Atty: Jiyam

DEPARTMENT OF GENERAL PLANNING

CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

BENJAMIN B. LEE
CHIEF PLANNING OFFICER

ROLAND D. LIBBY, JR.
DEPUTY CHIEF PLANNING OFFICER

POSTED

RECEIVED

'92 OCT -7 P12:55

MM

October 2, 1992

Honorable Brian J. J. Choy, Director
Office of Environmental Quality Control
Central Pacific Plaza
220 South King Street, 4th Floor
Honolulu, Hawaii 96813

Dear Mr. Choy:

Acceptance Notice for the Proposed
Kawainui Marsh Flood Control Project
Final Environmental Impact Statement (Final EIS)

We are notifying you of our acceptance of the Final EIS for the proposed Kawainui Marsh Flood Control Project, as satisfactory fulfillment of the requirements of Chapter 343, Hawaii Revised Statutes.

Pursuant to Section 11-200-23 (c), Chapter 200, Title 11 ("Environmental Impact Statement Rules") of the Administrative Rules, this acceptance notice should be published in the October 23, 1992 OEQC Bulletin.

We have attached our Acceptance Report of the Final EIS for the Kawainui Marsh Flood Control Project. Should you have any questions, please contact Melvin Murakami of our staff at 527-6020.

Sincerely,

BENJAMIN B. LEE
Chief Planning Officer

BBL:ft

Attachments

cc: U.S. Army Engineer District, Honolulu
Department of Public Works, City and County of Honolulu

1992 - Oahu - FEIS - Kawainui Marsh

PLANNER'S COPY

KAWAINUI MARSH FLOOD CONTROL PROJECT

KAILUA, ISLAND OF OAHU, HAWAII

DETAILED PROJECT REPORT AND ENVIRONMENTAL IMPACT STATEMENT

FINAL
JULY 1992

US Army Corps
of Engineers
Honolulu District

CITY AND COUNTY OF HONOLULU
STATE OF HAWAII

FINAL DETAILED PROJECT REPORT AND ENVIRONMENTAL IMPACT STATEMENT FOR KAWAINUI MARSH FLOOD CONTROL PROJECT

Jointly Prepared By:
US Army Engineer District, Honolulu
Building 230
Fort Shafter, Hawaii 96858-5440
and
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

C. Michael Street 7/14/92

C. Michael Street — Date
Acting Director and Chief Engineer
City and County of Honolulu
Department of Public Works

31 July 92

James T. Muratsuchi — Date
Lieutenant Colonel, U.S. Army
District Engineer

FINAL
JULY 1992

KAWAINUI MARSH
FLOOD CONTROL PROJECT
OAHU, HAWAII

COVER SHEET

KAWAINUI MARSH FLOOD CONTROL PROJECT
OAHU, HAWAII

COVER SHEET

Lead Agencies:

Federal	US Army Engineer District, Honolulu
City and County of Honolulu	Department of Public Works

Proposed Action: Improve Flood Protection of Coconut Grove

Project Location: Kawainui Marsh, Kailua, Oahu, Hawaii

Type of Report: Final Integrated Report - Detailed Project Report and Environmental Impact Statement

Abstract: The US Army Honolulu Engineer District, in partnership with the City and County of Honolulu, is planning to construct improvements to the Kawainui Marsh Flood Control Project, Oahu, Hawaii. The existing project was constructed by the Corps of Engineers, Honolulu District in August 1966. Because of changed conditions in the drainage basin and the marsh, the project no longer provides the designed degree of protection. Floods greater than the 10-year event will overtop the southern end of the levee. Final alternatives considered included raising the existing levee, constructing a floodwall on top of the existing levee and combinations of levee raise and flood wall. The National Economic Development (NED) Plan is Alternative 2, the floodwall at a 100-year level of protection. The concrete floodwall has received much public criticism for aesthetic reasons; therefore, Alternative Plan 3A, a combination levee raise and floodwall, at the 100-year level of protection is the Recommended Plan. The local sponsor has agreed to pay the incremental increase in cost for Plan 3A which is presently estimated at $1,420,000.

PROJECT FEATURES

RECOMMENDED PLAN	NED PLAN
Concrete floodwall on raised levee. The floodwall would vary in height to a maximum of 4.0 feet along the total levee length of about 6,300 feet. A flood warning system is an integral part of this plan.	Concrete floodwall. The floodwall would vary in height to a maximum of 8.0 feet along the total levee length of 6,300 feet. A flood warning system is an integral part of this plan.

