Upper Wailua Hydroelectric Project would come from the Island of Kauai. If a sufficient enough labor force is not available on Kauai, laborers would be drawn in from the remaining islands. All laborers during project construction would be based on the Island of Kauai.

4.2.5 Air Quality

The only effect of project operation on air quality will be dust and exhaust fumes generated by the operator during visits to the site. This effect will be insignificant in relation to vehicular activity associated with extensive nearby sugar cane fields.

4.2.6 Noise

Operation of the proposed project is not expected to create any adverse environmental effects associated with noise produced by the project. Any adverse noise impacts associated with the proposed project will be generated at the construction phase and are so addressed in section 4.1.6.

4.2.7 Traffic

Operation of the proposed Upper Wailua Hydroelectric facility is not expected to cause any significant changes in traffic amounts or patterns. After construction, an access road will remain to the powerhouse site but use of this road by personnel will be very light. Use of this access road will be by a few vehicles to perform maintenance on the facility.

5.0 ANY PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

The detailed environmental effects of the preferred alternative have been previously discussed in Section 4.0. A summary of the unavoidable effects which could not be mitigated (Section 8.0) are shown in Table 5.0-1.

TABLE 5.0-1. A table of adverse environmental impacts as a result of the project construction and operation.

	CONSTRUCTION IMPACTS
Aquatic Environment	• 1000 ft^2 of North Fork Wailua River and minor tributary benthic areas will be lost due to construction of the stream crossing. • 200 feet of stream channel between the mouth of the Hanalei Tunnel and Maheo Stream will be dewatered. • Short-term water quality impacts (e.g., increased suspended sediments in the North Fork Wailua River) will occur.
Terrestrial Environment	• 15.39 acres of vegetation will be temporarily removed. • There will be a potential maximum soil loss of 141 tons per month with no vegetation cover. Soil loss levels will decrease with revegetation. • Habitat will be temporarily lost during construction of the access road, penstock, powerhouse, and staging area. • Short-term degradation of local air quality and increased noise levels will occur.
	OPERATIONAL IMPACTS
Aquatic Environment	• 1000 ft^2 surface area of stream bottom will be lost due to river passage structures on the North Fork Wailua River.
Terrestrial Environment	• Terrestrial vegetation covered by (1) 30 foot by 5 foot diversion weir, (2) 40 foot by 40 foot powerhouse, (3) 50 foot by 10 foot tailrace, (4) approximately 4,462 feet of exposed penstock, and (5) 130 foot by 50 foot access road will be lost. • Soil loss rates from the powerhouse parking area and the road below the powerhouse will remain the same as during construction. • The quality of habitat in the lowest 600 feet of Maheo Stream for the Hawaiian duck will be degraded by an unknown amount due to increased activity associated with operation and maintenance of the powerhouse and to increased noise generated from the power station.

6.0 ALTERNATIVES TO THE PROPOSED PROJECT

6.1 NO PROJECT

If the proposed project is not implemented, the present situation would remain unchanged and the hydroelectric power plant would not be constructed. Obviously, the physical environment would remain in its present state. A no project alternative would preclude fulfillment of the intent of the State of Hawaii's plan to aid and promote the development of renewable energy resources in the state.

A no project option would also preclude fulfillment of much of the intent of the Waimea-Kekaha Regional Development Plan and the Kauai General Plan. Without the development of the hydroplant project, the regional and county goals of improving and expanding the economy, utilizing water resources, developing power sources, and controlling air pollution would not realize their maximum potential. A portion of the electrical energy which could be produced by the hydroelectric plant would continue to be produced from imported oil. Besides the production cost increase which would result from the rising cost of imported oil, electricity production would continue to generate attendant emissions from fossil fuel power plants.

Employment required for project construction of the facility would not be realized. Tax revenues and direct and indirect revenues for goods and services would not be produced. Water supply, recreation, and wildlife habitat would remain the primary uses of the project watershed.

6.2 ALTERNATIVE 1

Alternative 1 is illustrated in Figure 1.2-3. This alternative includes an intake weir approximately 5 feet high and 30 feet across at the outlet of the Hanalei Tunnel. A penstock used to convey 8 to 48 cfs of Hanalei tunnel irrigation water will be constructed from the diversion weir down to a powerhouse containing one pelton turbine generator at a location of approximately 760 feet above mean sea level (msl). The penstock in this alternative will be approximately 6,400 feet in length and have a vertical drop of 440 feet.

Although the powerhouse in Alternative 1 is removed from the North Fork Wailua River floodplain, the penstock location adjacent to Maheo Stream would result in extremely expensive and extensive protective mitigative measures in order to insure 100% containment of transported sediments. In addition, an access road 1900 feet long would be required for this alternative. This alternative would also require a large staging area on the north side of the North Fork Wailua River in a previously undisturbed area. The tailrace from the powerhouse to Maheo Stream would also require the most excavation through a potentially sensitive archaeological area of any alternative.

6.3 ALTERNATIVE 2

This alternative is similar to Alternative 1 except the powerhouse location has been moved further down Maheo Stream to a point at the confluence of Maheo Stream and the North Fork Wailua River (see Figure 6.3-1). This alternative was considered because the penstock route would traverse the maximum reach of Maheo Stream, thus accumulating the greatest head of all alternatives considered as it approached the powerhouse. Upon review of the Soil Conservation Service Soil Survey for the project area, it was determined that soils at the proposed location for the powerhouse were too wet for construction of the powerhouse. The proposed powerhouse location under this alternative is also subject to high water conditions and, in fact, is located within the floodplain of both the North Fork Wailua River and Maheo Stream.

Because of the penstock location near Maheo Stream and the wet soil conditions found at the confluence of the two streams (the proposed powerhouse site) this alternative was dropped from consideration as a potential plan.

6.4 ALTERNATIVE 3 - ALL MAHEO STREAM WATER UTILIZED

The design of Alternative 3 is similar to the design of Alternative 1. The primary difference between these 2 proposals is that Alternative 3 would utilize all the water available in Maheo Stream (see Figure 6.4-1). This would include all water being conveyed through the Hanalei Tunnel, as well as water generated within the Maheo Stream watershed.

This alternative was considered unworkable and not acceptable early-on, because of the unavoidable and adverse impacts to the fisheries resource of Maheo Stream associated with implementation of this alternative.

6.5 ALTERNATIVE 4 - PREFERRED ALTERNATIVE

Essential features of this alternative are the fish diversion screens on the Hanalei side of the diversion tunnel, an intake weir approximately 5 feet high and 30 feet across at the outlet of the Hanalei

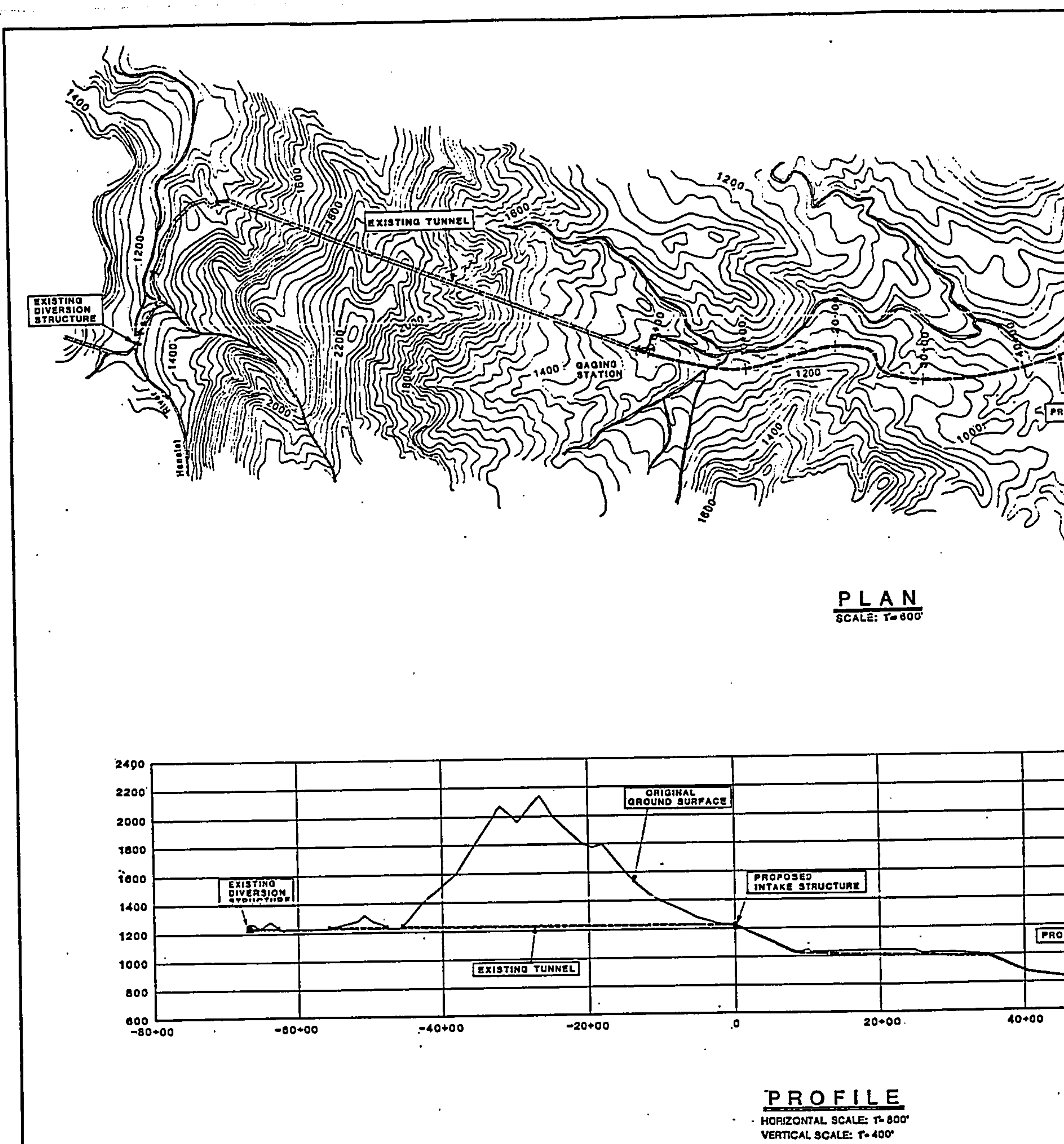
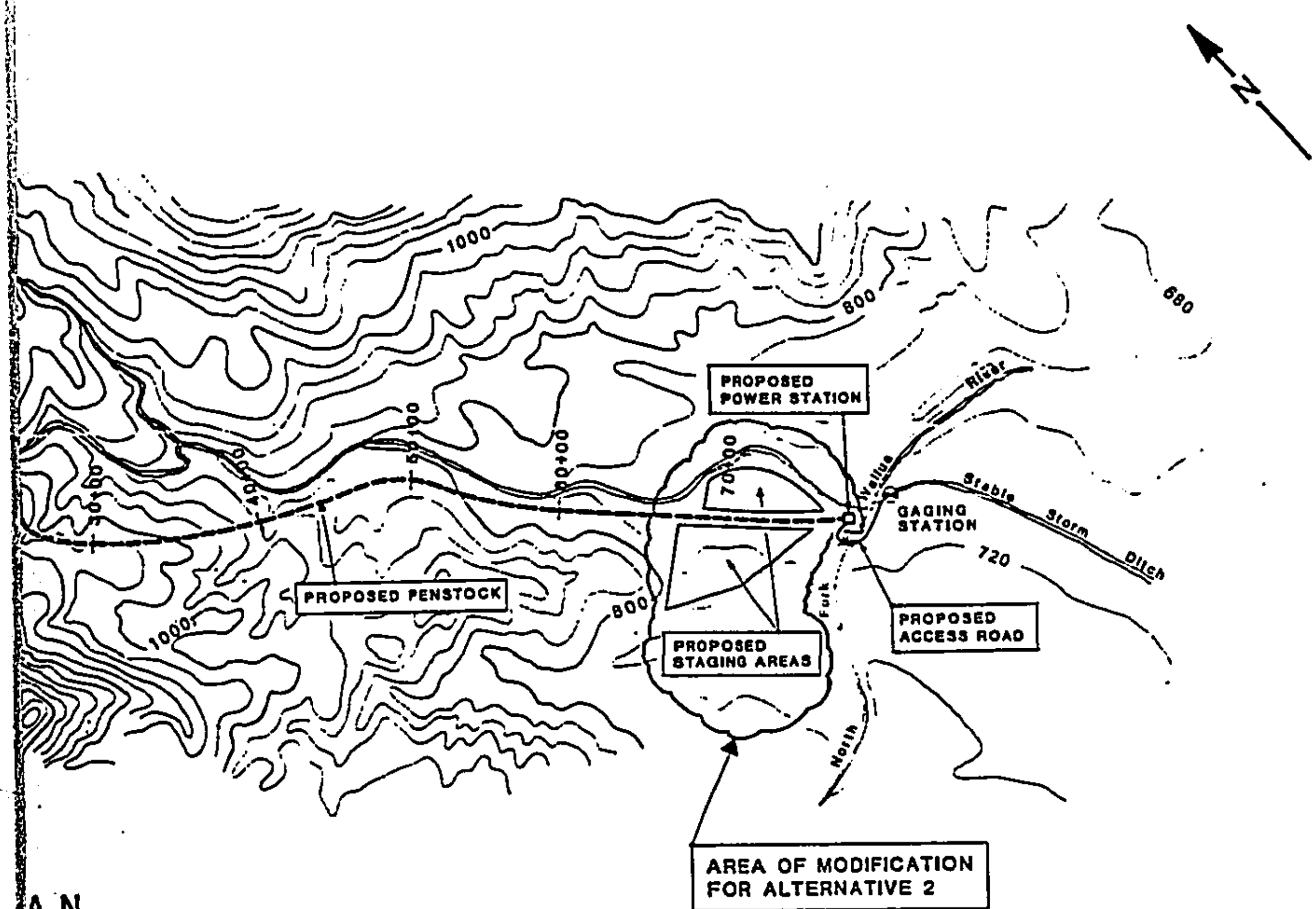


FIGURE 6.3-1. The plan and profile for the penstock alignment and powerplant location in Alternative 2.



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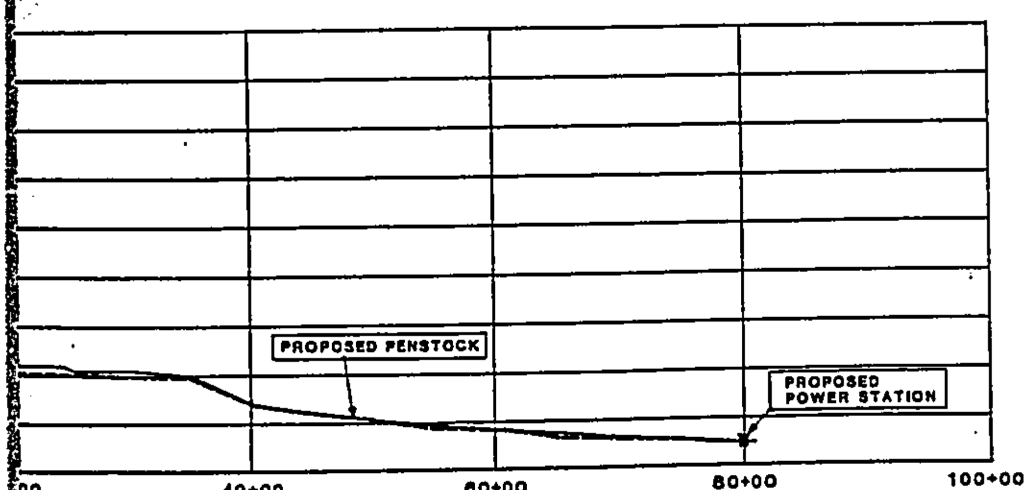

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plant

REVISION	DATE	DESCRIPTION	BY	APP.

UPPER WAILUA
HYDROELECTRIC PROJECT

PLAN & PROFILE
ALTERNATIVE 2

CALPINE SAN JOSE CALIFORNIA

DRAWN	CHECKED	APPROVED	DATE
DATE	SCALE	DWG. NO.	

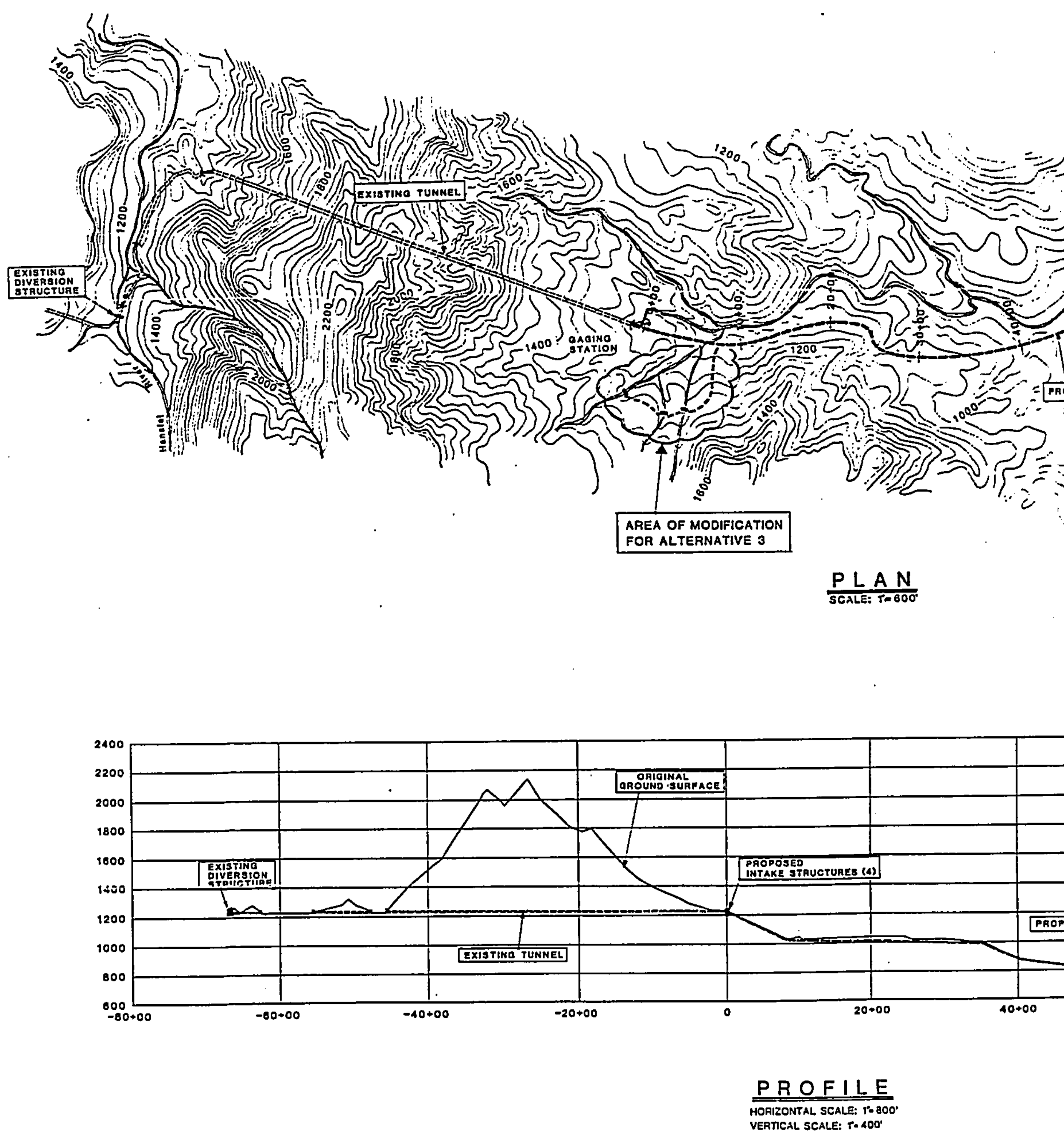
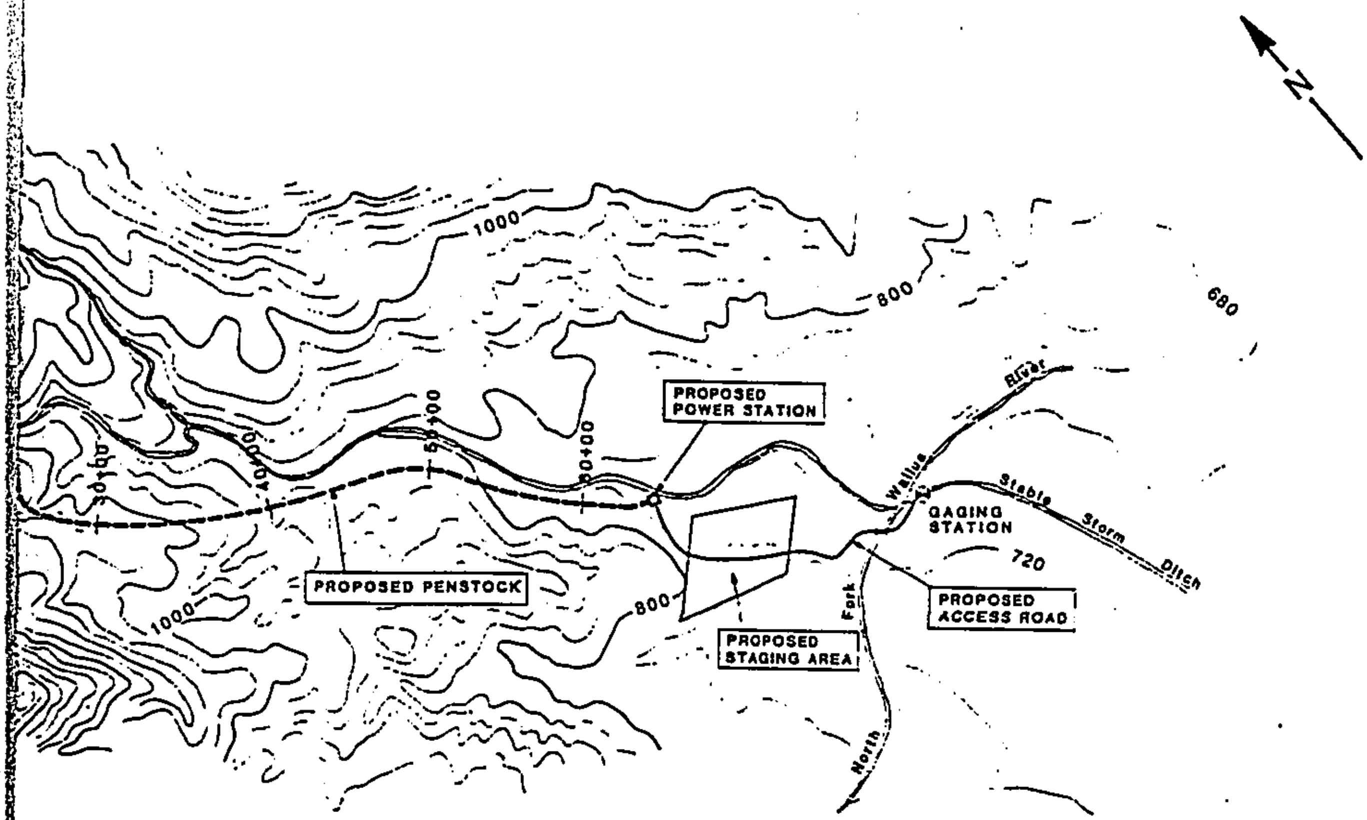


FIGURE 6.4-1. The plan and profile for the penstock alignment and powerplant location in Alternative 3.



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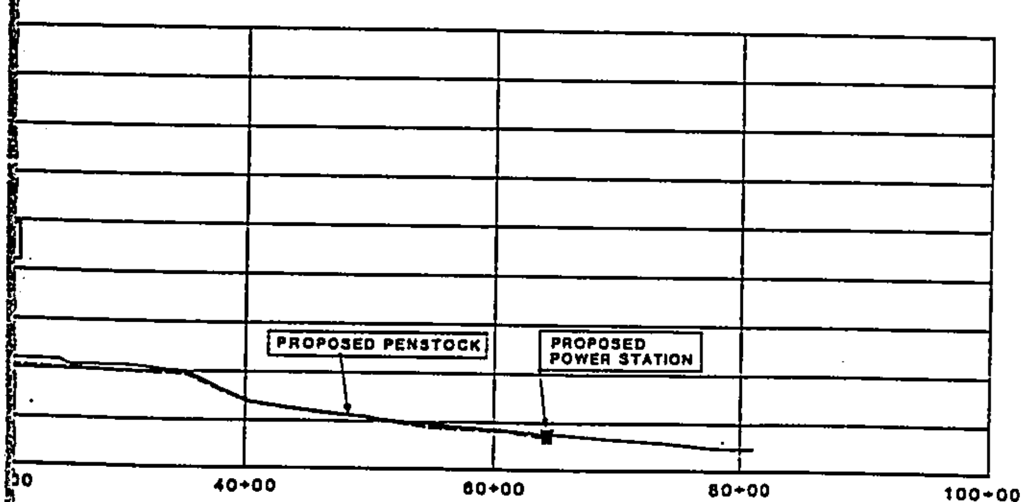

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REVISION	DATE	DESCRIPTION	BY	APPD

UPPER WAILUA HYDROELECTRIC PROJECT

PLAN & PROFILE
ALTERNATIVE 3

ALPINE SAN JOSE CALIFORNIA

DRAWN	CHECKED	APPROVED	DATE
DATE	SCALE	DWG NO	

Tunnel and a 48" to 32" penstock. The penstock will be able to convey 8 to 48 cfs of the Hanalei Tunnel irrigation water over a distance of 8,925 feet. The powerhouse will be located 200 feet upstream of the confluence of the Maheo Stream and the north fork of the Wailua River and be engineered to withstand a 100 year, high water event. The site for the powerplant represents the most favorable location for obtaining the maximum head, the least amount of access road disturbance, and the least tailrace distance and disturbance. In addition, the site has acceptable soil conditions. The staging area in this alternative will be smaller (1.5 acres), located on the north side of the North Fork Wailua River, and incorporate a large, currently disturbed area near the Stable Storm Ditch road.

The proposed penstock location is removed from the stream corridor in a reach from 2000 to 8000 feet from the diversion structure. This will allow for the complete mitigation of potential movement of sediment to Maheo Stream. Although the first 2000 feet are adjacent to the stream, extensive mitigation measures developed as part of the sediment and erosion control plan will prevent any soil movement into Maheo Stream.

6.6 ENERGY CONSERVATION

Energy conservation can rightly be considered an alternative to hydroelectric power as a source of energy for the state of Hawaii. Energy conservation offers a cost-effective, readily available, and environmentally benign means of securing additional energy resources.

Energy conservation is a vital component of the Hawaii State Energy Plan. It has directly contributed to an economy that is at least 20 percent more energy efficient today than it was ten years ago (State Energy Resources Coordinator Annual Report, 1986-1987, 1987). In 1986, state and federal energy conservation programs saved Hawaii $54 million - about 3.4 million barrels of oil. The Department of Business and Economic Development is responsible for administering the federal and state energy conservation programs in Hawaii.

Examples of projects funded under the State Energy Conservation Program include the following: a plan to improve county lighting systems, developing a plan to enforce building energy efficiency standards, and the installation of a new heat pump water heating system at the Al Moana Hotel in Honolulu. This heat pump can provide 9,000 gallons of hot water per hour, and save the equivalent of approximately 2,500 barrels of oil per year. Energy conservation requires no commitment of natural resources while contributing to the state's goal of becoming more energy self-sufficient.

7.0 RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The development and operation of the Upper Wailua Hydroelectric Project would help supply the electrical needs of the Island of Kauai. The development of hydroelectric facilities helps to reduce Hawaii's dependence on oil based utilities. Hydroelectric power is a renewable energy resource that is relatively clean to produce when compared to burning oil or coal to produce an equal amount of energy.

The proposed Upper Wailua Hydroelectric Project will cause many short-term impacts to the immediate project area. The majority of these impacts are construction related and are not anticipated to be significant in either their effect on the natural environment or their long-term influence on the existing environment.

The primary long-term impact to the existing environment along the affected reach of Maheo Stream will be a reduction in stream flows below the diversion. However, since the project will be utilizing irrigation water conveyed through the Hanalei Tunnel, the net loss of water in Maheo Stream will return the stream to more natural flow conditions present prior to the completion of the Hanalei Tunnel.

The proposed project is not anticipated to create any significant adverse impacts to agricultural production downstream of the project area. No short term or long term risks to health or safety will be caused by the proposed project.

8.0 MITIGATIVE MEASURES PROPOSED TO MINIMIZE IMPACT

8.1 AQUATIC ENVIRONMENT

Effects of the project on water quality and the aquatic environment consist primarily of increased sediment load from soil erosion. Measures to minimize soil erosion are described below in Section 8.2.

The major area of mitigation for the aquatic biota will be to prevent downstream entrainment of the native fishes. This will be accomplished by placing a fish screen at the upstream diversion structure (Figure 1.3-1). In addition, a series of rock steps will be placed on the downstream side of the diversion structure so that when flows are bypassing over the dam, a wetted area will be available for upstream migration (see Appendix A for details).

8.2 TERRESTRIAL ENVIRONMENT

SOILS

Detailed soil erosion control and revegetation plans will be developed in consultation with the appropriate agencies prior to initiation of construction. In general, the following practices will be implemented in order to minimize soil loss during project construction and after project completion to reduce the impacts of soil movement on vegetation and water quality:

Entire Project Site

1) With the exception of stream crossings, the Hanalei Tunnel diversion, and the tailrace, a minimum of 75 feet of undisturbed vegetation will separate construction areas from Maheo Stream.
2) A silt fence of filter fabric will be erected and maintained to protect undisturbed areas of vegetation downslope of construction from sediment encroachment.
3) All topsoil will be removed from areas to be excavated or filled prior to the start of construction. Topsoil will be used immediately if possible, or will be stored in broad, gently sloping berms of graded material. These storage piles will be lined with geotextile filter fabric and provided with French drains (Figure 8.2-1). The filter fabric will prevent loss of fine soil particles due to soil water movement out of the stockpile. Geotextile

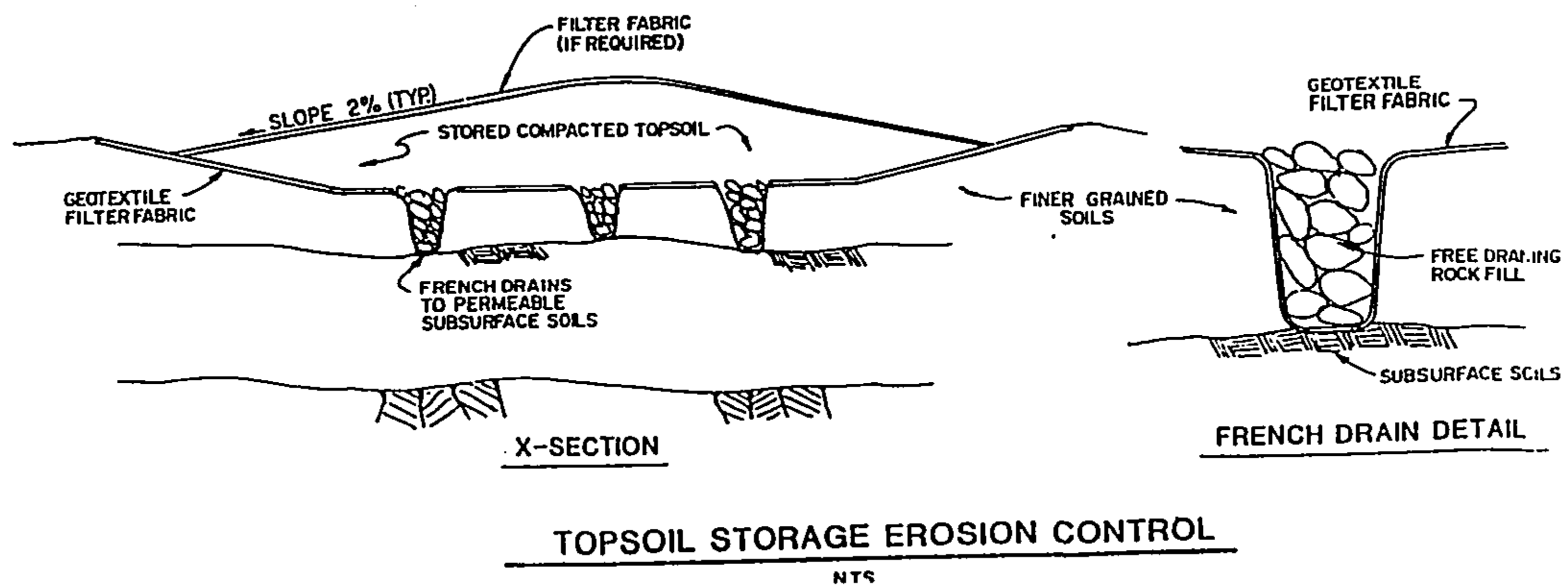

Figure 8.2-1. Topsoil and spoil stockpile design (Bingham Engineering, 1986).

fabric may also be anchored over the top of the pile to prevent wind erosion.

4) All spoil material excavated during construction will be stored in stockpiles similar to the topsoil stockpiles.

5) Any excess fill will be used as backfill along the penstock or in other fill areas associated with the project. No fill will leave the project site or remain stockpiled at the end of construction.

6) Drainage water originating on the site during project construction and operation will be diverted into ephemeral stream channels wherever the distance from the drainage discharge point to the confluence with a perennial stream is more than 200 feet. Riparian vegetation along the channel will function as a filter to reduce sediment yield to aquatic habitat in perennial streams. Where the drainage enters the ephemeral channel, the channel will be lined with rocks to prevent erosion and function as energy dissipators. Where 200 feet of channel is not available for sediment yield control, all drainage water from the project will pass through sedimentation basins before entering the stream. These basins will be lined with compacted clay soils or with a geotextile fabric if clay is not available (Figure 8.2-2). Once revegetation successfully reduces sediment load in drainage water to near pre-disturbance levels, sedimentation basins may be removed and their sites revegetated.

7) All exposed soil with the exception of the permanent access road will be covered with topsoil and revegetated. Compacted soil will be ripped to provide a favorable seedbed. Seeds and cuttings of native grasses and forbs found in the undisturbed areas nearby will be planted over the site. Mulch that is free of exotic seeds will be applied and anchored to the soil as necessary. Final revegetation procedures will be subject to approval by the Division of Forestry and Wildlife, Department of Land and Natural Resources.

8) Construction will begin at the Hanalei Tunnel diversion and proceed downhill. As each stretch of penstock is completed, that stretch will be recontoured, topsoiled, revegetated, mulched and protected from further disturbance.

<u>Diversion Weir</u>

1) Temporary diversions will be used to divert flows away from the construction area, during construction of the diversion weir.

2) An automatic bypass system will be installed which will immediately eliminate flows through the penstock in the event of a rupture.

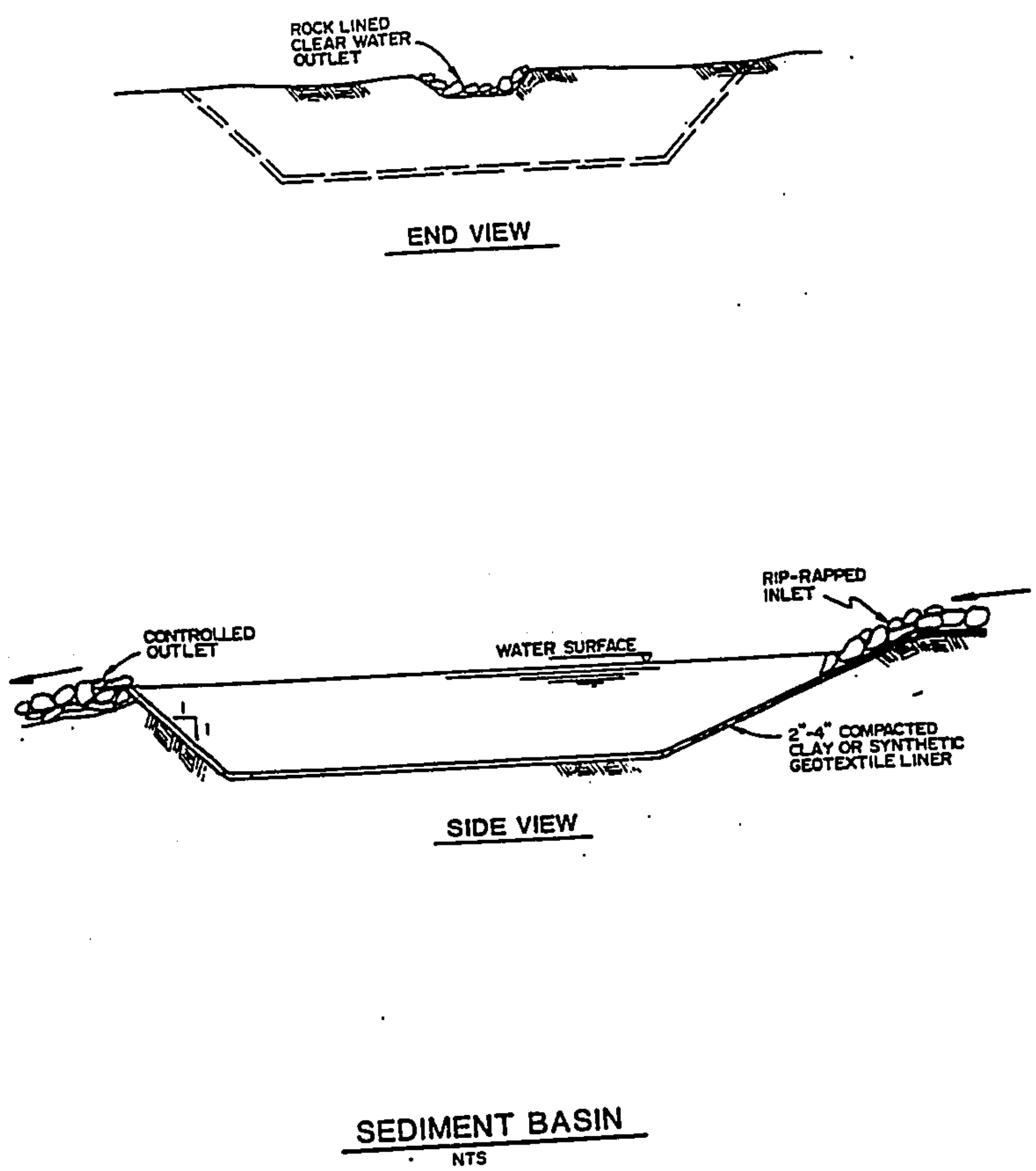

Figure 8.2-2. Design of typical sedimentation basin (Bingham Engineering, 1986).

Penstock Corridor

1) The penstock alignment which is to be used as a temporary access road will be angled slightly into the hill so that runoff from the road surface does not flow over the road edge and down the hillslope.

2) A ditch along the inside of the road will be constructed and maintained to collect runoff from the road surface. The ditch will be lined with rock or other impermeable material and periodic check dams and culverts will slow the water and transfer it under the road to ephemeral stream channels or sedimentation basins (see number 6 in reference to the entire project site above).

3) A berm will be constructed along the outside of the road to help confine runoff to the road surface.

4) Diversion dikes will be constructed above all long cut slopes to prevent runoff over those slopes. Water collecting above those dikes will be channeled to temporary flexible downdrains and transported to roadside ditches.

5) Where the road grade exceeds 2%, water bars will be installed at spacing recommended by the U.S. Forest Service for wooded areas (see Section 4.1.2.2).

6) Where the penstock is located above ground, surface runoff will be able to pass under the penstock except at the supports.

7) Where the penstock is buried or half-buried, the bedding material will be of controlled gradation, generally more permeable than surrounding natural materials. This increased infiltration rate should compensate for the impermeable zone represented by the penstock.

8) Periodic collars around the penstock that fill the entire trench width will serve to impede subsurface flow down the trench. At these locations, drains will be installed to carry excess water to ephemeral stream channels or sedimentation basins.

Powerhouse/Tailrace

1) The parking area at the powerhouse will be surrounded by a containment dike to confine runoff. A drainage system will transport excess water to a sedimentation basin.

2) The tailrace will be lined with either concrete or rock riprap to prevent soil loss.

Staging Area

1) The staging area will be surrounded by a low containment dike to confine runoff. A drainage system will transport excess water to a sedimentation basin.

2) A separate area within the staging area will be set aside for refueling purposes. A berm will be erected around it to confine runoff and a compacted clay layer will be applied to the surface to restrict infiltration. Water accumulating on this area will be collected in a separate drainage system and disposed of in a manner acceptable to state and federal agencies.

Permanent Access Road

1) Berms, drains, and sedimentation basins installed during construction as described under Penstock Corridor will be maintained and continue to function to control soil loss.

2) The area of disturbance outside of the 20 foot wide one lane road will be revegetated.

3) A gravel roadbed will be necessary to elevate the road above the water table level.

Transmission Line

1) Mitigation measures applicable to all sites subject to vegetation removal will be implemented where necessary.

VEGETATION

Impacts to vegetation will be mitigated by the revegetation measures described above. A detailed revegetation plan will be developed in consultation with the appropriate agencies prior to initiation of construction.

WILDLIFE

A field survey will be conducted in mid-April or May, 1989 before construction begins to determine whether Newell's shearwater, dark-rumped petrel or band-rumped petrels are nesting within or near the project area. In addition, a field survey will be conducted concurrently to determine whether hoary bats are using the project area. These surveys are designed to prevent accidental destruction of nesting or roosting sites in the event that these species are using the project area. Destruction or major disturbance of a nesting colony of these seabirds may cause significant adverse effects to their populations. If nesting areas of any of these seabirds are located and would be adversely impacted by the project, a mitigation plan will be developed in conjunction with and approved by the U.S. Fish and Wildlife Service to minimize any impacts.

Construction in the vicinity of the powerhouse will be limited during the peak nesting season (December through May) for the Hawaiian duck to avoid disturbing this endangered species. Removal of trees along the penstock route will not be done during the period, mid-May through July to prevent impacts to the flightless young of hoary bats.

8.3 ARCHAEOLOGICAL SITES

It is possible that the remains of ancient terraces may be hidden under the dense grass-covered areas to be traversed by the access road, tailrace, and powerhouse. An archaeologist should be present at this location during land clearing and grading work prior to construction in these areas. If ancient terraces are present, they can be located and mapped. The archaeological reconnaissance report (Hammatt, 1988) stated that the unforested portions of the alluvial flats near the confluence of Maheo Stream and the North Fork Wailua River were covered with an extremely thick mat of California grass approximately 2-3 feet thick. This thick vegetative cover has made it virtually impossible for the archaeologist to make a determination if ancient agricultural terraces do exist in the area.

There are two options available for eliminating or reducing any potential impacts to agricultural terraces that may exist near the confluence of Maheo Stream and the North Fork Wailua River. The Hawaii State Parks administrator has recommended the following plan of action if the proposed project is approved. Under this approach, the following wording must be attached to any approved CDUA:

1) In the proposed powerhouse location, the grass will be cleared (not using heavy machinery). A professional archaeologist shall then determine if significant historic sites are present. Findings shall be submitted to the State's Historic Site Section in report format. If significant historic sites are present, an acceptable mitigation plan shall be developed and be approved by the State's Historic Sites Section, and this plan shall be executed prior to any construction at this location.

2) An Alternative approach would be for the applicant to clear the vegetation prior to any further action on this application and determine if significant historic sites are present.

The applicant will contact the Historic Sites Section to inform them of which action will be taken.

8.4 SOCIO-ECONOMIC FACTORS

Impacts to visual values associated with recreation will be mitigated by penstock burial over up to 80% of the corridor and by revegetation of all areas other than the permanent access road, the powerhouse, and the unburied penstock. The powerhouse and penstock will be painted in earth tones to further minimize visual impact.

No mitigation will be required for economic impacts.

8.5 AIR QUALITY

All access roads will be graded and watered regularly to minimize dust.

8.6 NOISE

Noise impact will be temporary during project construction and will not be mitigated.

8.7 TRAFFIC

Significant increases in traffic will be temporary during project construction and will not be mitigated.

9.0 ANY IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES WHICH WOULD BE INVOLVED SHOULD THE PROPOSED PROJECT BE IMPLEMENTED

Construction of the proposed project will require an irreversible commitment of investment capital, labor, construction materials and fossil fuels. The facilities, once installed, will remain there for the life of the project and will require periodic maintenance.

1. Capital will be required to finance the construction of the project.
2. Human labor will be required for planning, engineering, construction, operation, and maintenance of the project.
3. Construction materials will be required to build the project, including steel for the penstock, powerhouse structure, and hydropower equipment; concrete for the diversion and intake structures, powerhouse, and structural supports; wood for transmission line poles, concrete forms, and supports; and copper for electrical conductors. Many other materials too numerous to list here will be consumed in small quantities during construction.
4. Land will be required to accommodate the physical structures of the project. Although the commitment of land can be reversed, as a practical matter the site will probably continue to be used for hydropower indefinitely. The terrestrial habitat supported by the land will be disturbed by the construction and to a minor extent by the operation of the project. Although care will be taken to prevent soil erosion, some soil will inevitably be lost.
5. Between 8 and 48 cfs of irrigation water being transported through the Hanalei Tunnel will be diverted through a penstock to a turbine generator for the production of electric power. The water itself is retrievable. It will be returned to Maheo Stream just downstream of the powerhouse after being used for power generation.
6. Petroleum fuels and lubricants will be directly consumed in construction vehicles, in the transportation of materials to the construction site, and in portable generators for on-site temporary power. Secondary energy consumption will occur in the production of steel, cement, wood, and other construction materials. The loss of this energy will be more than replaced by the long-term production of electricity from hydropower.

10.0 OFFSETTING BENEFICIAL EFFECTS, INTERESTS, OR CONSIDERATIONS

Construction of the Upper Wailua Hydroelectric Project is a move toward fulfilling both national and state goals of developing renewable energy resources. This will help to alleviate the dependence upon foreign resources which will eventually help to reduce the cost of electricity to ratepayers and will help insure a reliable, renewable, source of power. Generating electricity utilizing hydroelectric power is a considerably cleaner endeavor than producing electricity through the burning of petroleum or coal.

Impacts associated with this project are short term in nature and are not expected to be significant. Potential impacts that could have a significant adverse effect on the existing environment will be properly mitigated so as to reduce their significance to an acceptable level, or eliminate those impacts completely.

Generating electricity through hydroelectric power on Kauai has advantages over the burning of petroleum or coal. Hydroelectric power is a clean, renewable resource and ideal climatic and topographic conditions exist on the island for hydroelectric facilities.

It is felt that the production of energy through hydroelectric facilities is, in many cases, more environmentally benign than producing energy by burning petroleum or coal. The most significant advantage hydropower has over the burning of petroleum (the single greatest source of energy in the state of Hawaii) is improved air quality.

According to an annual report by the State Energy Resources Coordinator (1987), the state of Hawaii relies on petroleum to satisfy 90 percent of its energy needs. In 1986, Hawaii spent over one billion dollars - 10 percent of the gross state budget - on imported petroleum. The proposed Upper Wailua Hydroelectric Project is anticipated to save 11,700 barrels of oil annually. The proposed project, as well as future hydroelectric developments, can act to significantly improve both Hawaii's status for energy self-sufficiency and its overall air quality.

Kauai presently has seven hydroelectric installations which provide a total of 8.57 MW of generating capacity. In 1987, these installations produced about 55,800 megawatt hours of electricity for Kauai equaling 16.2 percent of the Island's electricity needs (State Energy Resources Coordinator Annual Report - Technical Reference Document, 1988).

11.0 SUMMARY OF UNRESOLVED ISSUES

(1) The exact location of an adze quarry located near the proposed penstock route at the confluence of Maheo Stream and the North Fork Wailua River is unknown. We believe it to be located near the Keahua Stream which is outside the project boundary. However, the State Historic Preservation Office feels this could be a significant archaeological site with high sensitivity to archaeological resources. Prior to disturbing the ground surface at the proposed powerhouse location, the State Historic Sites Section has proposed a plan of action. This plan is described in detail in Section 8.3 of the Final EIS. In general, it consists of detailed surveys at the exact location of project construction. This survey will involve removing the vegetation and inspection of the site. If historical or archaeological resources are found, any activity of a ground disturbing nature will be halted and the agencies contacted. At that time, a mitigation plan will be developed with the consultation of appropriate state and federal agencies prior to the start of construction activities.

(2) A survey for Newell's Shearwater needs to be conducted to determine if this threatened species nests within the project area or will be affected by the project. If the project is deemed to have an impact on this species, the project will need to be modified to minimize the impact. The survey for adult Shearwaters will be conducted in late April or May - the most likely time of year to locate these species within the project area. If they are found in the project area, a determination of nesting success will be made by additional surveys. If the Newell's Shearwater is found to be nesting in an area where direct impacts will occur, the project will be modified.

(3) Further surveys may be needed to establish the presence of the endangered hoary bat. A survey was conducted (in February, 1989), but the time of year was not optimum. An additional survey will be conducted in April-May during the Newell's Shearwater investigation.