PROJECT ECONOMICS

ITEM	RECOMMENDED PLAN	NED PLAN
Project First Cost	$ 9,900,000	$8,480,000
Interest During Construction	$ 1,043,000	$ 635,000
Project Investment Cost	$10,943,000	$9,115,000
Investment Cost	$ 930,000	$ 775,000
Maintenance Cost	$ 98,300	$ 101,300
TOTAL ANNUAL COST	$ 1,028,300	$ 876,300
Average Annual Benefits	$ 1,900,000	$1,900,000
Average Annual Net Benefits	$ 871,700	$1,023,700
Benefit to Cost Ratio (BCR)	1.9	2.2
BCR for Authorization and Budgeting [1]	2.2	—

Although four species of Federal and State listed endangered water birds inhabit the marsh area, no adverse effects on the birds are anticipated. The Kawainui Marsh area has been determined eligible for listing on the National Register of Historic Places; however, no cultural material was found in the immediate project area and no effect on historic properties is expected. The recommended plan would result in filling less than 2 acres of wetland. No other significant environmental effects are likely.

[1] ER 1105-2-100, para 5-16d. (2) States "... the increment between the federally supportable plan and the locally preferred plan should not reflect in the BCR used for authorization and budgeting purposes".

KAWAINUI MARSH
FLOOD CONTROL PROJECT
OAHU, HAWAII

SUMMARY SHEET

FINAL DETAILED PROJECT REPORT AND
ENVIRONMENTAL IMPACT STATEMENT
KAWAINUI MARSH FLOOD CONTROL PROJECT
OAHU, HAWAII

SUMMARY SHEET

1. **MAJOR CONCLUSIONS.** This summary addresses major factors which influenced planning related decisions in selecting the recommended plan. This report is an integrated Detailed Project Report and Environmental Impact Statement and fulfills the requirements of CEQ regulations (40 CFR 1500 et. seq.) and conforms with the requirements of ER 1105-2-100 as well as ER 200-2-2 and Chapter 343 HRS.

This project study was conducted under the authority of Section 205 of the Flood Control Act of 1948, as amended. Federal participation in any project under Section 205 authority is limited to flood control purposes. Flood control projects recommended for implementation under this authority must meet certain engineering, economic, and environmental criteria. After careful consideration of all planning criteria, a modification to the existing levee was identified as the only alternative that would meet these criteria. Four levee modification alternatives are evaluated in detail in this final document. This study has been conducted jointly by the City and County of Honolulu and Corps of Engineers. The open water channels being created in the marsh by the City and County of Honolulu have been included in the study baseline, so that a mix of marsh and levee modifications is a part of the overall flood control planning.

Over twelve alternatives were evaluated at various stages of planning for the present project, seven in detail in the draft stage, stemming from the public scoping process, agency input and Corps analysis. Two public meetings, two public workshops, and nine ad hoc committee meetings have been held by the Corps since 1988 for Kawainui Marsh.

The National Economic Development (NED) plan is Plan 2, a 6,300-foot long, 8-foot high concrete floodwall on top of the existing levee. This alternative prevents floodwaters from overtopping the existing levee, has a benefit-to-cost ratio (BCR) of 2.2, and is located entirely on top of the existing levee structure. However, as a result of negative reaction to the aesthetics of a concrete floodwall by the local community, this alternative was rejected and a Locally Preferred Plan was developed.

The recommended modification, Plan 3A, is the Locally Preferred Plan. Plan 3A consists of a 6,300-foot long, 4-foot high concrete floodwall on top of a raised levee. This alternative has the equivalent flood protection capabilities as the NED plan and is aesthetically more appealing than Plan 2. The local sponsor supports Plan 3A and is willing to pay the additional cost of implementing this alternative. The levee raise will fill 1.8 acres of wetland. Compensatory wetland mitigation will include the restoration of fastland near the Oneawa Channel to wetland habitat. The plan also includes an existing flood warning system and clearing of selected areas of the marsh by the local sponsor. Because of the $5.0M federal statutory limit, no financial credit is being given to the local sponsor for marsh clearing activities although the cost of maintaining the cleared areas is included in the project benefit/cost analysis.

2. **AREA OF CONTROVERSY.**

Issues Subject to Major Disagreement.

a. **Marsh Vegetation and Sediment Clearing.** At public workshops and by written testimony, various individuals, groups and agencies advocated vegetation and sediment removal within the marsh to keep Coconut Grove from flooding. Their reasoning was that since vegetation was determined to be the primary hindrance to flood flow through the marsh, then removal of vegetation should be the solution. Additionally, erosion control in the watershed was deemed important because some Kailua residents viewed a levee raise as only a temporary measure since they believed that the marsh would eventually fill with sediment and require additional levee raises in the future.

b. **Aesthetics of Floodwall Construction.** The placement of a concrete floodwall in the marsh area was opposed by some individuals in the community. Individuals and environmental organizations within the community believed that the floodwall was not in keeping with the wilderness characteristics of the marsh. Individual homeowners who overlook the wall felt that a floodwall could also become an eyesore. The height of the wall was identified as a major concern.