(4) Detailed construction plans for development of the project will need to be completed. This should be done in consultation with contractors and appropriate state and federal agencies.

(5) Detailed soil erosion control plans will need to be completed. This should be done in consultation with contractors and appropriate state and federal agencies.

(6) Detailed revegetation plans will need to be completed. The revegetation plan should utilize native plant species and be prepared in consultation with interested state and federal agencies.

(7) A geotechnical evaluation of soils and slope stability will need to be completed prior to construction.

(8) The exact diversion screening method has not been determined. The final design will depend upon obtaining bypass flows from the irrigation company. The project is, however, committed to screening the intake diversion.

12.0 LIST OF NECESSARY APPROVALS

This section discusses the permits that will be applicable for the project and the current status of permit applications or negotiations.

1. **CDUA Permit Application**

Preliminary survey work and consultation for the CDUA permit application have been completed. Additional studies of the flora, fauna, archaeology and construction and operational impacts need to be concluded prior to the filing of a CDUA permit application. In conjunction with the CDUA permit application, an environmental impact study will need to be completed which contains the information generated. Finalization of this document will satisfy this requirement.

2. **Special Purpose Revenue Bonds**

A request for the issuance of special purpose revenue bonds to finance the Upper Wailua Hydroelectric Project was presented to the Hawaiian legislative session.

3. **U.S. Army Corps of Engineers 404 Permit**

A 404 permit for the project will be required. This permit should not be too difficult to obtain. The 404 permit requires completion of the CDUA permit application and the attendant environmental impact statement. This permit should be processed simultaneously with the CDUA permit so that the public meetings can satisfy the requirements under both permits.

4. **Coastal Zone Management (CZM Permit)**

A CZM permit will not likely be required for the project but an attempt will be made to obtain a letter from the State indicating that a permit is not applicable.

5. **County of Kauai**

A building permit from the County of Kauai will be required along with a use permit and zoning permit. None of these permits have been applied for although it is not felt that they will be difficult to obtain.

6. **Water Rights**

An authorization from the Hawaii State Legislature for the issuance of water rights will need to be obtained. This permit has not been applied for. Water rights are normally applied for near the end of the CDUA permit process.

7. **Agreement for Water Use With Amfac/Lihue Plantation**

Negotiations will need to be completed with Amfac/Lihue Plantation for the use of water through the Hanalei Tunnel. Preliminary contacts have been completed but the contract has not been finalized.

8. **Power Sales Agreement**

A power sales agreement will need to be completed with Citizens Electric. The negotiations for the power sales agreement are almost completed and are associated with negotiations for the Lower Wailua Hydroelectric Project.

9. **FERC Jurisdiction**

It is not felt that FERC will have jurisdiction over the project. FERC can only assert jurisdiction for the following reasons: (1) navigability of the streams; (2) interstate commerce; and (3) federal lands involved. The Upper Wailua area is not subject to navigability, it is a small stream with a significant amount of drop and large pool-riffle and chute combinations that would make navigation impossible. There is no interstate transportation of power. In fact no power generated on the Island of Kauai leaves the island. Finally there are no federal lands involved. All lands are either state lands or state lands under lease to Amfac/Lihue Plantation. A petition for a Declaratory Order Finding Licensing Not Required under Part 1 of the Federal Power Act should be filed before the Federal Energy Regulatory Commission.

The following permits will be required before construction can commence on the Upper Wailua Hydroelectric Project:

<u>Federal:</u>

- Declaration of Intent - Finding that Licensing Not Required - Federal Energy Regulatory Commission (FERC)
- Section 404 permit - Corps of Engineers, Dept. of the Army

State:

- Conservation District Use Application (CDUA) permit - Department of Land and Natural Resources (DLNR)
- Section 401 Water Quality Certification - State Department of Health
- Coastal Zone Management Permit (CZM) - Department of Planning and Economic Development (DPED)
- Water License - Division of Land Management (DLNR)
- Petition to Amend Interim Instream Flow Standard - Commission on Water Resource Management (CWRM)
- Stream Channel Alteration Permit - (CWRM)
- Stream Diversion Works Alteration Permit - (CWRM)

County of Kauai:

- Special Permit - Kauai County Planning Department (KCPD)
- Use Permit -(KCPD)

13.0 ORGANIZATIONS TO BE CONSULTED DURING EIS REVIEW PROCESS

Agency coordination on the Upper Wailua Hydroelectric Project began in early 1987. A letter was sent to the various State and Federal agencies regarding predevelopment consultation on the Upper Wailua Hydroelectric Project. The letter contained a project map and a general description of the project along with a request for consultation and an indication of permits that may be necessary for the project and any special studies that would be required by the various agencies.

In response to the letter, the State of Hawaii Department of Land and Natural Resources, Division of Aquatic Resources, requested collection of baseline data and periodic monitoring surveys on aquatic resources and habitat in the area. Island Power Company responded with a letter to the agencies requesting a meeting to discuss the project followed by an on-site meeting to familiarize various agencies with the project and to determine what further studies would be needed. Following completion of the consultation meeting and the on-site familiarization and investigation, a request was made of the affected agencies to comment on the proposed development and indicate if their department would require any detailed studies or surveys which were not normally required under the Conservation District Use Application (CDUA) process.

Following the on-site meeting, it was determined that a biological survey of the aquatic habitat in the area, focusing on the species composition and relative abundance in the river, would have to be completed before the need for any additional studies could be determined. During the field trip the general feeling of the group was that development in the area was not as much of a concern as development in the Hanalei basin. The area has already been impacted by diversions and development relating to sugar cane cultivation for the Lihue Plantation and has experienced variable water diversions based on past irrigation needs. The only water diverted for the project will be the water coming through the Hanalei Tunnel from the other side of the mountain and so naturally occurring flow patterns in the drainage basin will not be affected. An important factor in the approval of this project is that there does not appear to be any threatened or endangered species in the area and flow from the tributaries will not be collected.

Bonneville Pacific contracted with Mr. Thomas R. Payne and Associates, a fisheries consultant, to complete a fisheries reconnaissance survey for the Upper Wailua River. Payne and Associates met with individuals from the U.S. Fish and Wildlife Service and Corps of Engineers to plan the scope for this study. Following the scoping meeting, the reconnaissance survey was completed. The survey concentrated on locating native species in the area. Examples of introduced species were captured and retained for later verification of field identification and estimates of the size, range and abundance of the various species were included. This survey was submitted to the agencies for their review and a subsequent meeting was held at the Fish and Wildlife Service office in Honolulu to discuss the fisheries reconnaissance survey. Following the meeting, the agencies felt that the project was developable. In a worst case situation, impacts from the project would return the area to its natural condition. Based on our discussions, it was felt by the agencies that an IFIM study in the Upper Wailua would not be required. The agencies are to complete their review of the data and to respond with a letter containing their recommendations on any further studies that will be required in the Upper Wailua area. Letters are expected from the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers and the Department of Land and Natural Resources.

In conjunction with completion of the CDUA permit application, the following studies will need to be accomplished. The normally required surveys of flora, fauna, archaeology and construction and operational environmental impacts in the area must be completed. A survey of endangered or candidate endangered species that may be present in the Ohia Forest and that will be affected by construction of the penstock, access road and transmission lines will need to be completed. It is not felt that any of these studies will disclose any unusual circumstances that may preclude development of the project.

The organizations to be consulted during the EIS Review Process are as follows:

1. Federal Agencies

   Department of Agriculture, Soil Conservation Service
   Department of the Army, U.S. Army Engineering Division
   Department of Interior, Fish & Wildlife Service
   U.S. Environmental Protection Agency

2. State Agencies

   Office of Environmental Quality Control
   Department of Land and Natural Resources
   Department of Health
   Department of Hawaiian Home Lands
   Department of Planning and Economic Development
   Department of Transportation

3. County of Kauai

   Department of Public Works
   Planning Department
   Department of Water
   Office of Economic Development

4. Other

Wildlife Society
1000 Friends of Kauai
Kauai Outdoor Circle
Sierra Club
Kauai Historical Society
Kauai Electric
Conservation Council for Hawaii
Life of the Land
West Kauai Commercial and Sport Fishing Club
Kauai Chamber of Commerce
Hui O'Laka of the Kokee Museum
Wai'ola

14.0 REFERENCES

Bennett, Wendell C. 1931. The Archaeology of Kaua'i. Bishop Museum Bulletin 80, Honolulu.

Bennion, Corbin A. 1987. Effects of the proposed Hanalei development on soil loss. Prepared for Bingham Engineering. Salt Lake City, Utah.

Berger, A. J. 1981. Hawaiian Birdlife. Univ. Press of Hawaii, Honolulu, HI. 260 pp.

Bingham Engineering. 1986. Wailua River Hydroelectric Project, Kauai, Hawaii. Final Environmental Impact Statement for Island Power Company, Inc. Prepared by Bingham Engineering. Salt Lake City, Utah.

Carothers, J. H., S. R. Sabo and R. B. Hansen. 1983. Ecological observations on an endangered species: the Maui Parrotbill, Pseudonestor xantholphrys. American Birds 37(5):820-821.

Char, W. P. 1986. Botanical Survey, Hanalei River Hydroelectric Project, Hanalei District, Island of Kauai. Prep. for Island Power Co., Inc. November, 1986.

Ching, Francis K.W. 1968. Archaeological Surface Survey; Wailua State Park, Kaua'i. State of Hawaii, Department of Land and Natural Resources, Honolulu.

County of Kauai. 1970. Kauai General Plan. Prepared by Eckbo, Dean, Austin and Williams and Muroda, Tanaka and Itagaki, Inc. for county of Kauai - State of Hawaii.

Couret, CL. 1976. The biology and taxonomy of a freshwater shrimp, Atya bisulcata Randall, endemic to the Hawaiian Islands. M.S. Thesis, University of Hawaii at Manoa, Honolulu, Hawaii. 168 pp.

Department of the Army. 1982. Wailua River Hydropower, Kauai, Hawaii. Final Interim Survey Report and Environmental Statement. U.S. Army Eng. District Honolulu, U.S. Army Corps of Engineers.

Dickey, L.A. 1917. Stones of Wailua, Kaua'i. Hawaiian Historical Society, 25th Annual Report, Archaeological Research Center Hawaii, Inc., Honolulu.

DLNR (Department of Land and Natural Resources, State of Hawaii). 1984. Hawaii Wildlife Plan. Publication of DLNR, Honolulu, HI. 113 pp.

Edmondson, C.H. 1929. Hawaiian Atyidae. Bernice P. Bishop Museum, Honolulu, Hawaii. 66:1-37.

Edwards, E.A., G. Gebhart, and O.E. Maughn. 1983. Habitat suitability information: Smallmouth bass. U.S. Dept. Int., Fish Wildl. Serv. FWS/OBS-82/10.36. 47 pp.

Ego, K. 1956. Life history of freshwater gobies. Proj. No. F-4-R, Freshwater Game Fish Management Research, Dept. of Land and Natural Resources, State of Hawaii, Honolulu, Hawaii. 24 pp.

Fosberg, F.R. 1972. Field Guide to Excursion III, 10th Pacific Science Congress. Revised edition. Depart. of Botany, Univ. of Hawaii, Manoa.

Fosberg, F.R. and D. Herbst. 1975. Rare and endangered species of Hawaiian vascular plants. Allertonia 1(1): 1-72.

Hammatt, H.H. and D. Borthwick. 1986. Archaeological Reconnaissance of Upper Hanalei Valley, Halele'a Kaua'i, Cultural Surveys Hawaii.

Handy, C. 1940. The Hawaiian Planter. Volume 1, Bishop Museum, Bulletin No. 161., Honolulu.

Harris, M. 1974. A Field Guide to the Birds of the Galapagos. Taplinger Press, New York, NY.

Harrison, P. 1983. Seabirds, An Identification Guide. Croom Helm Ltd., Beckenham, Kent, Great Britain. 448 pp.

Kanayama, R.K. 1968. Hawaii's Aquatic Animal Introductions. Proceedings of the Conference of the Western Association of State Game and Fish Commissioners. 48:123-133.

Kepler, A.K. 1986. Biological survey of Wailuku River Hydropower Project site, Windward Island of Hawaii, Hawaiian Islands. Report prepared for Associated Engineering Consultants, Auburn California. 9pp.

Kepler, C. B. and J. M. Scott. (undated). Distribution and behavior of the endangered Hoary bat (Lasiurus cinereus semotus) in Hawaii. unpublished draft report.

King, W. B. and P. J. Gould. 1967. The status of the Newell's race of the Manx Shearwater. Living Bird 6:163-186.

Kinzie, R.A., and J.I. Ford. 1982. Population biology in small Hawaiian streams. Water Resources Research Center, Technical Report No. 147, University of Hawaii at Manoa, Honolulu, Hawaii. 60 pp.

Lamoreux, C.H. 1984. Checklist of Hawaiian Pteridophytes. Ms.

Linney, G.K. and W.P. Char. 1986. Flora Survey, Makaleha Stream, Island of Kauai. Prep. for Portugal & Assoc. December, 1986.

Munro, G. C. 1944. Birds of Hawaii. Bridgeway Press, Rutland, VT.

Olson, S. L. and H. F. James. 1982. Fossil birds from the Hawaiian Islands: Evidence for wholesale extinction by man before western contact. Science 217(13):633-635.

Payne, Thomas R. 1988. Letter report on a fisheries reconnaissance survey of the Upper Wailua River, Kauai, Hawaii. Prepared for Bingham Engineering on February 2, 1988. Thomas R. Payne & Associates, Arcata, California.

Porter, J.R. 1972. Hawaiian names for vascular plants. Coll. of Trop. Agr., Univ. of Hawaii, Manoa, Depart. Paper No. 1.

Pratt, H. D., P. L. Bruner and D. G. Berrett. 1987. The Birds of Hawaii and the Tropical Pacific. Princeton Univ. Press, Princeton, NJ. 409+ pp.

Pukui, Mary K. and Samuel H. Elbert. 1981. Hawaiian Dictionary. University of Hawaii Press, Honolulu.

St. John, H. 1973. List and Summary of the Flowering Plants in the Hawaiian Islands. Pac. Trop. Bot. Gdn. Mem. No. 1, Lawai, Kauai, Hawaii.

Salisbury, M. 1936. "Wailua, Valley of Kaua'i Kings and Priests; Rich in Splendor." Honolulu Star Bulletin, September 5, 1936, Archaeological Research Center Hawaii, Honolulu.

Scott, M.J., S. Mountainspring, F.L. Ramsey and C.B. Kelper. 1986. Forest bird communities of the Hawaiian Islands: Their dynamics, ecology, and conservation. Studies in avian biology no. 9, Cooper Ornithological Society. Allen Press, Lawrence, Kansas. 431 pp.

Shallenberger, R. J. 1986. Hawaii's Birds. Hawaii Audubon Society, Honolulu HI. 96 pp.

Sincock, J. L. and G. E. Swedberg. 1969. Rediscovery of the nesting grounds of Newell's Manx Shearwater (Puffinus puffinus newelli), with initial observations. Condor 71:69-71.

State Energy Resources Coordinator Annual Report. 1987. State of Hawaii, Department of Business and Economic Development.

State Energy Resources Coordinator Annual Report. Technical Reference Document. 1988. State of Hawaii, Department of Business and Economic Development.

State of Hawaii. 1988. State Energy Resources Coordinator Annual Report, Technical Reference Document, July 1, 1987 to June 30, 1988.

State of Hawaii. 1987. State Energy Resources Coordinator Annual Report, 1986-1987. Department of Business and Economic Development.

Strong, J.J., and R.F. Ott. 1988. Intake screens for small hydro plants. Hydro Review 7(Oct):66-69.

Studley, T.K., J.E. Baldridge, and T.R. Lambert. 1986. Microhabitat of smallmouth bass in four California rivers. Pacific Gas & Electric Draft Report, San Ramon, CA. 50 pp.

Swedberg, G. E. 1967. The Koloa. DLNR, Division of Fish and Game, Wildlife Branch. 56 pp.

Timbol, A.S. 1986. A survey of aquatic macrofauna in Hanalei River, and the potential impact of hydroelectric development. Report prepared for Island Power Co., Inc., Kalaheo, Kauai, Hawaii. 26 pp.

Timbol, A.S., and J.A. Maciolek. 1978. Stream channel modification in Hawaii. Part A: Statewide inventory of streams, habitat factors, and associated biota. U.S. Fish & Wildlife Service FWS/OBS-78-16. 158 pp.

Tinker, S.W. 1978. Fishes of Hawaii: A Handbook of the Marine Fishes of Hawaii and the Central Pacific Ocean. Hawaiian Service, Inc., Honolulu, Hawaii. 532 pp.

Tomihama, M.R. 1972. The biology of Sicydium stimpsoni, freshwater goby endemic to Hawaii. B.S. (Honors) Thesis in Biology, University of Hawaii, Honolulu, Hawaii. 123 pp.

TRPA. 1988. Instream flow assessment for East, Middle, and West Wailuaiki Streams, East and West Wailuaiki Hydroelectric Project, Maui, Hawaii. Unpublished report prepared for Bingham Engineering Company by Thomas R. Payne & Associates, Arcata, California. 79 pp.

TRPA. 1987. Habitat utilization criteria for four native Hawaiian freshwater aquatic species (Awaous stamineus, Sicyopterus stimpsoni, Atya bisulcata, and Neritina granosa) in the Lumahai River, Kauai, Hawaii. Thomas R. Payne & Associates, Arcata California. 77pp.

TRPA. 1988. Instream flow assessment for East, Middle, and West Wailuaiki Streams, East and West Wailuaiki Hydroelectric Project, Maui, Hawaii. Thomas R. Payne & Associates, Arcata, California. 52 pp.

USDA-Soil Conservation Service. 1981. Erosion and Sediment Control Guide for Hawaii. In cooperation with the Hawaii Association of Soil and Water Conservation Districts and the Soil Conservation Society of America, Hawaii Chapter. Honolulu, Hawaii. March, 1981.

USDA-Forest Service. 1978. Permanent Logging Roads for Better Woodlot Management. State and Private Forestry, Northeast Area. Broomall, Pennsylvania. NA-FR-18.

U.S. Fish and Wildlife Service. 1985. Endangered and threatened wildlife and plants; Review of plant taxa for listing as Endangered and Threatened Species; Notice of review. Fed. Register 50(188): 39526-39527 plus 57-page table.

U.S. Fish and Wildlife Service. 1985. Hawaiian waterbirds recovery plan. U.S. Fish and Wildlife Service, Portland, Oregon. 99 pp.

USFWS. 1988. Letter from U.S. Fish and Wildlife Service, Honolulu, Hawaii to Bingham Engineering, Salt Lake City, Utah ,dated March 30, 1988.

Van Riper, S.G. and C. van Riper. 1982. A field guide to the mammals of Hawaii. Oriental Publishing Co., Honolulu, Hawaii. 68 pp.

Wagner, W.L., D. Herbst, and S. Sohmer. In press. Manual of the Flowering Plants of the Hawaiian Islands. B.P. Bishop Museum Press.

Warner, R. E. 1968. The role of introduced diseases in the extinction of the endemic Hawaiian avifauna. Condor 70:101-120.

White, G.C., K.P. Burnham, D.L. Otis, and D.R. Anderson. 1978. User's manual for program CAPTURE. Utah State University Press, Logan, Utah. 40 pp.

Wischmeier, W.H. and D.D. Smith. 1978. Predicting rainfall erosion losses - a guide to conservation planning. U.S. Department of Agriculture. Agriculture Handbook No. 537.

15.0 DRAFT EIS CONSULTATION AND CORRESPONDENCE

	ITEM	DATE
1.	Letter to Michael B. Burke of AmFac Hawaii, Inc. from Dean Anderson of Island Power Company, Inc. concerning the Upper Wailua Hydroelectric project Draft EIS.	March 9, 1989
2.	Letter to Mr. William Paty, chairman of the Board of Land and Natural Resources from Hermina M. Morita of Wai'ola concerning responses by Dean Anderson, Island Power Company to her testimony before the board.	February 24, 1989
3.	Letter to William W. Paty, chairman of the Board of Land and Natural Resources from Dean Anderson of Island Power Company concerning testimony at the public hearing.	February 17, 1989
4.	Testimony on Upper Wailua River Hydro Project by Kelvin L. Kai, manager of Kauai Electric.	January 12, 1989
5.	Letter to Mina Morita of Wai'ola from Clark Mower of Bonneville Pacific Corporation in regards to her interest in the project.	September 27, 1988
6.	Letter to Arnold Lum of the Sierra Club Legal Defense Fund from Clark Mower of Bonneville Pacific Corporation in regards to his interest in the project.	September 26, 1988
7.	Letter to Dean Anderson of Bonneville Pacific from Michael Burke of AmFac Hawaii, Inc. In regards to ownership and maintenance of the Hanalei Tunnel.	September 23, 1988
8.	Letter to the Department of Land and Natural Resources from Mina Morita of Wai'ola requesting to be consulted in regards to the project.	September 22, 1988
9.	Letter to Clark Mower of Bingham Engineering from William Paty of the Hawaii Board of Land and Natural Resources regarding the preparation of the Draft EIS.	August 17, 1988
10.	Memorandum to Upper Wailua Hydroelectric files from: Clark Mower of Bingham Engineering regarding the CDUA permit process.	July 20, 1988

ITEM		DATE
11.	Memorandum to Roger Evans of the Hawaii Office of Conservation and Environmental Affairs from Manabu Tagomori, Deputy for Water Resource Management regarding the application for proposed use of state-owned Conservation District Lands.	June 9, 1988
12.	Memorandum to Roger Evans of the Hawaii Office of Conservation and Environmental Affairs from Ralston Nagata, Hawaii State Parks Administrator regarding his concerns over possible historic sites in the project area.	June 9, 1988
13.	Memorandum to Paul Kawamoto, Program Manager, Aquatic Resources and Environmental Protection, Department of Land and Natural Resources, from Don Heacock, Kauai Aquatic Biologist, Department of Land and Natural Resources, through Eric Onizuka, Program Manager, Recreational Fisheries, regarding comments on the CDUA KA-2155.	June 9, 1988
14.	Memorandum to Roger Evans of the Hawaii Office of Conservation and Environmental Affairs, from Ralph Daehler of the Hawaii Department of Land and Natural Resources, through Ronald Walker of DOFAW, regarding the CDUA process and the design of the proposed project.	June 7, 1988
15.	Memorandum to Roger Evans of the Hawaii Office of Conservation and Environmental Affairs to Mike Shimabukuro of the Land Management Division, Hawaii Department of Land and Natural Resources, regarding the use of state lands leased to Lihue Plantation Co., and the effects of the project on irrigation ditch systems.	May 27, 1988
16.	Letter to Clark Mower of Bonneville Pacific from Ernest Kosaka of the U.S. Fish and Wildlife Service, stating that an Instream Flow Incremental Methodology study would not be necessary for this project.	March 30, 1988
17.	Letter to Andy Yuen of the U.S. Fish and Wildlife Service from Clark Mower of Bingham Engineering, regarding the completion of the Fisheries Reconnaissance Survey.	February 9, 1988
18.	Letter to John Ford of the U.S. Fish and Wildlife Service from Clark Mower of Bingham Engineering regarding the completion of the Fisheries Reconnaissance Survey.	February 9, 1988
19.	Letter to John Emerson of the U.S. Army Corps of Engineers from Clark Mower of Bingham Engineering, regarding the completion of the Fisheries Reconnaissance Survey.	February 9, 1988

ITEM		DATE
20.	Letter to Donald Heacock of the Department of Land and Natural Resources from Clark Mower of Bingham Engineering, regarding the completion of the Fisheries Reconnaissance Survey.	February 9, 1988
21.	Letter to Michael Lee of the U.S. Army Corps of Engineers from Clark Mower of Bingham Engineering, regarding the completion of the Fisheries Reconnaissance Survey.	February 9, 1988
22.	Letter to Jeff Burt of Island Power Company from Ralph Daehler of the Hawaii Department of Land and Natural Resources, regarding the preparation of a CDUA for the Upper Wailua Project.	November 4, 1987
23.	Letter to Jeff Burt of Island Power Company from Henry Sakuda of the Hawaii Department of Land and Natural Resources, regarding the distribution and abundance of important aquatic species in the project area.	May 13, 1987

ISLAND POWER COMPANY, INC.

March 9, 1989

Mr. Michael B. Burke
Project Manager
AMFAC HAWAII, INC.
700 Bishop Street, 20th Floor
Honolulu, HI 96813

RE: Upper Wailua Hydroelectric Project: Draft EIS

Dear Mike:

Thank you for your comments on the Draft EIS. I would like to respond to each of your comments.

Comment 1 addresses the question of who is to maintain the Hanalei and Kaapoko tunnels. Our proposal is that Lihue Plantation continue to perform the routine maintenance work and that Island Power Company reimburse Lihue for its actual out-of-pocket costs for doing this work. Island Power agrees that in the event Lihue ceases sugar planting operations altogether, Island Power will take over the actual maintenance work. Island Power accepts the risk of the tunnels becoming inoperable due to circumstances beyond the control of Lihue, such as natural cave-ins, and Island Power agrees that Lihue shall not be liable for maintaining water flows through the tunnels or for any plant downtime caused by flow interruptions or tunnel damage.

Comment 2 addresses the question of installing a fish ladder at the Hanalei Tunnel outlet. This seems to be a misunderstanding. No fish ladder has been proposed for the Hanalei Tunnel outlet. The only diversion would be the present one at the Hanalei Tunnel intake.

Comment 3 addresses the possibility that water flows needed by Lihue might be interrupted during and as a result of project construction. We agree to manage the construction in such a way that such flows are not interrupted. We believe that this can be readily accomplished through the use of appropriate construction methods.

Comment 4 concerns the power line alignment and road maintenance. The power line alignment is shown on Figure 1.6-3, page 19, of the Draft EIS. Please note that the power line follows the Stable Storm Ditch and two existing cane haul roads and terminates at the existing substation. This alignment was

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selected in order to minimize disruption to the natural terrain and vegetation. With regard to routine road maintenance after construction is completed and the plant is in operation, we are proposing that Lihue maintain the access roads, and that Island Power Company reimburse Lihue its actual cost of performing any special maintenance work required by or because of the presence of the project. Such maintenance will be minimal because the only vehicle routinely traveling to and from the power plant will be the plant operator's pickup truck.

We propose that during construction, Island Power be responsible for the performance and cost of all road maintenance. This will be part of the general contractor's scope of work.

We will be happy to provide you with two copies of the Final EIS and to respond to any additional comments or questions you may have.

Sincerely yours,

Dean R. Anderson
Vice President

cc: [redacted]
Mr. Bill Betchart, Consulting Engineer

Burke.let

Hermina M. Morita

P.O. BOX 791
HANALEI, KAUAI, HAWAII 96714
(808) 826-6612

February 24, 1989

received
2-28-89

Mr. William Paty, Chairman
Board of Land & Natural Resources
State of Hawaii
P.O. Box 621
Honolulu, Hawaii 96809

Ref: CDUA/Upper Wailua Hydroelectric Project, Kauai
File No.: KA-8/9/88-2155; Document No.: 5066E

Dear Mr. Paty:

1 I am writing in response to a letter addressed to you from Dean Anderson, Hawaii Projects Manager, Bonneville Pacific Corporation regarding my oral testimony at the public hearing for the Upper Wailua Hydroelectric Project.

2 I do not feel any of my statements were inaccurate or misleading. Each accident or violation was described straightforwardedly. If the Board wishes to look further into the matter I would suggest contacting the agencies involved for an objective overview.

3 I felt the Board and the public should be made aware of the accidents and violations which occurred in Idaho because the extent of environmental damages and the agencies involved in the Consent Decree, the State of Idaho, the Environmental Protection Agency and the Corps of Engineers. Given the deficiencies of the Draft Environmental Impact Statement this project was left open to similar disasters.

4 With reference to the enclosed letter from Ecosystems Research Institute, Inc. (which is the same company that is preparing the Upper Wailua EIS), the use of mitigative plan is a misnomer. What Bonneville Pacific refers to as a mitigative plan is after the fact corrective measures, the result of the cited incidents.

5 In the December 2, 1988 letter from the Idaho Sportsmen's Coalition it is distressing to learn that the organization finds it necessary to request "... Congress to extend the energy tax credits which appear necessary to economically finance the special environmental protection measures to which the Project proponents have committed themselves." Is this to imply no tax credits, no mitigative measures?

Mr. Anderson states "Bonneville Pacific Corporation is thoroughly familiar with and respectful of the process for obtaining state and local permits in Hawaii", however, a Federal Energy Regulator Commission Preliminary Permit Application was submitted on December 30, 1988 for the Upper Wailua Project.
6 The fact that this application was filed instead of a Declaration of Intention opens the possibility of FERC establishing jurisdiction over the project. The effect of this could usurp the State of Hawaii's ability to determine the appropriate use and protection of its natural resources.

I find it unsettling that the attorney that filed the Preliminary Permit
7 Application is the same person handling the Hanalei Power Company application which recently submitted the attached letter.

Thank you for the opportunity to clarify my position.

Sincerely,

Mina Morita

Mina Morita

cc: Commission on Water Resource Management
Ms. Elaine Wender
Mr. Kelvin Kai, Kauai Electric
Mr. Clark Mower
Mr. Merv Kimura

LAW OFFICES
BISHOP, COOK, PURCELL & REYNOLDS
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WRITER'S DIRECT DIAL

January 13, 1989

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Hon. Lois D. Cashell
Secretary
Federal Energy Regulatory Commission
825 North Capitol Street
Washington, D.C. 20426

Re: Hanalei Power Company
Project No. 10472

Dear Ms. Cashell:

By order dated June 17, 1988, the Director, Division of Project Review issued a preliminary permit for the proposed Hanalei River Project (FERC No. 10472). Hanalei Power Company, 43 F.E.R.C. ¶62,312. The State of Hawaii and Waimana Enterprises, Inc. appealed the order to the Commission, principally arguing that the Director erred in issuing the permit in light of an earlier order by the Director, Office of Hydropower Licensing that no license for the construction, operation and maintenance of the Hanalei River Project is required. See Island Power Company, Inc., 42 F.E.R.C. ¶62,129.

As we advised the Commission by letter dated and filed May 27, 1988, Hanalei Power Company requested a permit, despite the order disclaiming jurisdiction, in order to maintain its priority of application for license during the term of the permit. We offer the following additional clarification.

Hanalei Power fully supports the Director's finding that the Commission lacks jurisdiction to require a license for the project. Indeed, Hanalei does not currently anticipate that it will seek a license for the project. Hanalei could, however, due to unforeseen circumstances beyond its control, find it necessary voluntarily to seek a license, even though none is required. If, for example, Hanalei Power were unable to secure all necessary property rights despite its best efforts, then the condemnation power conferred by section 21 of the Act would suggest the advisability of seeking a license. In this context, there is no conflict between the Director's order finding that no license for the project is required by section 23(b) of the Act, and the possibility that Hanalei Power might eventually volunteer for a license under section 4(e) of the Act, in light of the Commission's decision in Clifton Power Corporation, 39 F.E.R.C. ¶61,117 (1987), aff'd, Cooley v. FERC, 843 F.2d 1464 (D.C. Cir. 1988).

To repeat, Hanalei Power does not currently anticipate that it will seek a license for the project. In the meantime, however, the permit will protect its priority of application in the event that circumstances dictate otherwise. The permit represents the protection of Hanalei Power's substantial investment in the project, which is the very reason for which Congress created the permit mechanism: "Compliance with statutory and regulatory conditions takes time and money, and an applicant may not be willing to undertake these up-front expenses without some level of protection." Delaware River Basin Comm'n v. FERC, 680 F.2d 16, 17 (3d Cir. 1982).

Respectfully submitted,

McNeill Watkins II
Counsel for Hanalei Power Company

cc: All Parties

Bonneville Pacific Corporation

February 17, 1989

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

RE: CDUA Permit for the Upper Wailua Hydroelectric Project,
Kauai; FILE NO.: KA-8/9/88-2155; DOCUMENT NO.: 5066E

Dear Mr. Paty:

Please accept this letter in supplement to the oral rebuttal
which I presented at the public hearing held in Lihue, Kauai on
January 12, 1989. Specifically, this letter is in response to
1 the oral statements of Ms. Hermina Morita and Ms. Elaine Wender
at the hearing. Some of the information presented by these
speakers was inaccurate and misleading.

Ms. Morita referred to environmental damage caused by Bonneville
2 Pacific Corporation at three hydroelectric project sites in
Idaho. The impression conveyed was that Bonneville has a poor
track record in environmental protection and sensitivity.

As I mentioned at the hearing, Bonneville has built and is
operating fifteen hydroelectric projects in Idaho. Four projects
3 have been completed since the three isolated incidents of
environmental damage took place in 1984 and 1985.

The problems mentioned were not caused directly by Bonneville
Pacific Corporation but rather by construction subcontractors who
had been engaged by Bonneville to construct roads. The damage
caused at the Pigeon Cove site resulted from an overloaded
4 dynamite blast. The damage caused at the Felt site resulted from
improper sidecasting of material down a slope. At the Crystal
Springs site, minor slope damage was caused by sidecasting of
material, and a small area of wetlands was disturbed.

Because the subcontractors involved were small companies without
substantial assets, Bonneville assumed responsibility for
correcting the problems. Bonneville then sought and obtained
(without litigation) partial compensation from one general
5 contractor and one subcontractor. Following the incidents,
Bonneville cooperated fully with concerned agencies and
authorities and did not attempt to disclaim responsibility for
the actions of the contractors who were directly responsible for
causing the damage.

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6 In 1986, after basic consensus had been reached with concerned agencies on what mitigation work was appropriate, Bonneville hired environmental consulting firms which drafted mitigation plans to restore the affected sites. Subsequently, in 1987, following extensive discussions, Bonneville willingly entered into a consent decree with the various involved agencies. In addition to on-site mitigation, the consent decree calls for Bonneville to perform some compensatory off-site mitigation work as well as to pay a fine of $30,000. All requirements of the consent decree have been met satisfactorily.

7 In demonstration of Bonneville's full compliance with the terms of the consent decree and its satisfactory completion of all stipulated mitigation work, I am attaching herewith a letter dated January 31, 1989, from Ecosystems Research Institute, Inc., the lead environmental consulting firm involved in mitigation work at the three project sites. This letter describes in detail the work performed to date. The summary of this letter states:

> 8 "Bonneville Pacific Corporation has complied fully with the stipulation of the consent decree and its attached mitigation plans for the Felt, Crystal Springs, and LQ/LS Drain (Pigeon Cove) Hydroelectric Projects. Monitoring results show that restoration and mitigation activities have been generally successful in controlling soil erosion and providing enhanced wildlife habitat, despite harsh site conditions and extraordinarily hot and dry climatic conditions."

9 Bonneville very much regrets that environmental damage was caused by its subcontractors at three of its fifteen project sites in Idaho; Bonneville has taken steps to be sure that nothing of this kind ever occurs again. Since 1985 Bonneville has made it a policy to involve an environmental consulting firm in the planning, permitting, construction, and operations phases of all of its projects. Bonneville has also made it a practice to have an in-house engineer supervise all construction work performed by contractors.

10 In her testimony, Ms. Morita makes a completely false statement to the effect that in the case of the proposed Island Falls (sic) hydro project Bonneville wishes to eliminate a State imposed condition requiring an environmental consultant to be involved. (The correct name of the project is Island Park, not Island Falls.)

The true facts are these: Without any prompting from any state
or federal agency, Bonneville established an environmental
advisory committee for the Island Park project, inviting the
participation of public and private fish and wildlife agencies
and groups, including the Idaho Sportsmen's Coalition, which
11 represents the interests of trout fishermen. Bonneville also
engaged the services of Ecosystems Research Institute, Inc. to
prepare the environmental assessment required by the U.S. Forest
Service.

Bonneville originally made and has consistently maintained a
commitment that should it proceed to build the Island Park
project, Fisheries West, an independent environmental coordinator
selected by the fish and wildlife public agencies and private
12 organizations, will be paid by Bonneville to formulate and
administer a construction and operations environmental master
plan. A contract between Bonneville and Fisheries West is
currently being drafted.

As a result of Bonneville's environmental efforts and commitments
with regard to the Island Park project, the Idaho Sportsmen's
13 Coalition supports the development of the project. Please see
attached herewith a copy of their letter of support dated
December 2, 1988, addressed to Congressman Richard Stallings of
Idaho.

While the testimony of Ms. Morita was inaccurate and misleading
in the areas I have mentioned, I would characterize the testimony
14 of Ms. Elaine Wender as distorted. Ms. Wender essentially
accuses Bonneville of buying and selling projects for purposes of
speculation in a manner which, in her words, "resembles a pyramid
scheme".

Bonneville Pacific Corporation is not now and has never been in
the business of speculating on undeveloped projects for short-
term profit. Since 1983 Bonneville has developed, and is
presently operating, twenty five alternative energy projects,
including hydroelectric, geothermal, wood-fired cogeneration, and
gas-fired cogeneration plants. In its early years, Bonneville
15 made a practice of selling partial interests in its developed
projects to private investors or investor groups (syndications).
It did this for the purpose of raising investment capital while
it was still a relatively small company. In recent years,
Bonneville has made it a practice to own as much of each
developed project as possible, preferably 100%. Its objective is
to increase its operating profits over the years.

The process of project development starts with the 'acquisition' of a project site. In some instances the acquisition takes the form of entering into a lease with a private landowner; in other situations it might involve acquiring water rights or easements, either from a public agency, a private owner, or both.
With respect to the Hawaii projects in which Bonneville has
16 acquired some form of interest, Bonneville acquired the 'rights' to develop the projects from a prior developer. What is commonly meant by 'rights' is simply whatever interest the prior developer had in the project at the time of acquisition. The term 'rights' does not imply that the State has approved the project. It does not remove the necessity of following the permitting process established by responsible State and local agencies.

In the case of the Lower Wailua and Upper Wailua projects on Kauai, Bonneville acquired the prior developer's interest in (i.e. 'rights' to develop) the projects by acquiring all of the stock of the development entity, Island Power Company, a Hawaii corporation originally founded and owned by engineers with hydroelectric experience. Included as part of the acquisition were extensive hydrological and engineering studies and design drawings as well as all of the work put into the Conservation District Use Application permit for the Lower Wailua project.
17 The 'value' of this work product in terms of time and materials was several hundred thousand dollars. The price which Bonneville paid for the Island Power stock naturally reflected this value; had this not been the case it would not have been a fair deal for the sellers. The price also reflected Bonneville's confidence that the projects had a reasonable likelihood of going forward, meaning that the State of Hawaii would ultimately approve permits for them, that long-term financing would be secured, power purchase agreements entered into, etc. There was and is no guarantee that the projects will be completed or that they will be profitable if completed. Bonneville made its investment decision after assessing the risks involved.

The question may reasonably be asked, "Why did the principals of Island Power Company sell their interest to Bonneville?". The basic reason is straightforward. After doing considerable work on these projects in the form of engineering analysis, design development, economic forecasting, and preliminary permitting, over a period of several years, the principals of Island Power
18 Company, who originally intended to develop the projects themselves, came to the realization that they had insufficient financial strength to secure long-term financing and proceed with construction. They then sought a strong financial partner, approaching Bonneville Pacific Corporation. Bonneville was interested in developing the projects as long-term investments

18 but preferred to acquire them outright rather than develop them
in partnership with the principals of Island Power Company.

Bonneville Pacific Corporation is an energy development company
with substantial assets as well as expertise in the areas of
financing and administering the development of energy projects.
It is not an engineering or construction company. In the
interest of strengthening its ability to design and build state-
of-the-art projects in Hawaii, it entered into discussions with
Calpine Corporation of California, which is an internationally
respected engineering company with substantial experience in
19 hydroelectric development. Calpine was interested not only in
providing engineering services for the Hawaii projects but also
in participating in the development (i.e. risk-taking) of these
projects. It acquired from Bonneville a 25% interest in Island
Power Company. Again, the price it paid for Island Power Company
stock reflected the 'value' of the projects based on the work
which had gone into them at the time of the transaction. All
known risk factors were disclosed by Bonneville and accepted by
Calpine, including the 'permitting risk' or likelihood of
securing all necessary State permits.

Ms. Wender, in her testimony, attempts to portray these
straightforward and normal business dealings as somehow designed
20 to deceive potential investors and/or as potentially detrimental
to the interests of the citizens of Hawaii. She reads
selectively from Bonneville's April 30, 1988, SEC Form 10-K
disclosure document. For example, she quotes the following
sentence:

> "Projects under development are those for which the
> 21 Company has entered into an agreement with the resource
> owner and are at various preconstruction phases, from
> preliminary engineering to project financing."

Referring to this quotation in her testimony, Ms. Wender alleges
that Bonneville Pacific Corporation, in describing projects which
have not received all necessary government approvals in language
such as the foregoing, is making "blatantly false" statements
serving "to encourage investors to invest in really nonexistent
22 projects". This allegation is false. Projects "under
development" are clearly defined in the 10-K as ones that are not
licensed. They are distinguished from "projects under
construction" which "have obtained all necessary permits,
licenses, rights, and exemptions". Ms. Wender fails to quote the
balance of the same paragraph from which the previous quote was
excerpted, which states:

"There can be no assurance that projects under
development or licensing will be successfully
developed, constructed or placed in service. The costs
23 of abandoned projects and other unrecoverable costs are
charged to expense at the time of abandonment or
determination as unrecoverable".

In spite of Ms. Wender's distortions, it is clearly evident from
the 10-K document that Bonneville makes a practice of full and
honest disclosure of project-related information to its actual
and potential investors. Bonneville Pacific Corporation is a
publicly-traded company with a solid reputation in the
alternative energy industry. It has been named recently by
Business Week magazine, Forbes magazine, INC. magazine, and
24 Alternative Sources of Energy magazine as one of the best and
fastest-growing small companies in America. As a publicly-traded
company, its business transactions are fully disclosed and open
to public scrutiny. Bonneville welcomes questions regarding its
business methods, background, and intentions from responsible
State of Hawaii officials and citizens.

Bonneville's intention in establishing a permanent office in
Hawaii in January, 1988, is to develop, construct, own, and
operate alternative energy projects as long-term investments.
This intention is consistent with its business history on the
Mainland as well as its publicly-disclosed business plan.
Bonneville's interest in Hawaii stems from its assessment that
25 Hawaii needs the energy which these projects will produce, a
judgment which the hearing testimony of Kelvin Kai (copy
attached), representing Kauai Electric, vigorously supports. One
of the announced goals of the State of Hawaii is to foster energy
self-sufficiency. We believe that this can be accomplished
through the thoughtful development of renewable energy sources.

Bonneville Pacific Corporation is thoroughly familiar with and
respectful of the process for obtaining state and local permits
in Hawaii. We are also aware and respectful of the sensitive
26 physical environment in which hydroelectric projects, such as the
two projects planned for the Wailua river basin of Kauai, are to
be located. One of our goals is to demonstrate to the citizens
of Hawaii and to the government officials who represent them that
alternative energy development, utilizing renewable resources,

26 can be accomplished in a manner which does not compromise the unique and precious island environment in which they are fortunate to live.

Sincerely yours,

Dean R. Anderson
Hawaii Projects Manager

Enclosures

cc: Members of the Board of Land and Natural Resources
Members of the Commission on Water Resource Management
Ms. Elaine Wender
Ms. Hermina Morita
Messrs. Kelvin Kai and Denny Polosky, Kauai Electric
Mr. Clark Mower
Mr. Merv Kimura

cduahear.let

TESTIMONY ON UPPER WAILUA RIVER HYDRO PROJECT

BY KELVIN L. KAI, MANAGER, TRANSMISSION AND DISTRIBUTION
KAUAI ELECTRIC DIVISION OF CITIZENS UTILITIES COMPANY

BEFORE THE DEPARTMENT OF LAND & NATURAL RESOURCES

JANUARY 12, 1989

My name is Kelvin L. Kai, Manager, Transmission & Distribution at Kauai Electric. I am here to testify in favor of the Upper Wailua River Hydro Project.

At year-end of 1988, Kauai Electric's generation requirement to
serve our customers was 332.6 million kwh. This requirement
1 represents an incredible 13.7% increase in customer requirements over
the year 1987.

In producing the 332.6 million kwh in 1988, approximately 34%
was purchased from plantation sources, i.e., largely produced from
2 the burning of bagasse and hydroelectric facilities. The balance of
the energy was produced by Kauai Electric by burning oil. In
producing this energy, Kauai Electric burned 429,263 barrels of oil.

Over the last ten years our generation requirements has
increased from 179.2 million kwh to the present 332.6 million kwh,
while our system peak increased from 35.9 MW to the present 56.2 MW.
3 This represents an increase of 85% for our generation requirements
and 56% for our demand requirements. Based on the number of hotels
and other commercial customers which are already planned, we see more
of the same for the future.

4 Our company's policy and practice is to reduce our dependence
on oil-fired generation by seeking to purchase all available energy

from alternate energy producers and to encourage new non-fossil resources. Since geothermal, wind, and undersea cables do not appear to be a viable alternate for Kauai, the mature technology of hydroelectric power and its development is a very real possibility at
4 a number of sites on the Island of Kauai including the upper Wailua project. The upper Wailua project's energy output if developed would represent approximately 2% of our total system output. This output would displace over 14,000 barrels of oil per year.

Our negotiations with Bonneville Pacific Corp. (Island Power Co.) are nearing completion regarding a contract including the level of the rate or the rate structure. We know you can appreciate that there are significant capital requirements in building a hydroelectric facility. Without a compensatory rate level, the
5 project will be unfinanceable and will not be constructed. Our negotiating posture has been to pay Island Power a rate over the 35-year life of the project, which would allow Island Power to build the project and at the same time not exceed the true avoided cost to the consumers of Kauai over that same long-term period.

We believe benefits of the project to the island of Kauai are as follows:

1. We believe that one of the key benefits to Kauai is that of achieving a higher degree of self-sufficiency with regard
6 to energy production. We believe our goal is consistent with that of the federal, state and county goals which is to burn fewer barrels of oil in the production of

electricity for the island. This project would be another
stepping stone in achieving that goal.

2. We believe another benefit of the project is what we call
"meeting diversity of load". Although this project is not
a firm energy source, we do realize that for certain
periods of the year, energy from the project would supply
7 areas of Kapaa. This allows KE to use less oil-fired
generation at its Port Allen facility and in turn displace
additional line losses and provide local area protection.

3. It should be emphasized that there are other agencies that
have considerable input with respect to the setting of the
rate level. Our proposed contract specifically requires
that the Public Utilities Commission approve such a rate.
8 This means that there will be due process for consumers and
possibly a public hearing. The PUC will decide whether or
not any rate that has been agreed to for this project will
be in the public interest of the consumers of Kauai.

4. By displacing 14,000 barrels of oil-fired generation a
year, there will be less sulfur dioxide as well as nitrogen
oxide emissions polluting Kauai's atmosphere. We believe
9 this is a very positive benefit in view of the implications
of acid rain and the "greenhouse effect", all of which are
receiving wide attention today.

5. We also believe that there are additional benefits with
10 regard to this project and to Kauai regarding creation of
jobs. We see that the construction and perhaps the

maintenance of the project over the next few years will
involve hiring local workers.

Based on the preceding summary, we believe that there are many
11 benefits to be derived by consumers on Kauai as a result of this
project.

We are concerned with any project which in and of itself has the
potential to environmentally degrade our island home. These should
12 be thoroughly aired and considered against KE's alternative of
fossil-fired generation and escalating oil burning elsewhere on Kauai.

It is our conclusion that the benefits accruing to our community
13 would far outweigh any deleterious effects that might occur.

We urge that this necessary and desirable project be permitted
14 to proceed in a timely manner for the benefit of the Island.

KLK:nyd[0558C]

Bonneville Pacific Corporation

September 27, 1988

Mina Morita
P.O. Box 791
Hanalei, Kauai, Hawaii 96714

RE: Upper Wailua Hydroelectric Project

Dear Mina:

I was pleased to hear of your interest in the Upper Wailua project. We are in the process of completing a Draft Environmental Impact Statement for the project and would welcome your input. A public informational meeting on the project has been scheduled for Wednesday October 12, at 7:30 p.m. in the cafeteria of the Wilcox School in Lihue Kauai. A draft EIS is scheduled to be available in early November. I will send you a copy and would welcome your review and comments.

I look forward to working with you again. Please let me know if you require any additional information.

Sincerely,

Clark M. Mower
Development Manager

CMM:cz

cc: Dean Anderson
Merv Kimura
Don Horiuchi, DLNR Hawaii
Vince Lamarra/

257 East 200 South, Suite 800 / Salt Lake City, Utah 84111 / 801-363-2520 / Facsimile 801-363-9557

Bonneville Pacific Corporation

September 26, 1988

Mr. Arnold Lum
Sierra Club Legal Defense Fund
212 Merchant Street Suite 202
Honolulu, Hawaii 96813

RE: Upper Wailua Hydroelectric Project
Kauai, Hawaii

Dear Mr. Lum,

It was a pleasure to discuss the Upper Wailua Hydroelectric Project with you. I have enclosed a copy the CDUA - permit application for your information.

As I told you, we are in the process of completing an Environmental Impact Statement for the Project.

We hope to have a draft available by late October or early November.

I will forward a copy of the draft for your review and would appreciate any comments.

If you have any questions or require any additional information, please feel free to contact whether Dean Anderson (808 - 526-4551) or myself.

Thanks again for your interest.

Sincerely,

Clark M. Mower

Clark M. Mower
Development Manager

cc: Dean Anderson
Merv Kimura

CMM/ga
gbc/004cm

257 East 200 South, Suite 800 / Salt Lake City, Utah 84111 / 801-363-2520 / Facsimile 801-363-9557

AMFAC HAWAII, INC.
700 Bishop Street
P.O. Box 3230
Honolulu, Hawaii 96801
(808) 945-8111

Amfac

September 23, 1988

Mr. Dean Anderson
Hawaii Project Manager
Bonneville Pacific Corporation
820 Mililani Street, Suite 701
Honolulu, Hawaii 96813-2972

Subject: CDUA for the Upper Wailua Hydroelectric Project

Dear Mr. Anderson:

We are in receipt of your Conservation District Use Application for the Upper Wailua Hydroelectric Project. In general, The Lihue Plantation Company, Ltd. (LPCo) supports the development of hydroelectric projects on the Island of Kauai.

As you are aware, LPCo currently leases the subject ditch system from the State of Hawaii. Since your project will be relying on the water developed by the Hanalei Tunnel, we do not feel that LPCo would in any way be liable for any interruption in flow from this system. A solution to this potential problem would be for Bonneville Pacific to assume the maintenance responsibilities for this portion of the East Kauai water system.

Additionally, we would like to review more detail plans of the project, specifically the fore bay, penstock alignment, tail race and power house location, and the power line. More details will let us determine if any specific conflicts exist.

Please keep us informed as to the status of this project. If any questions arise, feel free to call me at 945-8265.

Very truly yours,

Michael B. Burke
Project Manager

MBB/kk

xc: W. D. Balfour, Jr.
M. Furukawa

WAI 'OLA

P. O. Box 791, Hanalei, Kauai, Hawaii 96714
Telephone: Kauai - Mina Morita 826-9828, [redacted]

RECEIVED
'88 SEP 26 AM 9:21
DLNR
OCEA

September 22, 1988

Office of Conservation and Environmental Affairs
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Gentlemen:

I would like to be consulted on the preparation of the environmental impact statement for the Upper Wailua River Hydroelectric Project, Koloa Forest Reserve, Kauai.

Thank you for your attention to this matter.

Sincerely,

Mina Morita

Mina Morita

"Ho'omalu Na Kai Ewalu"

JOHN WAIHEE
GOVERNOR OF HAWAII

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAN' ' J NATURAL RESOURCES

'IES
NDGRAF
MORI
UMOTO

JPMENT

STATE OF
DEPARTMENT OF LAN'
HONOLU

- RESOURCES
SERVATION AND
ENVIRONMENTAL AFFAIRS
CONSERVATION AND
RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

AUG 17 1988

FILE NO.: KA-2155
DOC. NO.: 4028E

Mr. Clark Mower
Bingham Engineering
5160 Wiley Post Way
Salt Lake City, Utah 84116

Dear Mr. Mower:

Attached are the divisional comments from our initial review of your proposed Upper Wailua Hydroelectric Project. Please review these comments so that our concerns are addressed in your Draft Environmental Impact Statement.

If you have any questions about this, please contact Don Horiuchi of our Office of Conservation and Environmental Affairs in Honolulu at (808) 548-7837.

Very truly yours,

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

Attachments

RECEIVED AS FOLLOWS

BINGHAM
ENGINEERING
100 LINDBERGH PLAZA 2
5160 WILEY POST WAY
SALT LAKE CITY, UTAH 84116
801-532-2520

MEMORANDUM

TO: Upper Wailua Hydro Electric Files

FROM: Clark M. Mower

DATE: July 20, 1988

RE: CDUA Permit Process

The recently adopted Hawaiian State Water Code, (Chapter 174C Hawaii Revised Statutes) provides for the establishment of a Commission on Water Resource Management under the Department of Land and Natural Resources. William W. Paty is the chairman of the Committee on Water Resource Management, and the Chairman of the Department of Land and Natural Resources. The State Water Code allows the Commission on Water Resource Management to set instream flow standards for various streams. The Conservation District Use Application (CDUA) filed for the Upper Wailua project, will require the establishment of instream flow standards for the Upper Wailua River. In the past, these standards have been established by the Board of Land and Natural Resources in conjunction with the Department of Land and Natural Resources and other Agencies. The CDUA permit application for the Upper Wailua project will be the first application processed under the new water code, and will involve both the Board of Land and Natural Resources and the Commission on Water Resource Management. A procedure on the interrelationship of the two agencies and their roles needs to be defined. I spoke to Mr. William Tams, Assistant Attorney General over Water Resource Management, about the process. He stated that he is waiting for a recommendation from Mr. Don Horiuchi, from the Board of Land and Natural Resources. Mr. Horiuchi has assumed Dean Uchida's responsibilities on Hydro projects for the State of Hawaii. Dean Uchida has transferred to the Division of Land Management, Department of Land and Natural Resources, but will still be available for consultation on the project.

A definition of responsiblities regarding land and water use in conjunction with the Department of Land and Natural Resources, CDUA Permit process and the Commission on Water Resource Managements establishment of instream flows needs to be established. It is thought by the individuals that I have talked to that the commissions role may be inserted into the CDUA process. They will be allowed to review the information and make their recommendations. This information then will go to the Department of Land and Natural Resources and will be included in the CDUA permit.

I have talked to both Bill Tam and Don Horiuchi about this process and will set up a meeting between the two, and myself during my next trip to Hawaii so that we can get a definition of the process.

The next commission meeting is scheduled for August 17, 1988. It would be well to have a definition of the process prior to that meeting.

The proceedure on the CDUA Permit application will be as follows:

a. Department of Land and Natural Resources will review the additional information that I have submitted.

b. Following completion of their review, they will issue a letter of acceptance of the CDUA permit application and forward the application to the various agencies for their review and comment.

c. Following receipt of the letter of acceptance, we will have 180 days to provide the required environmental data to support the CDUA permit application. We will be required to file either an environmental assessment or an E.I.S. for the project. This determination should be made by the Department of Land and Natural Resource and included in the letter of acceptance.

   Since there is a limited time frame, (180 days) in which to complete the environmental information, it is important we clarify the interaction between the board and the commission and set the proceedure that needs to be followed. Because of the time constraints, we have started the completion of the additional studies that we know will be required before the filing of the environmental data.

Lower Wailua Water License

I also spoke to Bill Tam concerning the issuance of the Wailua Water License. They are currently waiting for the public auction-bid process to take place. I have asked Bill Tam for an explanation of the process that the Wailua Falls project will go through. The instream flow standards adopted for the State of Hawaii allow for grandfathering of all projects which had received final approval prior to July 1, 1987. The Wailua Falls Hydro Electric project had received both their 404 permit and their CDUA permit approval prior to that date. However, with the determination of FERC in March, 1988, that a license was required and the further requirement from FERC that a 401 Water Quality Certificate be issued by the State of Hawaii prior to commencement of construction. There is a cloud on this issue. Bill Tam said that the State of Hawaii is still aggressively opposing FERC's jurisdiction on the Lower Wailua Project, so he does not know how the Water Resource Management Commission will respond. He suggested that I meet with Mr. Manabu Tagomuri and discuss this with him. I have written a letter to the Water Commission in response to their proposed instream flow standards, in which I asked them for a determination of the status of the Wailua Falls Instream Flows. These flows were established in consultation with appropriate state and federal agencies and should be binding. However, we need to get a clarification of this from the Water Commission. Bill Tams said that there is a provision for petition under the new code, and that may be the way to proceed. I will attempt to meet with Mr. Tagomuri on the same day that I visit with Bill Tams and Don Horiuchi.

RECEIVED

'88 JUN 9 AM 8:17

DLNR
OCEA

June 8, 1988

MEMORANDUM

TO: Mr. Roger Evans
Office of Conservation and Environmental Affairs

FROM: Manabu Tagomori
Deputy for Water Resource Management

SUBJECT: Application for Proposed Use of State-Owned Conservation District Lands, Review for Chairperson's Signature Upper Wailua River Hydroelectric (CDUA KA-2155)

DOWALD supports and encourages the development of alternate energy resources and has no objection to the Chairperson signing this application. We offer the following comments on the application and environmental assessment and address State Water Code permit requirements for this project.

Instream Use Protection

Additional information on minimum by-pass flows to protect instream uses should be provided in the EIS for the project. We note the comment on page D-2 stating that the amount of bypass flow is being determined by the U.S. Fish and Wildlife Service and the Department's Division of Aquatic Resources.

Non-Consumptive Lease of Water Rights

The project will utilize state land and water that has been diverted from the Hanalei River. The lease of state land and the right to use the diverted water should be fully addressed in the application and environmental assessment or the EIS if one is required.

State Water Code Permit Requirements

Chapter 174C, HRS, the State Water Code, and its implementing Administrative Rule, Chapter 13-169 (effective May 27, 1988) provide for the protection of instream uses by establishing instream flow standards and by regulating stream channel alterations. The applicant will be required to apply for and obtain a stream channel alteration permit from the Commission on Water Resource Management. In addition, a stream diversion works permit will also be required under the Code. The applicant may contact the Division of Water and Land Development at 548-7619 to discuss these permit requirements.

Please note this project is not exempt from Water Code permit requirements. Chapter 174C-71(3)(B) specifically states, with respect to stream channel alteration permits, that only projects under construction or projects reviewed and approved by July 1, 1987 are unaffected by Part VI of the Code protecting instream uses.

George S. Matsumoto
for MANABU TAGOMORI

SS:dh

RECEIVED

'88 JUN 13 AM 11:13

DLNR
OCEA

June 9, 1988

MEMORANDUM

TO: Roger Evans, OCEA

FROM: Ralston H. Nagata, State Parks Administrator

SUBJECT: CDUA KA-2155 -- Upper Wailua Hydroelectric Project (Island Power Co.) Wailua, Kawaihau, Kauai

HISTORIC SITES SECTION CONCERNS:

The CDUA application indicates that a preliminary reconnaissance of the proposed project area found no significant historic sites (C-30). We are unable to evaluate this conclusion, as we have not seen the survey report. A comprehensive archaeological and historical investigation of the entire project area is planned for later this summer (C-30). Until it is completed and submitted to our office for review, however, we will be unable to evaluate the effects of this proposed project on significant historic sites. This survey report should be submitted well within the 180 day review period for the CDUA in order for us to comment on effects.

Additionally, since this project is on state land, compliance with the state's historic preservation law, Chapter 6E, must occur. Again, initial compliance steps will hinge on receiving the detailed survey report. This compliance can be done concurrently with the CDUA application.

RECREATION CONCERNS:

There are no known state park concerns.

for Richard Kanayama
RALSTON H. NAGATA

0262K

State of Hawaii
Department of Land and Natural Resources
DIVISION OF AQUATIC RESOURCES

June 9, 1988

'88 JUN 13 AM 8:55 RECEIVED DLNR OCEA

MEMORANDUM

To: Paul Kawamoto, Prog. Mgr., Aquatic Res. and Env. Protection
Through: Eric Onizuka, Prog. Mgr., Recreational Fisheries
From: Don Heacock, Kauai Aquatic Biologist
Subject: Comments on Conservation District Use Application KA-2155

Comments Requested By: Roger Evans, OCEA
Date of Request: May 20, 1988
Date Received: May 27, 1988

Summary of Proposed Project:

Title: Upper Wailua Hydroelectric Project

Project by: Island Power Company

Location: 7 miles northwest of Wailua, Kauai

Brief Description: The applicant proposes to construct and operate a hydroelectric power facility on an unnamed tributary of the north fork of the Wailua River, about 7 miles northwest of Wailua, Kauai. The project would be located on State lands and use water diverted from the upper reaches of the Hanalei River and Kaapoko Stream (through the Hanalei Tunnel) to the Wailua River system. The Tunnel conveys an average of 27 cfs of water.

The existing diversion weir on the Hanalei River was constructed at the turn of the century and is the only existing weir across the entire width of the River. The weir acts a formidable barrier to the upstream migration of native gobiids and to the downstream migration of larval gobiids and endemic opae kalaole, Atyoidea bisulcata as it is over 8 feet high, and its perfectly vertical surface is normally covered with a thick mat of filamentous algae. It is suspected that much of the time, all of the water from this reach of the Hanalei River is diverted.

Comments:

1. Several mitigative measures should be considered in conjunction with this proposed project. The existing Hanalei River diversion weir should be modified as it acts as a barrier to upstream and downstream migration of native stream fauna reducing the amount of habitat available below the weir especially during low flow periods. Mitigative measures suggested

are: 1) a "V-shaped" notch should be cut into the existing weir to create a waterfall and a "fish ladder" constructed by grouting boulders against the wall to create a gentle slope below the notch; and 2) a fish-screen and "deflecting wing" should be installed at the existing weir to minimize entrainment of o'opu and opae kalaole (by the tunnel to the Wailua River watershed where they would be exposed to potential impingement by the proposed hydroelectric facility) and predation by carnivorous fish (i.e., smallmouth bass).

2. The unnamed stream (which some fishers refer to as "bass creek") is one of the best and easily accessible smallmouth bass streams on Kauai, except for the area from the Tunnel outlet to about 1,000 feet downstream where an 8-foot waterfall forms a barrier to upstream movement by the smallmouth bass. It is believed that bass fishing is good along this stream due to the addition of water from the Hanalei Tunnel. The proposed diversion of the flow through an 8,000 feet penstock is anticipated to impact on the smallmouth bass fishery although the actual "socioeconomic" value of the recreational fishing activities has yet to be determined.

3. Page A-1. The statement concerning the non-consumptive use of the water is misleading from the standpoint of aquatic biota. The operation of a hydroelectric plant has potential for entraining and/or impinging the stream fauna. Also, the water temperature along the dewatered reach and that discharged from the plant would be raised and could adversely affect resident fauna.

4. Page B-1. There is no description on the length of the permanent access road or the type of bridge that would be constructed over the north fork of the Wailua River which experiences severe freshets. The construction, daily travel, and maintenance could cause siltation and turbidity and affect the production of, and good fishing for, smallmouth bass and other fauna along the entire length of the River. Also, we note that public access is available along reaches of the River. Most other smallmouth bass streams on Kauai are on private land requiring permission to fish from the landowner. We suggest that the developer consider negotiations with the private (sugar companies) to allow public access to such good/better smallmouth bass streams as a mitigating measure should the project be approved.

5. Table C-14 is illegible.

6. Page C-30 (Section C-9). The construction of the access road is expected to have only insignificant and short-term effects on vegetation, however, there is no discussion on the impact of the road on water quality.

7. Figures C-35 and 36. No fish abundance information is given for the affected stream reach. Smallmouth bass are abundant (see Comments No. 1b and 3).

8. Page D-1. A fish screen would be installed at the proposed weir to prevent entrainment of fish. In addition to the above screen, a fish screen (and a deflecting wing) at the existing weir on the Hanalei River would be most desirable (see Comment No. 1). O'opu and opae kalaole are diadromous requiring exposure to sea water to complete their life cycles; the native fauna entrained by the Hanalei tunnel would have a poor chance of reaching the ocean.

9. Page D-2. There should be a constant streamflow bypassing the existing Hanalei River diversion weir (see Comment No. 1). A minimum bypass flow would also be needed at the proposed hydroelectric project diversion weir.

10. Page D-5. It may be desirable for the indirect cost estimates to also consider the loss of recreational fishing opportunities and decrease in fishery productivity associated with diminished habitat availability and concomitant loss of carrying capacity.

11. Page D-8: The statement that the major environmental effects would be related to construction of the new hydroelectric diversion weir is questioned. As pointed out in Comments No 1 and 7, there is impact already occurring along the Hanalei River. Another impact would be the the long-term increases of sediment load and silt deposition within the entire Wailua River below the proposed hydroelectric project.

12. The statement that there are no endangered species in the affected area is untrue. Koloa ducks and ducklings have been seen in the area on numerous occasions between 1982 and present.

13. The statement that the project would cause only a temporary increase in turbidity downstream of the construction site is questioned (see Comment No. 10).

14. Figures E-1 and F-1 depict Honolii Stream on Big Island.

for Donald E. Heacock

RECEIVED
'88 JUN 13 AM 8:54
DLNR
OCEA

June 7, 1988

A-3-348

'88 JUN -8 A11:41
FORE... STATE ...

MEMORANDUM

TO: ROGER EVANS, Administrator, O.C.E.A.

THRU: RONALD L. WALKER, DOFAW Acting Administrator Concur 6/8/88

FROM: RALPH E. DAEHLER, District Forester, Kauai

SUBJECT: Pre CDUA KA 2155 - Island Power Co., Upper Wailua hydroelectric (ref. memo dtd 5/16/88)

(1)

APPLICANT: Island Power

OWNER: State of Hawaii - DLNR. Responsible land managing divisions: forest reserve - Division of Forestry and Wildlife; L.P. Co. lease lands - Division of Land Management.

LOCATION: TMK 3-9-1: 1 & 2 and 2-9-2: 1 - Lihue Koloa Forest Reserve. TMK 4-2-1: 2 Lihue Plantation Co., Ltd. lease.

C.D. SUBZONE: "R" Resource

USE REQUESTED: Upper Wailua hydroelectric project utilizing water diverted by tunnel from the Hanalei drainage by Lihue Plantation Co., Ltd.

COMMENTS/RECOMMENDATION:

The use of water diverted from the Hanalei River for sugarcane irrigation in the Wailua area could provide a power source enroute to the point of ditch diversion for sugarcane purposes.

The application however provides no design nor construction information upon which to base any opinion on the projects impacts on forest reserve vegetation, public recreation, and wildlife concerns.

We support consideration of the proposed use, but not approval based on the very limited information provided.

Ralph E. Daehler

RALPH E. DAEHLER
District Forester, Kauai

Attach: OCEA memo dtd 5/16/88
cc: Leonard Zalopany

STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

MEMORANDUM

TO: Roger C. Evans, Administrator
Office of Conservation and Environmental Affairs

FROM: Mike K. Shimabukuro, Administrator
Land Management Division

SUBJECT: KA-2155 Upper Wailua Hydropower Project by Island Power Company, Wailua, Kaua'i

According to Figure N-2 of the above-cited project, State Lands lease to Lihue Plantation Co., Ltd. will be affected. Moreover, the project will affect irrigation ditch systems and water sources now consigned by water license (G.L. S-3827) to East Kaua'i Water Company, Ltd.

Although the project is not water consumptive, input should be sought from the aforementioned lessees, as well as government agencies responsible for the management and protection of the environment. In this connection, DOWALD should be consulted on the applicability of minimum stream-flow requirements.

In general, Land Management has no objections to the acceptance of the application for processing purposes. For our perspective, however, please request the applicant to approximate the sites of the proposed facilities on the attached copies (3 sets) of C.S.F. No. 7106-A.

Mike Shimabukuro
MIKE K. SHIMABUKURO

RECEIVED
'88 MAY 27 PM 2:39
DLNR
OCEA

Attachments
cc: Leonard Zalopany Sr.
Sam Lee

United States Department of the Interior

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

ES
Room 6307

30 MAR 1988

Mr. Clark M. Mower
Executive Vice President
Bingham Engineering
100 Lindbergh Plaza 2
5169 Wiley Post Way
Salt Lake City, Utah 84116

Re: Upper Wailua River Hydroelectric Power Project, Kauai

Dear Mr. Mower:

We have reviewed your February 9, 1988 letter regarding the results of the fisheries reconnaissance survey of the Upper Wailua River conducted by Mr. Thomas R. Payne. This survey identified the native opae kala'ole (Atyoida bisulcata), o'opu nopili (Sicyopterus stimpsoni) and o'opu nakea (Awaous stamineus) in the tributaries of the Upper Wailua River and Hanalei Tunnel. The native fishes were considered "rare", while the mountain shrimp was "rare" to "common" in locations where recorded.

We understand that the proposed Upper Wailua River Hydroelectric Power project will capture water emanating from the Hanalei Tunnel only. The power plant will release the water into the North Fork of Wailua River upstream of the Stable Storm Ditch. Adjoining tributaries will not be diverted. While the flow will be reduced in the stream channel that transmits water from the Hanalei Tunnel to the Stable Storm Ditch, the net effect will be a return to flow conditions prior to the construction of the Hanalei Tunnel. Provided the project does not withdraw additional water from the Hanalei River, we believe an Instream Flow Incremental Methodology study to determine an instream flow for native freshwater species is not necessary in this case.

As your project plans formalize, we will provide recommendations to mitigate construction and operation impacts.

We appreciate the opportunity to comment.

Sincerely,

Ernest Kosaka

Ernest Kosaka, Field Supervisor
Environmental Services
Pacific Islands Office

cc: DLNR
CE, Operations Branch

RECEIVED AS FOLLOWS

BINGHAM ENGINEERING

100 Lindbergh Plaza 2, 5160 Wiley Post Way, Salt Lake City, Utah 84116, 801-532-2520

February 9, 1988

Mr. Andy Yuen
U.S. Fish & Wildlife Service
Room 6307, Federal Building
300 Aloa Moana Boulevard.
Honolulu, HI 96850

RE: Fisheries Reconnaissance Survey of the Upper Wailua River, Kauai, Hawaii

Dear Andy:

Enclosed please find the preliminary results of the fisheries reconnaissance survey for the Upper Wailua River.

We would like to discuss this at the end of our upcoming meeting in Honolulu.

Sincerely,

BINGHAM ENGINEERING

Clark M. Mower
Executive Vice President

CMM/jm
609-020

Attachment

cc: Thomas Payne

BINGHAM ENGINEERING

100 Lindbergh Plaza 2, 5160 Wiley Post Way, Salt Lake City, Utah 84116, 801-532-2520

February 9, 1988

Mr. John Ford
U.S. Fish & Wildlife Service
Room 6307, Federal Building
300 Aloa Moana Boulevard
Honolulu, HI 96850

RE: Fisheries Reconnaissance Survey of the Upper Wailua River, Kauai, Hawaii

Dear John:

Enclosed please find the preliminary results of the fisheries reconnaissance survey for the Upper Wailua River.

We would like to discuss this at the end of our upcoming meeting in Honolulu.

Sincerely,

BINGHAM ENGINEERING

Clark M. Mower
Executive Vice President

CMM/jm
609-020

Attachment

cc: Thomas Payne

BINGHAM ENGINEERING
100 Lindbergh Plaza 2, 5160 Wiley Post Way, Salt Lake City, Utah 84116, 801-532-2520

February 9, 1988

Mr. John Emerson - PODCO-O
U.S. Army Corps of Engineers
Pacific Ocean Division
Building 230, Room 205
Fort Shafter, HI 96808

RE: Fisheries Reconnaissance Survey of the Upper Wailua River, Kauai, Hawaii

Dear John:

Enclosed please find the preliminary results of the fisheries reconnaissance survey for the Upper Wailua River.

We would like to discuss this at the end of our upcoming meeting in Honolulu.

Sincerely,

BINGHAM ENGINEERING

Clark M. Mower
Executive Vice President

CMM/jm
609-020

Attachment

cc: Thomas Payne

BINGHAM ENGINEERING
100 Lindbergh Plaza 2, 5160 Wiley Post Way, Salt Lake City, Utah 84116, 801-532-2520

February 9, 1988

Mr. Donald E. Heacock
Aquatic Biologist
Department of Land & Natural Resources
State of Hawaii
P.O. Box 1671
Lihue, HI 96765

RE: Fisheries Reconnaissance Survey of the Upper Wailua River, Kauai, Hawaii

Dear Don:

Enclosed please find the preliminary results of the fisheries reconnaissance survey for the Upper Wailua River.

We would like to discuss this at the end of our upcoming meeting in Honolulu.

Sincerely,

BINGHAM ENGINEERING

Clark M. Mower
Executive Vice President

CMM/jm
609-020

Attachment

cc: Thomas Payne

BINGHAM ENGINEERING
100 Lindbergh Plaza 2, 5160 Wiley Post Way, Salt Lake City, Utah 84116, 801-532-2520

February 9, 1988

Mr. Michael Lee
U.S. Army Corps of Engineers
Pacific Ocean Division
Building 230, Room 205
Fort Shafter, HI 96808

RE: Fisheries Reconnaissance Survey of the Upper Wailua River, Kauai, Hawaii

Dear Mike:

Enclosed please find the preliminary results of the fisheries reconnaissance survey for the Upper Wailua River.

We would like to discuss this at the end of our upcoming meeting in Honolulu.

Sincerely,

BINGHAM ENGINEERING

Clark M. Mower
Executive Vice President

CMM/jm
609-020

Attachment

cc: Thomas Payne

HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
KAUAI DISTRICT
P. O. BOX 1671
LIHUE, KAUAI, HAWAII 96766

IN REPLY REFER TO
A-3c

November 4, 1987

Mr. Jeff Burt, President
Island Power Company, Inc.
5160 Wiley Post Way
Salt Lake City, Utah 84116

Dear Jeff:

Thank you for advising us in your October 2nd letter of Island Power Company, Inc.'s intent to prepare and file a CDUA for an "upper Wailua Hydroelectric Project" that would utilize Lihue Plantation Company's irrigation water, they are diverting by tunnel from the Hanalei River, for power production en route to its existing use for irrigation purpose.

I was able to familiarize myself with the area of intent by hiking in on October 14th with Clark Mower, Tom Telfer (Kauai District Wildlife Biologist), and Daniel T. Meyers and Jerry Santos of the U.S. Army Corp of Engineers. I've recently received copies of the photos Clark took that day.

The project is similar to an approved Conservation District project (KA 6/4/82-1455) titled "Kitano Hydroelectric Project" of West Kauai in that penstock water supply would consist entirely of water that has been diverted from another watershed source. I believe it is unlikely that there would be a minimum bypass flow requirement within the Wailua drainage of any of the Hanalei watershed diverted water.

As a result of wildfires many years ago, the vegetation in the area is a mixture of native and aggressive naturalized introduced species so a pristine native forest composition will not be a factor. I would expect the normally required surveys: flora, fauna, archaeology and construction, and operational environmental impacts will suffice. A current CDUA (KA 9/18/87-2066) relative to a project to increase the domestic water supply from the nearby Makaleha mountains could serve as an E.I.S. development guide.

We were certainly lucky to accomplish the field trip on October 14th. We've had lots of rain before and after that date. In fact my wife, Pat, called this morning to report that our rain gauge (we live in the Wailua Homesteads) recorded over one and a half inches in a 45 minute period.

Thank you for seeking our thoughts at the early planning stage.

Kindest regards,

Ralph

RALPH E. DAEHLER
District Forester, Kauai

cc: Ronald L. Walker, DOFAW Acting Administrator
Roger Evans, OCEA
Leonard Zalopany

JOHN WAIHEE
GOVERNOR OF HAWAII

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

LIBERT K. LANDGRAF
DEPUTY

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

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

May 13, 1987

Mr. Jeff Burt, President
Island Power Company
5160 Wiley Post Way
Salt Lake City, UTAH 84116

Dear Mr. Burt:

Thank you for your letter of April 21, 1987, informing us of your proposed hydroelectric facility in the upper Wailua (River) basin on Kauai.

We understand that the proposal will utilize the river water being transported by the Hanalei Tunnel from the Hanalei River basin to a tributary entering the North Fork, Wailua River. The water is to be diverted near the outlet of the Tunnel and conveyed through a pipeline to the powerplant located upstream from Stable Storm Ditch inlet.

As to the distribution and abundance of important aquatic species in the project area, we do not have such information available. However, we understand that fishermen fish for smallmouth bass in the tributary, which raises the concern that dewatering (degree unknown) could adversely affect smallmouth bass fishery values in the area. Furthermore, since native opae kalaole (Atya bisculata) and hihiwai (Neritina granosa) occur along the upper reaches of the North Fork of the Wailua River, they may also occur in the project area.

Accordingly, we believe the collection of baseline and periodic monitoring surveys (seasonally and during varying periods of flow) on aquatic resources and habitat appears to be in order.

We appreciate your effort to consult with us early in the planning for the project.

Yours truly,

Henry M. Sakuda

HENRY M. SAKUDA, Administrator
Division of Aquatic Resources

cc: OCEA
DOWALD
DOFAW
USFWS (E. Kosaka)
COE (J. Emmerson)

APPENDIX A

FLORA SURVEY

BOTANICAL SURVEY
UPPER WAILUA HYDROELECTRIC PROJECT
KAWAIHAU AND LIHUE DISTRICTS, ISLAND OF KAUAI

by

Winona P. Char
CHAR & ASSOCIATES

BOTANICAL SURVEY
UPPER WAILUA HYDROELECTRIC PROJECT
KAWAIHAU AND LIHUE DISTRICTS, ISLAND OF KAUAI

by

Winona P. Char

CHAR & ASSOCIATES
Botanical/Environmental Consultants
Honolulu, Hawaii

Prepared for: BONNEVILLE PACIFIC CORPORATION

September 1988

Table of Contents

BOTANICAL SURVEY
UPPER WAILUA HYDROELECTRIC PROJECT
KAWAIHAU AND LIHUE DISTRICTS, ISLAND OF KAUAI

INTRODUCTION

Bonneville Pacific Corporation proposes to construct a hydroelectric plant along the Upper Wailua River. The project begins at the outlet to the Hanalei Tunnel in the Wailua River drainage area and terminates just above the Stable Storm Ditch diversion on the North Fork, Wailua River. The transmission line will follow existing jeep and cane haul roads.

A survey to assess the botanical resources in the areas which would be directly affected by the proposed hydroelectric project was conducted on September 13-15, 1988. The primary objectives of the study were to 1) provide a general description of the vegetation; 2) inventory the terrestrial, vascular plant flora; 3) search for officially listed, proposed, and candidate threatened and endangered plant species; and 4) identify areas of potential environmental problems or concerns. The findings from this study will be incorporated into the Environmental Impact Statement (EIS) being prepared for this project.

SURVEY METHODS

Prior to undertaking the field studies, a search was made of the literature pertinent to the general area to familiarize the principal investigator with other botanical and biological surveys conducted in the nearby areas.

Existing topographic maps were examined to determine access, terrain characteristics, reference points, and potential logistical problems. A well-maintained trail which serves the existing outlet to the Hanalei Tunnel provided access to the site of the proposed intake structure. From here, the survey team consisting of archaeologists, botanists, and aquatic biologists proceeded downstream to the powerhouse site, following as closely as possible the proposed penstock route. The powerhouse site and a portion of the transmission line are easily accessed by the Stable Storm Ditch Road. Cane haul roads provide access to the remainder of the transmission line.

Notes were made on the structure, composition, associated species, substrate type, etc., of the different vegetation types. Plants were identified in the field; plants which could not be positively determined were collected for later comparison with herbarium material and the taxonomic literature..The species recorded are indicative of the season and environmental conditions under which this survey was made. Surveys taken at different times of the year and under varying field conditions would no doubt yield slight variations in the species list, especially of the weedy annual taxa.

DESCRIPTION OF THE VEGETATION

The proposed intake structure, penstock, and power plant are situated on state forest reserve land. Vegetation in these areas consists primarily of guava shrubs and dense mats of California grass. Other trees and shrubs, including several native species, as well as large clumps of Job's tears are also frequently encountered. Roughly one-half the length of the access road and transmission line are sited in forestry plantings composed mainly of paper bark and Eucalyptus species; extensive areas are also covered by dense hau thickets. The remainder of the access road and transmission line pass through actively cultivated sugar cane fields.

These three vegetation types are described in detail below. A checklist of all the plant species found during the survey is provided at the end of this technical report.

Guava/California Grass Association -- Vegetation on the area near the outlet to the Hanalei Tunnel (proposed intake structure site), along the penstock route, and on the proposed powerhouse site is composed almost exclusively of a guava (*Psidium guajava*)/ California grass (*Brachiaria mutica*) association. Guava is one of the most common shrubs in drainage areas which have been disturbed (Fosberg 1972); it is spread primarily by feral pigs in such areas. California grass, a large coarse perennial grass with hairy stems, forms dense patches to 7 ft. tall.

A number of native species are found within this association, especially in the areas where the drainage is narrow (from about 1,220 ft. to 800 ft. elevation). Trees and shrubs of 'ohi'a (*Metrosideros polymorpha*), papala-kepau (*Pisonia sandwicensis*), kawa'u (*Ilex anomala*), mamaki (*Pipturus albidus*), olomea (*Perottetia sandwicensis*), hame (*Antidesma platyphyllum*), and kopiko (*Psychotria kaduana*) are occasional. Other natives include a number of ferns such as ho'i'o (*Diplazium sandwichianum*), hapu'u pulu (*Cibotium splendens*), 'ekaha (*Elaphoglossum crassifolium*), wahine-noho-mauna (*Adenophorus tamariscinus*), kolokolo (*Grammitis tenella*), etc.; and a few climbers such as ieie (*Freycinetia arborea*), maile (*Alyxia oliviformis*), and hoi-kuahiwi (*Smilax melastomifolia*). Where the slopes are steep, the matted uluhe fern (*Dicranopteris linearis*) is abundant; less frequently observed is uluhe-lau-nui (*Diplopterygium pinnatum*).

Locally common in places along the stream sides are clumps of Job's tears (*Coix-lachryma jobi*), a robust erect grass to 6 ft. tall. Other species found occasionally along the stream or in the shallow water areas include such species as taro (*Colocasia esculenta*), primrose willow (*Ludwigia octovalvis*), honohono

(Commelina diffusa), drymaria (Drymaria cordata), Pycreus polystachyos, and cuphea (Cuphea carthagenensis).

Mixed Forests -- From the proposed powerhouse site, just above the Stable Storm Ditch diversion on the North Fork of Wailua River, to the cane fields located south (makai) of Hanahanapuni, the vegetation consists of large blocks of forestry plantings. The taller specimens such as Paraserianthes (Albizia) falcataria and various Eucalyptus species may be 50 to 70 ft. tall while paper bark (Melaleuca quinquenervia), the most abundant of the plantings, may vary in height from 12 to 18 ft. tall in open, scubby plantings to 25 to 35 ft. tall in the denser, older stands. Other forestry plantings include a few trees of tropical ash (Fraxinus uhdei), Terminalia myriocarpa, ironwood (Casuarina equisetifolia), satin leaf (Chrysophyllum oliviforme), etc. In the open scrubby paper bark plantings, uluhe fern (Dicranopteris linearis) commonly forms a dense cover between the trees. Also found in this area are scattered trees of 'ohi'a (Metrosideros polymorpha), hame (Antidesma platyphyllum), and 'ohi'a-ha (Syzygium sandwicensis).

In almost all parts of the mixed forests, with the exception of the hau forests, the shrub layer is dense, almost impenetrable. The common components of the shrub layer are Malabar melastome (Melastoma candidum), strawberry guava (Psidium cattleianum), and downy rose myrtle (Rhodomyrtus tomentosa). Because of the dense shrub layer, ground cover consists of more shade-tolerant species such as ni'ani'au (Nephrolepis exaltata), wood ferns (Christella parasitica, Christella dentata), thimbleberry (Rubus rosaefolius), and blechnum (Blechnum occidentale). Where there is more available light, as along the jeep road through the forested area, an assortment of various weedy grasses, sedges, and herbs can be found.

Hau (Hibiscus tiliaceus) forms dense forests, 18 to 25 ft. tall, on the lower slopes of Hanahanapuni where the proposed transmission line will run. Common associates of this forest type are bitter yam (Dioscorea bulbifera), pi'ia (Dioscorea pentaphylla), shampoo ginger (Zingiber zerumbet), hairy sword fern (Nephrolepis multiflora), Hilo grass (Paspalum conjugatum), elephant's-foot (Elephantopus mollis), and Oplismenus compositus.

Cane Fields -- Almost one-half the length of the transmission line will be located along or adjacent to existing cane haul roads. A number of weedy species commonly associated with agricultural lands are found along the roadsides and margins of fields. These include nutgrass (Cyperus rotundus), broad-leaved plantain (Plantago major), Bermuda grass or manienie (Cynodon dactylon), several crabgrass (Digitaria) species, radiate fingergrass (Chloris radiata), spurges (Chamaesyce spp.), and California grass (Brachiaria mutica). Within the fields themselves, weed numbers are low due to the dense stands of cane which tend to shade out the lower growing weedy plants.

THREATENED AND ENDANGERED SPECIES

No officially listed threatened or endangered plant species designated by the federal and/or state governments (U.S. Fish and Wildlife Service 1985; Herbst 1987) were found on the project site; nor are any plants proposed or candidate for such status. None of the native plants inventoried during the field survey are considered rare (Fosberg and Herbst 1975).

Previous field studies of the flora in drainage areas such as along the Hanalei River (Char 1986), Makaleha Stream (Linney and Char 1986), and the South Fork of Wailua River (Dept. of the Army 1982) have also resulted in similiar findings. Generally such drainage areas are dominated by introduced species such as guava, hau, and California grass. Native species are commonly those which are widespread throughout the islands in similiar environmental habitats.

DISCUSSION AND RECOMMENDATIONS

The proposed transmission line is sited along an existing 4-wheel drive road and cane haul roads. Vegetation in these areas consists of forestry plantings and actively cultivated sugar cane fields. No threatened or endangered species protected by the federal and/or state governments or sensitive plant communities occur in these areas.

On the proposed intake structure site and along the penstock, vegetation consists primarily of a guava/California grass association. Native species occur in this area, however, none are considered threatened or endangered. The proposed hydroelectric project is not expected to have a significant negative impact on the total island populations of the species involved as they occur in similiar environmental habitats throughout the islands or along the wet valleys of north and south Kauai.

Of greater concern is the generation of soil and sediments into the stream during construction of the proposed hydroelectric project. It is recommended that disturbance from construction be minimized wherever possible. All cuts and exposed areas, especially on steep slopes, should be revegetated as soon as possible. The ubiquitous California grass could be easily used for revegetation as well as a number of other species such as Hilo grass, carpetgrass, shampoo ginger (in heavily shaded areas), several species of *Desmodium*, etc.

LITERATURE CITED

Char, W. P. 1986. Botanical Survey, Hanalei River Hydroelectric Project, Hanalei District, Island of Kauai. Prep. for Island Power Co., Inc. November 1986.

Depart. of the Army. 1982. Wailua River Hydropower, Kauai, Hawaii. Final Interim Survey Report and Environmental Statement. U.S. Army Eng. District Honolulu, U.S. Army Corps of Engineers.

Fosberg, F. R. 1972. Field Guide to Excursion III, 10th Pacific Science Congress. Revised edition. Depart. of Botany, Univ. of Hawaii, Manoa.

Fosberg, F. R. and D. Herbst. 1975. Rare and endangered species of Hawaiian vascular plants. Allertonia 1(1): 1-72.

Herbst, D. 1987. Status of endangered Hawaiian plants. Hawaiian Botanical Society Newsletter 26(2): 44-45.

Lamoureux, C. H. 1984. Checklist of Hawaiian Pteridophytes. Ms.

Linney, G. K. and W. P. Char. 1986. Flora Survey, Makaleha Stream, Island of Kauai. Prep. for Portugal & Assoc. December 1986.

Porter, J. R. 1972. Hawaiian names for vascular plants. Coll. of Trop. Agr., Univ. of Hawaii, Manoa, Depart. Paper No. 1.

St. John, H. 1973. List and Summary of the Flowering Plants in the Hawaiian Islands. Pac. Trop. Bot. Gdn. Mem. No. 1, Lawai, Kauai, Hawaii.

U. S. Fish and Wildlife Service. 1985. Endangered and threatened wildlife and plants; Review of plant taxa for listing as Endangered and Threatened Species; Notice of review. Fed. Register 50(188): 39526-39527 plus 57-page table.

Wagner, W. L., D. Herbst, and S. Sohmer. In press. Manual of the Flowering Plants of the Hawaiian Islands. B. P. Bishop Museum Press.

PLANT SPECIES LIST

Following is a checklist of all those vascular plant species inventoried during the field studies. Plant families are arranged alphabetically within each of three groups: Ferns and Fern Allies, Monocots, and Dicots. Taxonomy and nomenclature of the Ferns and Fern Allies follow Lamoureux (1984); the flowering plants (Monocots and Dicots) are in accordance with Wagner et al. (in press). In most cases, common English and/or Hawaiian names given follow St. John (1973) or Porter (1972).

For each species the following information is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name, when known.
3. Biogeographic status. The following symbols are used:
   - E = endemic = native only to the Hawaiian Islands
   - I = indigenous = native to the islands and also to one or more other geographic areas
   - P = Polynesian = not native, plants of Polynesian introduction prior to Western contact (1778)
   - X = introduced or alien = not native, all those plants brought to the islands intentionally or accidentally after Western contact.
4. Presence (+) or absence (-) of a particular species within each of three vegetation types recognized on the project site (see text for discussion):
   - g = Guava/California Grass Association
   - m = Mixed Forests
   - c = Cane Fields

Scientific Name	Common Name	Status	Vegetation Type g	m	c
FERNS AND FERN ALLIES					
ADIANTACEAE (Maiden-hair Fern Family)					
Adiantum hispidulum Sw.	maiden-hair fern	X	+	-	-
ATHYRIACEAE (Athyrium Family)					
Athyriopsis japonica (Thunb.) Ching		X	+	-	-
Diplazium sandwichianum (Presl) Diels	ho'i'o	E	+	+	-
BLECHNACEAE (Blechnum Family)					
Blechnum occidentale L.	blechnum	X	+	+	-
DICKSONIACEAE (Tree Fern Family)					
Cibotium splendens (Gaud.) Krajina ex Skottsb.	hapu'u pulu	E	+	+	-
ELAPHOGLOSSACEAE (Elaphoglossum Family)					
Elaphoglossum crassifolium (Gaud.) Anders. & Crosby	'ekaha, hoe-a-Maui	E	+	-	-
GLEICHENIACEAE (False Stag-horn Fern Family)					
Dicranopteris linearis (Burm.) Underw.	uluhe	I	+	+	-
Diplopterygium pinnatum (Kunze) Nakai	uluhe-lau-nui	I	+	-	-
GRAMMITACEAE (Grammitis Family)					
Adenophorus hymenophylloides (Kaulf.) Hook. & Grev.	pai, palai-huna	E	+	-	-
Adenophorus tamariscinus (Kaulf.) Hook. & Grev.	wahine-noho-mauna	E	+	-	-
Grammitis tenella Kaulf.	kolokolo, mahina-lau	E	+	-	-

Scientific Name	Common Name	Status	Vegetation Type g	m	c
HEMIONITIDACEAE (Gold Fern Family)					
Pityrogramma calomelanos (L.) Link	gold fern	X	-	+	-
HYMENOPHYLLACEAE (Filmy Fern Family)					
Gonocormus minutus (Blume) v. d. Bosch.	gonocormus	I	+	-	-
Mecodium recurvum (Gaud.) Copel.	'ohi'a-ku	E	+	-	-
LINDSAEACEAE (Lace Fern Family)					
Sphenomeris chinensis (L.) Maxon	pala'a, palapala'a	I	+	+	-
LYCOPODIACEAE (Club Moss Family)					
Lycopodium phyllanthum Hook. & Arnott	wawae-'iole	E	+	-	-
NEPHROLEPIADACEAE (Sword Fern Family)					
Nephrolepis exaltata (L.) Schott	ni'ani'au, kupukupu	I	+	+	-
Nephrolepis multiflora (Roxb.) Jarrett ex Morton	hairy sword fern	X	+	+	-
OPHIOGLOSSACEAE (Adder's-tongue Fern Family)					
Ophioglossum pendulum subsp. falcatum (Presl) Clausen	puapua-moe	E	+	+	-
POLYPODIACEAE (Common Fern Family)					
Phlebodium aureum (L.) J. Sm.	laua'e-haole	X	+	+	-
Phymatosorus scolopendria (Burm.) Pic.-Serm.	laua'e, lauwa'e	X	-	+	-
Pleopeltis thunbergiana Kaulf.	'ekaha-'akolea, pakahakaha	I	+	+	-
PSILOTACEAE (Psilotum Family)					
Psilotum nudum (L.) Beauv.	moa, pipi	I	+	-	-

Scientific Name	Common Name	Status	Vegetation Type g	m	c
SELAGINELLACEAE (Small Club Moss Family)					
Selaginella arbuscula (Kaulf.) Spring	lepelepe-a-moa	E	+	-	-
THELYPTERIDACEAE (Downy Woodfern Family)					
Christella dentata (Forsk.) Brownsey & Jermy	downy woodfern	X	+	+	-
Christella parasitica (L.) Levl.	woodfern	X	+	+	-
Cyclosorus interruptis (Willd.) H. Ito	neke	I?	+	+	-
Pneumatopteris sandwicensis (Brack.) Holtt.		E	+	-	-
MONOCOTS					
AGAVACEAE (Agave Family)					
Cordyline fruticosa (L.) A. Chev.	ti, ki	P	+	+	-
ARACEAE (Arum Family)					
Colocasia esculenta (L.) Schott	taro, kalo	P	+	-	-
COMMELINACEAE (Spiderwort Family)					
Commelina diffusa N. L. Burm.	honohono	X	+	+	-
CYPERACEAE (Sedge Family)					
Cyperus difformis L.		X	-	+	-
Cyperus halpan L.		X	-	+	-
Cyperus rotundus L.	nutgrass, nut sedge	X	+	-	+
Cyperus sp.		X	-	+	-
Eleocharis geniculata (L.) Roem. & Schult.	eleocharis	X	+	+	+
Eleocharis cf. radicans (Poir) Kunth		X	+	+	-

Scientific Name	Common Name	Status	Vegetation Type g	m	c
Fimbristylis dichotoma (L.) Vahl.	tall fringe rush	I	+	+	-
Kyllinga brevifolia Rottb.	kyllinga, kili-o-opu	X	+	+	+
Machaerina mariscoides subsp. meyenii (Kunth) T. Koyama	'uki, 'ahu-niu	E	+	+	-
Mariscus cf. cyperinus (Retz.) Vahl		I	+	+	-
Pycreus polystachyos (Rottb.) P. Beauv.		I	+	+	+
Rhynchospora rugosa subsp. lavarum (Gaud.) T. Koyama	kuolohia, pu'uko'a	I	+	-	-
Schoenoplectus juncoides (Roxb.) Palla		I	+	-	+
DIOSCORIACEAE (Yam Family)					
Dioscorea bulbifera L.	bitter yam, pi'oi	P	-	+	-
Dioscorea pentaphylla L.	pi'ia	P	-	+	-
LILIACEAE (Lily Family)					
Astelia menziesiana Sm.	pa'iniu	E	+	-	-
MUSACEAE (Banana Family)					
Musa X paradisiaca L.	banana, maia	P	+	-	-
ORCHIDACEAE (Orchid Family)					
Phaius tankarvilleae (Banks ex L'Hér) Blume	phaius	X	-	+	-
Spathoglottis plicata Blume	Chinese ground orchid	X	+	+	-
PANDANACEAE (Screw Pine Family)					
Freycinetia arborea Gaud.	'ie'ie	I	+	+	-
POACEAE (Grass Family)					
Axonopus fissifolius (Raddi) Kuhlm.	carpetgrass	X	+	-	-
Brachiaria mutica (Forssk.) Stapf	California grass, paragrass	X	+	+	+

Scientific Name	Common Name	Status	Vegetation Type g	m	c
Cenchrus echinatus L.	common sandbur	X	–	–	+
Chloris barbata (L.) Sw.	swollen fingergrass	X	–	+	+
Chloris radiata (L.) Sw.	radiate fingergrass	X	–	+	+
Coix lachryma-jobi L.	Job's tears	X	+	+	+
Cynodon dactylon (L.) Pers.	Bermuda grass, manienie	X	–	–	+
Digitaria ciliaris (Retz.) Koeler	large crabgrass	X	+	+	+
Digitaria cf. horizontalis Willd.		X	–	+	+
Digitaria radicosa (Presl) Miq.	crabgrass	X	–	+	+
Digitaria setigera Roth	itchy crabgrass	I?	–	+	+
Digitaria violascens Link	kukai pua'a-uka	X	–	+	+
Echinochloa colona (L.) Link	jungle rice	X	+	+	+
Echinochloa crus-galli (L.) P. Beauv.	barnyard rice	X	+	+	–
Eleusine indica (L.) Gaertn.	wiregrass	X	–	+	+
Eragrostis sp.		X	–	–	+
Melinis minutiflora P. Beauv.	molassesgrass	X	–	+	–
Oplismenus compositus (L.) P. Beauv.		X	+	+	–
Paspalum conjugatum Bergius	Hilo grass	X	+	+	–
Paspalum dilatatum Poir	paspalum grass	X	+	+	+
Paspalum scrobiculatum L.	rice grass	I?	–	+	+
Paspalum urvillei Steud.	Vasey grass	X	–	+	+
Saccharum officinarum L.	sugar cane, ko	P/X	–	–	+
Sacciolepis indica (L.) Chase	Glenwood grass	X	+	+	+
Schizostachyum glaucifolium (Rupr.) Munro	bamboo, ohe	P	+	+	–
Setaria gracilis Kunth	foxtail	X	+	+	–
Sporobolus africanus (Poir) Robyns & Tournay	African dropseed	X	–	+	–
PONTEDERIACEAE (Pickerelweed Family)					
Monochoria vaginalis (N. L. Burm.) K. Presl	cordate monochoria	X	+	–	–
SMILACACEAE (Smilax Family)					
Smilax melastomifolia Sm.	hoi-kuahiwi	E	+	–	–