Outcome of Resolved Controversies. The NED plan, which includes an 8-foot high wall, was dropped and a 4-foot high wall on a levee raise was substituted (Plan 3A). An exception to the NED plan will be requested from the Assistant Secretary of the Army for Civil Works. The compromise alternative which reduces the height of the floodwall and fills less than two acres of wetland is the preferred alternative.

3. **UNRESOLVED ISSUES.** Unresolved major disagreements among agencies and public interests include the opinions for the removal of vegetation and sediments within the marsh for flood control purposes and erosion control within the contributing watershed. Corps of Engineers computer model studies conducted by the Hydrologic Engineering Center in Davis, California, and the Waterways Experiment Station in Vicksburg, Mississippi, indicate that the proposed project (Plan 3A) will provide the required level of flood protection to Coconut Grove under existing and expected future conditions in the marsh. No action is being taken to resolve this disagreement.

4. **REFERENCE TO PREVIOUSLY PREPARED EIS.** The FEIS prepared by the City and County of Honolulu entitled "*Kawainui Marsh Flood Damage Mitigation Project*" is incorporated by reference into this final document. Incorporation by reference is a recommended concept established in the CEQ Regulations (40 CFR Part 1502.21).

TABLE OF CONTENTS

KAWAINUI MARSH FLOOD CONTROL PROJECT
OAHU, HAWAII

TABLE OF CONTENTS

**Paragraph required for NEPA compliance (40 CFR 1502.10)*

KAWAINUI MARSH FLOOD CONTROL PROJECT
OAHU, HAWAII

TABLE OF CONTENTS (continued)

KAWAINUI MARSH FLOOD CONTROL PROJECT
OAHU, HAWAII

TABLE OF CONTENTS (continued)

**Paragraph required for NEPA compliance (40 CFR 1502.10)*

KAWAINUI MARSH FLOOD CONTROL PROJECT
OAHU, HAWAII

TABLE OF CONTENTS (continued)

**Paragraph required for NEPA compliance (40 CFR 1502.10)*

KAWAINUI MARSH FLOOD CONTROL PROJECT
OAHU, HAWAII

TABLE OF CONTENTS (continued)

Paragraph required for NEPA compliance (40 CFR 1502.10)

KAWAINUI MARSH FLOOD CONTROL PROJECT
OAHU, HAWAII

TABLE OF CONTENTS (continued)

LIST OF TABLES

• **Paragraph required for NEPA compliance (40 CFR 1502.10)*

KAWAINUI MARSH FLOOD CONTROL PROJECT
OAHU, HAWAII

TABLE OF CONTENTS (continued)

LIST OF FIGURES (figures follow page 67)

*LIST OF APPENDICES

**Paragraph required for NEPA compliance (40 CFR 1502.10)*

FINAL DETAILED PROJECT REPORT AND ENVIRONMENTAL IMPACT STATEMENT

Printed on Recycled Paper

KAWAINUI MARSH FLOOD CONTROL PROJECT
OAHU, HAWAII

1. **STUDY AUTHORITY.** This report was prepared under the authority of Section 205 of the Flood Control Act of 1948, as amended. The legislative authority for this study states that:

> *"The Secretary of the Army is authorized to allot from any appropriations heretofore or hereafter made for flood control, not to exceed $40,000,000 for any one fiscal year, for the construction of small projects for flood control and related purposes not specifically authorized by Congress, which come within the provisions of Section 1 of the Flood Control Act of June 22, 1936, when in the opinion of the Chief of Engineers such work is advisable. The amount allotted for a project shall be sufficient to complete Federal participation in the project. Not more than $5,000,000 shall be allotted under this section for a project at any single locality."*

US Army Engineer Regulation (ER) 1165-2-119, dated 20 September 1982, "*Modifications to Completed Projects,*" paragraph 11, authorizes the use of available authority in lieu of Congressional action to make changes to a Congressionally-authorized project. Therefore, needed project modifications may be accomplished under Section 205 of the Flood Control Act of 1948, as amended.

2. **STUDY PURPOSE, SCOPE, PROBLEMS AND OPPORTUNITIES.**

2.1 **Purpose**. The purpose of this study was to evaluate the need to modify the Kawainui Marsh Flood Control project because of changed conditions in the marsh and drainage basin evidenced by the project's failure to protect the community of Coconut Grove from severe flood damages on New Year's 1988. The project is located at Kailua, Oahu, Hawaii (Figure 1) and was authorized by the Flood Control Act of 17 May 1950 and completed in August 1966. This study developed and evaluated potential flood control solutions.

2.2 **Scope**. The scope of this report was to investigate the flood problem and to develop and evaluate alternative solutions to the flood problem in order to determine the most feasible and acceptable plan for implementing flood control improvements. These improvements would augment the existing federally constructed flood control works as well as the City and County of Honolulu's marsh clearing work. This study has been conducted as a joint City and County of Honolulu (C&C) and Corps of Engineers (COE) effort. This document is an integrated Detailed Project Report and Environmental Impact Statement in accordance with Section II of Appendix F, ER 1105-2-100.