Scientific Name	Common Name	Status	Vegetation Type g	m	c
ZINGIBERACEAE (Ginger Family)					
Zingiber zerumbet (L.) Sm.	shampoo ginger, 'awapuhi kuahiwi	P	+	+	-
DICOTS					
ACANTHACEAE (Acanthus Family)					
Thunbergia fragrans Roxb.	white thunbergia	X	-	+	-
AMARANTHACEAE (Amaranth Family)					
Amaranthus spinosus L.	spiny amaranth	X	-	-	+
ANACARDIACEAE (Mango Family)					
Mangifera indica L.	mango, manako	X	+	+	-
APIACEAE (Carrot Family)					
Centella asiatica (L.) Urban	Asiatic pennywort	X	+	+	-
Ciclospermum leptophyllum (Pers.) Sprague	fir-leaved celery	X	-	+	+
Cryptotaenia canadensis (L.) DC	wild celery, honeywort	X	+	-	-
Hydrocotyle sibthorpioides Lam.	marsh pennywort	X	+	-	-
APOCYNACEAE (Periwinkle Family)					
Alyxia oliviformis Gaud.	maile	E	+	-	-
AQUIFOLIACEAE (Holly Family)					
Ilex anomala Hook. & Arnott	kawa'u, ka'awa'u	E	+	-	-
ASTERACEAE (Daisy Family)					
Adenostemma lavenia (L.) Kuntz	kamanamana	I	+	-	-
Ageratum conyzoides L.	ageratum, maile-hohono	X	-	+	+
Ageratum houstonianum Mill.	ageratum	X	+	+	-

Scientific Name	Common Name	Status	Vegetation Type g	m	c
Bidens pilosa L.	Spanish needle	X	-	+	+
Conyza bonariensis (L.) Cronq.	hairy horseweed, ilioha	X	-	-	+
Conyza canadensis var. pusilla (Nutt.) Cronq.	Canada fleabane	X	-	+	-
Crassocephalum crepidioides (Benth.) S. Moore	crassocephalum	X	+	+	+
Eclipta alba (L.) Hassk.	false daisy	X	+	+	+
Elephantopus mollis Kunth	elephant's-foot	X	+	+	-
Emilia coccinea (Sims) G. Don		X	-	-	+
Emilia fosbergii Nicolson	red pua-lele	X	-	-	+
Erechtites valerianifolia (Wolf) DC	purple fireweed	X	+	+	-
Pluchea indica (L.) Less.	Indian pluchea	X	+	-	-
Pluchea symphytifolia (Mill.) Gillis	pluchea	X	+	+	+
Synedrella nodiflora (L.) Gaertn.	synedrella	X	-	+	+
Vernonia cinerea (L.) Less.	iron weed	X	-	+	-
Youngia japonica (L.) DC	oriental hawksbeard	X	+	+	-
BIGNONIACEAE (Bignonia Family)					
Spathodea campanulata P. Beauv.	African tulip tree	X	-	+	-
CAMPANULACEAE (Bellflower Family)					
Cyanea cf. fauriei H. Lév.	cyanea	E	+	-	-
CARYOPHYLLACEAE (Carnation Family)					
Drymaria cordata var. pacifica Mizush.	drymaria, pilipili	X	+	-	-
CASUARINACEAE (Casuarina Family)					
Casuarina equisetifolia L.	ironwood	X	-	+	-
CELASTRACEAE (Bittersweet Family)					
Perottetia sandwicensis A. Gray	olomea	E	+	-	-
COMBRETACEAE (Terminalia Family)					
Terminalia myriocarpa Van Heurck & Müll. Arg.		X	-	+	-

Scientific Name	Common Name	Status	Vegetation Type g	m	c
CONVOLVULACEAE (Morning-glory Family)					
Ipomoea alba L.	moonflower, koali-pehu	X	+	+	-
Ipomoea indica (J. Sm.) Merr.	koali-'awania	I	+	-	-
Ipomoea triloba L.	little bell	X	-	+	+
EUPHORBIACEAE (Spurge Family)					
Aleurites moluccana (L.) Willd.	kukui, tutui	P	+	+	-
Antidesma platyphyllum var. hillebrandii Pax & K. Hoffm.	hame, mehamehame	E	+	+	-
Chamaesyce hirta (L.) Millsp.	hairy spurge	X	-	-	+
Chamaesyce hypericifolia (L.) Millsp.	spurge	X	-	+	+
Chamaesyce prostrata (Aiton) Sm.	prostrate spurge	X	-	-	+
Euphorbia heterophylla L.	fire plant	X	-	+	-
Phyllanthus debilis Klein ex Willd.	phyllanthus weed	X	-	+	+
Ricinus communis L.	castor bean, koli	X	-	+	+
FABACEAE (Pea Family)					
Chamaecrista nictitans (L.) Moench	partridge pea, lauki	X	-	+	+
Crotalaria incana L.	fuzzy rattlepod	X	-	+	+
Desmanthus virgatus (L.) Willd.	virgate mimosa	X	-	+	-
Desmodium incanum DC	Spanish clover	X	-	+	+
Desmodium sandwicense E. Mey.	ka'imi	X	-	+	+
Desmodium tortuosum (Sw.) DC	Florida beggarweed	X	-	+	+
Desmodium triflorum (L.) DC	three-flowered beggarweed	X	-	-	+
Desmodium sp.		X	-	-	+
Indigofera suffruticosa Mill	indigo, 'iniko	X	-	+	-
Leucaena leucocephala (Lam.) de Wit	koa-haole	X	-	+	-
Macroptilium lathyroides (L.) Urb.	wild bush-bean	X	-	+	+
Mimosa pudica var. unijuga (Duchass. & Walp.) Griseb.	sensitive plant, pua-hilahila	X	+	+	+
Paraserianthes falcataria (L.) I. Nielsen		X	+	+	-

Scientific Name	Common Name	Status	Vegetation Type g	m	c
HYDRANGEACEAE (Hydrangea Family)					
Broussaisia arguta Gaud.	kanawao	E	+	-	-
LAMIACEAE (Mint Family)					
Leonotis nepetifolia (L.) R. Br.	lion's-ear	X	-	+	+
LAURACEAE (Laurel Family)					
Persea americana Mill.	avocado	X	+	+	-
LYTHRACEAE (Loosestrife Family)					
Cuphea carthagenensis (Jacq.) Macbr.	Colombian cuphea, puakamoli	X	+	+	-
MALVACEAE (Hibiscus Family)					
Hibiscus tiliaceus L.	hau	I?	+	+	-
MELASTOMATACEAE (Melastome Family)					
Heterocentron subtriplinervium (Link & Otto) A. Braun & C. Bouche	pearl flower	X	-	+	-
Melastoma candidum D. Don	Malabar melastome	X	+	+	-
MYRTACEAE (Myrtle Family)					
Eucalyptus robusta Sm.	swamp mahogany	X	-	+	-
Eucalyptus sp.	eucalyptus	X	-	+	-
Melaleuca quinquenervia (Cav.) S. T. Blake	paper bark	X	-	+	-
Metrosideros polymorpha Gaud.	'ohi'a-lehua, 'ohi'a	E	+	+	-
Psidium cattleianum Sabine	strawberry guava, waiawi	X	+	+	-
Psidium guajava L.	guava, kuawa	X	+	+	-
Psidium littorale Raddi		X	+	+	-
Rhodomyrtus tomentosa (Aiton) Hassk.	downy myrtle, rose myrtle	X	+	+	-
Syzygium cumini (L.) Skeels	Java plum, palama	X	-	+	-
Syzygium sandwicensis Gray	'ohi'a-ha	E	+	+	-

Scientific Name	Common Name	Status	Vegetation Type g	m	c
NYCTAGINACEAE (Four O'clock Family)					
Pisonia sandwicensis Hillebr.	papala-kepau	E	+	+	-
OLEACEAE (Olive Family)					
Fraxinus uhdei (Wenzig) Ligelsh	tropical ash	X	-	+	-
ONAGRACEAE (Evening Primrose Family)					
Ludwigia octovalvis (Jacq.) Raven	primrose willow, kamole	P?	+	+	+
OXALIDACEAE (Wood Sorrel Family)					
Oxalis corniculata L.	yellow wood sorrel, ihi	P	-	+	+
Oxalis corymbosa DC	pink wood sorrel	X	-	+	+
PASSIFLORACEAE (Passion Fruit Family)					
Passiflora edulis Sims	passion fruit, lilikoi	X	-	+	-
PIPERACEAE (Pepper Family)					
Piper methysticum G. Forster	'awa, kava	P	+	-	-
PLANTAGINACEAE (Plantain Family)					
Plantago major L.	broad-leaved plantain, lau-kahi	X	-	+	+
POLYGALACEAE (Polygala Family)					
Polygala paniculata L.	polygala	X	-	+	-
POLYGONACEAE (Buckwheat Family)					
Polygonum glabrum Willd.	knotweed, kamole	X	+	-	-
PRIMULACEAE (Primrose Family)					
Anagallis arvensis L.	scarlet pimpernel	X	-	+	-
ROSACEAE (Rose Family)					
Rubus rosifolius Sm.	thimbleberry	X	+	+	-

Scientific Name	Common Name	Status	Vegetation Type a	m	c
RUBIACEAE (Coffee Family)					
Hedyotis terminalis (Hook. & Arnott) W. L. Wagner & Herbst	manono	E	+	-	-
Psychotria kaduana (Cham. & Schlechtend.) Fosb.	kopiko	E	+	-	-
Spermacoce assurgens Ruiz & Pav.	buttonweed, spermacoce	X	-	+	+
SAPOTACEAE (Sapodilla Family)					
Chrysophyllum oliviforme L.	satin leaf	X	-	+	-
SOLANACEAE (Tomato Family)					
Solanum americanum Mill.	popolo	I?	-	+	-
URTICACEAE (Nettle Family)					
Boehmeria grandis (Hook. & Arnott) A. Heller	akoka	E	+	-	-
Pilea peploides (Gaud.) Hook. & Arnott	pilea	I	+	-	-
Pipturus albidus (Hook. & Arnott) A. Gray	mamaki	E	+	-	-
VERBENACEAE (Verbena Family)					
Lantana camara L.	lantana, lakana	X	+	+	-
Stachytarpheta dichotoma (Ruiz & Pav.) Vahl	Cayenne vervain	X	-	+	-
Stachytarpheta urticifolia (Salisb.) Sims	nettle-leaved vervain	X	+	+	-
Verbena litoralis Kunth	weed verbena	X	-	+	-

APPENDIX B

FISHERIES SURVEY

REPORT ON FISH, WILDLIFE AND BOTANICAL RESOURCES,
UPPER WAILUA PROJECT
KAUAI, HAWAII

by

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October 7, 1988

Mr. Clark Mower
Bonneville Pacific Corporation
257 East 200 South, Suite 800
Salt Lake City, Utah 84111

RE: Draft Materials for Exhibit E Report on Fish, Wildlife, and Botanical Resources, Upper Wailua Project, Kauai, Hawaii

Dear Clark:

At your request we have prepared the following draft materials for inclusion in your licensing documents for the Upper Wailua Project on Kauai. The materials rely on our studies over the past four years with Hawaiian stream species, on the fisheries reconnaissance survey we conducted in the project area in January 1988, and on our eight year's experience with hydroelectric projects and their potential impacts to aquatic resources.

Existing Fisheries Resources

The project area of the Upper Wailua Hydroelectric Project lies on the east side of the Mt. Wai'ale'ale crater on an unnamed tributary of the North Fork Wailua River (Figure 1). Topographically and hydrologically the tributary can be divided into three zones: (1) a 4700' lower gradient segment with a 3.4 percent slope beginning at the confluence of the North Fork and ending at a small tributary entering from the north at elevation 860', (2) a 4200' higher gradient segment with an 8.6 percent slope beginning at elevation 860' and ending at the mouth of the existing Hanalei River diversion tunnel, and (3) an upstream watershed above where water from the Hanalei tunnel enters the tributary. The two downstream sections are augmented with an average flow of 26 cfs from the tunnel while the upper watershed retains a natural flow regime. The diverted Hanalei River water is proposed for use in generating power by the Upper Wailua Project between the mouth of the tunnel and the North Fork Wailua. Flow within the lower two segments of the Upper Wailua tributary would revert to the pre-diversion regime present before the construction of the Hanalei Tunnel.

Below the proposed project the North Fork Wailua River is extensively diverted to serve as a water supply for the main island industry of sugar cane production. Water quality deteriorates through warming and increased turbidity, the river passes over Opaeka'a Falls (a popular tourist attraction), and the remaining flow reaches the ocean near the town of Wailua (see sections on hydrology and water quality). Runoff from the intensively cultivated sugar cane fields frequently turns the river reddish brown with eroded volcanic soils.

The distribution, species composition, and abundance of the fisheries resources in the Upper Wailua River coincide with topographic and hydrologic patterns (Table 1). The downstream lower gradient section contains populations of green swordtails (Xiphophorus helleri), variable platyfish (Xiphophorus variatus), and smallmouth bass (Micropterus dolomieui) (Payne 1988). These three species are among the numerous introduced fishes that have become established within the Hawaiian Islands (Kanayama 1968, Timbol and Maciolek 1978). Due to the character of the stream, none is very common. Over most of the reach, the Upper Wailua flows in a confined channel with steep banks that offers little of the quiet, sheltered habitat preferred particularly by the swordtails and platys. They were located only in restricted areas of backwater protected by the roots of terrestrial grasses. The abundance of all three exotic species combined is estimated at less than 10 per 100 feet of stream (Payne 1988). No native species have been recently reported from the area.

Higher in the watershed within the steeper section of the project reach, the exotic fishes are replaced by three species of native diadromous fauna. Most of this reach is composed of exposed bedrock and large boulders. A freshwater shrimp (Atyoida bisulcata), known by its Hawaiian name of opae kala'ole, is relatively common. Populations of the 2-3 inch crustacean are estimated at approximately 100 per 100 feet (Payne 1988). The life history and behavior of opae has been described by Edmondson (1929) and Couret (1976). They feed either by filter feeding, trapping detritus on fan-like setae attached to extended chelipeds, or by grazing on filamentous algae and diatom mats growing on the substrate. The shrimp can be found in mountain streams at elevations up to 3600 feet and has been used as a food source and fish bait by native islanders. Breeding occurs in the streams and eggs are carried by the females, after which the hatched larvae drift to the ocean to develop into juveniles. This diadromous life cycle then requires the juveniles to migrate back upstream, ascending rapids and vertical waterfalls by means of minute hooks on their chelipeds.

The other two aquatic species in the Upper Wailua River are diadromous gobies: the common goby (o'opu nakea, Awaous stamineus) and Stimpson's goby (o'opu nopili, Sicyopterus stimpsoni), although densities are very low. One intensive survey found only a few in several hundred feet of sampling towards the upper end of the reach (Payne 1988). The o'opu nakea rear in freshwater and descend downstream in mass migrations after fall freshets to spawn near the estuary, where deposited eggs quickly hatch and the larvae are swept out to sea (Ego 1956). After a four to seven month period in the marine environment, the fry migrate into rivers and stay until they reach sexual maturity. Upstream migration and movement within the river environment is assisted by a ventral sucking disk formed by the union of the pelvic fins (Tinker 1978). Habitat assessment work done in the Lumahai River on the north shore of Kauai (TRPA 1987) found two size classes of nakea, indicating that they spend at least two years in freshwater. The common goby often reaches nine to ten inches in length and they will take a baited hook on their spawning migration, making them popular as a food fish to the native Islanders (Ego 1956). The o'opu nopili has a life history similar to the o'opu nakea (Tomihama 1972) but they reach only an average size of two to three inches and are less attractive to fishermen.

The uppermost end of the project reach is on a short spur leading to the exit of the diversion tunnel from the Hanalei River. Here the stream is very narrow and swift, flowing through a seam in old lava flows. Some opae may be present in this section, as they were in the mouth of the tunnel itself, although high water velocity and physical hazard has precluded any sampling.

The portion of the Upper Wailua upstream of the confluence with the tunnel water is less confined than downstream. The substrate is composed of boulders, cobbles, and gravels instead of lava bedrock and the stream contains more pools, riffles, glides, and undercut banks. Opae are very abundant in this section, approaching some of the densities reported in other Hawaiian streams of about four or five animals per square foot (Couret 1976, Kinzie and Ford 1982, TRPA 1988), or 6,000 to 7,500 per 100 feet. The two gobies, o'opu nakea and o'opu nopili, remain uncommon and are present in approximately the same abundance as below the confluence (Payne 1988). The rarity of gobies is probably related to the distance of the area from the ocean (8 miles), predators in the lower river where the gobies must migrate, and extensive intervening irrigation diversions. It is possible that the gobies may have moved through the tunnel from the Hanalei River where they are more common (Timbol 1986). The opae are too abundant for them all to have moved through the tunnel, so they must be fecund and hardy enough to continue migrating through the lower Wailua. No individuals of another goby, the candidate endangered species o'opu alamo'o (Lentipes concolor), have been observed in or near the project area.

Impacts to Fisheries Resources

Construction Impacts

Construction of the Upper Wailua project is expected to cause short-term increases in the amount of turbidity and sediment present within the stream. The primary source of sediment will be runoff from exposed soil during installation of access roads and the penstock. Secondary sources of sediment will be construction activity on the diversion intake and the powerhouse and tailrace. These short-term increases should have very little effect on the aquatic species of the Upper Wailua, principally because Hawaiian streams regularly experience large, temporary increases in turbidity following the intense rain showers that are common on the islands (U.S.G.S. Stream Gaging Records). The introduction of feral pigs and their proliferation over the years has resulted in large populations that are capable of seriously disturbing a watershed and accelerating soil erosion (Kepler 1986). Turbidity due to construction should be small compared to the background levels normally experienced by the resident aquatic species, particularly after implementation of sediment control procedures designed as mitigation. The diadromous life history of the species also minimizes their susceptibility to impacts from temporary turbidity increases during their more vulnerable reproductive phases.

Operational Impacts

The principal feature of project operation will be the removal of flow added to the Upper Wailua River by the irrigation diversion from the Hanalei River. Existing flows between the mouth of the tunnel and the confluence with the North Fork Wailua will be reduced by a nearly constant 26 cfs and the drainage will revert to natural flow volumes. An instream flow study to quantify potential changes in aquatic habitat was determined to be unnecessary by the U.S. Fish and Wildlife Service (USFWS 1988), because no additional flow would be diverted from the Hanalei river. Reversion to natural flow is expected to have no negative effects on existing aquatic habitat and may possibly result in an improvement. This conclusion is based on the present pattern of species abundance and distribution within the watershed and on the physical character of the stream and its response to streamflow.

The large change in the abundance of opae above and below the confluence of the Upper Wailua with the tunnel water is most likely due to a combination of a difference in flow volume and in the character of the stream substrate. Above the confluence the Upper Wailua is mostly boulder and cobble, which offers abundant cover for the opae, while below the confluence the stream is mostly lava bedrock with little cover. The addition of 26 cfs from the Hanalei increases water velocity and turbulence without increasing wetted area because of the steep sidewalls of the stream. Removal of the 26 cfs will reduce velocity and turbulence and provide conditions more similar to those above the confluence, although the natural change in geology will still create differences. While opae are described as a "torrential" species (Edmondson 1929), they have been found to be most abundant in velocities less than 0.5 feet per second (TRPA 1987, TRPA 1988), and the reduction in flow to natural levels should improve the suitability of the habitat. The artificial addition of flow from the Hanalei River has not increased habitat, as might be assumed, because opae are less abundant below the confluence than they are above. No change is expected in the abundance of the o'opu because there is currently no apparent difference above and below the tunnel water confluence.

Reduction in flow by 26 cfs will lower the average depths and velocities of the downstream section of the Upper Wailua, probably to the benefit of the exotic species such as the swordtails and platys which occupy quieter, low velocity water. Increases in these species, the prey base for smallmouth bass, may result in greater numbers of the sportfish and a small improvement in fishing opportunity. Unfortunately, the presence of bass (a very effective piscivorous predator) and the continuation of flow and water quality problems downstream in the North Fork and mainstem Wailua will strongly inhibit any re-establishment of the native species within the lower project area.

Operation of the project may also affect the recruitment of native diadromous species by entraining downstream migrants in the diversion flow or by falsely attracting upstream migrants to the tailrace of the powerhouse. Downstream migrant gobies will be protected by installing a screening device on the project intake sized to exclude these large, mature fish, and will include a bypass to return them to the Upper Wailua below the tunnel. Larvae of opae should not be affected by passing through the turbines due to their planktonic size of 1 to 2 millimeters (Couret 1976), and would not be screened by the project. Upstream migrants of all species would be protected by designing the tailrace to include an energy dissipation structure to reduce velocities to less than one foot per second. Higher natural velocities in the stream channel should serve as a stronger attraction force and guide migrants past the powerhouse.

We hope this information meets your needs at this time. Please let us know if you would like further details or explanations.

Sincerely,

Tom Payne

Thomas R. Payne
Principal Associate

REFERENCES

Couret, C.L. 1976. The biology and taxonomy of a freshwater shrimp, Atya bisulcata Randall, endemic to the Hawaiian Islands. M.S. Thesis, University of Hawaii at Manoa, Honolulu, Hawaii. 168 pp.

Edmondson, C.H. 1929. Hawaiian Atyidae. Bernice P. Bishop Museum, Honolulu, Hawaii. 66:1-37.

Ego, K. 1956. Life history of freshwater gobies. Proj. No. F-4-R, Freshwater Game Fish Management Research, Dept. of Land and Natural Resources, State of Hawaii, Honolulu, Hawaii. 24 pp.

Kanayama, R.K. 1968. Hawaii's aquatic animal introductions. Proceedings of the Conference of the Western Association of State Game and Fish Commissioners. 48:123-133.

Kepler, A.K. 1986. Biological survey of Wailuku River hydropower project site, windward island of Hawaii, Hawaiian Islands. Report prepared for Associated Engineering Consultants, Auburn, California. 9 pp.

Kinzie, R.A., and J.I. Ford. 1982. Population biology in small Hawaiian streams. Water Resources Research Center, Technical Report No. 147, University of Hawaii at Manoa, Honolulu, Hawaii. 60 pp.

Payne, Thomas R. 1988. Letter report on a fisheries reconnaissance survey of the Upper Wailua River, Kauai, Hawaii. Prepared for Bingham Engineering on February 2, 1988. Thomas R. Payne & Associates, Arcata, California.

Timbol, A.S. 1986. A survey of aquatic macrofauna in Hanalei River, and the potential impact of hydroelectric development. Report prepared for Island Power Co., Inc., Kalaheo, Kauai, Hawaii. 26 pp.

Timbol, A.S., and J.A. Maciolek. 1978. Stream channel modification in Hawaii. Part A: Statewide inventory of streams, habitat factors, and associated biota. U.S. Fish & Wildlife Service FWS/OBS-78-16. 158 pp.

Tinker, S.W. 1978. Fishes of Hawaii: A Handbook of the Marine Fishes of Hawaii and the Central Pacific Ocean. Hawaiian Service, Inc., Honolulu, Hawaii. 532 pp.

Tomihama, M.R. 1972. The biology of Sicydium stimpsoni, freshwater goby endemic to Hawaii. B.S. (Honors) Thesis in Biology, University of Hawaii, Honolulu, Hawaii. 123 pp.

TRPA. 1987. Habitat utilization criteria for four native Hawaiian freshwater aquatic species (Awaous stamineus, Sicyopterus stimpsoni, Atya bisulcata, and Neritina granosa) in the Lumahai River, Kauai, Hawaii. Thomas R. Payne & Associates, Arcata, California. 52 pp.

TRPA. 1988. Instream flow assessment for East, Middle, and West Wailuaiki Streams, East and West Wailuaiki Hydroelectric Project, Maui, Hawaii. Thomas R. Payne & Associates, Arcata, California. 77 pp.

USFWS. 1988. Letter from U.S. Fish and Wildlife Service, Honolulu, Hawaii to Bingham Engineering, Salt Lake City, Utah, dated March 30, 1988.

Table 1. Results of Upper Wailua River survey, listed by site location (see Figure 1), length of site, species, size, and estimated abundance (rare = 1 to 3 per site, uncommon = 4 to 10 per site, common = 10 to 100 per site, abundant = >100 per site). (From Payne 1988)

Site 1 - Upper Wailua above Stable Storm Ditch, 300 m

Smallmouth bass, 10 to 30 cm, rare
Green swordtail, 4 to 6 cm, rare
Variable platyfish, 4 to 6 cm, rare

Site 2 - Trail stream above Stable Storm Ditch, 100 m

Smallmouth bass, 10 to 30 cm, uncommon
Green swordtail, 4 to 6 cm, uncommon
Variable platyfish, 4 to 6 cm, uncommon

Site 3 - North Fork Wailua above Stable Storm Ditch, 100 m

No species found

Site 4 - Stable Storm Ditch below USGS streamgage, 100 m

Smallmouth bass, 8 to 10 cm, rare
Variable platyfish, 1 to 4 cm, abundant

Site 5 - Upper Wailua below tunnel confluence, 100 m

Opae kala'ole, 5 to 7 cm, common
O'opu nakea, 6 to 16 cm, rare
O'opu nopili, 8 cm, rare

Site 6 - Hanalei tunnel, 10 m

Opae kala'ole, 5 to 7 cm, rare

Site 7 - Upper Wailua above tunnel confluence, 100 m

Opae kala'ole, 5 to 7 cm, abundant
O'opu nakea, 8 to 16 cm, rare

Site 8 - Small tributary at trail, 10 m

Opae kala'ole, 5 to 7 cm, uncommon

Site 9 - Trail stream at trail, 10 m

Opae kala'ole, 5 to 7 cm, uncommon

Site 10 - North Fork Wailua at trail, 50 m

Variable platyfish, 1 to 6 cm, common
Opae kala'ole, 5 to 7 cm, rare

IRP 10/7/88

"LADDER" TO PASS MIGRATING JUVENILE GOBIES AND SHRIMP

A. DESIGN SLOPE – 1:2 TO 1:4

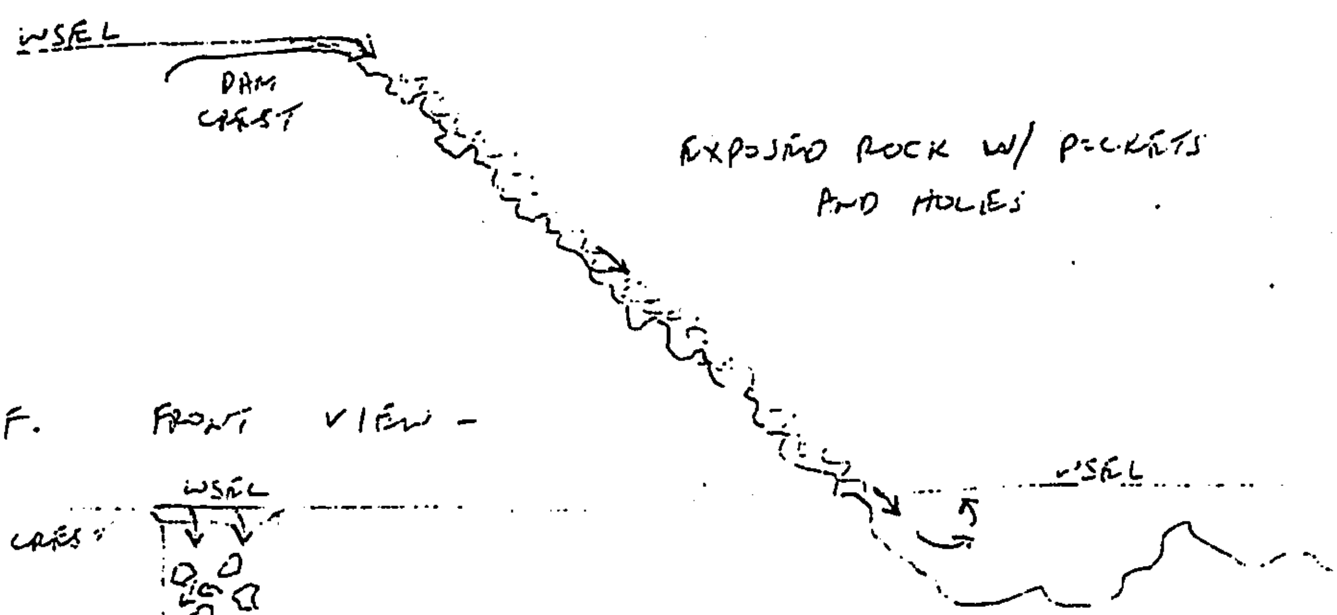
B. DESIGN FEATURES –

1. ROUGHNESS (MAXIMUM)
2. LOW FLOW CONFINEMENT
3. 100 gpm FLOW MINIMUM

C. COMPOSITION – CONCRETE AND 6" DIAMETER ROCK

D DESIGN CONCEPT – CONSTANT WETNESS, RESTING AREAS

E SIDE VIEW –



F. FRONT VIEW –

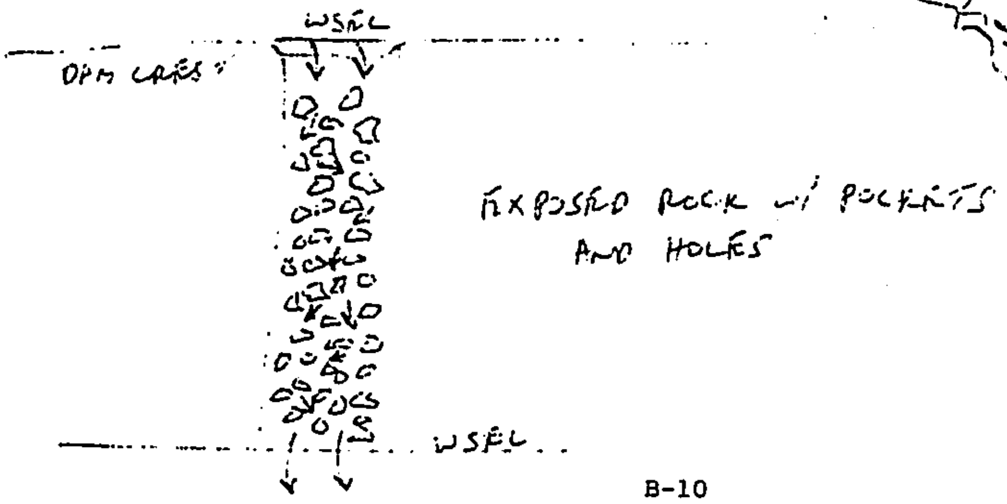
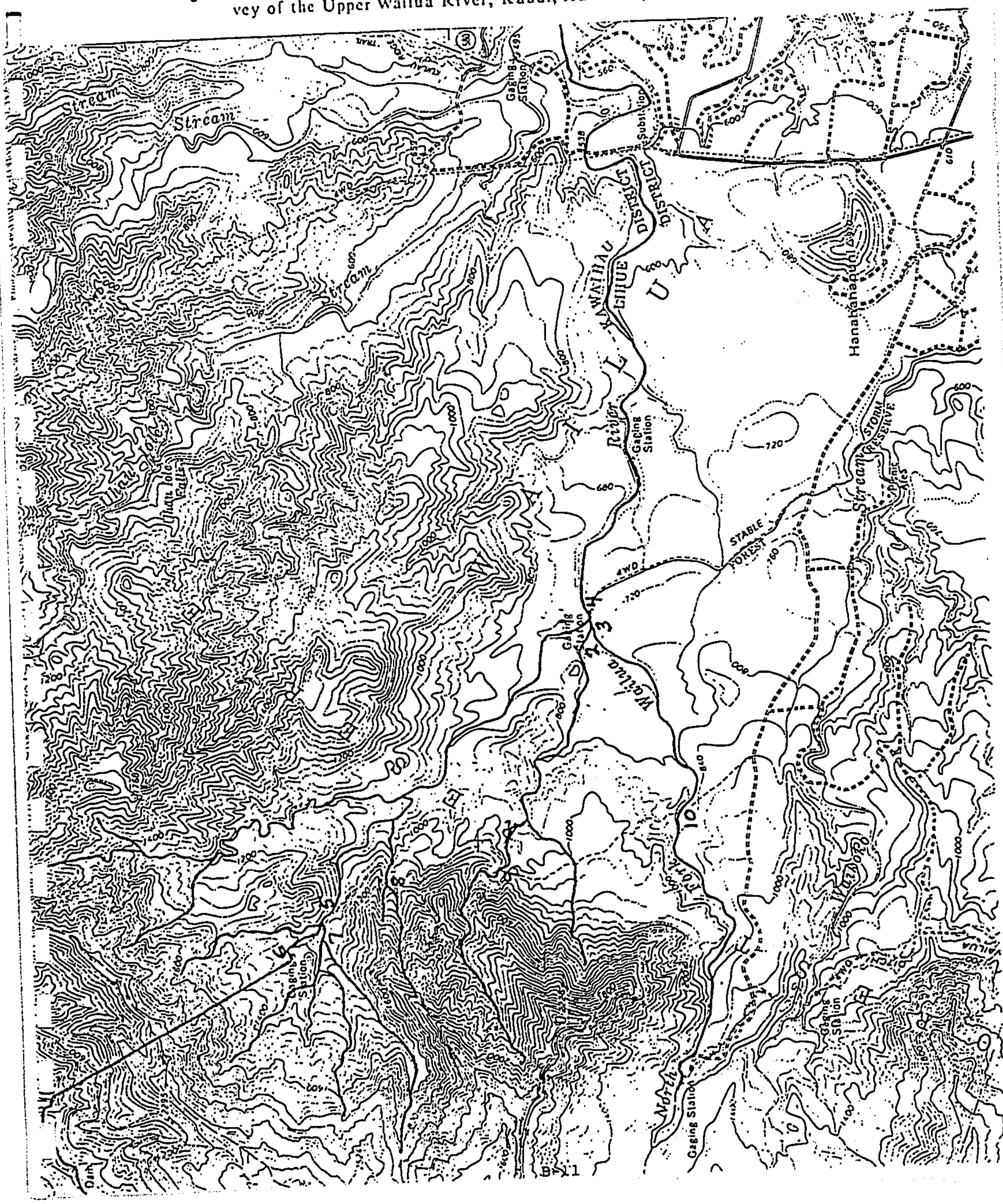


Figure 1. Direct Observation Sampling Locations, Fisheries Reconnaissance Survey of the Upper Wailua River, Kauai, Hawaii. (From Payne 1988)



APPENDIX C

ARCHAEOLOGICAL SURVEY

ARCHAEOLOGICAL RECONNAISSANCE OF THE UPPER WAILUA HYDROELECTRIC PROJECT: WAILUA, KAUA'I

by

Hallett H. Hammatt, Ph.D.
CULTURAL SURVEYS HAWAII

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ARCHAEOLOGICAL RECONNAISSANCE
OF THE UPPER WAILUA HYDROELECTRIC
PROJECT: WAILUA, KAUA'I

by

Hallett H. Hammatt, Ph.D.

prepared for

BONNEVILLE PACIFIC CORP.

by
Cultural Surveys Hawaii
October 1988

ABSTRACT

An archaeological reconnaissance survey was conducted for a proposed hydropower project along the north branch of the north fork of the Wailua River on Kaua'i. The proposed project includes an approximately 8,000 foot long pipeline running down the stream valley from the outlet of the Hanalei-Wailua Water Tunnel to the confluence with the north fork of the Wailua River. In addition, a power line is planned to parallel existing roads and cane fields to an Electric Substation near the north fork of the river. No archaeological remains were located within the project area, but the area near the confluence of the two streams by the proposed power plant is a potential site for traditional irrigated agriculture. Although this locality was carefully examined for sites, terraces may lie under a thick mat of California grass. Some historic evidence suggests Hawaiian terracing of the upper tributaries of the Wailua River. For these reasons archaeological monitoring is recommended during vegetation clearing before construction in the confluence area. No further archaeological research or field work is recommended for other areas of the proposed project.

ACKNOWLEDGMENTS

The field work was conducted by the author and Mr. Mark Stride. Mr. Clark Mower of Bonneville Power Co. provided support and much useful information during the field work and served as a guide to the project area. Also accompanying us in the field were botanists Ms. Winona Char and Mr. Clyde Imata, as well as Mr. Vince Lamar of Ecosystems Resources, Inc.

Mr. Douglas Borthwick and Mr. David Shideler of Cultural Surveys performed archival research and Mr. Charles Okino of the State Survey Office provided access to historic maps. Mr. William Folk provided useful firsthand information on the 1981 Ching Survey of the Wailua Valley. Typing was performed by Ms. Vicki Creed of Windword Processing. Grateful acknowledgement is given for this assistance.

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GLOSSARY

ahupua'a	Largest land unit within a district (moku); were self sufficient economic units extending from the mountains to the outer reef - where there was a reef, or a half mile to a mile to sea - where there was no reef; so called because the boundaries of these land units were marked by a cairn of stone (ahu) on which a pig (pua'a) or other tribute was laid as a tax to the ruling chief (ali'i nui).
'Aikanaka	An ancient high chief of Kaua'i.
ali'i	Chief; a member of the ruling class (nobility) in ancient Hawaiian society.
ali'i 'ai moku	Chief that rules over a moku or district.
ali'i nui	Ruling chief.
alluvial	A mode of sediment deposition, i.e., deposited by streams.
'auwai	A constructed ditch, usually for irrigation purposes.
avifauna	The birds or the kinds of birds of a region, period or environment.
cultigen	A cultivated organism of a variety or species for which a wild ancestor is unknown.
Great Mahele of 1848	An event in the "reformation of the land system in Hawaii" that "separated and defined the undivided land interests of King Kamehameha III and the high-ranking chief and konohiki(s)." This was carried out by the Board of Commissioners To Quiet Land Titles comprised of five commissioners appointed by King Kamehameha III. (Chinen 1974).
hale	House or building.
hau	A lowland tree, often found growing along streams (Hibiscus tiliaceus).
heiau	Hawaiian temple.
honohono	This work is used in the text to generally characterize several species of creeping grasses.
in situ	In an original or natural position.

Ka'ahumanu	Favorite wife of Kamehameha I, who later married Kaumuali'i, King of Kaua'i. She was also at one time Kuhina nui or executive officer of the kingdom.
ka'ao	A traditional Hawaiian fictional story.
kāeke	Or Kā'eke'eke. Bamboo pipes, varying in length with one end open. A player held one vertically in each hand tapping them down on a mat or the ground with the resulting tone varying according to the length of the bamboo (see footnote in text).
Kahiki	Tahiti or a general term describing any foriegn country.
kalo	Taro (Colocasia esculenta).
Kamehameha III Kauikeauoli	The third ruling monarch of the Kamehameha dynasty over the Kingdom of Hawaii.
kapu	Prohibited, forbidden, off limits; sacred, consecrated.
Kapule, Deborah	Wife of Kaumuali'i and Queen of Kaua'i. Deborah was her baptismal name, she being an early convert to Christianity. Ha'akulou was her Hawaiian name.
Kaumuali'i	The last ruling chief of Kaua'i previous to the unification of all islands under the rule of Kamehameha I.
Kawelo	A heroic chief of Hawaiian legend who was born at Hanamā'ulu, Kaua'i. Some of his exploits take place in Wailua such as his battle with 'Aikanaka at Nounou.
kī	The ti plant (Cordyline terminalis).
kīpuka	Variation of change of form, as a calm area in rough seas, a clearing in a forest, or, as used in the text, a remnant of older volcanic activity surrounded by later lava flows.
koloa	General term for duck (Anas spp.). The Hawaiian duck was sometimes called koloa maoli or native duck.
kōnane	A traditional Hawaiian game similar to checkers.
konohiki	Land manager (headman) of an ahupua'a.
kukui	Candlenut tree (Aleurites moluccana).
laua'e	A fern (Polypodium phymatodes). Its fragrance, when crushed, resembles that of the maile, and is famous on Kaua'i.

liana — A climbing plant that roots in the ground.

lo'i — Wet taro lands as opposed to kula lands, that was used for dry land farming.

mai'a — General term for all types of bananas. Another descriptive word follows to denote the specific variety such as mai'a'ele'ele.

maka'āinana — Commoner; the largest class of people in ancient Hawaiian society.

makai — Towards the sea.

mauka — Towards the uplands.

middle fork — The old term, as seen on historic maps, for what is today called the north fork of the Wailua River (see north fork).

Mo'ikeha — The grandson of Maweke who came to Hawai'i from Kahiki. His brother was Olopana, chief of Waipi'o, Hawai'i. Mo'ikeha became the ali'i nui of Kaua'i, inheriting the title from his father-in-law Puna.

moku — To divide, land district.

mo'olelo — A traditional story that is based on what the Hawaiians believed to be historical fact.

north fork — A name, often found on old maps, used to identify what is known today as 'Ōpaeka'a Stream, the northern most of the three large tributaries of the Wailua River. What is known today as the north fork was then called the middle fork.

'ohe — General name applied to all varieties of bamboo. Use in this text refers to 'ohe Hawaii (Bambusa vulgaris var. aureo variegata) or 'ohe kahiki (Schizostachyum glaucifolium).

'ohehanoihu — Nose flute.

'ōhi'a'ai — Mountain apple tree (Eugenia malaccensis).

'ōhi'a lehua — A native tree (Metrosideros collina).

palepiwa — All species of Eucalyptus trees. The name literally means to ward-off fever because the leaves were prepared medicinally for that purpose.

pali	cliff; precipice.
Palila	A demigod, chief and warrior of Kaua'i. Some of his exploits are related in legends of Wailua. He later became the ruling chief of Hilo.
piko	Umbilical cord, navel.
pōhaku piko	A significant boulder or outcrop, in the crevices and vesicles of which are ceremoniously placed the <u>piko</u> of new born infants, secured by a pebble or section of the <u>pū</u> <u>hala</u> fruit.
pū hala	Pandanus tree. Also known simply as <u>hala</u>.
pu'u	Any kind of protuberance from a pimple to a hill.
pu'uhonua	Place of refuge, asylum.
site	A discreet structure (including sinkholes) which contains evidence of construction or modification.
slope wash	Sheet erosion or the material transported by sheet erosion.
terrace complex	Two or more separable (for purposes of analysis), relatively level areas arranged in a step-like order to conserve moisture or to minimize erosion for planting.
uka	Uplands.

I. INTRODUCTION AND SCOPE OF WORK

This report contains the results of an archaeological reconnaissance of the proposed Upper Wailua Hydroelectric Project (Figs 1-4). The purpose of the reconnaissance was to identify archaeological remains within the project area and to evaluate the extent of impact of the proposed project on archaeological resources.

The reconnaissance work was to include the following:

1. search of relevant previous archaeological reports, historical documents and maps;
2. reconnaissance field work with on-the-ground examination of the proposed pipeline route and transmission line;
3. preparation of a report to include historical summary, descriptions of all archaeological sites located with interpretations and significance of assessments and a summary with discussion of potential impacts and mitigation recommendations.

Field work for the project was undertaken September 13th and 14th, 1988. The first day consisted of a survey of the proposed pipeline route following the north branch of the north fork of the Wailua River from the outlet of the Wailua-Hanalei Water Tunnel at elevation 1218 feet above sea level downstream along the river to its confluence with the south branch of the north fork of the Wailua River. The access to the upstream and of the

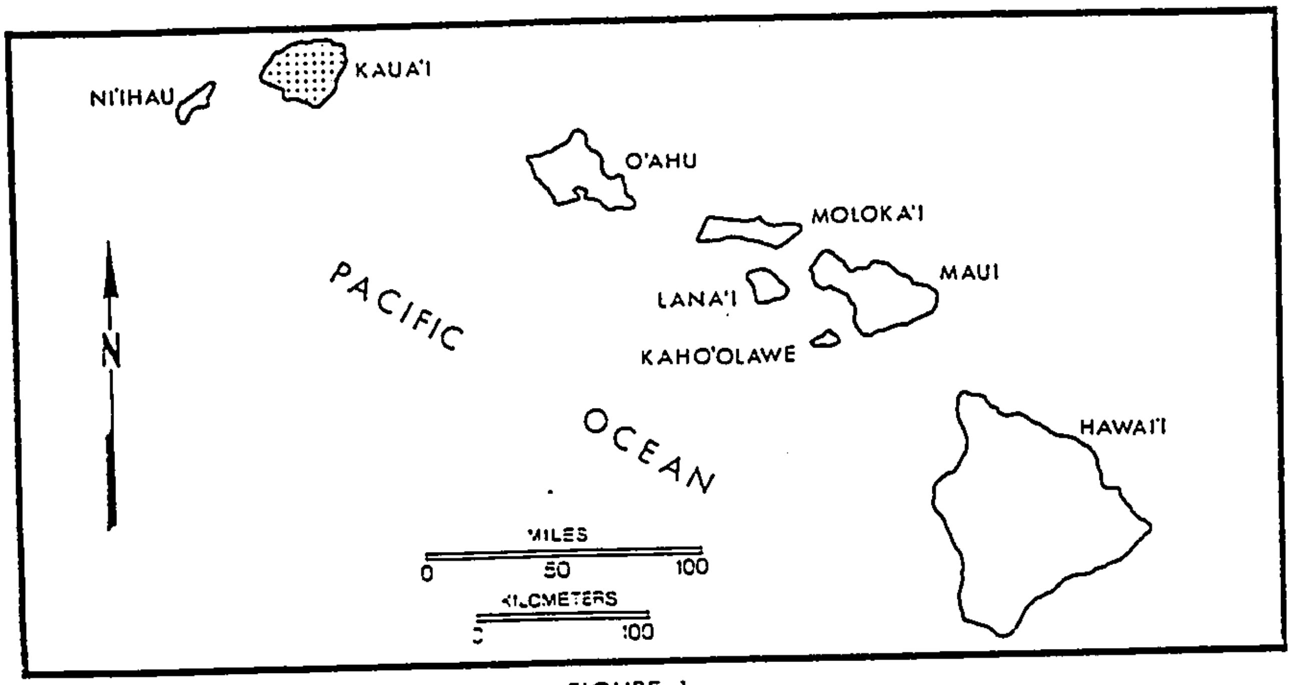

FIGURE 1
State of Hawai'i

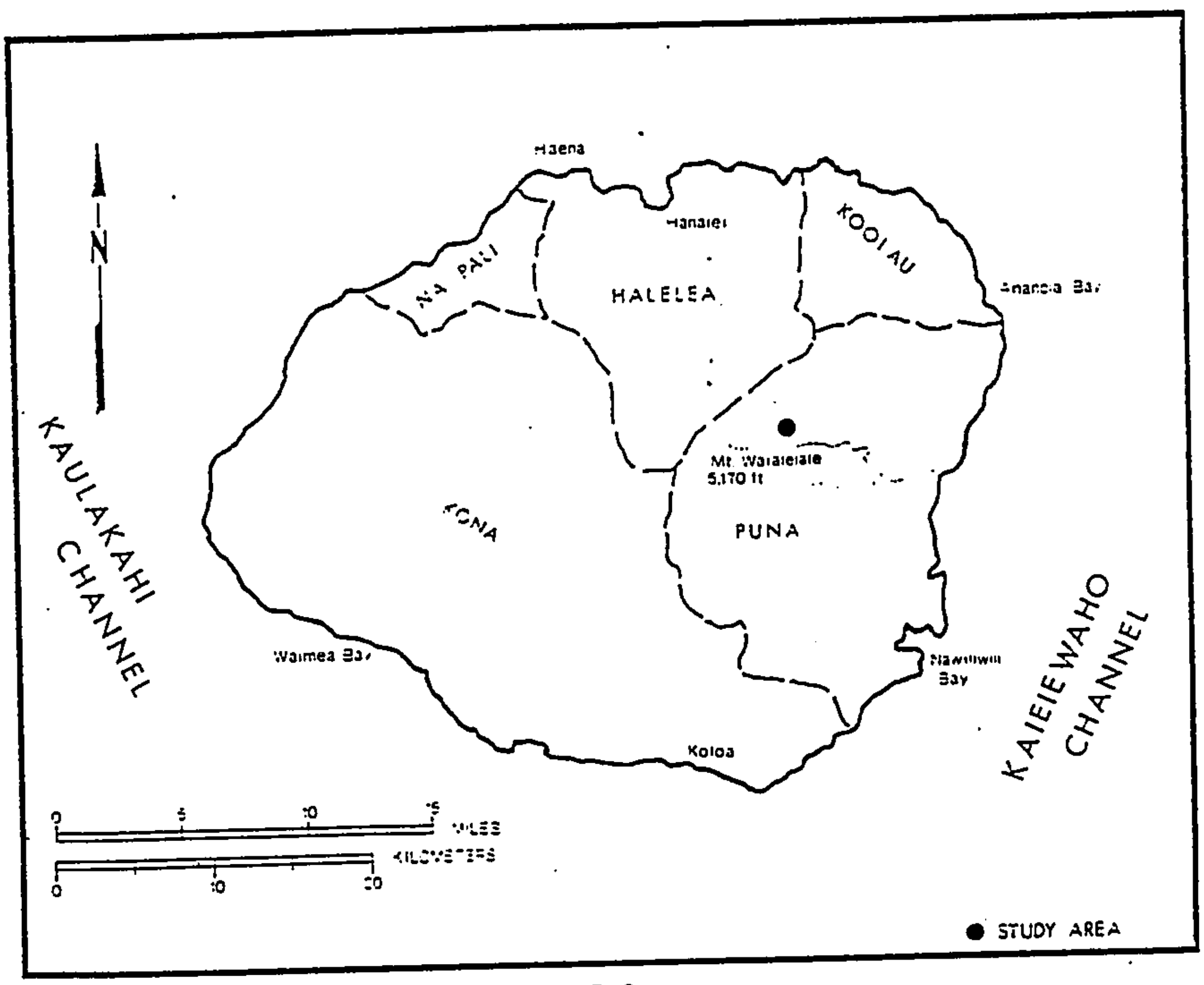

FIGURE 2
General Location Map, Kaua'i Island

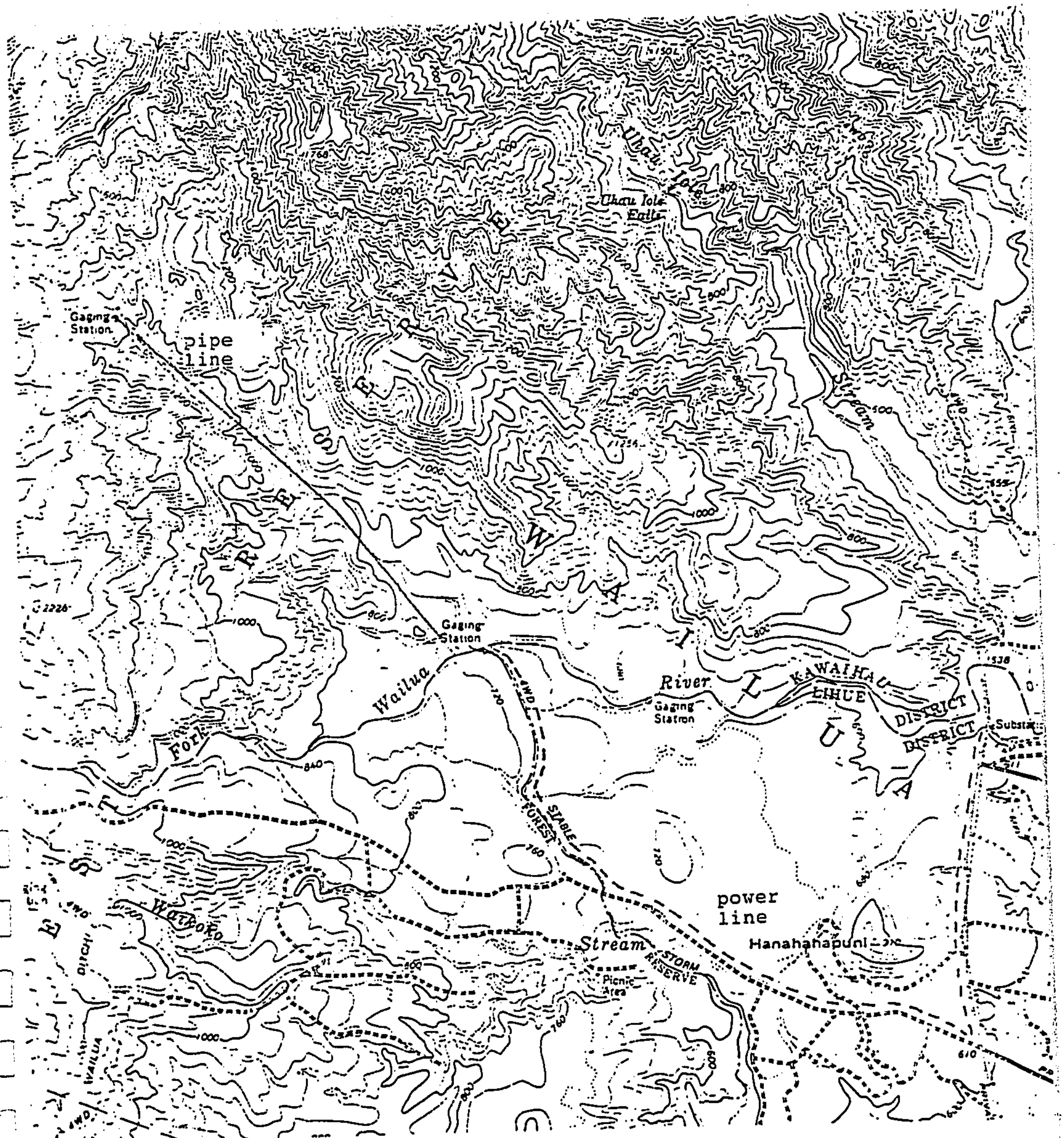

Figure 3 U.S.G.S. Map Waiakeale Quad 1983, Showing Project Area

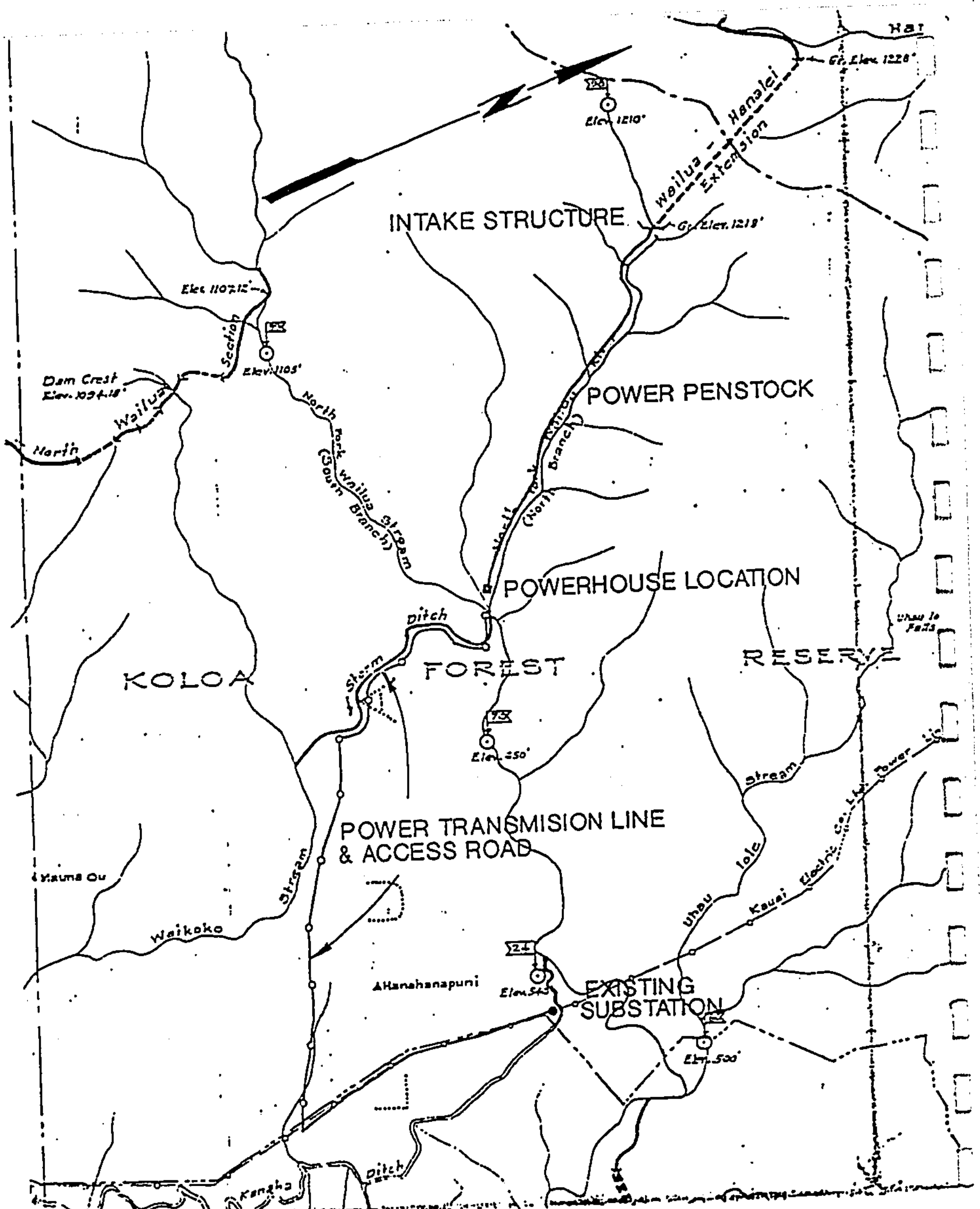

Figure 4 1939 Drainage map of Upper Wailua Showing Project Location proposed pipeline route was along a mountain trail which leads from the south branch along the ridge line to the tunnel outlet.

The second day of fieldwork consisted of an on-the-ground examination of the proposed powerhouse location at the confluence of the south and north branches of the Wailua River at the makai end of the proposed pipeline route. In addition, the route of the planned power transmission line and access road was surveyed. The powerline route runs along existing access and cane haul roads around the ancient cinder cone of Hanahanapuni to an existing substation above the north fork of the Wailua River.

The field work was followed by historical research and report preparation which included a search of historic documents, maps, and previous archaeological reports.

II. HISTORICAL AND ARCHAEOLOGICAL BACKGROUND

A. Natural Setting

The project area is located within the ahupua'a of Wailua. The Wailua River and its many tributaries drain the major portion of the large semi-circular depression known as the Līhu'e Basin. This large depression is between 7 and 10 miles across and is bordered on three sides by high mountain ridges. The basin is actually a collapsed caldera formed within the Waimea Canyon Volcanic Series. The floor of the caldera was covered by the later Kōloa lavas. Remnants of the Kōloa Series vents survive as hills in the alluvial plains - Kilohana and Hanahanapuni (McDonald and Abbott, 1970).

The Wailua River is the largest and geologically most mature in the state. The upper part of the drainage system is divided into the north and south forks. The north fork originates at the base of Waialeale and is fed by tributaries flowing southward from the Makaleha Ridge which separates the Hanalei and Wailua drainages. The major tributaries of the north fork are Kalama, Kāwī, Keāhua, Uhau'iole Streams. The stream valley which includes the proposed pipeline route is the western most of the tributaries. On maps there is no Hawaiian name for this stream and it is referred to as the north branch of the north fork of the Wailua River.

B. Historic Background

Wailua Ahupua'a is located in the district of Puna between

Hanamā'ulu to the south and Olohena and Hanalei to the north. The name Wailua is generally considered to refer to the 2 main forks of the Wailua River (<u>wai</u> = water, <u>lua</u> = two). However, if the name is translated as one word is means spirit, ghost, remains of the dead (Pukui and Elbert, 1971). This meaning would be more appropriate to the traditionally sacred nature of the place.

The area along the river mouth between the confluence of the north and south Forks and the Pacific Ocean was known as Wailua-nuiho'ānu or "great sacred Wailua" and was <u>kapu</u>, forbidden to all but <u>ali'i</u> (Dickey, 1916). Wailua is therefore comparable to similarly sacred localities on other islands, such as Waipio, Kahalu'u, and Holualoa on the Big Island or Kualoa on O'ahu. All of these places were used for training of young chiefs and residence for ruling <u>ali'i</u>. From legendary through historic times Wailua was a residence of great chiefs such as Moikeha Monokalani pō, Palila and Kaumualii (Salisbury, 1936). The importance of Wailuanuiho'ānu is underlined by the presence of eight major <u>heiau</u>.

There are virtually no substantial written accounts of descriptions of Wailua. This, in part, can be traced to the fact that no Protestant mission station was established in or close to the area, a condition that has benefited the reconstruction of history in other locales through the use of journals, diaries, letters, etc.

C. Land Court Awards

A check of land awards as a result of the Great Mahele (1848) shows only a total of approximately 75 acres of Wailua awarded to 25 individuals, among the D. Kapule and Iosia Kaumuali'i, wife and son of Kaumuala'i, the last chief of Kaua'i. None of these awards were near the present study area. The rest of this large ahupua'a was kept as Crown Lands or the private lands of Kamehameha III (Kauikeaouli), another testament of the importance and value of the area at that time.

D. Previous Archaeological Studies

Handy, in 1935, studied the ahupua'a as an agricultural area. He found extensive agricultural terracing along the lower two miles of the river. However, by 1935 little of the original Hawaiian agricultural staples were being cultivated. Most of the terraces, once in taro, were given over to rice by Chinese farmers along with some limited areas in sweet potato and pasture (Handy, 1940).

Handy described the agricultural terraces of the upper north and south forks of the Wailua River as follows:

> There are terraces in the canyon of the north Fork of the Wailua River; presumably there are terraces also in the flatlands along Kawi, Keahua and Iole Streams which form the head waters of this fork of the river above the junction with the north fork. Extensive areas of terraces fill the valley immediately above Wailua Falls and along the river for 3 miles above Waikoko. Iliiliula, Waiaka, Waiahi, Kaulu, Palikea and Halii Streams undoubtedly all had small terraces along their lower courses. (Handy 1940:67-68).

The archaeological implications of handy's comments are that flat lands along both forks of the Wailua River and presumably many of the headwater tributaries were developed into irrigated taro terraces or loi and that the Wailua River valley was a major taro-growing area of Kaua'i. However, Bennett (1931) makes no mention of these terraces in his island-wide survey of major sites, although he recorded heiau near the mouth of the valley. This lack of mention is worthy of note, considering that he explored other valleys, such as hanalei and noted taro terraces and house sites far back in the valleys (Bennett, 1931).

There are two previous studies which over portions of the River banks mauka of Wailuanuiho'ānu (great Sacred Wailua). Ching conducted a survey covering the north and south forks of the river from Koholālele Falls and Waiehu (Wailua Falls) to the confluence of the north and south forks (Ching, 1968). Four archaeological sites were recorded including taro terraces (lo'i), and irrigation ditches (auwai) along the alluvial flats. This area is still far downstream from the present project area.

In 1981 Ching conducted another survey for the Wailua River Hydropower study for the Army Corps of Engineers (Ching, 1981). Nine separate areas were surveyed mostly along the south fork of the Wailua River and lo'i, terrace complexes, auwai, and a rice mill were recorded in three of these areas. Of greatest interest to the present study was the survey of the mauka most area (Area I) which includes the portion of the proposed transmission line paralleling the Stable Storm Ditch. The description of this area is as follows:

> Area I is the most mauka of the study areas and contains a man made ditch that collects water from the north fork of Wailua River and delivers it to the Hanamā'ulu ditch intake on the south fork via Waikoko Stream. A gaging station access road runs along the northeast side of this ditch (except the southernmost 2,000 to 3,000 feet) providing access to the study area.
>
> No evidence of cultural remains was found in Area I aside from the ditch, gaging station and road, two (2) stands of 'ohe (probably Melocanna baccifera), two (2) large stands of palepiwa Eucalyptus spp.) or Melaleuca leucadendra (paper bark) of the family Myrtaceae. These stands are located on the north side of the downstream end of the ditch and on the south side of the upstream end near the gaging station. They are planted in straight rows, probably by forestry personnel experimenting with various introduced trees for industry. The 'ohe noted above is located near the gaging station at the north end of the area and is of the Hawaiian variety in that nodes are about 18 inches apart and the walls of the stalk, thin. This is the type of 'ohe used in making pū'ili (bamboo rattle) and 'ohehanoihu (nose flute) (Ching 1981:33).

The recommendations concerning this area were for no further archaeological investigation, considering the modern modifications of the landscape. The closest archaeological sites to the present project area were located by Ching along the south Fork of the River below the Hanamā'ulu Ditch. Here were a few surviving terraces in disturbed condition (Ching 1981:5)

E. Historic Maps

All the historic map sources available in the State Survey Office were checked for information relevant to the study area (Personnel Communication, Mr. Charles Okino). The results are summarized as follows in chronological order:

The Webster and Metcalf 1846 Map (Reg. No. 145) shows the heiau at the junction of the north and south forks of the Wailua River, but does not extend mauka to the project area.

The Monsarrat map of Līhu'e Plantation dated to 1900 (Reg. No. 2141) shows the north fork of the Wailua River up to the Konaha Ditch intake. The map notes 6 acres of rice at a flood plain meander with a trail leading up the west side of the river. This area is near the existing substation, at the end of the proposed transmission line. The substation is on a ridge above the river and is not on the flood plain where the terraces would be located, if they indeed survive today.

The R.B. Marshall U.S.G.S. 1910-1916 map does have coverage of the project area, but shows no roads, houses or settlements of any kind for the north fork of the Wailua River above the Kanaha Ditch intake.

It is of interest to note that the Hanalei Wailua Water Tunnel does not seem to appear on this map, bud does appear on the 1939 map. This would date the construction of the Tunnel and improvement of the trail leading to the Tunnel to the late 1920's or the 1930's.

The W.E. Wall Map of 1923 (Reg. No. 2698) extends mauka only to the forest reserve and does not show the present project area. The map does show Land Court Awards below and slightly above the junction of the north and south forks of the Wailua River.

The 1939 Map (CSF 7106-A) labelled "License - Waters in the drainage basins of north Wailua and Kapa'a Rivers and the Drainage basins of the Hanalei River" is shown as Fig. 4. This map shows no settlement in the project area, but does not show the Hanalei-Wailua Tunnel and the Stable Storm Ditch connecting the north fork of the Wailua River to Waikoko Stream.

III. RECONNAISSANCE RESULTS

A. Description of the Project Area

The survey area consists of two segments. The main section is the approximately 8,000 foot-long segment of the north branch of the north fork of the Wailua River, running from the outlet of the Hanalei-Wailua Tunnel to the confluence of the north fork of the Wailua River. The proposed pipeline route is along the west bank of the stream bed.

The upper reaches of the stream valley consist of steep bedrock slopes and cliffs with high gradient tributaries,joining a fairly straight stream course. Vegetation is an extremely thick mix of native and exotic species of trees, shrubs, and grasses with steep slopes covered with uluhe fern. Hawaiian cultigens such as ti, banana and wild taro occur intermittently along the stream banks. The only reasonable access for the survey was along the stream banks and in the stream bed itself.

At approximately 900 feet elevation, a major tributary enters on the northeast side of the stream and 1,000 feet below this the valley broadens to include flat alluvial meander bars on both sides of the stream. The largest of these alluvial flats is located on the southwest side of the stream directly above the confluence with the north fork. Here, a small tributary enters from the west at the upper end of the flat. All of these alluvial bars are covered with dense growth of California grass with intermittent areas of Guava forest along the edges.

B. Survey Results

One day was spent surveying the 8,000 foot-long proposed pipeline route. Clearly, the survey was hampered by difficult access to the areas above the stream bank and the lack of visibility due to dense vegetation. However, the author was able to locate archaeological remains in a previous survey of upper Hanalei Valley under similar conditions of terrain and vegetation (Hammatt and Borthwick, 1986). For comparative purposes no archaeological remains were located in Hanalei Valley where the valley was as steep sided as the upper reaches of the present project area and it is the opinion of the author that this area would have been unsuitable for traditional irrigated agriculture. The occurrence of ti, banana and wild taro in isolated patches would indicate some Hawaiian planting in former times.

The most likely area for archaeological sites along the proposed pipeline route is on the flat lands at the confluence of the project area stream with the north fork of the Wailua River. This area was surveyed thoroughly on the second day of fieldwork for this reason and also because it is the location of the proposed powerhouse.

The unforested portions of the alluvial flats were covered with extremely thick California grass. The surveyors walked on top of the grass which mantled the ground to a thickness of 2-3 feet. Stone or earthen terraces would have been impossible to see or even feel under these conditions. However, the edges of the flat area were forested and the bare ground was visible. No terraces or archaeological remains were observed. It was thought that the most obvious place for a water source and irrigation ditch for the large alluvial flat would have been upstream along the small tributary entering the north fork a few hundred feet west of the main confluence (See Fig. 3). The tributary was followed upstream to the mauka end of the alluvial flat where the ground was searched carefully to find traces of an auwai and terracing. However, no signs of former human modification were found.

The entire length of the proposed powerline route is within 100 feet or less of existing roads and there are two sections which are not in cane cultivation. The first section runs from the north fork confluence along the edge of a road parallelling the Stable Storm Ditch through Eucalyptus forest. This area appears to have been previously bulldozed before planting. The other section runs north through hau forest paralleling a cane haul road on the east side of the Hanahanapuni. This hau forested section was surveyed and no archaeological remains were found.

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IV. SUMMARY

The results of this reconnaissance survey show that the 8,000-foot length of the north branch of the north fork of the Wailua River was not modified by ancient or historic Hawaiians for settlement or traditional agriculture. this consludison appears surprising for the following reasons:

1. The confluence area at the base of the proposed pipeline route is definetly suitable for development of irrigated agriculture, considering the availability of flat land and water source;
2. Similar areas in Hanalei Valley and other valleys were developed by ancient Hawaiians (see Hammatt & Borthwick, 1986);
3. The Wailua Ahupua'a was definitely of great political importance in ancient Hawaii, as evidenced by heiau and other sites in the makai areas of the river valley. It would appear that the upper reaches would be developed accordingly for wetland agriculture and procurement of forest resources for the high status communities in the makai areas (bird feathers, wood for canoes, medicinal plants, etc.).

However, on present evidence, it appears that the stream valley in the project was not agriculturally developed and its almost certain use for procurement of forest resources apparently let no tangible archaeological evidence.

Recommendations

This reconnaissance survey has found no archaeological remains within the present survey area, including both the pipeline route along the stream valley, as well as the proposed transmission line. No further archaeological investigation is recommended for the powerline route or the upper portion of the pipeline route. However, in view of some historical evidence (Handy, 1940), as well as surveys of comparable areas on Kaua'i, (Hammatt and Borthwick, 1986), it is still possible that the remains of ancient terraces may be hidden under the dense grass covered areas by the proposed powerhouse location in spite of the present efforts to find them.

To accommodate this measure of doubt, it is recommended that an archaeologist be present during vegetation clearing at the powerhouse locality before construction. If ancient terraces are present they can be found and mapped. If they are not present, this fact can be definitely confirmed.

V. REFERENCES CITED

Armstrong, Warwick, Ed.
1973 Atlas of Hawaii. U.H. Press, Honolulu.

Bennett, Wendell C.
1931 The Archaeology of Kaua'i. Bishop Museum Bulletin 80, Honolulu.

Ching, Francis K.W.
1968 Archaeological Surface Survey; Wailua State Park, Kaua'i. State of Hawaii, Dept. of Land and Natural Resources, Honolulu.

Ching, Francis K.W.
1981 A Cultural Resources Reconnaissance for the Wailua River Hydro Power Study, Archaeological Research Center Hawaii, Inc., ARCH 14-79, Honolulu.

Dickey, L.A.
1917 Stones of Wailua, Kaua'i. Hawaiian Historical Society, 25th Annual Report, Archaeological Research Center Hawaii, Inc., Honolulu.

Hammatt, H.H. and D. Borthwick
1986 Archaeological Reconnaissance of Upper Hanalei Valley, Halele'a Kaua'i, Cultural Surveys Hawaii.

Hammatt, H.H., D. Borthwick and D. Shideler
1986 Archaeological and Biological Survey of the Proposed Kīahuna Golf Village Area, Kōloa, Kaua'i Island, Unpublished Ms., Archaeological Research Center Hawaii, Inc., Lāwa'i.

Handy, C.
1940 The Hawaiian Planter. Volume 1, Bishop Museum, Bulletin No. 161., Honolulu.

Handy, E.S., and Elizabeth G. Handy
1972 Native Planters of Hawaii, Bishop Museum Press, Honolulu.

MacDonald, G.A. and Abbott, A.T.
1970 Volcanoes in the Sea. University of Hawaii Press, Honolulu.

Marshall, R.B.
1910 Topographic Map of the Island of Kaua'i. Survey by U.S. Geological Survey in Cooperation with Territory of Hawaii. U.S. Department of Interior Geologic Survey, Washington, D.C.

Metcalf, T.
1946 Map. State Survey Office, Reg. No. 145, Honolulu.

Monsarrat, M.D.
1900 Map of the Līhu'e Plantation (Northern Portion). Hawaii Territorial Survey, Reg. No. 2141, State Survey Office, Honolulu.

Office of the Commissioner of Public Works
1929 Indices of Awards, Made by the Board of Commissioners to Quiet land Title in the Hawaiian Islands. Honolulu Star Bulletin, Honolulu.

Pukui, Mary K. and Samuel H. Elbert
1981 Hawaiian Dictionary. University of Hawaii Press, Honolulu.

Pukui, Mary K., Samuel H. Elbert and Esther Mookini
1974 Place Names of Hawaii. University of Hawaii Press, Honolulu.

Salisbury, M.
1936 "Wailua, Valley of Kaua'i Kings and Priests; Rich in Splendor." Honolulu Star Bulletin, September 5, 1936, Archaeological Research Center Hawaii, Honolulu.

Wall, W.E.
1923 Map: Wailua Rice and Kula Lots, Wailua, Puna, Kaua'i. Hawaii Territorial Survey, State Survey Division, Dept of Accounting and General Services, Reg. No. 2698, Honolulu.

VI. PHOTOGRAPHIC APPENDIX

Figure 5 Upper Portion of Project Area, Stream View Upstream

Figure 6 Upper Portion of the Project Area, Stream View Downstream

Figure 7 Mid Portion of Project Area Stream, Showing Uluhe Covered Slopes, View Downstream

Figure 8 Mid portion of Project Area, Stream Showing wild Bananas above Stream, View Downstream

Figure 9 Confluence of North and South Branches of the Wailua River, View Upstream

Figure 10 Forested Land at Confluence Area of Proposed Powerhouse Location, View to East

Figure 11 Level Land Covered with California Grass at Pro- posed Powerhouse Location, View Southwest

Figure 12 Road and Stable Storm Ditch, Showing Eucalyptus Forest along Proposed Powerline Route, View Northeast

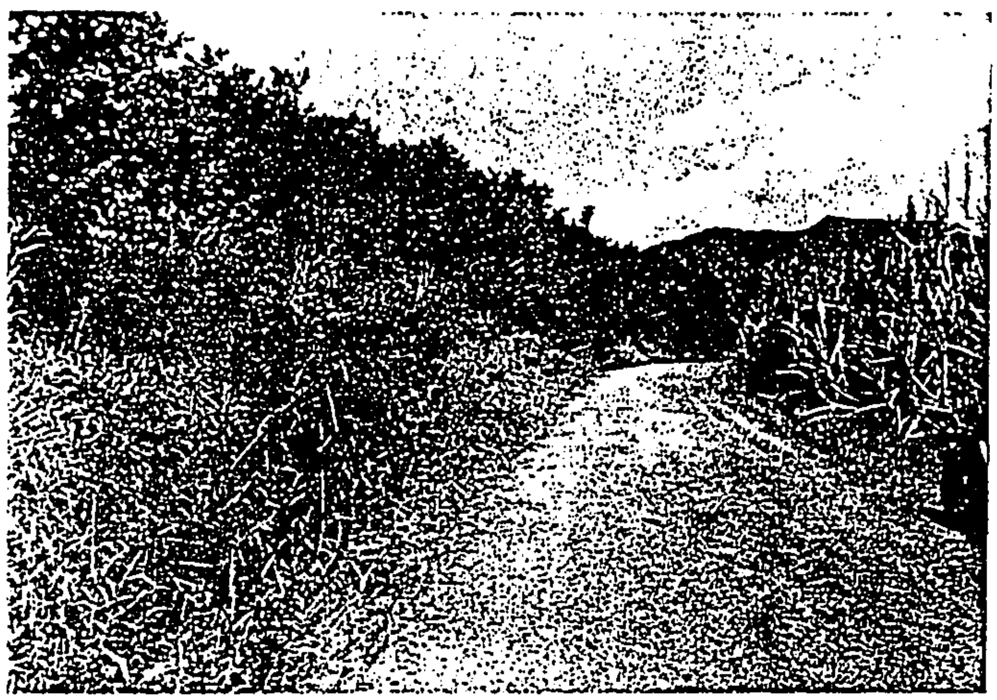

Figure 13 Hau Forest along proposed Powerline Route, View to East

Figure 14 Proposed Powerline Route from Existing Substation, View to South

APPENDIX D

COMMENTS AND RESPONSES TO
DRAFT ENVIRONMENTAL IMPACT
STATEMENT

APPENDIX D
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CORRECTION

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

APPENDIX D

COMMENTS AND RESPONSES TO DRAFT ENVIRONMENTAL IMPACT STATEMENT

APPENDIX D
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DOCUMENT #1

12/22/87

State of Hawaii
Department of Land and Natural Resources
DIVISION OF AQUATIC RESOURCES

DATE: December 23, 1988

MEMORANDUM

TO: Paul Kawamoto, Program Manager, Aquatic Resources & Environmental Protection
THROUGH: Eric Onizuka, Program Manager, Recreational Fisheries
FROM: Don Heacock, Kauai District Aquatic Biologist
SUBJECT: Comments on X 1. Draft EIS for Conservation District Use Application KA-2155
___ 2.

Comment Requested by Roger Evans, Office of Conservation and Environmental Affairs — Date of Request 11/30/88 — Date Rec'd 11/30/88

Summary of Proposed Project

Title: Upper Wailua Hydroelectric Project

Project by: Island Power Company

Location: Wailua, Kauai

General Comments:

1 Our primary concern involves the protection and enhancement of native Hawaiian stream fauna, particularly the native fishes and shrimp found in relative abundance in the Hanalei River, from which the water is being diverted. It can be argued that the Hanalei River water is already being diverted for sugar production, therefore, there is no need for mitigative measures such as requiring a constant bypass flow over the weir. However, the future of sugar production is tenuous, while in contrast, the approval of a hydropower facility will require a long-term commitment of the water resource, and the biota.

1 It is possible that Lihue Plantation will reduce sugar production in the future but it is unlikely that they will eliminate it entirely. It is probable that Lihue will diversify its agricultural operations in response to changing markets. Diversified agriculture and reduced sugar cultivation will require continuing diversions of Hanalei River water and ongoing maintenance of the Hanalei and Kaapoka tunnels.

Island Power Company has proposed to Lihue Plantation that as part of the hydroelectric project it construct a weir at the Hanalei Tunnel intake incorporating a fish bypass channel which would provide a constant bypass flow over the weir as suggested by the Division of Aquatic Resources. Island Power is presently negotiating a water use agreement with Lihue Plantation pertaining to water flowing through the Hanalei Tunnel, and provision for the proposed fish bypass channel is a subject of these negotiations. It is not known at the present time if Lihue Plantation will be willing to accept the concept of a fixed, minimum fish bypass.

The Upper Wailua project, as proposed, will not alter historic diversion practices which have been in effect since the completion of the Hanalei and Kaapoka tunnels in the 1920s. The project will not affect the water rights which Lihue Plantation has by virtue of its lease with the State. If Lihue's lease or water rights were to change in the future (by operation of law, abandonment, or other circumstances), Island Power Company would be pleased to cooperate with appropriate State agencies to implement measures to protect and enhance fish habitat. The specific actions to be taken should be 'reasonable', which is to say they should be based on scientific criteria and site-specific analysis performed by qualified experts.

2 We are also concerned about protecting the smallmouth bass fishery in Maheo Stream, since the stream is one of few that has good public access (i.e., on State land with maintained dirt road).

3 Generally, our previous comments (memo of June 9, 1988, p. 185 of EIS) remain applicable. However a few specific comments are needed.

Specific Comments:

4 Hanalei River: Mitigative measures in the Hanalei River should include, in addition to the proposed fish-screen, a "deflecting wing" to prohibit the entrainment of 'opae kalaole larvae from the Hanalei River, into the tunnel, and ultimately into the hydropower turbines or the Wailua River where the larvae have much less chance of survival. The applicant states (p. 141) that the major area of mitigation for the aquatic biota will be to prevent downstream entrainment. The applicant claims that 'opae larvae will not be affected by passage through the turbines, therefore they do not intend to screen larvae out of the tunnel (p. 127) because they are very small (1-2 mm). However, our point of contention is that 'opae larvae would have a much lower survival rate in the degraded Wailua River as compared to the relatively pristine Hanalei River. A deflecting wing can prevent larvae from entrainment (and remain in the Hanalei River system).

2 The project is not likely to have an adverse effect on the bass fishery. This issue is discussed in detail in the response to comments 6, 7 and 8 in this Document.

3 No comment.

4 A revised design concept is proposed for the fish screen/diversion on the Hanalei River (see Figure 13-1). This over-the-spillway fish screen (trade name is Aqua Shear, also known as the Johnson wedge-wire screen), will prevent diversion of opae larvae without need for a deflecting wing. If, for any reason, it is necessary to return to the originally proposed fish screen concept, the developer is committed to providing a deflecting wing or similar feature, if an effective, economical configuration can be identified and agreed to by fisheries technical experts.

The Aqua Shear Screen, manufactured by Aquadyne, Inc., operates with a combination of flow shear and the Coanda effect to separate particulates from water with very high efficiency and little or no maintenance (Strong and Ott, 1988). Constructed of stainless steel wedgewire and standard slot openings of 1 mm, the screen will separate 90% of solids larger than 0.5 mm and everything greater than 1 mm, and will work at all flows.

In operation, water will pass over the crest of the diversion weir, flow through the screen slots, and enter a collection chamber for conveyance to the Wailua River watershed (Figure 13-1). Particulate matter, including any aquatic organisms, will be separated from the diverted water and deposited into a trough running laterally to the weir at the base of the screen. Water that originates from a notch cut in the top of the weir next to the screen will be flowing through the trough to carry screened material below the diversion. O'opu or opae moving upstream can reverse this path (which will be roughened with embedded stones) back up the base of the weir, through the trough, and up the side of the screen to the pool above the weir.

This screen design will provide complete protection for large o'opu migrating downstream to spawn by not having any openings larger than 1 mm, plus being smooth and non-abrasive. Fish passing over the weir and past the screen will be collected in the trough and carried safely downstream. Opae larvae, which are about 2 mm in size, will also follow this route and be excluded from possible diversion to the power facility and the Wailua River.

The revised fish screen design concept (see Figure 13-1) satisfies the environmental concerns expressed. The major environmental advantages are that the Aqua Shear screen is self-cleaning and excludes even larvae from diversion. The key to making the concept work environmentally is to provide a fish trough below the screen to collect the excluded biota and to provide sufficient water in the trough to keep them alive and to conduct them to the Hanalei River downstream. These features will be included if this concept is implemented.

If it is necessary to return to the original fish screen design concept, it will be of mesh size 0.25 inches and a maximum approach velocity of 0.5 feet per second (measured immediately in front of the screen). Mechanical cleaning would not be provided. The design would be refined to enhance the "self-cleaning" characteristics of the screen by slanting the screen and providing a continuous flow of water down its face (top to bottom) during low to moderate flows. This flow will dislodge small debris from the screen surface. Large debris will be held away from the screen surface by the trashrack. During high flows the flushing flow down the face of the screen will increase substantially and carry debris over the dam and down the river.

COMMENT LETTERS TO DEIS

5 Also, the applicant appears to completely reject an earlier mitigative recommendation to allow a small, continuous, release of water over the existing Hanalei River diversion weir in order to promote the upstream migration of native fishes. Although a small "notch" created in the existing weir would supply a little less water to the hydropower facility at times, the environmental benefits gained may outweigh the small costs in the loss of power. In fact, as a mitigative effort, it may never be necessary to "notch" the weir per se; rather, it may be more appropriate to simply include a one-inch diameter pipe and gravity siphon water over the weir to assist the upstream migration of fishes which need to climb over the weir's "fish ladder" (i.e., small boulders cemented into the right side of the weir looking upstream). These mitigative actions (i.e., diversion wing and constant, yet relatively small, bypass flow) would significantly help the native 'o'opu and 'opae populations, and would probably have virtually no impact on total power output.

6 Maheo Stream: It appears that neither the applicant, nor consultants, surveyed the middle reaches of this stream (p. 56, 3rd para.). Maheo Stream is often referred to as "bass creek", and along its middle reaches, offers some of the best smallmouth bass fishing on Kauai, particularly since it is on public (State) land that has a well-maintained dirt road for access. Hence the applicant's statements as to smallmouth bass being either rare or uncommon (p. 62) are not correct.

RESPONSES TO COMMENTS

5 The applicant recognizes the desire, by natural resource agencies, to obtain a flow bypass at the Hanalei Diversion for enhancement of the Hanalei River fishery resource. This, however, is a water-rights issue of vital interest to Lihue Plantation and they have stated that no agreement or precedent which compromises this water right will be accepted. The applicant cannot offer nor make a binding commitment to any bypass flow that is unacceptable to Lihue Plantation.

A "fish ladder" of exposed rocks and pockets will be provided to promote/facilitate the upstream migration of native fish while still providing an adequate barrier to non-native species. Even without a routine bypass flow, such an improved fish passageway will enhance the resource.

The revised over-the-spillway (Aqua Shear) fish screen design shown in Figure 13-1 requires a very small by-pass flow to keep water in the fish trough. This has been indicated in the drawing in the form of a notch weir as requested by the Division of Aquatic Resources. The applicant is hopeful that this design can be accepted by both Lihue Plantation and the resource agencies without the necessity of formally defining the by-pass flow and causing a precedent-setting compromise of water rights. There are substantial advantages to this design for all parties, even though it will be more expensive than the alternative design concept.

6 Additional surveys on the abundance and distribution of smallmouth bass in Maheo Stream were conducted at a flow near 8 cfs over the entire length of stream to be affected by the project. Sampling methods included visual observation from streambanks, hook-and-line, and direct underwater observation with mask and snorkel. All pools with depths greater than 4 feet were recorded, along with habitat types where fish were sampled or sighted. Within the 6800 feet of stream below an impassable falls, there were 20 de p pools capable of containing adult smallmouth bass (greater than 20 cm). The number of large bass in these pools was estimated to average about 10, giving a total population estimate of approximately 200 adult fish in the reach. Juvenile bass abundance could not be determined, even when electroshock sampling was attempted, but they are estimated from observations to be about three times as numerous as the adults.

Access to the stream from the road at the lower end required hiking predominantly within the channel over rocky substrate and only occasionally along the banks. Fifteen bass were actually caught that averaged 24 cm in length, with the largest at 31 cm. This level of success means that a single fisherman is capable of harvesting 10 percent or more of the entire adult bass population in one day. While the access conditions will limit utilization of the resource to robust fishermen wearing good footgear, the low abundance of large fish and the ease of capture will soon require either strict harvest limits or catch-and-release regulations if the populations are to be maintained. Providing better access to fishermen will quickly result in the depletion of adult bass and the elimination of the fishery.

7 Also, the applicant states (p. 122) that the reversion of Maheo Stream to its original flow (i.e., minus 26 cfs that is diverted from the Hanalei River) is expected to have no negative effects on existing aquatic habitat and may result in an improvement, based on the existing pattern of species distribution and abundance. If the middle reaches were not surveyed there is no data on species distribution and abundance on which to base such a statement. Furthermore, Maheo Stream, as compared to other Wailua River tributaries of similar size located nearby, has a much larger bass population with the only apparent difference being that Maheo Stream has a much greater flow, due to input of the diverted water from the Hanalei River.

8 Additionally, p. 127 is full of suppositions; again, it is important to point out that the applicant did not survey the middle reaches of Maheo Stream. The statement that "the addition of 26 cfs from the Hanalei tunnel increases water velocity and turbulence without increasing wetted area because of the steep sidewalls of Maheo Stream" applies only to an area about 1,000 feet below the confluence of the tunnel water and the stream, and does not apply to the middle reaches of the stream. Similarly, it states that lowering the average depths and velocities of Maheo Stream downstream (of the hydropower intake) by reducing the flow (i.e., bypassing 26 cfs) will probably benefit alien species such as swordtails and platys which are the prey base for the smallmouth bass.

9 It is important to realize that most animal populations are limited by the availability of food and habitat. Similarly, smallmouth bass production along the middle reaches of Maheo Stream is a function of the availability of abundant food and good habitat. 'Opae are a major food item in the diet of smallmouth bass in Maheo Stream (swordtails and platys may play an insignificant role in the diet). Hence, it is believed that 'opae are abnormally abundant in this Stream due to the significant influx (26 cfs) of water and suspended food particles from the Hanalei River. Reverting Maheo Stream back to its original flow could cause a reduction in the smallmouth bass population, and a decrease in the quality of fishing.

10 Also, there appears to have been no attempt made to estimate the "socioeconomic value" of the existing smallmouth bass fishery (p. 99, 115) in this area. The proposed project could likely result in a significant loss of water and the smallmouth bass fishery in Maheo Stream. Therefore, an objective analysis of the societal "costs and benefits" appears tenuous at this time, due to lack of data.

Other Comments:

11 P. 8 – bypass flows over the existing Hanalei River weir (i.e., without a notch or gravity siphon installed) will occur only about 20% of the time.

7 8 9 In order to evaluate the potential effect on aquatic organisms and habitat of a reversion to natural flow in Maheo Stream, an instream flow study was conducted using the Instream Flow Incremental Methodology. Study site areas were selected with the assistance of DLNR/DAR and hydraulic data collected to calibrate computer models for physical habitat simulation. The entire affected reach of Maheo Stream (7600') was mapped on foot by habitat type in 100' intervals to assign weights to ten individual transects located in the middle portion of the reach. Habitat use criteria for opae were taken from data collected in similar habitat on Maui (TRPA, 1988), and smallmouth bass curves were acquired from publications of the U.S. Fish and Wildlife Service (juvenile, adult, and spawning; Edwards et al. 1983) and Pacific Gas & Electric Company (fry; Studley et al. 1986).

Results of this study confirm that aquatic habitat in Maheo Stream is relatively insensitive to flow alteration, that is, there are no strong peaks in habitat area that occur at particular flows. Total weighted usable area (the IFIM index to habitat suitability) for 'opae kalaole is at its highest level at flows between 5 and 10 cfs (Figure 2.2-2), which is the range of discharge that would be normally present in the stream under post-project conditions. The addition of 26 cfs from the Hanalei River diversion reduces habitat area for 'opae by about 20 percent. Smallmouth bass habitat area for fry, juvenile, and adult fish is also shown to be somewhat decreased at higher flows than at lower flows (Figure 2.2-2). Fry habitat is almost doubled under post-project conditions, while juvenile and adult habitat remain relatively the same, although they are also increased at flows in the post-project range of 10 cfs. Spawning habitat is shown to increase slowly as flow is increased up to the limits of the study.

The physical habitat simulation of the IFIM indicates that the flows added to Maheo Stream from the Hanalei diversion are generally detrimental to both native opae and introduced smallmouth bass. Removal of this water and reversion to natural conditions would act to increase habitat area, probably by lowering the high velocities created at higher flows. Data on wetted area from the instream flow study shows that Maheo Stream does have steep sidewalls that prevent water from expanding into a wider channel and increasing suitable habitat area (Figure 2.2-3). Discharges greater than average natural conditions provide very little increase in wetted area, so flow increases translate into higher depth and velocities to the point where the habitat becomes less suitable for existing aquatic species.

10 The length of stream containing bass, the estimated levels of populations, and the current ease of capture indicate that the bass fishery in Maheo Stream is very limited and fragile. One fisherman taking 10 fish per day could eliminate all large fish in less than a month. An estimate of existing fishing pressure from available evidence is that the stream presently supports no more than 6 to 10 man-days of fishing per year. Under maximum control of harvest, such as lures only, barbless hooks, and catch-and-release, the stream could potentially support no more than a few times this level of pressure before the fish would become extremely wary of anglers and cease to be susceptible to capture by any but the most skilled fishermen. Anything less than these restrictions would result in the rapid elimination of the bass. Under either the existing or maximum utilization of Maheo Stream, the fishery will remain a negligible component of freshwater fishing opportunities on Kauai.

11 This comment is referring to the fact that bypass flows over the existing Hanalei River weir at the Hanalei Tunnel intake occur only when the river is running high enough that the tunnel is full and spilling water from its turnouts. Island Power Company has proposed to Lihue Plantation that as part of the proposed hydroelectric project it reconstruct the weir to incorporate a fish bypass channel. Please see also the previous responses to the comment 5 in Document #1 and comment 17 in Document #8.

COMMENT LETTERS TO DEIS	RESPONSES TO COMMENTS
12 P. 9 - need a detailed description and diagram of the "deflecting wing" required to prohibit 'opae larvae in the Hanalei River from being entrained into the Wailua River system through the tunnel.	12 The proposed diversion structure and fish screen to protect aquatic organisms on the Hanalei River is discussed under responses to comments 4 and 5 in Document #1.
13 P. 13 and 18 - the "Irish stream crossing" placed on the north fork of the Wailua River will likely wash out on the first large winter rain since this river drains the wettest spot on earth - Mt. Waialeale.	13 The "Irish Crossing" concept was selected specifically because such crossings are designed to be overtopped by severe freshets without being washed out. Boulders stabilized by dental concrete will be used to cope with overtopping flows. Culverts for normal low flows will be placed on the stream bed at upstream and downstream ends so that fish passage will not be impeded. The streamflow regime will be essentially unaltered. The crossing will be constructed during low flows as a matter of practicality, thus erosion will be minimized. This design concept is applied successfully at other road/stream crossings in the Wailua watershed and design details will be borrowed from those applications for adequacy of erosion protection and economy of construction.
14 P. 121 - many of the figures (e. 4.2-3) have conflicting headings; for example this one shows flow frequencies for 20 years, yet the heading states 1960-1985 (which is 25 years!).	14 These corrections have been made.
15 P. 122 - USFWS did not recommend an IFIM study in Maheo Stream because native species are not abundant in this stream.	15 Agreed. The changes have been made in the Final EIS.
16 P. 130 - states that the project will have a slight impact on the recreational opportunities! Considering that the low flow of Maheo Stream will go from 34 t 8 cfs, the quality smallmouth bass fishing that exists today could be non-existent after the 26 cfs bypasses Maheo Stream.	16 It is felt that overall, considering the potential impacts to many recreational opportunities in the area including hiking, hunting, and fishing, the proposed project will have a slight impact on recreation as a whole in the area. Considering specific impacts to the smallmouth bass fishery in Maheo Stream, it is felt that post-project flows may enhance smallmouth bass habitat and increase the weighted usable area for the 'opae kalaole, the major food item. Increases in the prey base for smallmouth bass, may result in greater numbers of the smallmouth bass and small improvement in fishing opportunity. The proposed project is not expected to decrease public fishing access along Maheo Stream. However, increased access may quickly deplete the adult bass population.
17 P. B-1 (Fisheries Survey by TRPA) - is full of suppositions, and some incorrect information. For example:	17 No comment.

P. 1 - no water from the north fork of the Wailua River passes over 'Opaeka'a Falls;
18 these are two different tributaries.

P.2 - implies that smallmouth bass are not common in Maheo Stream (even though the middle reaches, which were not surveyed, have abundant bass resources). Also, it is likely that the abundances of 'opae kalaole was underestimated since a visual survey was conducted.
19 Surveys conducted by myself and Amadeo Timbol found that, because 'opae are often cryptic, the best estimates of 'opae abundance is made using electroshocking sampling methods.

DON HEACOCK

18 Agreed.

19 Results of a survey for smallmouth bass in Maheo Stream are presented in response to comment 6 of Document #1.

Electroshock sampling of Maheo Stream was conducted to estimate the abundance of opae and other species within a representative section of the affected reach. A sample site was selected with the assistance of DLNR/DAR, blocked at both ends with nets, and shocked with two backpack units using the three-pass removal depletion technique. Only 'opae were captured within the reach, which contained shallow pool, cascades, riffle, run-glide, and a small section of deep pool. A sub-sample of 100 opae was counted and measured to determine numbers per volume, and the remainder were counted by volumetric displacement. The length-frequency distribution of the sub-sample is presented in Figure 2.2-4. Population estimates made with the computer program CAPTURE (White et al. 1978) from a total of 696 opae generated a point estimate of 1025 opae and a 95 percent confidence interval of 881 to 1169. Measurement of the sample are (1853' sq.) and calculation of opae density resulted in an estimate of 1 opae per 1.8 square feet.