2.3 **Problems and Opportunities**.

2.3.1. **Problems**. A major function of the marsh is that of a flood storage basin protecting portions of Kailua. The dense, floating wetland vegetation within the marsh impedes the movement of water into the interior portion and out the Oneawa Canal. This can result in water levels that will exceed the crest of the existing levee. During the New Year's flood of 1988, the mat was observed floating upward with an increase in the marsh water levels. Due to the unpredictable behavior of the mat, alternatives which are not dependent on the mat dynamics are considered more reliable. No mat movement was observed in the April 1989 and March 1991 storms; however, these storms were much smaller than the 1988 flood.

Heavy rains during the winter rainy season (October-March) bring greater risk of excess runoff with increased flood potential. Over twenty floods have occurred since the turn of the century inundating areas bordering the marsh. The most recent flood occurred on December 31, 1987 - January 1, 1988. Damages in the community of Coconut Grove from that flood are estimated at more than $10 million. The New Year's storm resulted in up to 23 inches of rain on eastern Oahu over a 24-hour period and caused major flooding in the coconut Grove area. Flooding at Coconut Grove was caused by water overtopping the flood control levee. The rainfall from this storm was estimated at a frequency of less than one chance in 100 years. The average rainfall over the 11.2-square mile Kawainui drainage basin was 17 inches. Since heavy growth of vegetation restricted water movement within the marsh, most of the marsh was ineffective in storing flood flows and floodwaters could not reach the Oneawa outlet channel. The result was concentrated ponding in the southern end of the marsh and eventual levee overtopping.

In the aftermath of the New Year's 1988 flooding on Oahu, Federal, State, and City emergency declarations were proclaimed to authorize public actions to provide relief and reduce the imminent threat of additional danger. U.S. Marine Corps Amphibious Assault Vehicles were used shortly after the flood to push aside vegetation along the levee to allow water to drain to the Oneawa outlet channel. The New Year's Flood water levels still remained very high for weeks. Therefore, at the recommendation of the COE, vegetation was removed by the C&C from the marsh (west) side of the flood control levee and an emergency ditch was constructed to pass waters stored in the marsh to Oneawa Channel; thus lowering the water levels more quickly in preparation for subsequent storms. The emergency ditch by itself is not a significant flood control channel because the ditch capacity is only 1,700 cubic feet per second (cfs) and is much less than the 100-year design inflow (21,300 cfs) into the marsh and outflow (6,750 cfs) to the Oneawa Channel. Widening the ditch would not have a significant effect on the design of the flood control alternatives. The primary function and need for the ditch is to more quickly evacuate flood waters from the marsh in preparation for subsequent flood events. The C&C also raised the levee crest to elevation 10.0 feet msl using approximately six inches of gravel material in conjunction with constructing the emergency ditch.

2.3.2. **Needs and Opportunities**. The actions taken to date have effectively lowered water levels in the marsh so that subsequent storm runoff can be more readily stored. However, the flood control measures including the emergency ditch, flood warning system and partial marsh clearing have only partially improved distribution of floodwater within the marsh and have not been effective in moving water more quickly to the Oneawa Channel. The existing flood control project needs to be modified in order to restore its intended function. The residents of Coconut Grove and the Kailua area have expressed the need for an environmentally acceptable solution to the flooding problem in that area. Two public workshops were held in February and April 1990 to obtain public input for potential solution to the flooding problem. The need for flood protection was addressed by residents directly affected by the New Year's flood. The participants expressed a desire for installation of an early flood warning system. A flood warning system was installed by the State Civil Defense Office in May 1990. The system includes two water level gages and rainfall intensity gages that signal the local police station on rising water levels and rainfall intensity. A concern expressed at the workshop was that the project be environmentally compatible with the marsh and not detrimental to the endangered species in the marsh, nor be harmful to the archaeological sites located in and around the marsh. An opportunity identified by several sectors of the public was to combine a flood control project with wildlife habitat improvement. According to the public and government agencies, removal of large portions of the floating mat to create open water would provide habitat for endangered waterbirds as well as allow floodwaters to more evenly distribute within the marsh.

3. **PRIOR STUDIES, REPORTS, AND EXISTING WATER PROJECTS.** The US Army Corps of Engineers completed a Survey Report in May 1950 and a General Design Memorandum in 1957 which led to the construction of the existing project. The existing project (Figure 2) consists of a trapezoidal channel, 9,470 feet long with a base width of 80 to 110 feet wide and 3-horizontal to 1-vertical side slopes; an earth levee with a maximum crest elevation of 9.5 feet msl and 3-horizontal to 1-vertical side slopes totalling 6,850 feet in length; a stub groin 50 feet long; shore revetment 50 feet long; a silt basin 370 feet long and 10 feet deep; and drainage outlets.