DOCUMENT #2

State of Hawaii
Department of Land and Natural Resources
COMMISSION ON WATER RESOURCE MANAGEMENT

December 27, 1988

MEMORANDUM

TO: Chairperson and Members
Commission on Water Resource Management

FROM: Manabu Tagomori, Deputy Director

SUBJECT: Public Hearing Summary - Island Power Co., Upper Wailua Hydroelectric Project at the Hanalei Tunnel Ditch and Maheo Stream, Wailua, Kauai

BACKGROUND

1 Island Power Company, Inc. proposes to divert irrigation water from the Hanalei Tunnel ditch by constructing a 5 feet high, 10 feet wide concrete diversion weir. The water will be conveyed through an 8,000-foot long, above-ground, 32-48" diameter penstock to a pelton turbine and generator to be located on the left bank of the Maheo Stream above its confluence with the North Fork of the Wailua River and above the existing Stable Storm Ditch Diversion. All water will be returned to the Maheo Stream through a tailrace structure.

2 The Upper Wailua Project would divert all flows from the existing Lihue Plantation-Hanalei Tunnel ditch outlet up to approximately 40 cfs--the maximum hydraulic capacity of project penstock. These flows are currently diverted from the Hanalei River drainage to the Wailua River drainage to supplement irrigation flows used in the Amfac-Lihue Plantation sugarcane operation. Since the project utilizes water already diverted from the Hanalei River drainage area, no naturally occurring flows on Wailua River will be affected. However, with the diversion in place, there would be less water available in Maheo Stream which normally carries the diverted water from the Hanalei Tunnel outlet to the North Fork of the Wailua River.

INSTREAM USES

3 A stream species survey of the Upper Wailua River by the applicant indicated the presence of three native species in the upper portion of the watershed. The survey sites and species list are shown in the attached map and table excerpted from the pending Conservation District Use application. The affected stream reach is highlighted on the map.

Responses:

1 No comment.

2 No comment.

3 No comment.

PETITIONS/PERMITS

4 The project will require an amendment to the interim instream flow standard for Kauai streams as well as a stream channel alteration permit and diversion works permit. A copy of the interim instream flow standard for Kauai streams is attached.

AGENCY REVIEW

5 The petition to amend the interim standard and application for a stream channel alteration permit were sent to the U.S. Corps of Engineers, U.S. Fish and Wildlife Service, County of Kauai Planning and Public Works departments, and the Department of Land and Natural Resource diversions. No comments have been received as yet.

ANALYSIS

6 Analysis for this project will be prepared after comments have been received from reviewing agencies. A draft Environmental Impact Statement is under review at this time and is being processed by the Department of Land and Natural Resources Office of Conservation and Environmental Affairs. The deadline for comments on the EIS is January 9, 1989. A Conservation District Use Application File No. KA-2155 is also pending.

MANABU TAGOMORI

SS:dh

4 The applicant has filed a petition to amend the Interim Instream Flow standard for the project and for a Stream Channel Alteration Permit and a Diversion Works Permit. These were filed in December of 1988 and have been forwarded to the appropriate agencies for their review. A public hearing on the Island of Kauai was held in January to discuss the permit applications.

5 No comment.

6 No comment.

COMMISSION ON WATER RESOURCE MANAGEMENT
Department of Land and Natural Resources

Ref. SCAP-KA-33
Suspense Date: Two Weeks

RECEIVED
'89 JAN 3 AM 8:04
DLNR
OCEA

December 28, 1988

MEMORANDUM

TO: Aquatic Resources
Forestry and Wildlife
State Parks/Historic Sites
Land Management
Office of Conservation & Environmental Affairs
Natural Area Reserve System

FROM: Manabu Tagomori, Deputy Director

SUBJECT: Request for Review and Comment on a Petition to Amend the Kauai Interim Instream Flow Standard, and an Application for Permit to Alter a Stream Channel for the Upper Wailua Hydroelectric Project at the Tunnel Ditch and Maheo Stream, Wailua, Kauai

7 Pursuant to the Department's Administrative Rule, Chapter 13-169, a permit is required for the above proposed stream channel alteration work. A petition to amend the interim instream flow standard for Kauai Streams has also been submitted. We would appreciate your review of the attached application. A copy of the interim instream flow standard for Kauai is attached.

If you have any questions or need additional information to complete your review, including a site visit, please don't hesitate to call us.

MANABU TAGOMORI

SS:ko
Attach.

7 No comment.

DOCUMENT #3

RECEIVED
DEC 19 1988

HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
KAUAI DISTRICT
P. O. BOX 1671
LIHUE, KAUAI, HAWAII 96766

IN REPLY REFER TO
A-3-348

December 16, 1988

MEMORANDUM

TO: ROGER EVANS, Administrator, O.C.E.A.

THRU: CALVIN H. S. LUM, D.V.M., Administrator, DOFAW

FROM: RALPH E. DAEHLER, District Forester, Kauai

SUBJECT: Draft EIS Upper Wailua River Hydroelectric Project CDUA - KA-2155

1 The E.I.S. gives a very thorough description of the project and has addressed concerns that we previously voiced. These include elimination of the earlier plan to retain the construction access route along the penstock as a permanent maintenance road. The burying of over 50% of the penstock should also relieve our earlier concern that the pipeline might block animal and people travel along its route.

2 Concerning revegetation work, we will recommend to the Board of Land and Natural Resources that one of the conditions of CDUA approval be that revegetation work to be accomplished must be coordinated with and approved by the Kauai District Division of Forestry and Wildlife.

Ralph E. Daehler
RALPH E. DAEHLER

cc: Herbert K. Apaka, Jr.
Dean Anderson, Bonneville Pacific Corp.

1 No comment.

2 Detailed revegetation plans will be developed with and approved by the Kauai District Division of Forestry and Wildlife prior to initiation of construction. The applicant will continue to work with the Regional Forester on the development of these plans.

DOCUMENT #4

JOHN WAIHEE
GOVERNOR OF HAWAII

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

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

LIBERT K. LANDGRAF
DEPUTY

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

FILE NO.: KA-8/9/88-2155
180-Day Exp. Date: 2/5/89
DOCUMENT NO.: 4810E

January 12, 1980

Board of Land and
Natural Resources
State of Hawaii
Honolulu, Hawaii

Gentlemen:

SUMMARY

REGARDING:	Conservation District Use Application for the Upper Wailua Hydroelectric Project at Wailua, Kauai
APPLICANT:	Island Power Company, Inc. P. O. Box 625 Kalaheo, Kauai, Hawaii 96741
AGENT:	Dean Anderson Bonneville Pacific Corporation 820 Mililani St., Suite 701 Honolulu, Hawaii 96813
LANDOWNER:	State of Hawaii
LOCATION/ TMKs:	Koloa Forest Reserve, Wailua, Kauai 3-9-01: 1, 2, 3; 3-9-02: 1; 4-2-1: 2

LOT SIZE/ 14,603.153 acres
USE: Approximately 32 acres

SUBZONE/s: Protective/Resource

DESCRIPTION OF AREA/CURRENT USE:

1 The Wailua River basin is on the eastern site 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

areas of 18.5 and 25 square miles, respectively, merge into the 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 second (cfs) to 89,000 cfs. Similar to typical Hawaiian rivers, the flows are highly variable. The median discharge is 36 cfs.

2 The project area bounds the steep, rugged terrain of the Upper Wailua Stream channel. The project will follow along the length of the Upper Wailua Stream down to the North Fork Wailua River.

3 The headwaters of the Wailua River lie in steep, heavily forested areas where native plant species are abundant. The dominant riparian vegetation along the 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.

4 Three native species of fish are found in the upper portions of the watershed. Opae Kala'ole (mountain shrimp) are the most numerous, particularly in the main tributary of the Upper Wailua above the Hanalei irrigation tunnel outlet. Four specimens of two goby species are present near the confluence of the Upper Wailua and the tunnel, three are identified as o'opu nakea (common goby) and one as o'opu nopili (Stimson's goby). Three introduced and no native species are present at the confluence of the Upper and North Fork Wailua: small mouth bass, green swordtail, and variable platyfish.

PROPOSED USE:

5 The applicant proposes to use water from the Wailua River, as well as land along the banks of the river, to build and operate a hydroelectric power plant. The electricity generated by the plant would be transmitted through an approximately three-mile long, above ground transmission line to an existing Kauai electric transmission line. The total land area required for this project is estimated at 32 acres.

1 No comment.

2 Upper Wailua Stream is referred to as Maheo Stream in the Draft and Final EIS.

3 No comment.

4 No comment.

5 Water used by the project will come from an existing irrigation diversion of Hanalei River water through the Hanalei Tunnel. Some of this water later flows through the Stable Storm Ditch into the Wailua River. No Wailua River water will be diverted.

6 The project would divert irrigation water from the Hanalei Tunnel Outlet with a concrete diversion weir, approximately 5 feet high and 30 feet wide, at an elevation of 1,210 feet above mean sea level (msl). The diverted water would be conveyed through an above ground pressure penstock (Exhibit 4) approximately 8,000 feet long with a diameter varying between 48 to 32 inches. The penstock would direct the water to a turbine within a building located on the bank of the North Fork Wailua River at the 710 feet (above msl) elevation level. The building would also contain the electrical generator and have the following approximate dimensions: 25 feet wide, 30 feet long, and 20 feet high. The water would be returned to the Wailua River immediately after exiting from the generating plant.

7 A 12 feet wide access road along the penstock route would be needed to provide long term maintenance for the diversion weir, the penstock and powerhouse. Routine cleaning of the trashracks and screens would be required. It may be necessary to protect the above ground penstock by coating it every 5 years with a coal-tar epoxy which could be applied with a brush or sprayer.

- 2 -

8 The project would cost $5 million to construct and would produce approximately 8 million kilowatt hours of electricity per year or about 3% of the total energy consumed on the island of Kauai. The project would supplant the need to import 2,000 barrels of oil annually and service an equivalent of 1,500 households (based on current rate of fuel oil utilization and household demand).

SUMMARY OF COMMENTS TO DATE:

9 The application was referred to the following agencies for their review and comment: the United States Fish and Wildlife Service, and Corps of Engineers; the County of Kauai Department of Planning, Department of Water, and Department of Public Works; the State Department of Health, the Office of Environmental Quality Control, the Environmental Council, the Office of Hawaiian Affairs, Office of State Planning, and the Department of Land and Natural Resources, Divisions of Aquatic Resources, Forestry and Wildlife, State Parks/Outdoor Recreation/Historic Sites, Land Management, Conservation and Resources Enforcement, Water and Land Development, and the Natural Area Reserves System. Their comments are as follows:

6 The powerhouse will be located on the west bank of Maheo Stream. Water will be returned to Maheo Stream.

7 Existing roads will be utilized to gain access across Lihue Plantation property to the Stable Storm Ditch. Construction of the project will require a new access road from the Stable Storm Ditch to the powerhouse. This is the only newly constructed road that will be maintained during project operation. Along the penstock, the access road will be revegetated to return to natural brush vegetation. Inspection and maintenance access will be by trail or helicopter. The access road will be recovered/reconstructed for vehicular traffic only in the case of a severe, unforeseen maintenance or repair need.

Where the access road crosses side gullies with permanent culverts as part of the penstock installation (see Figure 1.4-2), the gully crossings will be regularly inspected and maintained as necessary. However, the design is such that maintenance will be limited to cutting up and removing trees that cannot be accommodated by the culverts. Where gully road crossings do not involve the penstock, the culverts and fill will be removed and the sites restored. The diversion and intake structures and the penstock are being designed for minimum maintenance. Above-ground sections of the penstock will be routinely inspected, but initial painting will be specified for long life (Zinc-rich primer and epoxy urethane, life of up to 20 years).

8 No comment.

9 No comment.

County of Kauai, Planning Department

10 We have reviewed the subject application and have determined that the proposal is situated outside of the Special Management Area of the County of Kauai. As such, no SMA permit is required. We do, however, have the following comments to offer:

11 1. The proposed application does not make any reference to the hydroelectric project proposed at a location in the vicinity of the Wailua Falls. We are not sure if this project will replace the previous project located at the falls, known as the Wailua River Hydroelectric Project.

12 2. If the Wailua River Hydroelectric Project is scheduled for construction, we suggest that the subject application be reviewed in terms of its potential impacts to the scenic quality of the Wailua Falls, as well as impacts to the river environment.

Office of State Planning

13 In general, we support the exploration of alternative methods of energy generation that have the potential to reduce environmental and economic costs associated with petroleum-based electricity production. However, in this instance, there are several factors that should be considered before allowing the project to proceed in this particular location.

14 We note that the subject area experiences extremely heavy annual rainfall. Consideration should be given to the potential for increased erosion in this area as a result of grading for the proposed roadway. Increased siltation of streams and coastal waters may result, with potentially adverse impacts on coastal ecosystems.

10 We agree that a Special Management Area (SMA) permit is not required for the project.

11 The Upper Wailua project does not replace the Lower Wailua (Wailua Falls) project, but, in fact, utilizes some of the same flows at a point above their diversion to the Stable Storm Ditch. The Upper Wailua project utilizes flows diverted by Lihue Plantation for irrigation of their properties. The project picks up water diverted through the Hanalei Tunnel at the Tunnel outlet and returns them to the Maheo Stream above its confluence with the North Fork Wailua River directly above the Stable Storm Ditch Diversion. The Lower Wailua (Wailua Falls) project utilizes waters diverted from the Stable Storm Ditch. The Lower Wailua project is located on the South Fork Wailua River. Waters from the North Fork Wailua River are diverted to the South Fork Wailua River through the Stable Storm Ditch. This is a historic diversion and irrigation practice. These projects, in fact, enhance each other but do not replace each other. They also provide utilization of some of the same resources for the production of power.

12 The Wailua River Hydroelectric project was the subject of several Environmental Impact Statements, the latest of which was completed in 1986. The Environmental Impact Statement included a specific discussion about the scenic quality and potential impacts to Wailua Falls as well as impacts to the river environment. These have already been addressed in a document that has been approved and accepted by the state. The Upper Wailua project will not affect the flows available to the Lower Wailua project, or to Wailua Falls.

13 Alternative methods of energy production are addressed in Section 6.6.

14 This concern has been included as potential impact of the project in Sections 4.1.2.2 and 4.2.2.2. Soil erosion control measures described in Section 8.2 will be implemented to prevent increased siltation of streams.

COMMENT LETTERS TO DEIS

15 According to the Environmental Assessment, there are abundant native species around the project area. These species are fairly resistant to invasion by exotic plants, as long as their environment remains undisturbed. However, the construction of roads in the subject area could bring about the introduction of exotic flora. We recommend careful consideration before allowing an activity that could contribute to and speed the decline of native Hawaiian forests.

16 In general, it is difficult for us, based on the information provided, to evaluate the appropriateness of the proposed use at this location. There is no discussion of the factors influencing the selection of this site. The property appears to be relatively undisturbed; however, the document is not sufficiently detailed for this to be conclusively determined. Before the area is modified by a hydroelectric project, an assessment of alternative sites should be made. There may be other sites that are suitable for providing the desired energy production with fewer adverse environmental impacts.

Division of Aquatic Resources

17 1. Several mitigative measures should be considered in conjunction with this proposed project. The existing Hanalei River diversion weir should be modified as it acts as a barrier to upstream and downstream migration of native stream fauna reducing the amount of habitat available below the weir especially during low flow periods. Mitigative measures suggested are: 1) a "V-shaped" notch should be cut into the existing weir to create a waterfall and a "fish ladder" constructed by grouting boulders against the wall to create a gentle slope below the notch; and 2) a fish-screen and "deflecting wing" should be installed at the existing weir to minimize entrainment of o'opu and opae kalaole (by the tunnel to the Wailua River watershed where they would be exposed to potential impingement by the proposed hydroelectric facility) and predation by carnivorous fish (i.e., smallmouth bass).

18 2. The unnamed stream (which some fishers refer to as "bass creek") is one of the best and easily accessible smallmouth bass streams on Kauai, except for the area from the Tunnel outlet to about 1,000 feet downstream where an 8-foot waterfall forms a barrier to upstream movement by the smallmouth bass. It is believed that bass fishing is good along this stream due to the addition of water from the Hanalei Tunnel. The proposed diversion of the flow through an 8,000 feet penstock is anticipated to impact on the smallmouth bass fishery although the actual "socioeconomic" value of the recreational fishing activities has yet to be determined.

RESPONSES TO COMMENTS

15 Native forest in the project area is not particularly pristine and already supports areas of exotic vegetation. Revegetation will take place concurrently with completion of construction. A final revegetation plan requiring use of native plant species will be approved by the Division of Forestry and Wildlife prior to the initiation of construction.

16 This site was considered to have advantages over other streams in the area because only diverted Hanalei River water would be used in power production. The remaining flow would be the natural hydrologic pattern for that stream system.

17 The proposed diversion structure and fish screen to protect aquatic organisms on the Hanalei River is discussed under responses to comments 4 and 5 in Document #1.

18 The effects of flow reduction on the smallmouth bass fishery is discussed in the response to comments 7, 8 and 9 in Document #1. The socioeconomic value of the fishery is discussed in the response to comment 10 in Document #1.

Comment	Response
3. 19 Page A-1. The statement concerning the non-consumptive use of the water is misleading from the standpoint of aquatic biota. The operation of a hydroelectric plant has potential for entraining and/or impinging the stream fauna. Also, the water temperature along the dewatered reach and that discharged from the plant would be raised and could adversely affect resident fauna.	19 Measures to prevent entrainment of aquatic life into the turbines from the diversion are discussed in response to comments 4 and 5 in Document #1. Water leaving the powerhouse will be conveyed to Maheo Stream through a tailrace that will be elevated above the normal water surface level of the stream by about 1 foot (Figure 1.5-1). The lip of the tailrace will be extended on a shelf and will remain dry underneath. The drop to the stream and the dry shelf will combine to create an impassable barrier to aquatic organisms migrating upstream by not providing a wet surface for them to ascend. With no means to reach the tailrace they should be attracted by the natural flow of Maheo Stream and pass by the powerhouse. Changes in water temperatures have been discussed in the EIS. In summary, it is anticipated that temperatures in the Maheo Stream will change 1-2°C with changes in elevation. Because of a limited surface area and being buried up to 80% of the length, temperatures in the penstock should not rise more than the normal 1-2°C encountered in the Maheo Stream.
4. 20 Page B-1. There is no description on the length of the permanent access road or the type of bridge that would be constructed over the north fork of the Wailua River which experiences severe freshets. The construction, daily travel, and maintenance could cause siltation and turbidity and affect the production of, and good fishing for, smallmouth bass and other fauna along the entire length of the River. Also, we note that public access is available along reaches of the River. Most other smallmouth bass streams on Kauai are on private land requiring permission to fish from the landowner. We suggest that the developer consider negotiations with the private (sugar companies) to allow public access to such good/better smallmouth bass streams as a mitigating measure should the project be approved.	20 The access road will be maintained only from the Stable Storm Ditch to the powerhouse. Discussion of the crossing over the North Fork Wailua is contained in the response to comment 13 in Document #1. Soil erosion control measures described in Section 8.2 will be implemented to prevent increases in siltation and turbidity in the North Fork Wailua River. There should only be minimal and temporary impacts during construction on fishery resources in the North Fork Wailua River. Fishing conditions and access to the North Fork Wailua River should not change due to this project.
21 5. Table C-14 is illegible.	21 The readability of this table has been improved.
6. 22 Page C-30 (Section C-9). The construction of the access road is expected to have only significant and short-term effects on vegetation, however, there is no discussion on the impact of the road on water quality.	22 The access road will have a short term effect upon water quality (increased sedimentation) during construction of stream crossings over perennial streams. The access road and penstock alignment route are well away from the Maheo Stream course. In addition, construction staging areas are to be placed near the new powerhouse and in a previously disturbed area. A detailed sedimentation and erosion control plan will be submitted for review and approval by State and Federal agencies prior to construction.
7. 23 Figures C-35 and 36. No fish abundance information is given for the affected stream reach. Smallmouth bass are abundant (see Comments No. 1b and 3).	23 Results of surveys for smallmouth bass abundance are presented in the response to comment 6 in Document #1.
8. 24 Page D-1. A fish screen would be installed at the proposed weir to prevent entrainment of fish. In addition to the above screen, a fish screen (and a deflecting wing) at the existing weir on the Hanalei River would be most desirable (see Comment No. 1). O'opu and opae kalaole are diadromous requiring exposure to sea water to complete their life cycles; the native fauna entrained by the Hanalei tunnel would have a poor chance of reaching the ocean.	24 The Hanalei River diversion weir located at the upstream entrance to the Hanalei Tunnel is an existing diversion structure which will be modified with a fish screen. This diversion structure and fish screen to are discussed under responses to comments 4 and 5 in Document #1.

COMMENT LETTERS TO DEIS

9. Page D-2. There should be a constant streamflow bypassing the existing Hanalei River diversion weir (see
25 Comment No. 1). A minimum bypass flow would also be needed at the proposed hydroelectric project diversion weir.

10. Page D-5. It may be desirable for the indrect cost estimates to also consider the loss of recreational
26 fishing opportunities and decrease in fishery productivity associated with diminished habitat availability and concomitant loss of carrying capacity.

11. Page D-8. The statement that the major environmental effects would be related to construction of the new hydroelectric diversion weir is questioned. As pointed
27 out in Comments No. 1 and 7, there is impact already occurring along the Hanalei River. Another impact would be the long-term increases of sediment load and silt deposition within the entire Wailua River below the proposed hydroelectric project.

12. The statement that there are no undangered species in the affected area is untrue. Koloa ducks and ducklings have
28 been seen in the area on numerous occasions between 1982 and present.

13. The statement that the project would cause only a temporary increase in turbidity downstream of the
29 construction site is questioned (see Comment No. 10).

30 14. Figures E-1 and F-1 depict Honolii Stream on Big Island.

<u>Division of Water and Land Development</u>

DOWALD supports and encourages the development of alternate energy resources and has no objection to the Chairperson
31 signing this application. We offer the following comments on the application and environmental assessment and address State Water Code permit requirements for this project.

Instream Use Protection:

Additional information on minimum by-pass flows to protect instream uses should be provided in the EIS for the project.
32 We note the comment on page D-2 stating that the amount of bypass flow is being determined by the U. S. Fish and Wildlife Service and the Department's Division of Aquatic Resources.

RESPONSES TO COMMENTS

25 There will be one existing diversion weir (on the Hanalei River at the Hanalei Tunnel). Please see the responses to comments 5 and 11 in Document #1 regarding minimum bypass flows. These flows are currently being negotiated with Lihue Plantation. There will also be a diversion at the intake strucutre, but this diversion weir is termed penstock intake because it will use all Hanalei Tunnel water between 8 and 48 cfs.

26 This issue is discussed under the response to comments 7, 8, 9 and 10 in Document #1.

27 The only components of the project that will impact the stream directly during construction are the intake structure, the tailrace, and the stream crossings over perennial streams. Construction of the penstock and access road will take place at a considerable distance from the stream.

Soil erosion control measures described in Section 8.2 have been designed to prevent increases in sediment load and silt deposition during construction and operation of all aspects of the project.

28 Koloa ducks do occur along Maheo Stream within the project area and were observed numerous times during the wildlife survey, February 12-17, 1989.

29 Soil erosion control measures described in Section 8.2 have been designed to prevent increases in sediment load and silt deposition during construction and operation of the project. A final detailed soil erosion control plan will be submitted to State and Federal resource agencies for review and approval prior to initiation of construction.

30 Corrected in Final EIS.

31 No comment.

32 The referenced statement, which is made on page D-2 of the <u>Environmental Assessment</u> dated March, 1988, is incorrect. Lihue Plantation has consistently maintained the position that it plans to continue diverting all available flows into the Hanalei Tunnel, which it has an established legal right to do by virtue of its lease with the State of Hawaii. Minimum bypass flows for the project are presently being negotiated with Lihue Plantation.

Comment		Response
Non-Consumptive Lease of Water Rights:		
33 The project will utilize state land and water that has been diverted from the Hanalei River. The lease of state land and the right to use the diverted water should be fully addressed in the application and environmental assessment or the EIS if one is required.	33	The applicant will apply to the state for a land and water lease for the project. The project lies within a Conservation District and will require leases from the Department of State Land and the right to use diverted water. Discussions have been held with state officials, however, the leases have not yet been completed.
State Water Code Permit Requirements:		
34 Chapter 174C, HRS, the State Water Code, and its implementing Administrative Rule, Chapter 13-169 (effective May 27, 1988) provide for the protection of instream uses by establishing instream flow standards and by regulating stream channel alterations. The applicant will be required to apply for and obtain a stream channel alteration permit from the Commission on Water Resource Management. In addition, a stream diversion works permit will also be required under the Code. The applicant may contact the Division of Water and Land Development at 548-7619 to discuss these permit requirements.	34	This issue is discussed under the response to comment 4 in Document #2.
35 Please note this project is not exempt from Water Code permit requirements. Chapter 174C-71(3) specifically states, with respect to stream channel alteration permits, that only projects under construction or projects reviewed and approved by July 1, 1987 are unaffected by Part VI of the Code protecting instream uses.	35	This issue is discussed under the response to comment 4 in Document #2.
Historic Sites Section		
36 The CDUA application indicates that a preliminary reconnaissance of the proposed project area found no significant historic sites (C-30). We are unable to evaluate this conclusion, as we have not seen the survey report. A comprehensive archaeological and historical investigation of the entire project area is planned for later this summer (C-30). Until it is completed and submitted to our office for review, however, we will be unable to evaluate the effects of this proposed project on significant historic sites. This survey report should be submitted well within the 180-day review period for the CDUA in order for us to comment on effects.	36	The report of a full archaeological and historical investigation of lands within the proposed project area can be found in Appendix C of the Final EIS. In addition, a new survey will be undertaken at the time of construction (see Section 8.3).
37 Additionally, since this project is on state land, compliance with the state's historic preservation law, Chapter 6E, must occur. Again, initial compliance steps will hinge on receiving the detailed survey report. This compliance can be done concurrently with the CDUA application.	37	We agree. No further comment is necessary.

COMMENT LETTERS TO DEIS

ANALYSIS TO DATE:

Following review and acceptance of the application for processing, the applicant, by letter dated August 11, 1988 was notified that:

38 1. The proposed use is a conditional use in the Protective and Resource Subzones of the Conservation District according to Title 13, Chapter 2, Administrative Rules, as amended;

2. A public hearing pursuant to Chapter 183-41, Hawaii Revised Statutes, as amended, will be required; and

3. In conformance with Title 11, Chapter 200 of the Administrative Rules, an Environmental Impact Statement (EIS) was determined to be required for the proposed action; and written clearance from the County of Kauai regarding SMA requirements has been obtained.

39 The objective of the Protective subzone is to protect valuable resources in such designated areas as restricted watersheds; marine, plant or wildlife sanctuaries; significant historic, archaeological, geological, and volcanological features and sites; and other designated unique areas.

40 The objective of the Resource subzone is to develop, with proper management, areas to ensure sustained use of the natural resources of those areas.

41 Section 13-2-21(b)(1) relating to standards requires all applications be reviewed in such a manner that the objective of the subzone is given primary consideration.

RESPONSES TO COMMENTS

38 A Conservation District Use Application (CDUA) has been filed and in response to the CDUA permit filing, this Environmental Impact Statement has been prepared. A public hearing was held on the Island of Kauai to discuss response to the Draft Environmental Impact Statement filed for the project. Kauai County has been given copies of the Environmental Impact Statement and discussions have been held with the Kauai County Planning Department. The final approvals from Kauai County will not be received until a Conservation District Use Application permit is issued for the project.

39 No comment.

40 No comment.

41 No comment.

DOCUMENT #5

1231

JOHN WAIHEE
GOVERNOR

RECEIVED
'88 DEC 8 P1:09
DEPT. OF LAND
& NATURAL RESOURCES
STATE OF HAWAII

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

EDWARD Y. HIRATA
DIRECTOR

DEPUTY DIRECTORS
JOHN K. UCHIMA
RONALD N. HIRANO
DAN T. KOCHI
JEANNE K. SCHULTZ

IN REPLY REFER TO
STP 8.3249

December 5, 1988

RECEIVED
'88 DEC 9 AM 9:50
DLNR
OCEA

MEMORANDUM

TO: The Honorable William W. Paty, Chairperson
Board of Land and Natural Resources

FROM: Director of Transportation

SUBJECT: DRAFT ENVIRONMENTAL IMPACT STATEMENT
UPPER WAILUA HYDROELECTRIC PROJECT
WAILUA, KAUAI

1 Our only concern involves the weights of construction vehicles on our State highway facilities. A permit is required for vehicles with unusually heavy loads. If there is any question on whether or not a permit is necessary, the contractor should check with our Kauai District Office, Highways Division.

Thank you for this opportunity to provide comments.

for Edward Y. Hirata

1 Prior to construction, the contractor will be responsible for obtaining all necessary permits from the Kauai district office of the Hawaii Department of Transportation.

RECEIVED AS FOLLOWS

DOCUMENT #6

December 20, 1988

MEMORANDUM

TO: Roger C. Evans

FROM: Ralston H. Nagata, State Parks Administrator

SUBJECT: CDUA KA-2155 -- Draft EIS - Upper Wailua Hydroelectric Project (Island Power Company)
Wailua, Lihue, Kauai
TMK: 3-9-1: 1, 2, & 3; 3-9-2: 1; 4-2-1: 2

HISTORIC SITES SECTION CONCERNS:

1 We have reviewed this Draft EIS sections on historic sites (p. 115) and the supporting archaeological survey report.

2 The archaeological survey (Hammatt 1988. Archaeological Reconnaissance of the Upper Wailua Hydroelectric Project: Wailua, Kaua'i.) found no historic sites in the project area. Based on some historical evidence and comparable surveys, there is still the possibility that agricultural terraces may be present near the confluence of two streams (which is the proposed powerhouse, staging area and access road location) where dense grass prevented thorough observation of the ground surface. The consulting archaeologist has recommended additional survey take place at this location during the vegetation clearing, but prior to construction. The Draft EIS calls this monitoring. If sites are found at that time, it is proposed to locate and map them.

3 We agree that all other areas of the project appear to have no historic sites. Generally, in the one area where the streams meet, we agree with the proposed approach. However, we have a few concerns. One, vegetation clearing should be done without heavy equipment to avoid damage to any historic sites that might be present. Two, if sites are present, enough information must be gathered to evaluate their significance. Three, if sites are present and if they prove to be significant, a mitigation plan must be developed and executed prior to construction to treat them.

1 No comment.

2 The additional survey will take place during vegetation clearing prior to construction. Any sites located by the survey will be mapped.

3 Vegetation clearing in areas of potential historical significance (near confluence of streams) will be accomplished without use of heavy equipment. If sites are located, their significance will be evaluated. If sites are significant, a mitigation plan will be developed and submitted for approval prior to initiation of construction.

4 If these concerns are met, we believe that the project would have "no adverse effect" on significant historic sites. Under this approach, a condition to any approved CDUA must be attached with the following wording:

> 1. In the proposed powerhouse location, the grass will be cleared (not using heavy machinery). A
> 5 professional archaeologist shall then determine

if significant historic sites are present. Findings shall be submitted to the State's Historic Sites Section in report format. If significant historic sites are present, an acceptable mitigation plan shall be developed and be approved by the State's Historic Sites Section; and this plan shall be executed prior to any construction at this location.

6 An alternative approach would be for the applicant to clear the vegetation prior to action on this application and determine if significant historic sites are present. We would appreciate being contacted by the applicant so we know which approach will be taken. Ms. Nancy McMahon, our Staff Archaeologist handling Kauai, is our contact person in the Historic Sites Section (548-7460).

RECREATION CONCERNS

7 There are no known recreation concerns involving state parks. Wailua River State Park is located in the lower portion of the Wailua River watershed, but no significant environmental impact is anticipated.

RALSTON H. NAGATA

4, 5 The language utilized in this paragraph has been incorporated into the EIS.

6 This suggestion was considered but dismissed by the applicant because the techniques described in 62 and 63 were more appropriate. Complying with this alternative would result in disturbing vegetation prior to obtaining a CDUA permit.

7 No comment.

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
Division of Water and Land Development
Honolulu, Hawaii

RECEIVED
'89 JAN 3 PM 10:47
OCEA

December 29, 1988

MEMORANDUM

TO: Mr. Roger Evans

FROM: Manabu Tagomori

SUBJECT: KA-2155 - Upper Wailua Hydroelectric Project

8 Our initial comments on this project remain unchanged. For your information, the applicant has filed a petition to amend the interim instream flow standard for Kauai streams and applications for a stream channel alteration and diversion works permit.

9 The Commission on Water Resource Management will receive comments and testimonies at the January 12, 1989 Public Hearing on this project and will consider the petition and applications at their regularly scheduled Commission meeting soon thereafter.

MANABU TAGOMORI

SS:fc

Attachment

8 No comment.

9 No comment.

JOANN A. YUKIMURA

COUNTY OF KAUAI
DEPARTMENT OF PUBLIC WORKS
3021 Umi Street
LIHUE, KAUAI, HAWAII 96766

STEVEN M. KYONO
COUNTY ENGINEER
TELEPHONE 245-3318

ARNOLD F. LEONG
DEP. COUNTY ENGINEER
TELEPHONE 245-3602

Mailing Address:
4444 Rice St., Rm. 230
Lihue, HI 96766

December 19, 1988

State of Hawaii
Department of Land & Natural Resources
P. O. Box 621
Honolulu, HI 96809

Gentlemen:

SUBJECT: DRAFT ENVIRONMENTAL IMPACT STATEMENT
UPPER WAILUA HYDROELECTRIC PROJECT
WAILUA, KAUAI

We completed our review of your Draft Environmental Impact Statement for the subject project and offer the following comments:

10 A new access road will be graded which length will be approximately 1 1/2 miles in length from the confluence with Maheo Stream and the North Fork of the Wailua River. Since the grading work will be confined in State lands, a grading permit will not be required. Our Grading Ordinance No. 262 exempts grading work in a self-contained Government controlled area.

Thank you for this opportunity to comment.

Very truly yours,

STEVEN KYONO, P.E.
County Engineer

WK/sm

10 The applicant has contacted Kauai County regarding the various permits required. There will not be a grading permit for the project. The applicant will, however, be required to obtain a building permit for the project prior to commencement of construction and following receipt of the Conservation District Use permit.

DOCUMENT #7

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

REPLY TO ATTENTION OF:

January 9, 1989

RECEIVED
JAN 11 1989
Ans'd..........

Planning Branch

Mr. William W. Paty, Director
State of Hawaii
Department of Land and Natural Resources
P.O Box 621
Honolulu, Hawaii 96809

Dear Mr. Paty:

1 Thank you for the opportunity to review the Draft Environmental Impact Statement (DEIS) for the proposed Upper Wailua River Hydroelectric Project, Wailua, Kauai. The following comments are offered:

2 a. The DEIS is correct in stating (page 155, paragraph 3) that the project will require a Department of the Army (DA) permit; however, the DEIS is incorrect in stating that the Conservation District Use Application (CDUA) is necessary for approval of the DA permit.

3 b. If further clarification of DA permit requirements is needed, the applicant should contact Operations Branch (telephone (808) 438-9258).

4 c. According to the Flood Insurance Study for the County of Kauai, the project area is located in Zone X, "other areas" determined to be outside the 500-year flood plain, as designated by the Federal Emergency Management Agency's (FEMA's) Flood Insurance Rate Map (FIRM).

Sincerely,

Kisuk Cheung
Chief, Engineering Division

Copy furnished:

Mr. Dean Anderson
Bonneville Pacific Corporation
820 Mililani Street, #712
Honolulu, Hawaii 96813

RESPONSES TO COMMENTS

1 No comment.

2 We stand corrected. The comment has been changed in the EIS.

3 No comment.

4 The powerplant has been moved adjacent to the Maheo Stream in the preferred Alternative #4. The powerplant will be engineered to withstand a designed low probability storm event. The details are provided in Section 1.5.

DOCUMENT #8

United States Department of the Interior
FISH AND WILDLIFE SERVICE
PACIFIC ISLANDS OFFICE
P.O. BOX 50167
HONOLULU, HAWAII 96850

ES
Room 6307
JAN 12 1989

RECEIVED
JAN 13 1989
Ans'd............

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

Re: Draft Environmental Impact Statement for the Upper Wailua Hydroelectric Power Project, Kauai

Dear Mr. Paty:

1 We have reviewed the referenced Draft Environmental Impact Statement (EIS) and offer the following comments for your consideration.

General Comments

2 The Service has participated in several pre-development meetings with the developer and consultants for this project since 1987. Because the proposed hydropower facility is utilizing water from an existing surface water diversion, and no additional stream diversions are planned, the identification of a biologically appropriate instream flow for native aquatic animals is not a major unresolved issue.

Specific Comments

3 a. Diversion and Intake Structure. Page 8. The developer is proposing to install a fish screen with mesh size of 0.25 inches at the intake to the Hanalei Tunnel to limit the entrapment of adult fish and invertebrates. In addition, we recommend a maximum approach velocity of 0.5 feet per second measured immediately in front of the fish screens. The approach velocity should be evenly distributed across the face of the intake. As shown in Figure 1.3-1 of the referenced Draft EIS, the screens should be aligned parallel to the direction of stream flow. We recommend that scale drawings of the intake structure at the intake to the Hanalei Tunnel be included in the Final EIS.

4 We understand that a screen cleaning device would be installed to keep the fish screen free of debris. The construction and operational details of this screen cleaning device should be included in the Final EIS.

RESPONSES TO COMMENTS

1 No comment.

2 We agree, however additional studies were undertaken as part of this report. The purpose of the additional studies was to address concerns expressed by other responses to the DEIS. The results of the studies have been incorporated into the Final EIS.

3 The issue of the fish screen design is discussed in the response to comment 4 in Document #1.

4 The issue of the fish screen design is discussed in the response to comment 4 in Document #1.

The developer is proposing to construct a fish passage structure over the existing diversion dam on the Hanalei River. However, there is little discussion on the dimensions and design of this structure in the Draft EIS. We recommend that this fish passage

5 structure be discussed and scale drawings be included in the Final EIS. It may also be appropriate to construct a fish passage structure on the diversion dam on Kaapoka tributary. The fish passage structures should be designed in coordination with the Service and the State Division of Aquatic Resources.

6 The statement that "Bypass flows will be maintained to allow downstream movement" should be clarified. This statement suggests that a continuous flow over the existing diversion on the Hanalei River is being proposed by the developer.

b. Penstock. Page 8. This section states that "several stream crossings will be encountered" along the penstock route.

7 The number of crossings over perennial streams by the proposed penstock should be identified in the Final EIS. Methods "to remain out of the stream channel during the construction phase" hould be discussed in the Final EIS.

c. Access Road/Power Transmission Line. Page 13. We recommend that a bridge be used to cross the North Fork Wailua

8 River instead of an Irish crossing. The upstream migration of native diadromous species may be impeded by the use of culverts at this road crossing. In addition, construction activities on the North Fork Wailua River should be conducted during low flow periods to limit sediment run-off.

d. Soil. Page 106. Geotechnical studies on the stability

9 of soils classified as rough broken land may be necessary to determine the potential for landslides which may result in penstock failure.

e. Flora and Fauna. Page 127. The statement that "Larvae of opae should not be affected by passing through the turbines due to their planktonic size of 1 to 2 millimeters" should be

10 substantiated. To the best of our knowledge, there have been no studies that has examined the mortality of opae larvae as they pass through a pressurized penstock and turbine.

11 Scale drawings of the energy dissipation structure that would reduce false migration into the tailrace should be included in the Final EIS.

12 f. Aquatic Environment. Page 141. Please note that Appendix A does not describe the fish passage structure.

5 The fish passage structure for the Hanalei Diversion has been designed as part of the Final EIS. The specific details can be seen in Section 1.3. Construction of a fish passage structure on the diversion dam on Kaapoka tributary was not considered.

6 Bypass flows are being negotiated with Lihue Plantation. See responses to comments 5 and 11 in Document #1.

Penstock crossings of perennial streams and side gullies are identified in Figure 1.4-2. Methods to minimize stream impacts during construction of gully crossings will be delineated as part of the final detailed soil erosion control plan to be submitted to resource agencies for approval prior to construction.

8 The rationale for an Irish Crossing is discussed in the response to comment 13 in Document #1. It is designed to not impede the movement of native diadromous species.

9 Results of geotechnical studies of soil stability on rough broken land soil types will be included in the detailed construction plans submitted to resource agencies prior to initiation of construction.

10 Minimal numbers of aquatic organisms will be exposed to the turbine due to screening. The proposed diversion structure and fish screen to protect aquatic organisms on the Hanalei River is discussed under responses to comment 4 in Document #1.

11 Energy dissipation is not necessary in the tailrace except for normal erosion control for flood situations provided by the riprap shown on Figure 1.5-1. The drawing has been extended/revised to show a dry-step to inhibit false fish migration into the tailrace.

12 We agree, it has been corrected. In addition, scale drawings of the diversion are in Section 1.3.

COMMENT LETTERS TO DEIS

13 g. Terrestrial Environment. Page 143. We recommend that native plants be used to revegetate road cuts and the restoration of the temporary penstock access road.

14 h. Wildlife. Page 146. Several field surveys may be necessary to determine the presence of nesting sites for the Newell's Townsend's Shearwater (Puffinus auricularis newelli) and endangered Hawaiian Bat (Lasiurus cinereus semotus). We recommend that fledglings and nesting sites be located by professional ornithologists during the nesting season using playback tapes of Newell's Townsend's Shearwater songs. If nesting sites are located within the project site, we will recommend that the project be re-designed to avoid the nesting habitat for these endangered seabirds.

15 The endangered Hawaiian Duck (Anas wyvilliana) has been reported from streams at the project site. We recommend that construction activities near streams be limited during the peak nesting season for the Hawaiian Duck (December through May) to avoid disturbing this endangered species (Hawaiian Waterbirds Recovery Plan, 1985).

16 i. We request that the developer provide the Service and other resource agencies with a copy of their detailed construction plans and specifications to control erosion, stream sedimentation, and soil mass movement resulting from construction activities for the access roads, penstock, powerhouse, and tailrace. The site specific erosion and sedimentation control measures should include, among other things, revegetation of disturbed areas, design and location of sedimentation ponds, grades of slopes and cuts, control of surface drainage, measures to control slope stability, and the stockpile and disposal of excavation material. These plans should be submitted to these agencies for their review and approval prior to construction.

Summary Comments

17 The Hanalei Tunnel transports water from the Hanalei River and Kaapoka Stream to irrigate sugar cane lands for Lihue Plantation. However, the acreage of land dedicated to the cultivation of sugar cane by Lihue Plantation may decrease in the future. If this were to occur, the amount of water needed for crop irrigation may be also decrease. In this instance, the Service would likely recommend to the State Commission on Water Resource Management that a continuous instream flow be provided over the existing diversions at the Hanalei River and Kaapoka Stream to restore the upper reaches of these streams. The restoration of instream flows in the upper reaches of these streams may affect the operation of the proposed hydropower project.

RESPONSES TO COMMENTS

13 Native plant species will be used in revegetation of the areas disturbed by the project.

14 A survey for the endangered Hoary (Hawaiian) bat was conducted as part of the wildlife survey, February 12-17, 1989. No bats were observed.

A survey to determine the presence of nesting Newell's Shearwaters will be conducted in late-April or May. If nesting sites are located on-site, a mitigation plan will be developed in conjunction with the U.S. Fish and Wildlife Service and the DLNR.

15 Heavy construction will be limited during the period of December through May in areas adjacent to Mahco Stream and North Fork Wailua River to avoid disturbance to the Hawaiian duck.

16 All reasonable precautions, as practiced by Hawaii contractors under the guidance of State and local agencies in similar circumstances, will be implemented to control erosion, stream sedimentation and soil mass movements. Detailed erosion control plans and specifications based on site specific geotechnical information and final designs will be submitted to the Fish and Wildlife Service and other resource agencies for comments prior to initiation of construction. These plans will include revegetation of disturbed areas, design and location of sedimentation ponds, grades of slopes and cuts, control of surface drainage, slope stability control measures, and details for stockpile and reuse of excavation material.

17 Island Power Company supports the concept of a continuous instream flow over the diversion weir on the Hanalei River at the inlet to the Hanalei Tunnel intake. It has proposed to Lihue Plantation that the weir incorporate a fish bypass channel as an integral design feature. However, Lihue Plantation has a preexisting right to divert all of the flow at the Hanalei Tunnel intake for its agricultural use.

The question of whether Lihue Plantation would have the right to use diverted Hanalei River water for purposes other than agriculture is a subject which has received attention by the courts in recent years and which is still being considered by the courts. In 1977, the water rights of private agricultural interests such as plantations was reaffirmed in a decision of the U.S. District Court.

Please see also the previous response to comment 1 in Document #1.

18 We appreciate the opportunity to comment on the Upper Wailua Hydropower Project.

Sincerely,

Allan Marmelstein
Pacific Islands Administrator

cc: State Commission on Water Resource Management
U.S. Army Corps of Engineers
Bonneville Pacific Corporation
Division of Aquatic Resources, DLNR

18 No comment.

DOCUMENT #9

RECEIVED
JAN 10 1989
RECEIVED
JAN 1989

University of Hawaii at Manoa

Environmental Center
Crawford 317 • 2550 Campus Road
Honolulu, Hawaii 96822
Telephone (808) 948-7361

January 9, 1989
RE:0515

Mr. William Paty, Director
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Paty:

Draft Environmental Impact Statement
Wailua Hydroelectric Project
Wailua, Kauai

1 This document proposes construction of a 1.26 MW hydroelectric power plant on the west bank of Maheo Stream, a tributary of the Wailua River. Water currently being diverted from the Hanalei River through the Hanalei Tunnel to Maheo stream will be diverted to a 6,400 foot long penstock of 48 and 32 inch pipe at an elevation of 1,210 feet above MSL. The penstock will run adjacent to Maheo Stream, and the powerplant will be located above the high water of both Maheo Stream and the North Fork Wailua River at an elevation of 760 feet above MSL. Once the water runs through the powerplant turbine, it will be discharged near the end of Maheo Stream. This review was conducted with the assistance of Michael Graves, Anthropology; James Parrish, Hawaii Cooperative Fisheries Research Unit; Amedeo Timbol, Kauai Community College; Yu-Si Fok, Water Resources Research Center; and Steven Armann, Environmental Center.

2 We find this document in violation of various rules regarding the content requirements of an EIS as outlined in section 11-200-17 of the EIS rules. The EIS process is intended to allow comprehensive public review and evaluation of potential impacts of a particular project. Thus, it is essential that all pertinent studies be conducted prior to publishing of the Draft EIS, and that, at a minimum, the Draft EIS discuss the findings of the studies. On page 113 there is a brief discussion of potential Endangered Species within the project area. The discussion states that the Hawaiian Duck may inhabit the area and that the project would have an adverse impact on the duck. Furthermore the EIS lists six other species which may inhabit the area and be affected during the project construction. However no wildlife study has been conducted, and none will be conducted until May or early June. Therefore, this EIS does not describe adequately the potential impacts and does not meet the requirements of section 11-200-17(e)(6) of the Environmental Impact Statement rules.

RESPONSES TO COMMENTS

1 The powerhouse location has been moved to 710 feet above MSL, 50 feet from Maheo Stream.

2 A wildlife survey was conducted in February, 1989. Surveys for the Hawaiian duck located numerous individuals while those for the Hawaiian bat located none. During project construction, impacts to the Hawaiian duck in the project area are expected to be minimal and temporary in nature and precautions are being taken to ensure this (see response to comment 15 in Document #8). Post-project impacts to the Hawaiian duck might result from increased activity at the powerhouse. Those impacts will be minimal and only in the lower 600 feet of Maheo Stream.

A survey for nesting Newell's Shearwaters will be conducted in mid-April or May. If nesting individuals are located in the project area, a detailed mitigation plan will be developed in conjunction with the U.S. Fish and Wildlife Service.

No other endangered species are likely to inhabit the project area.

3 In addition, the EIS rules specifically state that the contents of a Draft EIS shall include a "summary of unresolved issues and either a discussion of how such issues will be resolved prior to commencement of the action, or what overriding reasons there are for proceeding without resolving the problems" (11-200-17(n)). The section devoted to this requirement simply states "[t]his section will be completed after the consultation process." This is in direct violation of the EIS rule quoted above, and therefore, once again, this document does not fulfill the requirements of the EIS rules.

3 A revised and expanded "Summary of Unresolved Issues" has been incorporated into Section 11 of the Final EIS.

4 Unfortunately, the inadequacies of this document negate the possibility of an adequate public review. Even if present inadequacies were corrected in the Final EIS, the general public would not have the opportunity to constructively comment on the potential impacts. Therefore, we recommend that this Draft EIS be resubmitted at a later date when all pertinent studies have been completed and when all unresolved issues can be discussed.

4 The intention of the Draft EIS was to provide decision makers and the public enough information to constructively analyze the proposed project. The letters received on the content of the Draft EIS have helped considerably in the formulation of an expanded and improved Final EIS.