The project was designed to accommodate the Standard Project Flood (SPF) as established in 1957 with a peak inflow to the marsh of 18,100 cfs and a peak discharge in the Oneawa Channel of 6,700 cfs and storage of 3,000 acre feet. Kawainui Marsh drains an 11.2-square mile area of the Koolau Mountains. Normal drainage and storm waters collected within the marsh are transported to north Kailua Bay through the federally-constructed flood control channel (Oneawa Channel). Kaelepulu Stream, also called Kawainui Canal, is located seaward of the flood control levee and collects interior drainage from the Coconut Grove area and discharges into south Kailua Bay (Figure 1). Seven hundred and fifty acres of marsh land were acquired by the C&C for temporary storage of flood flows as part of the flood control project.

An "emergency ditch" was constructed on the marsh side of the levee in February 1988 to discharge flood storage waters from the marsh and to reduce marsh flood water levels. Subsequent to the New Year's 1988 flood event, the C&C completed a report in November 1989 entitled, "A Kawainui Marsh Flood Damage Mitigation Project." This was followed by the City and County's Final Environmental Impact Statement in June 1990. A Reconnaissance Report was completed by the Corps in November 1989 at the request of the City and County of Honolulu to determine what measures were required to modify the federally-constructed flood control project in order to restore and continue project flood protection.

4. **PLAN FORMULATION.** Formulating alternative plans included describing the existing conditions, identifying public concerns, analyzing the flooding problems and needs and establishing planning considerations. Specific planning objectives were then identified and refined based on national policies and local concerns.

4.1 **Problems and Opportunities.** Floods greater than the 10-year flood will overtop the southern end of the existing levee due to the heavy vegetation restricting the flow of water from the southern end of the marsh to the Oneawa outlet channel. Flooding causes extensive losses in Coconut Grove with average annual damages exceeding $1.9 million. An opportunity exists to reduce property damage and other economic losses and human suffering from flooding and to contribute to national economic development (NED) by the efficient use of floodplain lands by removing the flood threat.

4.1.1. **Planning Methodology.** National planning policies are prescribed by the Water Resources Council's Principles and Guidelines (1983), the National Environmental Policy Act of 1969 (PL 91-190), National Historic Preservation Act of 1966, as amended, Section 122 of the River and Harbor and Flood Control Act of 1970 (PL 91-611), the Water Resources Act of 1986 (PL 99-662), the Clean Water Act of 1977 (PL 95-217) and various Corps of Engineers policy guidelines and regulations. The base condition is the existing physical, economic, social and environmental characteristics of the study area. Future conditions were then projected and analyzed to arrive at the "most probable future." This is the condition that would be most likely to occur without any changes to the existing facilities or resource management plans. This is also referred to as the "without project" condition. Proposed plans of improvement were compared against the "without project" condition to determine their potential positive and negative impacts.

The "without project condition" includes the City and County of Honolulu plans to create channels into the marsh (Figure 4). Based on the Technical Review Conference (TRC) held in April 1990, (with Headquarters, US Army Corps of Engineers; US Army Engineer District, Honolulu; US Army Engineer Division, Pacific Ocean; and, the City and County of Honolulu), the "without project condition" (baseline condition for planning) does not include the ditch on the marsh side of the levee for reasons discussed in paragraph 2.3. A memorandum on the conference (dated 7 May 1990) established planning and design baseline procedures to follow and documented a summary of issues and concerns that were raised and resolved at the TRC. One of the major considerations was that the best flood control solution be one which is not dependent on marsh dynamics, but should consider future conditions and changes likely to occur within the marsh.

4.1.2. **National Objectives.** The Water Resources Council Principles and Guidelines (P&G) for planning water and related land resources, define the objectives of NED. The NED objective is achieved by increasing the value of the nation's output of goods and services and improving national economic efficiency. The Federal objective is to contribute to NED consistent with protecting the Nation's environment pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. In accordance with the P&G, various alternative plans are to be formulated in a systematic manner to insure that all reasonable alternatives are evaluated, including a plan that maximizes the NED benefits, consistent with the Federal objective. Normally, the recommended Federal action will be the alternative plan with the greatest economic net benefit (the NED plan); however a plan other than the NED plan may be recommended, but its acceptance requires an approval by the Assistant Secretary of the Army (Civil Works). All additional project costs associated with deviating from the NED plan must be paid by the local sponsor (City and County of Honolulu). Three accounts as shown below are established to facilitate evaluation and display of effects of alternative plans.

a. The NED account displays changes in the economic value of the national output of goods and services.

b. The Environmental Quality (EQ) account displays effects on significant natural and cultural resources.

c. The Other Social Effects (OSE) account registers plan effects from perspectives that are relevant to the planning process but are not reflected in the other two accounts.

4.2 Base Conditions.

4.2.1. Physical Setting.

4.2.1.1. **Geology**. Maunawili Valley, which drains into Kawainui Marsh, is part of the remnant of the volcanic dome, the *Koolau Range*, which constitutes the eastern three-fourths of the island of Oahu. The precipitous cliffs, or ***pali***, have slopes between 45 to 85 degrees; above 1,500 feet the slopes are about 60 degrees. The highest points along the crestline within the study area are in excess of 2,000 feet. The trend of the cliffs coincides with the rift zone that occurred along the flanks of the active volcano which ended during the late Pleistocene and Holocene Periods. The soil conditions within the marsh vary considerably with depth from the surface. Borings taken in the Marsh (Dames and Moore, 1961 and Corps of Engineers, 1988 and 1990) indicate that a thick blanket of roots and peat overlay this area underneath the floating mat vegetation. The geologic formation underlying the marsh has been identified as unconsolidated calcareous marine sediments, chiefly cream colored and light tan, and consist of very permeable beach sand of grains of worn coral, coralline algae, and shells with appreciable amounts of foraminifera and other marine organisms.

4.2.1.2. **Climate**. Hawaii has a subtropical climate with temperatures that are mild and fairly uniform year round. The wet season is usually from October through April. The median annual precipitation varies from about 45 inches along the coastal areas to over 150 inches in the Koolau Mountains. The mean annual temperature in Honolulu is 76° F. August and September are the warmest months; January and February are the coolest. Spatial and temporal distributions of rainfall are pronounced in the Kawainui study area. In general, the orographic effect of the *Koolau Range* produces the most intense rainfall in the study area nearest the ridgeline's summit. The result of the strong uplifting of tradewinds is a maximum precipitation point for the island of Oahu just slightly leeward of the crest. Rainfall patterns for individual storms also reflect this topographic influence. The annual rainfall cycle is generally recognized by climatologists as wet period, October to April and dry period from May to September. Mean annual rainfall over the Maunawili drainage basin is estimated at 86 inches with 39 inches in the lower elevations and 110 inches in the headwaters.

4.2.1.3. **Winds and Waves**. Oneawa Channel discharges into the northern end of Kailua Bay. The bay is an open bight exposed to the northeast tradewinds. The daily tidal cycle range between mean lower low water and mean higher high water is 1.8 feet (Waimanalo Landing, Waimanalo Bay, Oahu, Lat. 21° 21.1'; Long. 157° 41.6'). Tidal influence extends 9,000 feet up Oneawa Channel to Kawainui Marsh. The northern part of the bay is generally free from fringing reefs and the channel outlet has not experienced a buildup of sediment since the construction of the Oneawa Channel outlet in August 1966.

Wind and wave action affects the nearshore water levels and circulation patterns. Wave data indicate that 64 percent of waves for the northern coasts of Hawaiian Islands are from the northeasterly and easterly directions. To the north of the outlet channel, the bottom consists primarily of coral ledge and lava rock which provides very little source of along shore drift material. The predominant wave pattern in the area of the channel outlet produces littoral currents primarily in a southeasterly direction from the outlet mouth.

Northeast tradewinds prevalent through April to September dominate the local wave conditions. The strong steady winds blowing over long fetches of open ocean generate deep water waves that have typical periods of 6 to 8 seconds and heights of 4 to 10 feet. The North Pacific swell is generated most often in the winter months and has typical periods of 10 to 16 seconds and heights 5 to 15 feet. Other waves such as local storm and hurricane waves which may affect Kailua Bay arrive less frequently. The waves that reach the outlet area are different from deep water offshore waves having been transformed by processes of refraction, diffraction, shoaling, and breaking. Wave heights measured on the reef adjacent to Popoia Island (Kailua Bay about 2 miles south of the Oneawa Channel outlet) during June through August 1977 averaged 2.5 feet. Average wave heights at Kailua Beach Park shoreline during June to August 1977 were less than 1 foot with an average period of 7 seconds during the same period.

4.2.1.4. **Storms**. Three classes of weather disturbances cause major storms in Hawaii: cold fronts, low pressure passages, and true tropical storms or hurricanes. Cold fronts, which occur about one to eight times during the winter, cause spotty rainfall and gusty winds. Low pressure storms, called "Kona" storms, also occur during the winter months. These storms are characterized by strong and persistent southerly and south westerly winds and intense rainfall. Hurricanes are infrequent, but tropical storms with winds below hurricane force are more prevalent and pass close to the Hawaiian Islands on the average of once every three years. Tropical storms generate very strong winds and intense rainfall.

4.3. **Affected Environment.** This section describes the physical, chemical, cultural and biological characteristics, and previous environmental documentation of Kawainui Marsh of relevance to this study. Available literature (such as EAs, EISs and various technical reports) was reviewed, new data obtained where necessary, and information collected through site visits, telephone calls and other appropriate means. Considerable information was obtained from the C&C of Honolulu which released its FEIS in June 1990 to open waterways in the marsh. The information presented in this section is commensurate with the importance of the potential impacts, with attention focused on the key issues. The reader is referred to various sources for more detailed information in some areas.