Specific Comments

5 In regard to Endangered Species, page 129 states that "project operation will have no effect(s) beyond those incurred during construction relative to endangered species." However, the next sentence contradicts this statement by stating "[r]educed flows in Maheo Stream may make this stream less desireable to the Hawaiian Duck..." This uncertainty is evidence that a wildlife survey should have been conducted.

5 Impacts during project operation are discussed in response to comment 2 of Document #9.

6 Although the Hanalei diversion structure was built many years ago, it would be helpful to know the specifications of the diversion weir in evaluating the cumulative effects and mitigating measures of this project. Often projects which cause disturbances in one area will mitigate the disturbance by creating benefits for another environment, a sort of give and take situation. Since it is generally agreed that the Hanalei River is a much better habitat for native species, especially the goby, than is the Wailua River, it may be better and cheaper to redesign the Hanalei diversion weir and forgo some of the costly mitigating measures along Maheo Stream.

6 Mitigative measures associated with the Hanalei diversion are discussed in the response to comment 4 and 5 in Document #1.

7 Similarly, we agree with the statement on page 64 that at least some of the gobies in upper Wailua may have moved through the tunnel from the Hanalei River. For this reason, the fish screen planned for the Hanalei tunnel should be sited at the diversion weir to insure that the Hanalei gobies remain in Hanalei where the chances for survival are higher than at Wailua.

7 The proposed fish screen is designed to ensure that "Hanalei" gobies remain in the Hanalei River. The proposed diversion structure and fish screen to protect aquatic organisms on the Hanalei River is discussed under responses to comments 4 and 5 in Document #1.

8 Page 56 states that the project site was sampled at 10 locations but it does not mention the method(s) (electroshocking, snorkeling, etc.) used. Without this information, we are not able to compare data in Table 2.2-4 on page 62 with other published and unpublished data. Furthermore,

8 The stream was sampled by snorkeling and the survey was intended to be a measure of relative abundances of the macrofauna. The methodology employed was not intended to give absolute abundances (i.e. - #'s/m²).

8 table 2.2-4 mentions the quantity (rare, uncommon, common, abundant) of animals observed per site. The numerical equivalence for rare is 1 to 3 per site, uncommon is 4 to 10 per site, common 10 to 100 per site and abundance is > 100 per site. But the length of site 1 is 300 meters, while site 2 is 100 meters long. The table indicates that there are between 1 and 3 smallmouth bass per 300 meters in site 1 and between 4 and 10 in 100 meters in site 2. For a reasonable comparison, abundances at site 2 should be multiplied by 3. If we do such a multiplication, then the estimated abundances in this table need to be reevaluated. In addition, page 64 states that "(t)he two gobies remain uncommon and are present in approximately the same abundance as below the confluence (Payne 1988). However, the O'opu nopili is not reported above the confluence in Tables 2.2-2 or 2.2-4.

9 Page 64 states that there are other species not observed in the upper Wailua, but which occur in the Hanalei drainage. The sampling done at the upper Wailua drainage was confined only to the upper Wailua and not the whole drainage system. Native aquatic animals are diadromous, and they need and use the whole drainage system from the mouth of the river to the upper reaches. Since the whole Wailua drainage system was not sampled, it seems premature to conclude that there are other aquatic macrofunal residents in Hanalei that are not found in Wailua. Data for the Hanalei River are taken from the whole drainage system. We suggest that a more comprehensive sampling be done for the Wailua drainage system from the mouth up to the upper reaches in recognition of the diadromy of native animals.

10 Page 105 states that the water quality will be unaffected during the construction phase. This cannot be correct, considering that an estimated 166 tons of sediment will be deposited into the stream. Similarly, page 106 states that the penstock will be covered by soil for 50 percent of its length. Has the route of the penstock been surveyed to determine the availability of soil to cover the penstock? If soil is not available, the EIS should discuss the means of obtaining soil. Furthermore, it appears that important information is missing from the sentence running from the end of page 105 to page 106.

11 Page 143 discusses drainage mitigations, including sedimentation basins. However, we cannot determine the effectiveness of the sedimentation basins without specifications of the basins and the topography of the adjacent areas.

12 Page 127 and page B-5 state that "larvae of opae should not be affected by passing through the turbines due to their planktonic size of 1 to 2 millimeters (Couret 1976)." Couret's work gives the size of opae larvae. It does not mention that such larvae will not be affected by such unnatural occurrence as "passing through turbine blades." If a study has been made to merit such conclusion, please state so and include data in the EIS. Another impact not discussed in the Draft EIS and possibly more important is Gas Bubble disease caused by the pressure head inside the

9 The diadromous aquatic species found by sampling in Maheo Stream are present on a year-round basis, as shown by the length-frequency data on the opae. Smallmouth bass are a resident freshwater species. Regional differences in their abundance can be attributed to the effects of migration barriers, flow diversions, water quality, competition, predation, attraction flows at the ocean, and behavior. There is no feature of diadromy that requires sampling of the entire Wailua River or different seasons of the year to determine whether additional species are present or absent.

10 The 166 tons of soil calculated in Section 4.1.2.2 of the Draft EIS and the 141 tons calculated in the Final EIS represent the maximum potential amount of soil that will be moved from its original position on the site by the process of water erosion under Alternatives 1 and 4. It does not represent sediment yield to the stream. Soil erosion control measures described in Section 8.2 will be implemented to prevent soil transported from its original position on the site from entering the streams.

Where sufficient soil is available and design/construction practicality allows, the penstock will be buried. Where bedrock is too close to the surface to allow economical burial, the penstock will not be buried.

11 Detailed information adequate for determination of sedimentation basin adequacy will be submitted to resource agencies for approval prior to construction as part of final construction plans. See the response to comment 16 in Document #8.

12 The intent of the paragraph was not to quote Couret's work as turbine mortality studies, but to describe the size of opae larvae as 1 to 2 mm. There have been a number of studies which have shown that limnetic zooplankton (1-2 mm in size) have low mortalities when passed through turbines. The same would be true for opae larvae.

Gas bubble disease would not affect the larvae because they do not have gas bladders. In addition, the natural environmental hazards of downstream migrations (i.e., waterfalls) would be easily equivalent to the proposed pressure changes.

12 penstock and the immediate pressure release upon discharge. Various studies have been conducted on mainland organisms in the southwestern United States on this effect; however, we do not know of any studies conducted on the opae.

13 Page 128 indicates that an energy dissipation structure will be devised to reduce the discharge velocity to less than one foot per second. The tailrace energy dissipation structure should be shown in the Draft EIS and studies of similar designs should be discussed and referenced. In addition, the velocities of the stream channel at low flow should be graphically displayed since there may be times, especially during low flows, when the energy dissipator will not decrease the velocity below that of the stream.

14 Page 41 states that the flows in the tunnel remain relatively constant at between 30 and 40 cfs. However, according to figure 2.2-13, it appears that the actual flow is between 20 and 30 cfs. Furthermore, the following sentence regarding wet years makes a generalization using a one year period of 1981-1982. Is this statement generally true for all wet years? How many years of each type have been compared? What criteria are being used to determine wet and dry? In addition, the last sentence in the paragraph makes mention of a regression analysis; however, there is no discussion of the results in the EIS.

15 Page 43 is a map of USGS Stream Gages which corresponds to table 2.1-3 on the following page. It is very difficult to determine that gage 1000 on the map is gage 161000000 in the table. The EIS should either discuss this relationship or change the map or table to be consistent. In general we found the maps to be very difficult to read. In many cases, it is the quality of reproduction was such that it was difficult to read contour lines and labelling of the tributaries. It may be helpful to highlight the Maheo, Wailua and Hanalei Rivers on some maps.

16 The two plots of Maheo Stream flow under different limiting circumstances (Figures 4.2-1 and 4.2-4) appear to be exactly the same plot. We would imagine that during the plant operation, the plot would not be exactly the same as it would be without the water from the Hanalei tunnel unless all the water from the Hanalei tunnel was being used for the project.

17 We have noted numerous spelling mistakes in regard to Hawaiian and Scientific names of various species. In particular page 65 misspelled <u>Eleotris sandwicensis</u> and three of the five common names have mistakes. In addition the crustacean <u>Atya bisulcata</u> has been changed to the genus, <u>Atyoides</u>.

18 Water temperature was not given much attention in the Draft EIS. For the following reasons we suggest that more discussion be devoted to the water temperature change. First, the penstock will be covered for 50 percent of its length, which means it will be open to direct environmental

13 This issue is discussed in the response to comment 11 in Document #8.

14 The comment is correct, the flows should be between 20 to 30 cfs as noted in Figure 2.1-11. In terms of generalizations, we have provided the flows from the Hanalei Tunnel for the period of record (Figure 2.1-11). Criteria for wet, dry or average years were based upon seasonal bulk precipitation (Figure 2.1-9). An analysis of the data would indicate that more water is available than is actually diverted because siltation at the diversion structures (resulting from periods of high flows) reduces flow through the Hanalei Tunnel.

15 Table 2.1-3 will be changed in the Final EIS. The USGS stream gage numbers appearing in Table 2.1-3 will correspond to the gage numbers in Figure 2.1-10. Significant streams in the project area, including the Maheo, Wailua, and Hanalei, will be highlighted in the Final EIS to aid in identifying these streams in the report figures.

16 The comment is correct in that with an operational range of 8 to 48 cfs, flows will always be diverted. Figure 2.1-11 shows two periods when flows are greater than 48 cfs and would thus be diverted into the Maheo Stream (note flat tops to peaks in the figures).

17 All spelling mistakes have been corrected.

18 Water temperatures were not and are not considered to be an issue. It is doubtful that increases above ambient will occur with the penstock buried up to 80% of its length. Even where exposed, the surface area of penstock exposed to the sun vs. the volume of water in the penstock will be considerably less than the surface area to volume ratio of water in the stream. In addition, vegetation will ultimately cover much of the exposed sections of the penstock and provide shade. The power plant will not increase the water temperatures. If one inspects the available water quality data for temperatures for all the streams in Kauai for the warmest months (August - September), the Maheo Stream would naturally increase 2-3°C over its diverted length (Figure 2.1-19) as a result of the drop in elevation. The temperature in the pipeline should not change any more than the natural increase in temperatures observed on Kauai.

18 factors, including the sun, for approximately 50 percent of its length. This will be especially important during the initial operation since vegetative cover will not have been replaced. We expect the water inside of the penstock will reach a higher than normal temperature. Also, heat will be generated by the turbine, and finally, the simple fact that there will be less water in the stream will cause the temperature to rise. Considering these factors, we believe that more discussion is needed in this area.

19 The archaeological survey was conducted over heavily vegetated terrain, and the archaeologist who surveyed the area is uncertain that there are no archaeological sites obscured by vegetation. The archaeologist recommends monitoring during the construction phase of the project in case sites are encountered.

20 We take issue with this type of arrangement. As the H-3 Freeway and Kapalua Hotel projects demonstrate, when we put off necessary survey and testing work until projects begin (or are about to begin) all sorts of problems can arise. Sites may be found which are highly significant and which may delay the project. Thus, we recommend that adequate surveys be conducted now for the project so that we can be relatively certain that there are no significant archaeological sites within the project's boundary.

21 Page 5 indicates that reserve capacity is presently 29.2 MW which reduces to 12.2 MW when the 12 MW bagasse plant shuts down. By our calculations, withdrawing 12 MW (bagasse) from 29.2 MW (total) leaves 17.2 MW of reserve power, not 12.2 MW as indicated in the text. Furthermore, if the gas turbine produces 22.2 MW, this combined with the 12 MW bagasse plant gives 34.2 MW of reserve power. It appears that the gas generator produces an adequate amount of reserve power for the needs of Kauai Electric Division. With this being the case, it is difficult to see the need for a minor 1.26 MW plant. This small amount of additional power does not appear to be significant considering the costs, both environmental and economic, of capturing the electricity.

Thank you for the opportunity to comment on this Draft EIS. We look forward to your response.

Yours truly,

John T. Harrison
Environmental Coordinator

cc: L. Stephen Lau
OEQC
Dean Anderson, Bonneville Pacific Corporation
Michael Graves
James Parrish
Amadeo S. Timbol
Yu-Si Fok
Steven Armann

19 The response to comment 9:20 found below adequately answers the concerns expressed in comment 9:19.

20 There are several options available for eliminating or reducing any potential impacts to agricultural terraces that may exist near the confluence of Maheo Stream and the North Fork Wailua River. These options include leaving the area undisturbed, removing sufficient amounts of vegetation at the site in an effort to determine if ancient agricultural terraces do exist there, contracting with a consulting archaeologist to be on site during vegetation removal and project construction, or, moving ahead with project construction with no more archaeological surveys or monitoring.

The archaeological reconnaissance report (Hammatt, 1988) stated that the unforested portions of the alluvial flats near the confluence of Maheo Stream and the North Fork Wailua River were covered with an extremely thick mat of California grass approximately 2-3 feet thick. This thick vegetative cover has made it virtually impossible for the archaeologist to make a determination if ancient agricultural terraces do exist in the area. Because of this condition, it is believed that having a consulting archaeologist on site during vegetation removal and construction in the alluvial flats area would be the best method available for avoiding any impacts to potential terraces in the area.

The project developer and the appropriate state agencies have agreed to a course of action that will be followed if ancient agricultural terraces are uncovered in the subject area (see Section 8.3 of the EIS). If this situation does occur, all construction activities in the area of concern will be stopped immediately and the responsible state agencies contacted for further direction and instructions.

21 The environmental center at the University of Hawaii is correct. Reserve capacity in the KED system is presently 29.2 MW. This reserve capacity is reduced to 17.2 MW when the 12 MW bagasse plant shuts down. The Draft EIS incorrectly stated that reserve capacity in the KED system went from 29.2 MW to 12.2 MW when the 12 MW bagasse plant shuts down.

DOCUMENT #10

RECEIVED
DEC 27 1988
Ans'd..........

Carol Wilcox
111 Royal Circle
Honolulu, HI 96816

December 20, 1988

Dept. of Land and Natural Resources
Box 621
Honolulu, HI 96809

RE: Comments re. the Upper Wailua Hydroelectric DEIS

Dear Mr. Paty,

I have the following general comments regarding the above cited DEIS.

1 1) The DEIS is not clear and complete. It is not possible to review the project since it is not described in the text and the maps are unreadable. I could not locate the project physically, or, more specifically, the location of the penstock, from information in the DEIS.

2 2) The DEIS does not deal with the public safety issues of the proposed exposed penstock, its construction, what would happen in case of collapse or rupture, what measures would be taken to minimize such possibilities, and precisely how it would be designed to withstand the impact of flood waters in the stream crossings or landslides in the exposed mountainous area. This would be the first long (6000 ft) penstock project in Hawaii, and although they are much cheaper to build, my understanding is that they pose some serious safety concerns, especially when the penstock is exposed and in the floodway and on unstable slopes.

3 3) The DEIS does not provide budget and economic information. It does not discuss the purchase power agreement, economic analysis or financial aspects of this project. The DEIS says the "Feasibility Study" will include this information in the Final EIS (p.20). However, Ch. 343 requires that it be included in the DEIS.

1 Maps and figures included in the Draft EIS were reduced to too small of a scale. Maps and figures included in the Final EIS are 11x17 fold outs and are a higher quality copy. These figures should prove to be more readable.

2 Design plans for penstock crossings are discussed in the response to comment 7 in Document #8.

The Engineer is very well aware of the public safety and environmental consideration inherent in the presence of the penstock and the potential damage that would result from penstock rupture. Similarly, any such failure would have a major adverse impact on the economic health of the project. For all of these reasons, penstock design is taken very seriously and designs are ultimately developed in detail incorporating all relevant site specific data. They are designed to avoid unstable slopes or/and slides, to avoid any impact by flooding streams (e.g., by bridging them at sufficient height) and to cope with all other foreseeable natural or man-generated impacts.

Even beyond the above precautions, the penstock intake is to be equipped with a gate that will close automatically in event of higher than expected water velocities in the penstock (see Figure 13-3). This is conventional practice and was foreseen in the Draft EIS as well. Similarly, an inspection program will be developed to monitor the penstock and the associated terrain in order to identify potential problems and implement preventative measures.

3 The power purchase agreement is being negotiated with Citizens Utilities at the present time. The proposed term of the agreement is 35 years. The rate to be paid for energy produced by the project has yet to be determined. The rates and terms of the contract will be subject to review and approval by the State of Hawaii Public Utilities Commission.

Preliminary economic analysis of the project has been performed by the developer. The information has not been made public because: (1) negotiations for a power purchase agreement are ongoing with the utility, and the rate to be paid for energy is part of those negotiations; (2) negotiations for use of water flowing through the Hanalei Tunnel are ongoing with Lihue Plantation, and the fees for such use are part of those negotiations; (3) the State has yet to determine the annual fee which will be charged for use of water emanating from State lands in the Hanalei basin; and (4) certain design features of the project are still being reviewed in the context of agency environmental requirements, and final costs have not been determined.

Comment	Response
4) I question the validity of the habitat information in the DIES. Based on personal reconnaissance of the project area last month, it seems that the DEIS does not accurately state the case when it says the project area is primarily exotic vegetation coverage. My observation was that the region mauka of the cane road appears to be original, undisturbed native canopy with only occasional exotic intrusion, and for that reason may be important habitat. The ohia trees were aflutter with birds, native or not I don't know. **4**	**4** The lower half of the proposed project, from the powerhouse site to the existing substation (transmission section), is covered by sugar cane fields and forestry plantings. The forestry plantings are found in the area between Hanahanapuni and the powerhouse site (near the lower gaging station at the end of the Stable Storm Ditch 4-WD road, ±700 ft. elevation) and are composed of such species as _Eucalyptus_, paper bark, _Paraserianthes_ (formerly _Albizia_), tropical ash, etc. There are patches of native trees such as 'ohi'a, hame, and 'ohi'a-ha and the mat-forming uluhe fern scattered among the forestry plantings. The proposed permanent access road, the lower penstock route and the intake site are situated in open areas near the stream. Unfortunately, most of the riparian system, especially at mid to lower elevations, has been disturbed and, in many places, guava scrub has replaced much of the native vegetation. Over these areas of the project, the vegetation is composed largely of guava shrubs, dense mats of California grass, and scattered clumps of Job's tears. Where the penstock is located on the steeper slopes and ridge areas above the stream, the native taxa dominate and a vegetation consisting of an open 'ohi'a forest with large areas occupied by uluhe fern is found. As pointed out in Section 2.2.2.1, there are no threatened and endangered plant species in this area and the native plants in the vegetation are not considered to be rare. The Draft EIS, as well as the Final EIS, included in Appendix A the Botanical Survey of the Upper Wailua Hydroelectric Project, Kawaihau and Lihue Districts, Island of Kauai. This survey includes a complete description of the vegetation existing in the proposed project area. Native forest birds were not found in the project area during the wildlife survey. They are not expected to use these forests as the project area is outside the known range of the native forest birds.
5) This is in part a Hanalei River project and should be considered in that light in the DEIS,...particularly in reference to water taken from the Hanalei watershed, the impact of the existing diversion on the Hanalei river, and the condition and gaging of the Kapooka Tunnel. **5**	**5** The intent of this project is to utilize flows which are currently being diverted from the Hanalei watershed. These flows, which are managed by the Lihue Plantation, are not under the control of the project.
6) The gaging figures, tables and analysis are unclear and incomplete. They should be updated to verify current flows, and should include Hanalei River Valley gaging stations. Where are the gages located in relationship to the project? The average flow figures for the Hanalei Tunnel is stated variously from 40 to 26 cfs. What is the correct figure? Rainfall, temperature, etc. figures at Lihue are inappropriate (p.34). **6**	**6** The issues raised in this comment have been addressed in the Final EIS. Hanalei River valley flows have not been included in this report because they are outside of the site boundaries and influence. The average flow for the Hanalei Tunnel is 26 cfs. The climate section of the Draft EIS - Section 2.1.4 - has been revised and expanded in the Final EIS. Meteorological data from two recording precipitation and temperature stations located near the project area have been added to the climate section of the Final EIS. The meteorological data from these two stations present a fair representation of the climate of the project area.
7) The presence of native aquatic species makes this a river of special concern. The fish screen as proposed seems useless if the diversion takes 100% of the water. Does DAR consider the fish survey and proposed mitigation adequate? The DEIS does not even comment on or consider the suggestions made by the Division of Aquatic Resources, F&WS, or DOWALD regarding aquatic habitat. **7**	**7** The proposed diversion structure and fish screen to protect aquatic organisms on the Hanalei River is discussed under responses to comments 4 and 5 in Document #1.

8 8) The DEIS does not consider the alternatives to this project, in particular, conservation.

9 9) The DEIS does not put the amount of power projected into any perspective. What are future power requirements of Kauai, and what is that based on? What other energy projects are being considered for Kauai? What is their status? What is the relationship of flow to power? What sort of power would this project provide? (Peak hours? Base load?) How much power is required for new Kauai projects, such as the Westin Hotel?

8 Energy conservation can rightly be considered as an alternative energy source for the state of Hawaii. If the citizens of Kauai could conserve energy, and somehow keep that energy they conserved in an "energy reservoir", then retrieving that energy would be much more environmentally acceptable than developing new energy sources. Energy conservation offers a cost-effective, readily available, and environmentally benign means of obtaining additional energy resources.

The decision whether to promote energy conservation as an energy resource readily available to the citizens of Kauai is the responsibility of the people of Kauai and decision-makers in the state of Hawaii. A section entitle "Energy Conservation" has been added to Section 6.0 of the Final EIS - Alternatives to the Proposed Project.

9 The information requested by Ms. Wilcox is covered in detail in the oral testimony which Kelvin L. Kai, Manager, Transmission and Distribution, Kauai Electric Division of Citizens Utilities Company, presented at the CDUA/DEIS hearing held in Lihue on January 12, 1989. A written version of this testimony is provided in the Final EIS (Section 13).

Mr. Kai mentions in his testimony that Kauai Electric's generation requirements increased 85% over the last 10 years. He predicts a similar growth rate for the future. He states that the Upper Wailua project's projected energy output will represent approximately 2% of the utility system's total output, replacing over 14,000 barrels of oil.

Mr. Kai mentions that a benefit of the project is that it will help Kauai Electric diversify its load, i.e. use less oil-fired generation in the future.

Island Power Company is aware of at least two other hydroelectric projects being proposed for Kauai. One of these projects is the Lower Wailua project being developed by Island Power Company.

Based on projected load growth, Kauai Electric has preliminary plans to add, in the form of diesel generators, 16 megawatts of capacity by the end of 1990 and another 16 megawatts by the end of 1992. The source of this information is Denny Polosky at Kauai Electric.

The relationship between flow and electrical output is directly proportional. For example, if flow were to increase 10% then electrical output would also increase 10%. As an example of the relationship of flow to energy production, if average flow through the Hanalei Tunnel is 21 cfs, then the total water through the plant in a year would be 15,200 acre feet and the resulting energy production would be 6,800,000 kilowatt hours.

The "sort" of power which the project will provide is referred to as "as available" or "non-firm" energy as distinguished from "firm" energy. These terms infer that the electrical generation will occur only when there is water flowing in the stream. However, because of the consistency of flows through the Hanalei Tunnel as evidenced by over 50 years of streamflow data collected at the tunnel outlet, it is possible to gauge the reliability of the project's anticipated production. The flow duration curve indicates that the project will produce power approximately 90% percent of the time.

According to Kauai Electric, the amount of power which will be required by the Westin Hotel complex upon completion is approximately 6 megawatts. The total new load of all major commercial complexes planned for completion through 1990, including the Westin Hotel, is approximately 14 megawatts. The source of this information is Denny Polosky.

Kelvin L. Kai, in his hearing testimony, states unequivocally that the utility and the island of Kauai need the power to be generated by the Upper Wailua project. It will help the island achieve a higher degree of self-sufficiency in energy production as well as less dependence on imported oil. Reduced burning of fossil fuels will be helpful to the environment by decreasing sulfur dioxide and nitrogen oxide emissions.

It should be clarified that the project will displace between 14,000 and 17,000 barrels of oil per year.

10 10) I do not see any comment, support or acknowledgement by Lihue Plantation.

11 11) The DEIS does not address the significant impact on recreational resources of the area, except to say "future development ...will be limited by the lack of public access" (p.104) and that pigs and hunters can "easily bypass" the penstock (p.115).

12 12) Correction on page 6, "...laborers would be based on the Island of Hawaii."

13 13) Who is the developer? What are the connections between this project and other hydro projects being considered in Hawaii? What other projects have they done? Have they "sold the rights" to this or any other project?

14 14) This DEIS does not answer the concerns of the various agencies and divisions as expressed in the DEIS consultation and Correspondence.

15 As currently presented, this document provides insufficient, incorrect and incomplete information, and is not a disclosure statement. This document doesn't deal with the basic issues of public safety and significant environmental disturbance, which are of major concern in this project. It is not possible to comment on the merits of this project without having a reasonable disclosure of the project itself. It may be deficient by the requirements of Chapter 343, HRS.

Sincerely,

Carol Wilcox

Carol Wilcox

✓cc Dean Anderson, Island Power Co.

10 The only response received from Lihue Plantation (Amfac Hawaii, Inc.) is a letter from Michael B. Burke of AmFac, to Dean Anderson of Bonneville Pacific Corporation dated February 28, 1989. This is Document #14 and is included in full in this section of the Final EIS.

11 The proposed project is not expected to create any significant adverse impacts to recreational opportunities in the area. Up to 80 percent of the penstock will be buried. These buried sections of penstock will offer access routes over the penstock for both recreationists and wildlife.

The project is also not expected to significantly impact the bass fishery in Maheo Stream. For a more detailed response to this concern, see the response to the comments 6 and 10 of Document #1.

12 At this time, laborers needed for construction of the Upper Wailua Hydroelectric Project would come from the Island of Kauai. If a sufficient enough labor force is not available on Kauai, laborers would be drawn in from the remaining islands. All laborers during project construction would be based on the Island of Kauai.

13 The developer of this project is Island Power Company. Island Power Company is a wholly owned subsidiary of Hawaii Power Corporation. Hawaii Power Corporation is a partnership comprised of Bonneville Pacific Corporation and Calpine. Bonneville Pacific Corporation is an independent power producer and has operations throughout the United States. Calpine is an engineering firm located in the state of California. The joint venturing of this project brings together two experienced developers with a long history and hydro power development. The only other hydroelectric project that is currently being considered in Hawaii by the joint venture partnership is a project on the East and West Wailuaiki Rivers in Maui. It is their intent that the developer develop and operate this project and to continue ownership of this project.

14 We feel that the concerns of the agencies involved in the proposed Upper Wailua Project have been adequately addressed.

15 This document was intended to be a disclosure statement analyzing potential environmental impacts associated with developing a hydroelectric project on Maheo Stream. The Final Environmental Impact Statement prepared for this project is a more extensive and complete document that is designed to satisfy the concerns of all interested parties.

DOCUMENT #11

Hermina M. Mc ita

P.O. BOX 791
HANALEI, KAUAI, HAWAII 96714
(808) 826-6612

January 9, 1989

Office of Conservation & Environmental Affairs
State of Hawaii, Department of Land & Natural Resources
P.O. Box 6221
Honolulu, Hawaii 96809

RECEIVED
JAN 12 AM 8 :
DLNR
OCEA

Reference: Comments on the Draft Environmental Impact Statement
Upper Wailua River Hydroelectric Project .

1 The Draft Environmental Impact Statement (DEIS) for the Upper Wailua Hydroelectric Project lacks substance to throughly discuss and to adequately evaluate the proposed facility making it very difficult to comment. Instead I was barraged with broad generalizations or useless information to wade through. I find it insulting that the developer has chose to submit a deficient document to waste time over. If this type of document is labeled as acceptable the State of Hawaii's criteria to uphold the validity of HRS Chapter 343 will have to be reevaluated.

2 Foremost, the developer fails to address a statement of purpose or need for action. Although the need for alternate energy is mentioned broadly throughout the DEIS no substantive information is given to discuss Kauai's energy requirements, present or future, and this project's direct impact on it. Some other areas that are not clear or are inconsistent are:

1. 3 The project is hard to locate with the given maps and description. The engineering drawings are difficult to understand, unlabeled and appear to be generic. These drawings could be applicable to any hydro facility throughout the nation and not exclusively for this project. For a layman, as many people who will review the EIS are, it would help to have conceptual elevation drawings with topographical features to visualize the project.

2. 4 Figure 1.3-1 - There are no details on how the proposed .25 fish screen will work. Will the velocity of the water approaching the intake smash the fish against the screen? Will the accumulation of rubbish against the screen hinder the effectiveness of the screen and overflow water and fish into the intake?

3. 5 The DEIS does not say how many times the penstock will cross the stream, where it will cross the stream or how it will done and mitigated.

1 Please refer to the response to comment 15 of Document #10 for a response to this comment.

2 Please refer to the response to comment 9 in Document #10 and to the testimony of Kelvin L. Kai, Manager, Transmission and Distribution, Kauai Electric Division of Citizens Utilities company (Section 13).

3 The project maps were made more readable in the Final EIS. The Engineering drawings are also more readable in the final document. Project maps have significant streams in the area highlighted (including the Hanalei, Maheo, and North Fork Wailua) and the maps are not reduced in size as much as they were in the Draft EIS.

4 The proposed diversion structure and fish screen to protect aquatic organisms on the Hanalei River is discussed under responses to comments 4 and 5 in Document #1.

5 Additional field work was conducted to select a specific route for the penstock and access road. The route selected follows ridge lines away from streams where possible and thus minimizes cuts on steep side slopes, streambanks and gullies (Figure 1.6-4). Erosion potential is thereby also lessened significantly. This is beneficial both environmentally and for practical construction. Where crossings of streams or gullies are essential, the crossings are designed to take all practical precautions to limit erosion. Where crossings are for the temporary access road only, they will be removed and the site restored. Where crossings are permanent, they will be conservatively designed to cope with severe high flows while minimizing erosion.

Penstock stream crossings are shown on Figure 1.6-4. Penstock crossings of perennial streams and side gullies will be of two types, as illustrated in Figures 1.4-1 and 1.4-2. For the two significant stream crossings labelled on Figure 1.6-4, the penstock will bridge the stream at a height sufficient to avoid the impact of streamflows even for extreme floods (see Figure 1.4-1). Construction activity for such crossings will be concentrated on the two banks. For crossing gullies in conjunction with a permanent culvert installation, the culverts will be sized and/or the rockfill will be stabilized to cope with maximum foreseeable flood flows. Bridge type penstock crossings may be used at gullies if site specific conditions or economics indicate advantages for that design.

6 4. Figure 1.4-2 - Indicates penstock saddles set into granite bedrock. This information is inconsistent with Section 2.1.3 Soils.

7 5. Figure 1.6-2 - No information is given regarding permanent Irish crossing on the North Fork Wailua River: How will this structure alter the flow regime of the stream, what size are the culverts, what are the effects of pooling behind the culvert or the effect on the migratory pathway of diadromous species.

8 6. Section 2.1.4, Section 2.1.4.1, Figure 2.1-5, Figure 2.1-6, Figure 2.1-12, Figure 2.1-13, Figure 2.1-14, Figure 2.1-16 are comparison charts reflecting rainfall at Lihue and mean flows of Hanalei Tunnel, Haheo Stream and North Fork Wailua River. After being barraged with charts and statistics Paragraph 2 of Section 2.1.5.1 concludes bulk precipitation at Lihue has no relationship to annual flow patterns of these waterways. All this useless information is confusing.

9 7. There is no information regarding the methodology used for the aquatic survey. What are the qualifications of Lamarra in conducting the October 1988 survey? What criteria is being used to classify abundance, would it not vary with each species? Would it not have been better judgement to conduct a second survey during mid-summer prior to the downstream migration of the diadromous gobies?

10 8. Given the probability of finding several endangered or threatened species of birds within the project area why was an avian fauna survey not done?

11 9. Section 2.4.3.2 - statistics regarding wages paid by employers is inaccurate. - Hawai'i Data Book

Section 2.4.4 - statistics regarding harbor arrivals at Port Allen seem inaccurate. - Hawai'i Data Book

12 10. Section 3.0 is incomplete.

13 11. Section 4.2.1.3 states that the larvae of the opae can pass through the turbines with no affection. The cite (Couret 1976) may be misleading as this thesis did not study survival rates of opae larvae passing through turbines.

6 Figure 1.4-2 appearing in the Draft EIS has been corrected in the Final EIS. Section 2.1.3 - Soils - is correct.

7 The Irish Crossing is discussed in the response to comment 13 in Document #1. It is designed to not impede the movement of native diadromous species.

8 Precipitation and stream flow data was collected and analyzed in order to draw comparisons and establish relationships between precipitation totals at Lihue and stream flow in project area streams. There is no apparent relationship between these two factors. This conclusion was stated in Section 2.1.5.1 of the Draft EIS.

Analysis of precipitation and stream flow data in the Final EIS is different than what appeared in the Draft EIS. Precipitation data in the Final EIS was utilized from a rainfall station operated by Lihue Plantation (Station #1051). Average precipitation amounts recorded at Station #1051 are much greater than amounts recorded at Lihue, and are more representative of the project area. Refer to the Final EIS for a revised discussion on precipitation and streamflows.

9 The methods used in collecting the macroinvertebrates in the October, 1988 survey can be found in Standard Methods (APHA-AWWA-WPCF, 1980; pg. 1001). Dr. Lamarra has a PhD in aquatic ecology and 14 years experience working in aquatic environments. His resume is contained in Appendix H of this report. The methodology was not used to sample gobies (October, 1988 study).

10 An avian fauna survey was completed in February, 1989. An additional survey will be conducted in late April or May, 1989 to determine if Newell's Shearwaters nest within the project area.

11 Section 2.4.3.2 of the Draft EIS, Income on the Island of Kauai was typed incorrectly. The Draft EIS stated that the total wages paid by employers in 1986 was $322,720. The correct figure is $322,720,000 (State of Hawaii Data Book, 1987).

The statistics regarding harbor arrivals at Port Allen (12 inbound vessels in 1985) is correctly stated in the Draft EIS (State of Hawaii Data Book, 1987). This figure, however, excludes domestic fishing vessels.

12 Section 3 of the Draft EIS - Relationship of the Proposed Project to Land Use Plans, Policies, and Controls - has been expanded in the Final EIS.

13 The issue of 'opae larvae mortality in the turbines is discussed in response to comment 10 in Document #8 and comment 12 in Document #9.

COMMENT LETTERS TO DEIS

14 More information is needed regarding the design of the tailrace to include an energy dissipation structure to reduce velocities to less than one foot per second. It appears that 55% of the time the volume of water from the tailrace will be more than Maheo Stream.

15 12. Section 10.0 has no substance.

13. The following information should have been included in the DEIS to give a full disclosure and better overview of the project:

16 a) background information on Hanalei Tunnel

b) replies to various correspondence received (Section 15.0)

Item #3 - letter from AmFac Hawaii, Inc. regarding the ownership maintenance of the Hanalei Tunnel. More information is needed regarding agreements between Lihue Plantation and Island Power Company. It is difficult to assess, when the

17 resource belong to the State of Hawaii and the "improvements" belong to a private company, what is a fair compensation froe the third party.

18 Item #7 - Hanabu Tagomori memorandum questions the applicant's right to use diverted water and lease of state lands. Both issues are not addressed in the DEIS.

19 Item #9 - The concerns of Don Heacock are not addressed in the DEIS.

RESPONSES TO COMMENTS

14 This issue is discussed in the response to comment 11 in Document #8.

15 Section 10 of the Draft EIS on the Upper Wailua River Hydroelectric Project - Offsetting Beneficial Effects, Interests, or Considerations - has been expanded in the Final EIS.

16 Information on the historical flows of the Hanalei Tunnel has been provided in the EIS in Section 2.1.5.1.

17 Island Power Company is presently negotiating an agreement with Lihue Plantation (AmFac) for the use of water flowing through the Hanalei Tunnel. Island Power Company is also negotiating a similar water and land use agreement for the Lower Wailua project. These agreements, as presently drafted, call for cooperative maintenance of the Hanalei Tunnel. Basically, Island Power Company is proposing to Lihue Plantation that Lihue continue performing the annual maintenance work in the tunnel and that the costs of such work be reimbursed by Island Power Company.

Ms. Morita's reference to the 'resource' belonging to the State of Hawaii, while "improvements" belong to a private company, is an oversimplification of the matter of water rights. Her reference seems to be to the fact that the land on which Hanalei River water arises in the upper reaches of the Hanalei basin is State-owned. Irrespective of the land ownership, Lihue Plantation has an established right to divert water flowing in the Hanalei River through the Hanalei Tunnel for agricultural use in the Wailua River basin. The validity of Lihue's water rights has been upheld by the courts.

The question of compensation to the State of Hawaii for use of Hanalei River water by the Upper Wailua project is under consideration presently by the Division of Land and Natural Resources. At present it appears that an annual fee for water use will be charged based on actual energy production.

18 Discussions with Mr. Tagamori have indicated that the applicant does not have a right to use diverted water and state lands without applying to the state for such rights. The applicant has had discussions with the state concerning the right to lease the state lands and to utilize diverted waters and, in fact, has filed for the necessary permits for the diversion of the waters and filed applications to amend the instream flow standards. The leases will not be finalized until a conservation district use permit has been obtained for the project. It should be noted that the applicant is not diverting any additional water from the Hanalei River. The purpose of this project is to utilize flows currently diverted for use in the Amfac/Lihue Plantation irrigation system. The flows have been diverted since the 1920's on a continuing basis. The project simply will utilize the waters from the outlet of the Hanalei tunnel on the Wailua River side for the production of power and will re-divert those flows above the confluence of the Maheo Stream/North Fork Wailua River above the Stable Storm Ditch Diversion which is the existing diversion for Amfac/Lihue Plantation. There are no existing diversions between the outlet to the tunnel and the Stable Storm Ditch Diversion.

19 Issues raised by Don Heacock have been addressed in this section of the EIS (Appendix D) in response to Documents 1 and 4.

20 Item #11 - Questions raised by Mike Shimabukuro regarding the water license to East Kauai Water Company, Ltd. are unanswered.

21 c) More information should be given on pending or preliminary agreements between Kauai Electric and the developer.

14. Section 12.0 - Information regarding the Special Purpose Revenue
22 Bonds is inaccurate. The developer should disclose that legislation was approved for the issuance of revenue bonds for this project.

From a layman's point of view, barring the fact that water is being diverted from the Hanalei watershed, the location of this hydroelectric facility may
23 be the least objectionable of sites with regard to the environment impact should acceptable mitigative measures be taken. However, the DEIS is so deficient that one cannot even begin to evaluate the impacts or BENEFITS of this project.

This is only a small sampling of inaccurate or inconsistent statements found in the DEIS. Until the developer provides a full disclosure of the
24 project's impacts as well as benefits so a thorough evaluation can be made, the permitting process should be halted.

This comment is being submitted on behalf of Wai Ola, a proponent for a river conservation program, and as an individual.

Sincerely,

Nina Morita
Director, Wai Ola

20 Following receipt of Mr. Shimabukuro's letter, the requested information was forwarded to Mr. Shimabukuro. There have been no further comments from his department.

21 Please see the previous response to comment 9 in Document #10.

22 At the time this Final Environmental Impact Statement was released, legislation was still pending to authorize issuance of revenue bonds for the proposed project.

23 The Final EIS on the proposed project has been revised, expanded, and includes new information relative to the affected environment of the project area. The applicant feels that an informed decision can be made in regards to the project utilizing the information found within the Final EIS.

24 See the response to comment 23 in Document #11.

DOCUMENT #12

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT
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MANABU TAGOMORI, P.E.
DEPUTY

January 24, 1989

Received
1-30-89

Mr. Clark Mower
Development Manager
Bonneville Pacific Corporation
257 East 200 South, Suite 800
Salt Lake City, Utah 84111

Dear Mr. Mower:

Upper Wailua Hydroelectric Project
Request for Clarification of Petition and
Application Declarations, and Comments on
Project Draft Environmental Impact Statement

During the past week, our Division of Water and Land Development Instream Program staff fully reviewed your petition to amend the interim standard and applications for stream channel alteration and diversion works permits for the Upper Wailua Hydroelectric Project. The petition and applications are also being reviewed by other federal, state, and county agencies at this time.

Our review indicated a number of areas needing clarification. The information or clarification. The information or clarification asked for in our comments below is essential to our preparation of a recommendation to the Commission.

Petition to Amend Interim Instream Flow Standard

1 A. Are the average monthly flow values for gage #16100000 indicated in Item 4 of the petition for the period of record of the gage or some other time period?

1-15 These comments are in reference to the petition to amend interim instream flow standards and applications for stream channel alteration and stream diversion work permits and will not be addressed here.

2 B. How often (in days) will flows be diverted into the penstock if flows between 8 cfs and 48 cfs (as indicated on page 8 of the project draft EIS) are diverted?

3 C. In the Project Impact Statement attached to the petition, it is indicated that "the Upper Wailua Project will divert all flows from the existing Lihue Plantation - Hanalei Tunnel Outlet up to approximately 40 cfs (the maximum hydraulic capacity of the project penstock)" (emphasis added).

The draft EIS states that:

4 (1) "The penstock will convey Hanalei tunnel irrigation water (approximately maximum flow of 42 cfs) ..." (page 1); and,

5 (2) "The proposed intake structure at the outfall of the Hanalei tunnel will have the ability to divert 8 to 48 cfs" (page 8).

6 It is also stated in the General Project Description attached to the petition that the penstock will convey an approximate maximum flow of 42 cfs.

7 Please clarify the range of flows that are proposed for diversion into the penstock and the penstock capacity.

Stream Channel Alteration Permit

8 A. In Item 4, "Matleo" Stream should be changed to "Maheo" Stream and "Dauai" to "Kauai".

9 B. In Item 5, it is indicated that 5 feet high 10 feet wide concrete diversion structure is proposed. Page 1 of the draft EIS describes the diversion structure to be 5 feet high and 30 feet across. Please clarify.

10 C. Further information will be required for the number, location, and description of stream crossings for the access road and penstock construction. These crossings will need to be evaluated for stream channel alteration permit requirements.

11 D. In Section 4.1.2.4, page 113 of the draft EIS, which discusses endangered avian fauna, it is stated that "a survey will be conducted in late May or early June 1989, prior to construction of the project to determine the status of these species in the project area". This survey should be conducted prior to the issuance of permits to allow for mitigative measures, if necessary, to be discussed and considered before the project proceeds.

12 E. Section 4.1.4.1., page 115 of the draft EIS. A plan view of the penstock indicating the areas where it is buried and where exposed will be helpful to determine the impact of the penstock on recreational concerns in the area.

13 F. Section 4.1.5, page 116 of the draft EIS. When using water to control dust along the access road during dry periods, precautions should be taken to prevent the water used in dust control from entering the stream.

Stream Diversion Works Permit

14 A. In Item H, clarify whether the weir width is 10 or 30 feet wide. See Stream Channel Alteration Permit comment B.

15 B. In Item J, clarify whether all flows or a certain range of flows will be diverted. See Petition to Amend Interim Instream Flow Standard comment C.

Also attached to this letter are comments regarding the project draft EIS. We realize that the comment period for the draft EIS ended January 9, 1989, but resolution of the questions raised in or comments on the draft EIS will be necessary for the preparation of our recommendation to the Commission on Water Resource Management. We hope that our comments can also be incorporated into your revised EIS.

Please call George Matsumoto at (808) 548-7619 should you have any questions.

Sincerely,

MANABU TAGOMORI
Deputy Director

SC:SS:ko
Attach.
cc: Don Horiuchi
Office of Conservation and Environmental Affairs

Comments on Draft Environmental Impact Statement

16 1. Section 1.3, page 8, paragraph 1. In reference to the diversion structure in the Hanalei drainage basin, the statement "...bypass flows will be maintained to allow downstream movement" needs further discussion and detail describing flow quantities and the bypass structure. Also, will the maintenance of bypass flows be consistent with the statement that "the diversion structure in the Hanalei drainage will not alter the existing diversion volume or pattern currently followed by Lihue Plantation"?

17 2. Section 1.3, page 8, paragraph 2. It is indicated that the intake at the Tunnel outfall will be able to divert 8 to 48 cfs. How will these flows be regulated?

16 These concerns have been addressed previously in this section of the EIS. Responses are included in comments 1 and 5 in Document #1 and comment 17 in Document #8.

17 At flows below 8 cfs, gates will be closed which will maintain the penstock in a full condition. Water will then overflow the intake structure and be bypassed into the headwaters of the Maheo Stream. In a similar manner, when flows exceed 48 cfs, excess water will also be diverted into the headwaters of the Maheo Stream.

Comment	Response
18 3. Section 1.4, page 13. The penstock route will have "several stream crossings". More detail is needed as to the location and exact number of streams to be crossed and how the penstock will cross the channels since these crossings may require stream channel alteration permits. The profile of the stream crossing shown in Figure 1.4-2, page 12, would most likely require a stream channel alteration permit.	18 Penstock crossings of streams are indicated on Figure 1.6-4. Details of these crossings are given on Figures 1.4-1 and 1.4-2. It is realized that a stream channel alteration permit will be required for penstock and access road crossings.
19 4. Section 1.6, page 13. The access roads to the diversion weir and the transmission line require detailed descriptions as to their impact on stream crossings. In particular, the "permanent Irish crossing" over the North Fork Wailua River described in paragraph 1 will require a stream channel alteration permit.	19 As stated previously, it is realized that permits will be required for all stream crossings.
20 5. Figure 2.1-5, page 36. Discuss the selection of average, wet, and dry years.	20 The selection of wet, dry and average years were based upon the total annual runoff (ac-ft) at USGS Station #680 and bulk annual precipitation (inches/year) at Lihue plantation Station #1051. An average year was determined by comparing the individual annual data with the overall period of record average. Wet and dry years were determined by selecting those years substantially above and below the annual averages.
21 6. Section 2.1.5.1, page 41, paragraph 1. It is stated that the average flow from the Hanalei Tunnel for the period of record is 27.0 cfs. However, on page 56, and in other sections of the document (e.g. page 122 and 127), 26.0 cfs is used. Is 26.0 cfs the average Tunnel flow or some other flow value?	21 The average flow is 26 cfs.
22 7. Section 2.1.5.1, page 41, paragraph 1. Explain the use of only 25 years of record rather than the entire period of record.	22 The selection of the most current 25 years represents a complete data set for both USGS stations (#1000 and #680) as well as meteorological data from Lihue plantation stations #1051 and 1054.
23 8. Section 2.1.5.1, page 41, paragraph 2; and Figure 2.1-13, page 47. How were average, wet, and dry water years determined?	23 See response to comment 20 in Document #12.
24 9. Section 2.1.5.1, page 41, paragraph 2; and page 51, paragraph 1. Discuss the rationale for relating the Tunnel and stream flows to rainfall in Lihue rather than a rainfall measurement station closer to the project site.	24 At the time of the Draft EIS, Lihue Airport data were the only available information. However, with the acquisition of Lihue plantation data (Stations #1051 and #1054) located within the drainage basin, a more accurate description of rainfall and temperature for the site has been included in this report.
25 10. Figure 2.1-11, page 45; Figure 2.1-15, page 49. Clarify if flow values used are mean monthly flows or some other flow value.	25 Values are mean monthly flow unless otherwise stated.
26 11. Table 2.2-4, page 62. The method of estimating fish abundance is not consistent if the length of each site is not the same.	26 This comment has been previously addressed in comment 8 in Document #9.
27 12. Section 4.1.1.3, page 106. Expand on the description of stream crossing structures and the resulting permanent loss of stream habitat. Include alternatives for avoiding permanent loss of habitat.	27 The most cost-effective means of crossing the major streams with the permanent access road will be to use Irish crossings which are already in use elsewhere on the Wailua River. Penstock stream crossings will consist of two types, temporary and permanent, which are depicted in Figures 1.4-1 and 1.4-2. Benthic habitat will be lost under the Irish crossing and the permanent tributary crossings. Discussion of alternative crossing designs is included in Section 4.1.1.3.

COMMENT LETTERS TO DEIS

28 13. Section 4.2.1.1, page 118, paragraph 1. What points on Maheo Stream and the East Branch of the North Fork Wailua River were used to calculate their respective drainage areas?

29 14. Section 4.2.1.1., page 118, paragraph 1. The estimated natural flow for Maheo Stream has a range of 140 cfs to 5 cfs. At what point on Maheo Stream do these values apply? Will any portions of Maheo Stream be dewatered?

30 15. Section 4.2.1.3, page 127. It is stated that "downstream migrant gobies will be protected by installing a screening device on the project intake sized to exclude the large, mature fish, and will include a bypass to return them to the Upper Wailua River below the tunnel". This screening device and bypass should be shown in Figure 1.3-2, page 10, which illustrates the diversion structure at the Hanalei Tunnel outlet.

31 16. Table 5.0-1, page 134. Describe how the loss of habitat due to stream crossings are unavoidable and a detailed description of the crossings. Also see comment 12.