4.3.1. **Wetland Environment.** The project area lies on the existing levee and in the wetland on the Coconut Grove side of the levee located within Kawai Nui Marsh *(the great water)*. Thousands of years ago, the area that is now Kawainui Marsh, was a marine embayment, open to the sea until the Kailua sand barrier began to form. It is believed that the entire area of Kawainui Marsh was formerly a large lagoon until the marsh basin was transformed into a relatively closed, freshwater system.

The marsh provides habitat for four species of federally-listed and State-listed endangered waterbirds and was the site of an early Hawaiian fishpond, wetland agriculture and numerous archaeological remains. It serves to retain floodwaters protecting the Coconut Grove area of Kailua Town, performs valuable ecological functions through food production, fish and wildlife habitat, groundwater recharge, as a nutrient sink and sediment filter for marine receiving waters, and provides recreational, cultural, and educational opportunities for the people of Oahu and the State.

4.3.2 **Water Quality.** Water quality in and around Kawainui Marsh is influenced by a multitude of factors including storm water and urban runoff, previous wastewater discharges, growth and decay of vegetative material, solar heating, water percolation from springs, possible leachate production from the landfill, sediment runoff from the quarry operations, and livestock grazing.

It is well established in the literature that wetlands improve the water quality of receiving waters (Stockdale, 1991). In particular, the deposition of sediments and nutrients from stormwater runoff in wetlands reduces the potential impacts to other receiving waters. The hydraulic resistance from vegetation and soil decreases the velocity of water entering the wetland and enhances the deposition of suspended sediments. Suspended organic and inorganic sediments have a strong tendency to absorb other pollutants, such as heavy metals, nutrients, hydrocarbons, bacteria and viruses. These "pollutants" then become effectively deposited with the trapped sediment. The use of wetlands for wastewater treatment is well known. Results indicate that wetlands do improve the quality of influent wastewater; however, the long-term ecological effects of wastewater or stormwater addition to wetlands are uncertain. Water quality improvements have not been observed in areas where stormwater flow was channelized through the wetland (Morris, et al., 1981).

a. Groundwater: Groundwater in Maunawili Valley is principally high-level and dike-confined. Groundwater moves northeastward, due to geological constraints, and discharges at numerous springs which feed the marsh and the area's two major stream systems, Maunawili and Kahanaiki streams.

b. Feeder Streams: Maunawili Stream is larger than Kahanaiki Stream. Estimates of average daily flow vary and appear related to the amount of water diverted from the Maunawili Ditch system which intercepts water from Makawao Stream (tributary to Maunawili Stream). Conservative estimates are 7.8 mgd for Maunawili and 1.0 mgd for Kahanaiki Stream with about 2.0 mgd diverted by the ditch system (In Chun, 1981). USGS gaging data recorded 12.1 mgd for Maunawili Stream between 1967-1970. Runoff from the watershed has increased due to urbanization since the construction of the flood control project in 1966. Over a dozen storm water drains enter the feeder streams which flow to the marsh.

c. Marsh Water Levels: Water surface levels in the marsh have fluctuated over the years from human controlled impoundments and drawdowns for irrigation purposes as well as from natural variability. The U.S. Geological Survey recorded water levels prior to and following the construction of the Corps flood control project. The average peak water level in the marsh has been significantly higher since the construction of the levee (5.2 feet msl v.s. 3.7 feet msl). However, use of marsh water for irrigation purposes ceased at about the same time (1965), leaving unknown the relative impact of each action. A water control structure was proposed as part of the Corps original flood control project to allow for irrigation pumping activities in the marsh and to inhibit salinity intrusion as a result of such pumping. When the decision was made to abandon the irrigation practice, salinity concerns were dropped and adjustments were made to the flood control project. These adjustments included a reduction in the levee height by 0.5 feet and the exclusion of the water control structure.

After the January 1988 flood, mean water levels near the levee remained around 8 feet msl for over a month and provided elevated water levels which flooded and destroyed emergent vegetation and attracted migratory waterfowl.

d. Nutrient Levels: Maunawili Stream has historically received a greater volume of wastewater than Kahanaiki Stream (Chun, 1981). However, nutrient measurements taken in the two streams in 1989 show similar concentrations of nitrogen and phosphorus and reduced levels of most nutrients (C&C FEIS, 1990). Little change in water quality occurred at the confluence of the two streams as they entered the marsh.

Nutrient levels measured in the emergency ditch close to Oneawa Channel are characterized by low dissolved nitrates and ammonia, elevated organic nitrogen, and elevated dissolved orthophosphates as compared with the stream concentrations. By contrast, water quality in the emergency ditch near Kailua Road had ammonia and orthophosphate clearly elevated by an order of magnitude and higher levels of organic forms of nitrogen and phosphorus (C&C FEIS, 1990). Differences in water quality within the emergency ditch may be related to the" breakthrough from the marsh" along the ditch's course. Visible ripples of incoming marsh water can be observed at various places along its length.