32 17. A scaled map or drawing should be provided to show the hydropower facility (intake to powerhouse tailrace), affected portions of Maheo Stream, and any inflows between the intake and powerhouse.

RESPONSES TO COMMENTS

28 The Maheo Stream watershed area was calculated above its confluence with the North Fork Wailua River. The East Branch of the North Fork watershed area was calculated above USGS Station #680.

29 They were determined at the confluence with the North Fork Wailua River. No. The water used in the project is added to the drainage from the Hanalei Diversion.

30 This comment has been previously discussed in responses to comments 4 and 5 in Document #1.

31 This comment has been addressed in the text of the report (Section 4.1.1.3) as well as in response to comment 27 in Document #12.

32 A detailed site map and project maps have been provided in the text of this report. There are no inflows to the project between the intake and the powerhouse. Maheo Stream will be affected only by one stream crossing (Figure 1.6-4) and by the tailrace.

DOCUMENT #13

OFFICE OF STATE PLANNING
Office of the Governor
STATE CAPITOL, HONOLULU, HAWAII 96813 TELEPHONE (808) 548 3893

JOHN WAIHEE, Governor

received 2-3-87

RECEIVED
JAN 3 1 1989
Ans'd............

Ref. No. P-9109

January 25, 1989

MEMORANDUM

TO: The Honorable William W. Paty, Chairperson
Department of Land and Natural Resources

SUBJECT: Upper Wailua River Hydroelectric Project, Draft Environmental Impact Statement (DEIS), Wailua, Kauai

We have received the subject Draft Environmental Impact Statement (DEIS) relative to the Coastal Zone Management (CZM) objectives and policies of Chapter 205A, HRS, and have the following comments.

Coastal Ecosystems

A CZM objective is to protect valuable coastal ecosystems from disruption and minimize adverse impacts on all coastal ecosystems.

1 The Hanalei River is listed in the Nationwide Rivers Inventory and has notable features that are considered valuable CZM resources. Water diversions from the Hanalei Tunnel will affect the Hanalei River flow. However, the impacts from the proposed flow reduction were not discussed in the DEIS.

2 The diversion could disrupt estuarine wetland, marine and other habitats including the Hanalei National Wildlife Refuge, the Hanalei Fishpond and historic taro fields. Anadromous species such as the native Oopu Nakea rely on the stream for migration, reproduction and survival. The taro fields provide an important habitat for endangered Hawaiian Stilt, Coot, Gallinule and Duck. In addition, native flora and fauna, some of which are rare and endangered, could be adversely impacted from the diversion. The DEIS should include studies on the endangered Hawaiian waterbirds, as well as on the biota and ecological communities of native flora and fauna to ascertain the potential environmental impacts of the diversion.

---

1 The proposed Upper Wailua Hydroelectric Project will do nothing to alter existing diversions of water out of the Hanalei watershed or the condition or gaging of the Kaapoka Tunnel. The project will create no new or incremental impact on the Hanalei River. The proposed project utilizes only irrigation water presently flowing through the tunnel and down Maheo Stream.

2 See the response to comment 1

Historic Resources

3 Another CZM objective is to protect, preserve, and where desirable, restore those natural and man-made historic and pre-historic resources in the CZM area that are significant in Hawaiian and American history and culture.

3 We agree. No further comment is necessary.

4 According to the State Historic Preservation Office, an adze quarry (TMK 4-2-1:02) located in a grassy area along the proposed penstock route near the confluence is a significant archaeological site with high sensitivity to encounter undiscovered archaeological resources. Therefore, because construction usually results in adverse impacts on archaeological resources in the area the applicant should formulate mitigation measures that satisfy the State Historic Preservation Office.

4 This issue was discussed under the response to comment 20 in Document #9.

Thank you for this opportunity to comment on the DEIS.

Harold S. Masumoto
Director

cc: ✓Mr. Dean Anderson
Bonneville Pacific Corporation

DOCUMENT #14

AMFAC HAWAII, INC.
700 Bishop Street
P.O. Box 3230
Honolulu, Hawaii 96801
(808) 945-8111

February 28, 1989

Amfac

RECEIVED
MAR 0 1 1989
Ans'd.........

Mr. Dean Anderson
Bonneville Pacific Corporation
820 Mililani Street, Suite 701
Honolulu, Hawaii 96813

Subject: Upper Wailua Hydroelectric Project: Draft EIS

Dear Mr. Anderson:

We have reviewed the draft EIS for the Upper Wailua Hydroelectric Project and would like to offer the following comments:

1) As mentioned in our September 23, 1988 letter, Lihue Plantation is concerned about the maintenance responsibility and liability relative to the Hanalei and Kaapoko section of the East Kauai Water Company system. This concern must be addressed to our satisfaction. **1**

2) Recently there have been discussions of installing a fish ladder from Wailua Stream to the Hanalei Tunnel outlet. This would allow fish which currently do not exist in Upper Hanalei stream to enter the stream and possibly endanger the Oopu population. **2**

3) During construction, the water which Lihue Plantation relies upon cannot be interrupted. If water is needed by Lihue Plantation during this time, Bonneville will have to find a solution or halt construction. **3**

Responses:

1 Our proposal is that Lihue Plantation continue to perform the routine maintenance work and that Island Power Company reimburse Lihue for its actual out-of-pocket costs for doing this work. Island Power agrees that in the event Lihue ceases sugar planting operations altogether, Island Power will take over the actual maintenance work. Island Power accepts the risk of the tunnels becoming inoperable due to circumstances beyond the control of Lihue, such as natural cave-ins, and Island Power agrees that Lihue shall not be liable for maintaining water flows through the tunnels or for any plant downtime caused by flow interruptions or tunnel damage.

2 This seems to be a misunderstanding. No fish ladder has been proposed for the Hanalei Tunnel outlet. The only diversion would be the present one at the Hanalei Tunnel intake.

3 We agree to manage the construction in such a way that such flows are not interrupted. We believe that this can be readily accomplished through the use of appropriate construction methods.

4) More information regarding the power line alignment would be useful. Also, Lihue Plantation cannot accept 4 any additional road maintenance responsibilities. Any roads which Bonneville uses will need to be maintained by Bonneville.

5) We would like two copies of the EIS when it is 5 completed. We reserve the right to make additional comments at a future date.

Very truly yours,

Michael B. Burke
Project Manager

4 The power line alignment is shown on Figure 12-6 of the Final EIS. Please note that the power line follows the Stable Storm Ditch and two existing cane haul roads and terminates at the existing substation. This alignment was selected in order to minimize disruption to the natural terrain and vegetation. With regard to routine road maintenance after construction is completed and the plant is in operation, we are proposing that Lihue maintain the access roads, and that Island Power Company reimburse Lihue its actual cost of performing any special maintenance work required by or because of the presence of the project. Such maintenance will be minimal because the only vehicle routinely traveling to and from the power plant will be the plant operator's pickup truck.

We propose that during construction, Island Power be responsible for the performance and cost of all road maintenance. This will be part of the general contractor's scope of work.

5 We will be happy to provide you with two copies of the Final EIS and to respond to any additional comments or questions you may have.

APPENDIX E

PERSONNEL QUALIFICATIONS

CHAR & ASSOCIATES

WINONA P. Char

4471 Puu Panini Avenue
Honolulu, Hawaii 96816

Telephone: 734-7828

EDUCATION

Master of Science (M.S.) degree in the Botanical Sciences, University of Hawaii, Manoa. December 1983. Area of specialization: Plant taxonomy with special emphasis on the native Hawaiian flora. M.S. thesis topic: "A revision of the Hawaiian species of Sesbania (Leguminosae)."

Bachelor of Arts (B.A.) in the Botanical Sciences, University of Hawaii, Manoa. May 1970.

Graduate of Kaimuki High School. June 1965.

EXPERIENCE

Botanical Consultant - 1976 to present; self-employed. Field investigation, data analysis, and preparation of findings for the biological section in Environmental Impact Statements (EIS). The scope of work involves: (1) a discussion of rare, threatened or endangered plant species found on the study site; (2) a general description of the major vegetation types found on the study site; (3) an inventory of the flora on the study site; (4) the identification of areas of potential environmental problems or concerns; and (5) a summary of the extant botanical knowledge of the study site.

Natural Area Biologist, SR-21 - July 1985 to June 1986. One year funding. Natural Area Reserves System (NARS), State Department of Land and Natural Resources. Major duties: Plan, develop, and direct native and non-native plant and animal surveys within the reserves system. Evaluate existing and potential impact of non-native species within each reserve. Develop site-specific management programs as well as direct on-site management activity. Supervise a lower-level NARS biologist and, when available, part-time and volunteer workers.

Horticulturist, SR-18 - May 1978 to September 1979. Honolulu Botanic Gardens, City and County Department of Parks and Recreation. Major duties: Program director, Exceptional Trees Program. Working with the City Administration and the City Council in establishing a permanent staff organization and Arborist Advisory Committee necessary to fulfill the Exceptional Trees' Law; documentation and identification of the Exceptional Trees designated by the City and County Ordinance; identification of additional trees to the list. End of contract; left to complete M.S. degree program.

INTERESTS

Hiking, fishing native plants, bonsai, photography, trivia collector.

Member of the following organizations:
- Hawaiian Botanical Society. Life membership. Served as Chairman, Science Fair Committee, 1981, 1983. Secretary 1978, 1979. Director 1977. Native Coastal Plants Committee 1986.

- The Nature Conservancy. Sponsor 1986.

Community service:

- The Nature Conservancy. Resource person. Scientific Advisory Committee.

- State Department of Education (DOE). Resource person and lecturer, native plants and island ecosystems.

- Marine Advisory Program, Sea Grant, University of Hawaii. Resource person, strand vegetation.

PERSONAL BACKGROUND

One-quarter Hawaiian, that's why the active interest in native plants and island ecosystems. Single, 5 ft. 5 in. tall, roughly 128 lbs. Born 16 May 1947(a baby boomer).
References will be furnished on request.

PUBLICATIONS

Char, W. P. 1976. Field studies of the Sesbania complex on the island of Hawaii. Pacific Tropical Botanical Garden Bulletin 6(2): 41.

__________. 1977. Strand vegetation of Hawaii. Hawaii Coastal Zone Newsletter 12(1): 4-6.

__________. 1981. Strand ecosystems in Hawaii. pp. 3-5. In: R. Tabata, ed. Conserving Hawaii's Coastal Ecosystems. Uni. Hawaii Sea Grant Cooperative Report.

__________ and N. Balakrishnan. 1979. 'Ewa Plains Botanical Survey. U.S. Fish & Wildlife Serv., Honolulu. 119 pp. + maps.

__________ and C. H. Lamoureux. 1985. Puna Geothermal Area Biotic Assessment, Puna District, County of Hawaii. Prepared for Hawaii State Dept. of Planning and Economic Development, Honolulu. 126 pp. + maps

CULTURAL SURVEYS HAWAII
ARCHAEOLOGICAL STUDIES

CULTURAL SURVEYS HAWAII

Archaeological Studies
Hallett H. Hammatt, Ph.D.
49 S. Kalaheo Avenue
Kailua, Hawaii 96734
(808) 261-8293
262-9972

HALLETT H. HAMMATT, Ph.D., owner and sole proprietor - founded 1982

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PERSONNEL AND ASSOCIATES

Hallett H. Hammatt, Ph.D. (Proprietor)
Twenty-three years experience in archaeology, ten years in Hawaiian archaeology, directed and completed approximately 275 archaeological projects in Hawaii involving work on all major islands and in most aspects of Hawaiian archaeology. Ten years experience in consulting with over 50 governmental agencies and private companies in Hawaii.

Douglas Borthwick (Associate)
B.A. in Archaeology, graduate study in Pacific Islands Studies, ten years experience in Hawaiian archaeology work on all major islands, specialty in site survey, artifact analysis, historical search.

David Shideler (Associate)
B.S. in Zoology, B.A. Anthropology, M.A. Environmental Health Management, ten years experience in Hawaiian archaeology, founding member of the Malacological Society, specialty in floral and faunal identification, ecology, analysis of faunal remains from archaeological sites.

Stephen Clark (Associate)
B.A. in Anthropology, 15 years experience in Hawaiian archaeology, field and laboratory studies, archaeological drafting.

Kirsten Nakamura (Associate)
Field and laboratory assistant, ten years experience in archaeology, cataloging, illustration.

PARTIAL LIST OF CLIENTS

U. S. Army Corps of Engineers
Hawaii Housing Authority
Hawaii Community Development Authority
Belt, Collins and Associates
Gerald Park, Urban Planner
Kamehameha Investment Corp.
R. M. Towill
Keauhou-Kona Resorts
Keauhou-Kona Realty
Imata and Associates
Project Planners Hawaii
Gamlon Corp.
Bingham Engineering
Dames and Moore
Portugal and Associates
Lone Star Hawaii
Hawaii Omori Corp.
Taiyo Fudosan
Kohala Ranch
Friends of I'olani Palace

OTHER ASSOCIATES AND SUB-CONSULTANTS

William Kikuchi, Ph.D.
Kauai Community College, Crafts Hawaii volcanic glass dating, petrographic studies, Hawaiian fishponds

Michael Pietrusewsky, Ph.D.
University of Hawaii, Manoa, physical anthropology, osteological analysis

Other consultants in Hawaiian language, Hawaiian history, radiocarbon dating, botany, floral and faunal identification, planning

AREAS OF EXPERIENCE

Reconnaissance, survey, excavations, coring, site stabilization, site and area management, mapping, aerial survey, recovery of human burials, stratigraphy, historic search, fishponds, beach sites, cave sites, petroglyphs, survey of unaccessible areas, historic archaeology, urban archaeology, federal and state regulations in historic preservation.

FIELD AND LABORATORY EQUIPMENT AND FACILITIES

Cultural Surveys has the full range of field and laboratory equipment. The laboratory facility of 600 square feet is equipped with measuring and photographic equipment, scales, etc. and a Nikon petrographic microscope.

GEOGRAPHICAL EXPERIENCE

Oahu - Bellows, Olomana, Kualoa, Waiahole, Kaneohe, Kaka'ako, I'olani Palace, Mokapu, Waipio, Pearl Harbor, Barber's Point, Waiau, Moanalua, Ewa Beach, Wai'anae Valley, Pokai Bay, Makaha, Mākua, O'hikilolo, Keeau

Hawaii - Hilo, Puna, King's Landing, Waimea, Kohala, Kau , South Kona, Keauhou, Kahaluu, La'aloa, Holualoa, Kailua, Kaloko, Keahole, Lalamilo, Honalo, Kawaihae

Kauai - Lihue, Koloa, Poipu, Hanapepe, Waimea, Wailua, Hanalei Valley, Wioli, Ha'ena, Kapa'a

Molokai - West Molokai - Kaluako'i

Maui - Kaanapali, Wailuku

Kaho'olawe - Entire island site survey

ECOSYSTEMS RESEARCH INSTITUTE

DR. VINCENT A. LAMARRA

PERSONAL INFORMATION

Born: May 14, 1947, Palo Alto, California

EDUCATION

Post-doc. 1974, 1975. (Limnology) University of Minnesota
Ph.D. 1974. (Ecology and Behavioral Biology) University of Minnesota
B.S. 1969. (Natural Science - Mathematics) Fresno Pacific

PROFESSIONAL EXPERIENCE

1985-Present. President of ERI Logan, Inc.

1980-Present. Co-Director, Ecosystem Research Institute.

1981-1987. Adjunct Professor, Department of Civil and Environmental Engineering, Utah State University, Logan, Utah.

1975-1981. Assistant Professor, Department of Wildlife Science, Utah State University, Logan, Utah.

1975. Post-doctoral Fellowship, University of Minnesota, Minneapolis, Minnesota.

1972-1974. Environmental Protection Agency Fellowship. University of Minnesota.

1971. Research Assistant, Limnological Research Center. University of Minnesota.

1969-1971. Research Assistant, Department of Horticulture, University of Minnesota.

PROFESSIONAL SOCIETIES

American Society of Limnology and Oceanography
American Fisheries Society
International Association of Theoretical and Applied Limnology
Lake Management Society

CURRENT PROJECTS

* Upper Wailua Hydroelectric project Environmental Impact Statement.
* Bear Lake Preservation Project.
* Natural Resources Damage Assessment - Kessler Canyon, Utah.
* Determination of spring salmonid migration at Felt Hydroelectric facility.
* Environmental assessment of streambank reclamation - Teton Creek, Idaho.

* Evaluation of turbine induced mortality at a low-level hydro St. Anthony, Idaho.
* The development of a Fisheries Management Plan for Ashton Reservoir, Idaho, as fulfillment of a FERC license condition.
* The development of a Wildlife Managment Plan for Ashton Reservoir, Idaho, as fulfillment of a FERC license condition.

PAST PROJECTS

* Natural Resource Damage Assessment at Uravan Uranium Mill, Colorado.
* Natural Resource Damage Assessment at Globe Smelter, Denver, Colorado.
* Natural Resource Damage Assessment at Cotter Uranium Mill, Canon City, Colorado.
* An investigation of soil, vegetation, and groundwater contamination at the old Wasatch Chemical Plant, a *superfund* site in Salt Lake City, Utah.
* The development of guidelines for assessing the effects of fossil fuel development on environmental quality in the upper Colorado River Basin.
* An Environmental Assessment of the Proposed Island Park Hydroelectric on the Henry's Fork River.
* The impact of organics and heavy metals from spent oil shale leachate on community structure and function in hard-water trout streams and high order warm rivers.
* The evaluation of heavy metals and potentially carcinogenic organics released into coal mine and oil shale accrual waters within the Colorado River ecosystem.
* The projected environmental impacts of the proposed Smiths Fork Hydroelectric Project upon the Bear River/Bear Lake ecosystem.
* The assessment of community interrelationship between the Colorado squawfish and other fish species with special emphasis on trophic community structure in the upper Green River, Utah and Colorado.
* The determination of the physical, chemical, and biological factors regulating the White River ecosystem on Federal Lease Tracts Ua and Ub.
* Investigation of factors which regulate the reclamation of acid strip mine lakes for certain beneficial uses.
* The determination of metal dynamics in the proposed White River Dam - a eutrophic environment.
* Ecological investigations of a suspected spawning site of endangered Colorado squawfish of the Yampa River.
* A study of the primary production and standing crop of phytoplankton in the Colorado and Green Rivers.
* An evaluation of sewage disposal techniques in Canyonlands National Park, Colorado and Green Rivers, Utah.

* Investigations of fish distribution, habitat, and food preference in the White River, Green River Basin, Utah and Colorado.
* An environmental assessment of the potential oil pollution in Bear Lake: The effects of oil on primary, secondary, and tertiary producers.
* The response of freshwater ecosystems to allochthonous organic material.
* A Diagnostic-Feasibility 314 Clean Lakes Study for Bear Lake and the Bear River, Utah-Idaho.
* Development of methodologies in the use of Dingle Marsh to reduce the phosphorus and nitrogen loading from Bear River into Bear Lake, Utah- Idaho.
* Assessment of trihalomethane compounds and their precursors in Salt Lake County: The role of Mountain Dell Reservoir.
* *The effect of marina construction and other in-lake structures upon the chemistry and* primary productivity in Bear Lake, Utah.
* Environmental impact assessment of a potential fish hatchery on the Blacksmith Fork River, Utah.
* The use of power plant effluents in fish aquaculture.
* The evaluation of coal mine accrual waters from the Wasatch Plateau coal fields, Utah.
* The determination of factors which regulate the internal phosphorus cycling from benthophagous fish.

PUBLICATIONS

1989 - Preliminary Exhibit E. Environmental Report, FERC Relicense Cutler Hydroelectric Plan. Utah Power and Light. January, 1989. 48 pp.

1989 - An evaluation of and recommendations for a fisheries management plan Ashton Reservoir, Idaho. Utah Power and Light. February, 1989. 44 pp.

1989 - Assessment of Egin Diversion Dam as a Fish Barrier: Evaluation and Solution as required in FERC License Article 403. Utah Power and Light. March, 1989. 28 pp.

1988 - Investigation of Fish Migration at Felt Hydroelectric Project in satisfaction of Article 34 Agreements under FERC License No. 5089. Year II. Bonneville Pacific Corporation. 79 pp.

1988 - Closure Plan, Browning Manufacturing Company, Hazardous Waste Management Facility. 78 pp.

1987 - Bear Lake Water Quality Management Plan. BLRC. December 1987. 59 pp.

1987 - Investigations of Fish Migration at Felt Hydroelectric Project in Satisfaction of Article 34 Agreements under FERC License No. 5089. Year I. November, 1987. Bonneville Pacific Corporation. 60 pp.

1987 - A Riparian and Aquatic Off-site Mitigation Plan for the Felt Hydroelectric Project, FERC No. 5089. Bingham Engineering. December, 1987. 15 pp.

1987 - Island Park Hydroelectric Project, FERC #2973, Environmental Assessment - Volume I, II, and III. U.S. Forest Service, Targhee National Forest.

1987 - Idarado Remedial Investigation. State of Colorado. Department of Law, Office of the Attorney General.

1987 - Idarado Feasibility Investigation. State of Colorado. Department of Law, Office of the Attorney General.

1987 - Winter baseline investigation of surface media Uravan Uranium Mill, Colorado. The State of Colorado, Department of Law, Office of the Attorney General.

1987 - Remedial Investigation, Cotter Corporation Uranium Mill Site. The State of Colorado. Department of Law, Office of the Attorney General.

1987 - Feasibility Investigation, Cotter Corporation Uranium Mill Site. The State of Colorado. Department of Law, Office of the Attorney General.

1986 - Hydrology of Bear Lake Basin and its impact on the trophic state of Bear Lake. Great Basin Naturalist 46(2):690-705.

1986 - Drift of Larval Fishes in the Upper Colorado River. Journal of Freshwater Ecology. 3(4):567-578.

1985 - Fisheries Habitat Dynamics in the Upper Colorado River. Journal of Freshwater Ecology. 3(2):249-264.

1985 - Ecological investigation of a suspected site of endangered Colorado squawfish in the Yampa River, Utah. The Great Basin Naturalist 45(1):127-140

1985 - Responses of model freshwater ecosystems to crude oil. Water Research 19(3):285-292.

1984 - Consequences of oil pollution on the decomposition of vascular plant litter in freshwater lakes: Part II - Nutrient exchange between litter and the environment. Environmental Pollution (Series A) 34(2):101-118.

1984 - Consequences of oil pollution of the decompositions of vascular plant litter in freshwater lakes: Part I - Decomposition rates and dissolved oxygen utilization. Environmental Pollution (Series A) 34(1):83-100.

1984 - Eutrophication. Journal of Water Pollution Control Federation 56:697-704.

1984 - A historical perspective and present water quality conditions in Bear Lake, Utah-Idaho. USEPA. EPA 440/5-84-001. Edited by J. Taggart. 213-218 pp.

1984 - Socioeconomic and political issues associated with the implementation phase of the Bear Lake 314 Clean Lakes Study. USEPA. EPA 440/5-81-001. Edited by J. Taggart. 219-222 pp.

1984 - The nitrogen, phosphorus, and carbon budgets of a large riverine marsh, and their impacts on the Bear Lake Ecosystem. USEPA. EPA 440/5-81-001. Edited by J. Taggart. 223-228 pp.

1984 - The effect of coprecipitation of $CaCO_3$ and phosphorus on the trophic state of Bear Lake. USEPA. EPA 440/5-81-001. Edited by J. Taggart. 229-234 pp.

1983 - Investigations of fish distribution, habitat and food preference in the White River, Green River Basin, Utah-Colorado. Final Report to White River Shale Oil Corporation. Report #ERI 83-01. 162 pp.

1983 - The evaluation of metals and other substances released into coal mine accrual waters on the Wasatch Plateau coal field, Utah. Water Quality Series UWRL/Q-83/09. Utah Water Research Laboratory. 156 pp.

1983 - Environmental management - A data based ecosystem approach from the Oil Shale Industry. Journal of Environmental Management 17:17-34.

1983 - Aquatic guidelines for aquatic ecosystem restoration. IN: National Conference on Environmental Engineering. (Eds.) A. Medine and M. Anderson. American Society of Civil Engineers. 618-624 pp.

1983 - Heavy metal distribution and interactions in the White River Ecosystem. IN: National Conference on Environmental Engineering. (Eds.) A. Medine and M. Anderson. American Society of Civil Engineers. 867-876 pp.

1983 - A diagnostic-feasibility 314 Clean Lake Study for Bear Lake and it's watersheds. Final Report: Bear Lake Regional Commission. 269 pp.

1982 - Impact assessment of the White River Dam, Green River Basin, Utah. Final Report: White River Shale Oil Corporation. Report #ERI 82-01. 96 pp.

1982 - Experiments and experiences in biomanipulation. Studies of biological ways to reduce algal abundance and eliminate blue-greens. Interim Report No. 19. Limnological Research Center. Minneapolis, Minnesota. EPA-60013-82-096. 251 pp.

1982 - The aquatic resource management of the Colorado River Ecosystem. Editor. Ann Arbor Press. 697 pp.

1982 - Consequences of oil pollution on the decomposition of vascular plants in freshwater lakes. Part I: Decomposition rates and dissolved oxygen utilization. (In Press: Journal of Environmental Pollution).

1982 - The nature and availability of particulate phosphorus to algae in the Colorado River, Southeastern Utah. IN: Aquatic Resource Management of the Colorado River Ecosystem. (Eds.) V. Lamarra and V.D. Adams. Ann Arbor Science, Ann Arbor, Michigan. 161-180 pp.

1982 - An ecosystem approach to environmental management. IN: Aquatic Resource Management of the Colorado River Ecosystem. (Eds.) V. Lamarra and V.D. Adams. Ann Arbor Science, Ann Arbor, Michigan.

1982 - Assessing the effects of coal mining and related Energy development on aquatic environmental quality in the Upper Colorado Basin. IN: Aquatic Resource Management of the Colorado River Ecosystem. (Eds.) V.A. Lamarra and V.D. Adams. Ann Arbor Science, Ann Arbor, Michigan. 383-396 pp.

1982 - Water Quality Management Plan - Bear Lake Marinas. Bear Lake Regional Commission. 27 pp.

1981 - The 1981 aquatic monitoring program, White River, Green River Basin. Final Report: White River Shale Oil Corporation. Report #ERI 81-01.

1981 - The residence time of energy as a measure of ecological succession. IN: International Symposium on Energy and Ecological Modeling. Louisville, Kentucky. 591-600 pp.

1981 - The Bear Lake littoral zone: A limnological perspective. transactions, Bonneville Chapter American Fisheries Society. 83-92 pp.

1980 - The nitrogen and phosphorus budget of the Bear River, Dingle Marsh System, and its impact on a large oligotrophic water storage reservoir. IN: Surface Water Impoundments. (Eds.) H.G. Stefan. 1:371- 380. American Society of Civil Engineers, New York.

1980 - An evaluation of sewage disposal techniques in Canyonlands National Park. Final Report: National Park Service. 48 pp.

1980 - Bear River 208 water quality summary. Final Report: Bear River Association of Governments. Utah Water Research Laboratory, Utah State University, Logan, Utah.

1978 - To prey or not to prey, that is the consumption. An evaluation of a stocking program. IN: Transactions of the American Fisheries Society Meetings. 153-160 pp.

1977 - The use of hydroacoustic devices in Bear Lake fisheries. IN: The Laterial Line. Bonneville Chapter of the American Fisheries Society. October.

1976 - The environmental impact of the Bear Lake regional sewer - westshore system upon water quality. Bear Lake Regional Commission - EPA.

1975 - Biomanipulation: An ecosystem approach to lake restoration. IN: Water Quality Management Through Biological Control. (Eds.) P.L Brezonik and J.L. Fox. Department of Environmental Engineering Science, Gainesville, Florida. No. Env-07-75-1. 85-96 pp.

1975 - The digestive activities of carp as a major contributor to the phosphorus budget in lakes. International Association of Theoretical and Applied Limnology. Winnipeg, Canada. 19:2461-2468.

1973 - The use of drainage patterns and densities to evaluate large scale land areas for resource management. Journal of Environmental Systems 3(2):85-100.

RECEIVED AS FOLLOWS

MARIANNE CRAWFORD LAMARRA

PERSONAL INFORMATION

Born: September 24, 1950 in Price, Utah

EDUCATION

B.S. Utah State University; September, 1969 - June, 1973
Major - Zoology, Minor - Chemistry

M.S. Utah State University; March, 1976 - June, 1979
Department of Wildlife Science

PROFESSIONAL EXPERIENCE

April, 1981 - Present. Research biologist, Ecosystem Research Institute, Logan, Utah.

* Conducted survey of Colorado squawfish spawning sites on the Yampa River at River Miles 16.5 and 18.0.
* San Miguel River/Telluride, Colorado. 1986 to present.
* Water Quality Laboratory Supervisor/EPA and State Certified water analysis lab. 1986 to 1987.

1979 - April, 1980. Metals Analyst - Atomic Absorption Spectrophometer. Utah Water Research Laboratory, Utah State University.

July, 1978 - March, 1979. Fisheries Biologist, Non-game Section, Utah Division of Wildlife Resources, Salt Lake City, Utah.

* Conducted fisheries survey for the Deep Creek Mountain Inventory for Wilderness Classification.
* Member of the Woundfin Recovery Team.
* Member of the Colorado Squawfish Recovery Team.

March, 1976 - July, 1978. Conducted research on the reproductive biology of the least chub (Iotichthys phlegethontis); Fisheries Biologist, Utah Division of Wildlife Resources, Graduate Student, Utah State University.

November, 1973 - March, 1976. Fisheries Biologist, Water Quality Section and Assistant Project Leader of Hatchery Effluent Monitoring Program, Utah Division of Wildlife Resources, Salt Lake City, Utah.

June, 1973 - November, 1973. Biological Aide, Utah Division of Wildlife Resources, Flaming Gorge, Utah.

CONSULTING EXPERIENCE

March, 1982. Literature review and manuscript for the status report on least chub (Iotichthys phlegethontis) and Utah Lake suckers (June sucker - Chasmistes liorus mectus and webug sucker - Catostomus fecundus).

September, 1980. Literature survey and manuscript for the endemic fishes of the White River, Utah. White River Shale.

June, 1980. Participated in the research for Aquatic Biological Study of a Spring in Snake Valley, Utah, P.R.-36-1. Bio/West.

May, 1979. Literature survey and manuscript for the introduction to the Utah prairie dog (Cynomys parvidens) recovery plan. USFWS.

December, 1976. Participated in EPA Clean Lakes Program by training National Guard units to sample Bear Lake and Willard Bay.

PROFESSIONAL SOCIETIES

American Fisheries Society, Bonneville Chapter
Desert Fishes Council

1978. Award of Merit, Bonneville Chapter of the American Fisheries Society.

1976. Secretary-Treasurer, Bonneville Chapter of the American Fisheries Society.

1976-1978. Editor of the "Lateral Line", the Bonneville Chapter AFS newsletter.

1989. Executive committee, Bonneville Chapter of the American Fisheries Society.

PUBLICATIONS

1979 - An aquatic inventory of the streams of the Deep Creek Mountains, Utah (With Kent Miller). Utah Division of Wildlife Resources.

1979 - The reproductive modes of the least chub (Iotichthys phlegethontis). Utah Division of Wildlife Resources, Pub. #79-2.

1979 - The reproductive modes of the least chub (Iotichthys phlegethontis). Masters Thesis. Utah State University, Logan, Utah.

1978 - Least chub: the case of a generalist. Trans. Bonneville Chapter American Fisheries Society. 1 (Fed.):90-99.

1985 - Ecological investigation of a suspected spawning site of Colorado squawfish on the Yampa River, Utah. 1985 V.A. Lamarra, M.C. Lamarra and J.G. Carter. The Great Basin Naturalist 45(1):127-141.

MS. CYNTHIA K. JOHNSON

EDUCATION

M.S. 1984 (Range Ecology) Utah State University, Logan, Utah

B.A. 1979 (Biology) Rice University, Houston, Texas

PROFESSIONAL EXPERIENCE

1983-Present Biologist, Ecosystem Research Institute, Logan, Utah

1980-1984 National Science Foundation Graduate Fellowship, Utah State University, Logan, Utah

1979-1980 Research Technician, Dept. of Environmental Science and Engineering, Rice University, Houston, Texas

PROFESSIONAL SOCIETIES

Society for Range Management
Phi Kappa Phi
Phi Beta Kappa

CURRENT PROJECTS

* Preparation of Exhibit E document for relicensing of hydroelectric project on reservoir in Cache County, Utah.
* Preparation of Environment Impact Statement for proposed hydroelectric development on Kauai, Hawaii.
* Assessment of present environmental conditions and impacts of industry on those conditions in Salt Lake and Tooele Counties, Utah.
* Development and implementation of detailed plan for a riparian zone revegetation and wetland establishment program on a tributary of the Snake River in southern Idaho.
* Consultation and monitoring of implementation of mitigation plan for hydroelectric power project on Teton River in Fremont County, Idaho.
* Implementation of revegetation plan in riparian zone and on canyon slopes in Snake River Canyon in Twin Falls County, Idaho.
* Habitat Evaluation Procedures analysis of wetland to be impacted by gold mining operations near Stanley, Idaho.

PAST PROJECTS

* Preparation of FERC License Articles and 404 permit application for hydroelectric power project on a tributary of the Snake River in Twin Falls County, Idaho.
* Assessment of damages to natural resources at inoperative mining and milling sites in Colorado. Tasks include literature review for pertinent information, development, and implementation of a vegetation sampling plan, collection, and analysis of data for damage assessment, on site evaluations of natural resources damages and litigation support.

* Development of plan to obtain property to serve as off-site compensation for damages associated with a road construction accident in the Snake River Canyon in southern Idaho.

* Preparation of Exhibit E documents for three hydroelectric power projects in Utah.

* Compilation of all environmental data for the Bear Lake Basin, Utah, for the purpose of development of a water quality management plan. The product of the project will be a system of site-specific guidelines for development in the Bear Lake Basin.

* Development and implementation of a computer model to predict water yield enhancement from snow trapped in proposed topographic catchments in southwestern Wyoming. This model was used to develop a reclamation plan for a large pit on a coal strip mine.

* Design and implementation of project to quantify viable seeds in topsoil piles on a coal strip-mine in southwestern Wyoming.

* Development of system to catalog all data files pertaining to the White River oil shale tracts from several consulting firms.

* Systematic, data-based evaluation of the environmental monitoring program on the White River Shale Oil Corporation Tracts Ua and Ub. This evaluation was used to suggest changes in monitoring parameters and procedures to allow detection of industry-related environmental perturbations.

<u>PUBLICATIONS AND PRESENTATIONS</u>

1989 - "Seed Reserves in Stockpiled Topsoil on a Coal Stripmine Near Kemmerer, Wyoming", with N.E. West, submitted to Landscape and Urban Planning (in press).

1989 - "Determination of Impacts of Industrial Emissions on Colorado Rangelands", with V.A. Lamarra, R.Ryel, and S. Jensen, poster presentation at the annual meeting of the International Society of Range Management, Billings, Montana.

1988 - "Laboratory Comparisons of Five Seed Trap Designs for Dry, Windy Environments", with N.E. West, Canadian Journal of Botany 66: 346-348.

1988 - "Viability of Seeds Stockpiled Topsoil on the Kemmerer Coal Mine, Wyoming". Presentation at Utah Land Rehabilitation Workshop, Salt lake City, Utah. March 11, 1988.

1987 - "Land Form Design to Enhance Water Harvest". Presentation at Utah Reclamation Workshop, February 20, 1987.

1984 - "Seed Reserves in Stockpiled Topsoil on a Coal Mine Near Kemmerer, Wyoming", poster presentations at the annual meetings of the Utah Section of the Soil Conservation Society and the International Society for Range Management, Salt Lake City, Utah.

1984 - <u>Seed Reserves in Stockpiled Topsoil on a Coal Mine Near Kemmerer, Wyoming</u>, M.S. Thesis, Utah State University, Logan, Utah.

SCOTT R. GEORGE

EDUCATION

M.A. 1988 (Geography and Environmental Planning) California State University, Chico. Chico, California.

B.A. 1983 (Geography) Humboldt State University, Arcata, California.

PROFESSIONAL EXPERIENCE

1988 - Present. Environmental Planner, Ecosystem Research Institute, Logan, Utah.

1986 - 1988. Environmental Specialist, California Department of Water Resources, Northern District, Red Bluff, California.

1981 - 1988. Various positions with U.S. Forest Service and U.S. Bureau of Land Management, California and Nevada

CURRENT PROJECTS

* Preparation of Environmental Impact Statement for Upper Wailua Hydroelectric Project. Island of Kuai, Hawaii.
* Preparation of "Exhibit E" (FERC) - Environmental Assessment for a reservoir in Northern Utah.
* Natural resource damage assessment for a mill site near Salt Lake City, Utah.
* Streambank restoration on Teton Creek, Idaho.

PAST PROJECTS

* Team Member. Upper Sacramento River study team task force - riparian vegetation preservation committee. 1988.
* Cottonwood Creek aggregate extraction project. Environmental and economic assessment. 1988.
* Sacramento River environmental database development and management. 1986.
* Reed's Creek flood control and land use assessment. 1987.
* Team member. Upper Sacramento River Instream Flow Incremental Methodology (IFIM) study. 1987-1988.
* Bio-engineering stream bank protection and restoration projects. Sacramento River, Big Chico Creek, and Lindo Channel. 1987-1988.
* Land use recommendations and environmental design guidelines for conserving wildlife habitat in the residential development process: San Juan Ridge, Nevada County, California. (Master's Thesis, California State University, Chico.) 1988.

PUBLICATIONS

1988 - Land Use Recommendations and Environmental Design Guidelines for Conserving Wildlife Habitat in the Residential Development Process: San Juan Ridge, Nevada County, California (Master's Thesis. California State University, Chico.).

1987 - Reed's Creek Flood Study. With Echols; Kayl, and Mendenhall; William. California Department of Water Resources, Northern District.

PERSONAL INFORMATION

Born: April 21, 1960, Long Beach, California

Married

Residence: Logan, Utah

RONALD J. RYEL

Personal Information

Born: January 21, 1955 in West Branch, Michigan

Education

M.S. 1980 (Wildlife Ecology) Utah State University
B.S. 1977 (Zoology and Mathematics) Michigan State University

Licenses

Class 1 whitewater boatman, State of Utah

Professional Experience

1987-Present. Self Employed Systems Ecologist, Logan, Utah.

1981-1986. Systems Ecologist, Data Analyst and Manager, Ecosystem Research Institute, Logan, Utah.

1980-1981. Operations Research Analyst, Northern Fur Seal Project, National Marine Fisheries Service, U.S. Department of Commerce, Seattle, Washington.

1979-1980. Research Assistant, Department of Range Science, Utah State University, Logan, Utah.

1978-1979. Ornithologist, Bio/West Inc., Logan, Utah.

1977-1978. Research Assistant, Department of Wildlife Science, Utah State University, Logan, Utah.

1975-1977. Student Biological Aid, Utah Division of Wildlife Resources, Cedar City, Utah.

Current Projects

Development and validation of a multi-species canopy photosynthesis model for use in assessing the competitive abilities of wheat and wild oats under increased ultraviolet radiation exposure (for Range Science Department, Utah State University, Logan, Utah).

Development of a classification system to assess non-point source impacts on riverine-riparian ecosystems.

Database development and management for a data collected on a mill site near Salt Lake City.

Assessing wildlife resources for FERC permitting for small hydroelectric facilities.

Past Projects

Conducted bird survey in Pumpkin Buttes Wyoming for Cleveland Cliffs Iron Co.

Coordinated and participated in census of bald and golden eagles in Cache County, Utah for Utah Division of Wildlife Resources.

Conducted census of snowy plovers in Cache County, Utah for Utah Division of Wildlife Resources.

Conducted raptor and forest bird surveys near Steamboat Springs, Colorado, for Bio/West Inc. in conjuction with proposed ski resort development.

Participated in census of the endangered Kirtland's Warbler in Michigan for Michigan Department of Natural Resources.

Participant in three birding field trips to the Hawaiian Islands, covering Kauai, Maui, Oahu and the Big Island.

Compiled database and constructed habitat utilization curves for rare fishes in the upper Colorado River basin for U.S. Bureau of Reclamation.

Managed and summarized stream habitat data from Utah, Idaho and Nevada for Whitehorse Associates, Smithfield Utah.

Management, analysis and summary of various fish data for Bio/West Inc., Logan, Utah.

Collection of biological data on Northern Fur Seals for National Marine Fisheries Service, Seattle, Washington.

Study design, data analysis, data management, modeling, report preparation and expert testimony for natural resource damage assessment for Colorado State Attorney General's Office in regards to four CERCLA lawsuits.

Determination of hazardous waste sources and extent of contamination for a site in Salt Lake City, Utah for Huntsman-Christensen Inc.

Data management, monitoring and evaluation of surface and ground water resources for White River Shale Oil Corporation oil shale development near Bonanza, Utah.

Compilation of all the Colorado River basin rare fish data into a single data base for the Colorado Water Congress.

Data management and analysis of data collected during a larval fish study on the Colorado River, near Grand Junction Colorado.

Data management, analysis and summary of data concerning water resources in the Needles District of Canyonlands National Park, Utah.

Analysis and development of aquatic monitoring parameters of White River ecosystem for oil shale development.

Design and operate data management system for data collected on White River oil shale tracts.

Baseline assessment and monitoring of White River ecosystem for oil shale development.

Simulation modeling of Northern fur seal population dynamics.

Development of a single species canopy photosynthesis model.

Baseline assessment of avian populations on proposed uranium mines in central Wyoming.

Simulation modeling of raptor nesting success with agricultural encroachment in the Birds of Prey Natural Area, Idaho.

Publications

Ryel, R. J., P. Barnes, W. Beyshlag and M. M. Caldwell. 1988. Competition for light between Triticum aestivum and Avena fatua under enhanced UV-B conditions analyzed with a multi-species canopy model. I. Model development, validation and application. (in preparation, to be submitted to Oecologia).

Ryel, R. J. 1987. Aquatic system. in: J. C. Carter (ed), Remedial investigation for the Uravan uranium mill site, Uravan, Colorado. Report to the Colorado State Office of the Attorney General.

Ryel, R. J. 1987. Aquatic resources. in: J. C. Carter (ed), Background report on the aquatic and terrestrial resources of the Uravan uranium mill site, Uravan, Colorado. Report to the Colorado State Office of the Attorney General.

Ryel, R. J., T. P. Landis and H. E. Skjold. 1986. 1985 water resources Monitoring Program for White River oil shale tracts, Ua and Ub. Prepared for In/Situ, Inc. 105 pp.

Ryel, R. J. 1984. Date tape and file documentation for data collected by Ecosystem Research Institute for Union Oil Corporation during 1982 and 1983.

Ryel, R. J. 1980. An analysis of a measure of productivity in mule deer populations. M.S. Thesis, Utah State Univ. 102 pp.

Ryel, R. J. 1979. Avian survey. in: J. L. Arnette (ed), Collection and analysis of background data on the terrestrial and aquatic wildlife of the Pumpkin Buttes project, northeastern Wyoming. Vol I. Final report to Cleveland Cliffs Iron Company, Casper, Wyoming. 237+ pp.

P. Barnes, W. Beyshlag, R. J. Ryel and M. M. Caldwell. 1988. Competition for light between Triticum aestivum and Avena fatua under enhanced UV-B conditions analyzed with a multi-species canopy model. II. (in preparation, to be submitted to Oecologia).

W. Beyshlag, P. Barnes, R. J. Ryel and M. M. Caldwell. 1988. Competition for light between Triticum aestivum and Avena fatua under enhanced UV-B conditions analyzed with a multi-species canopy model. III. (in prep., to be submitted to Oecologia).

Valdez, R. A., P. B. Holden, T. B. Hardy and R. J. Ryel. 1987. Suitability index curves for Colorado squawfish, humpback chub and razorback sucker. Final report to U. S. Fish. and Wildl. Serv., Office of Endangered Species, Denver, CO. Contract no. 14-16-0006-86-055.

Valdez, R. A., J. G. Carter and R. J. Ryel. 1986. Drift of larval fishes in the Upper Colorado River. Journal of Freshwater Ecology. 3(4):567-577.

Valdez, R. A., J. G. Carter and R. J. Ryel. 1985. Drift of larval fishes in the Upper Colorado River. Proceedings of the Western Assoc. of Fish and Wildlife Agencies and the Western Div. Am. Fish. Soc., Snowmass, CO. 172-185.

Carter, J. G., R. A. Valdez and R. J. Ryel. 1985. Fisheries habitat dynamics in the Upper Colorado River. Journal of Freshwater Ecology. 3(2):249-264.

Fowler, C. W., L. Nelson and R. J. Ryel. 1982. Sperm whale population analysis. U.S. Dept. of Commerce, NTIS Publication No. PB82-174335.

Fowler, C. W. T. Bunderson, M. Cherry, R. J. Ryel and B. Steele. 1980. Comparative population dynamics of large mammals: A search for management criteria. U.S. Dept. of Commerce, NTIS Publication No. PB80-178627.

Innis, G., R. J. Ryel, et al. 1979. Birds of Prey study area simulation model. Final Report to U.S. Dept. of Interior, Bureau of Land Management. 277 pp. (with G. Innis et al).

Fowler, C. W. and R. J. Ryel. 1978. Projection matrices in population dynamics. Encyclia. 55:39-46.

THOMAS R. PAYNE & ASSOCIATES

THOMAS R. PAYNE
FISHERIES BIOLOGIST
Instream flow analysis and stream ecology

EDUCATION

M.S. Degree in Fisheries Biology 1972
Thesis title: Effect of prior residence on dominance in rainbow trout. Humboldt State University, Arcata, CA. Course work included fish diseases, reservoir management, population dynamics, and genetics.

B.S. Degree in Fisheries Biology 1970
Minor in Psychology, Humboldt State University, Arcata, CA. Course work included ichthyology, fisheries management, limnology, animal behavior, bacteriology, fish culture techniques, biometrics, fish ecology, and psychobiology.

University of California, Irvine, CA. Course work included biology, calculus, physics, inorganic and organic chemistry and parasitology.

EXPERIENCE

Principal Associate 1982 - Present
Thomas R. Payne & Associates Fisheries Consultants, Arcata, CA
Perform pre- and post-project impact evaluations of aquatic resource development projects, primarily for hydroelectric development. Specialize in application of the Instream Flow Incremental Methodology for flow release determinations. Negotiate fishery protection provisions as part of licensing and permitting requirements. Provide biological expertise for projects and other activities affecting fishery resources, including expert witness testimony.

Fish and Wildlife Biologist 1981 - 1982
U.S. Fish & Wildlife Service, Olympia, WA
Coordinated USFWS environmental review of hydroelectric development in Washington State, including commenting on preliminary permits, negotiating license conditions, setting exemption terms and conditions, and establishing minimum instream flows. Chaired multi-agency coordinating committee to improve inter-agency and agency-developer communication. Performed and/or reviewed most hydropower-related instream flow studies conducted in the state. Functioned as technical adviser to state, private and tribal biologists in the Instream Flow Incremental Methodology.

Fisheries Management Biologist 1977 - 1981
U.S. Fish & Wildlife Service, Arcata, CA
Assisted in the monitoring and management of sport, commercial and Indian salmon fisheries on the Klamath and Trinity Rivers, recovered coded-wire tags and harvest information from Indian gillnet fishery, performed salmon population-estimate studies, inventoried and electrofished tributary streams for fish habitat quality, salmonid utilization, and accessibility, directed stream clearance operations for log-jam removal and fish habitat improvement, and built and operated a fish weir and small hatchery.

Fisheries Management Biologist 1975 - 1977
U.S. Fish & Wildlife Service, Olympia, WA
Advised Indian and other groups on siting, construction and operation of small streamside salmon hatcheries. Conducted spawning ground surveys to count spawning salmon and recover tags for estimating salmon populations. Assisted in inventory of herring spawning distribution in Puget Sound. Reviewed logging plans and wrote logging stream impact assessments.

Fisheries Biologist 1972 - 1974
Envirogenics Systems Company, El Monte, CA
Performed long and short-term toxicity tests on several fish species with various pesticides and toxic chemicals. Helped design and construct toxicant delivery apparatus and environmental control systems. Acquired and maintained fish stocks for laboratory testing.

Research Assistant 1971 - 1972
National Science Foundation Sea Grant Program, Humboldt State University, Arcata, CA
Assisted with the development and construction of experimental fish ponds which used tertiary-treated sewage to supplement food sources by nutrient enrichment. Monitored water quality in ponds. Helped build laboratory and fish culture facilities.

TECHNICAL TRAINING

Technical training in the complete USFWS Instream Flow Incremental Methodology and Habitat Evaluation Procedures series
Supervision and Group Performance
Technical Writing

ACCOMPLISHMENTS

Special Achievement Award, U.S. Fish and Wildlife Service
Certified Fisheries Scientist, American Fisheries Society
President, American Fisheries Society, Humboldt Chapter
Associate Professor of Fisheries, Humboldt State University
Numerous publications

REFERENCES

Available on request.