Nutrient levels measured beneath vegetation near the Kapaa stream entrance to the marsh were similar to those found at the Kailua Road end of the emergency ditch with elevated levels of ammonia, organic nitrogen, and orthophosphate (AECOS 1981). Suspended solids and turbidity levels did not show great variation from location to location within the marsh at the time the measurements were taken.

Turbidity measurements taken by the Corps on October 17,1991 following three days of heavy rains indicated elevated levels of turbidity in Maunawili Stream (greater than 125 ntu). Turbidity levels at the head of Oneawa Channel were considerably lower (33 ntu), verifying the effectiveness of the marsh in trapping sediments.

Measurements of pH show distinct patterns in the marsh with an increase in hydrogen ion concentration (decrease in pH units) as water passes through the marsh. Lowering of the pH as the water flows through the marsh is believed to result from the addition of organic acids leached from the decomposing vegetation. Water draining from the marsh has the distinct yellow-brown color indicative of dissolved organics leaching from the peaty material which is usually acidic. Results showed that the pH of the water became basic again as it came into contact with brackish water and limestone substrate in the Oneawa Channel. Dissolved oxygen was relatively low within the marsh waters.

e. Bacterial Contamination: The Water Resources Research Center (WRRC) of the University of Hawaii is presently investigating water quality of Kailua Bay and water bodies that feed into it. These include the Oneawa Channel and Kaelepulu Stream. Preliminary results (following a year of data collection by the WRRC) suggest that although the sewage treatment plants are no longer discharging into the streams, Kawainui Marsh and its tributaries through Oneawa Channel, and Kaelepulu Stream are the primary contributor to nearshore bacterial contamination of Kailua Bay (Roger Fujioka, personal communication). The sources of contamination are unknown, but the grazing cattle and horses may be contributing to the problem.

f. Kaelepulu Stream. Kaelepulu Stream can be considered an estuarine system due to its connection to and influence by the ocean. The portion of it behind the levee (referred to here as Kaelepulu Drainage Canal) is man-made. Four interior finger-like drainage canals enter it from Coconut Grove. Further south, over a dozen storm water discharges enter the stream on its way to the ocean. When the outlet to the ocean is blocked by sand, the stream maintains a lower salinity than when opened to tidal and salinity influences.

g. Oneawa Channel: The tidal influence into the marsh is dampened by the Oneawa Channel. The salinity in Oneawa Channel and the depth of water at the estuary end of the marsh is sufficient to impede the growth of vegetation that is so prevalent throughout the rest of the marsh. The water quality in the estuary is of sufficient quality to maintain a variety of fishery resources.

4.3.3. **Sedimentation and Heavy Metals**. Sediment sample analysis performed for the C&C of Honolulu indicated that the marsh has trapped some heavy metals, particularly copper, chromium, iron, nickel, and zinc. The heavy metal burden is substantially greater in the sediments at the upstream end of the marsh. These metals have also become absorbed through plant uptake. However, the quantities of heavy metals in marsh sediments and vegetation are below the standards established by EPA for landfill disposal purposes. There are discrepancies in the literature regarding the potential for movement through and the accumulation of heavy metals in wetlands from stormwater and sewage effluent (Stockdale, 1991). See Appendix E for heavy metals data.

The potential loss of water storage in the wetland due to sedimentation has been evaluated with respect to the long-term effectiveness of the Kawainui Marsh flood control project. The rate of sedimentation in Kawainui Marsh is directly related to the amount of soil exposed in the watershed, the size of the particles, the hydrologic regime, the presence or absence of channels, the configuration of channel flow, flow velocity, and vegetation. Vegetation itself contributes a substantial amount of sediment to the marsh not only through its trapping effect, but from addition of organic material through the natural decaying process.

A sediment assessment was performed for Kawainui Marsh and is presented in Appendix B. The analysis concluded that sedimentation rates differed throughout the marsh, but that an average sedimentation rate over the 600-acre surface area of Kawainui Marsh was on the order of 0.3 feet/10 years (180 ac-ft 110 years). Runoff sedimentation contributed 0.17 ft/10 years (100 ac-ft) while the vegetation contribution was estimated at 0.13 ft/10 years (80 ac-ft) over a 600-acre marsh surface. These figures are consistent with other estimates of marsh sedimentation rates with the exception of M&E Pacific's estimate of 0.9/ft 10 years which assumed a higher trap efficiency of the marsh, and an AECOS (1981) estimate of .003 ft/10 years which was considerably lower by several orders of magnitude.

4.3.4. **Biological Resources.**

4.3.4.1. **Vegetation**. Over the years, marsh photos and written and oral histories have shown a progression from open water to encroaching vegetation floating above the water. The character of the vegetation in Kawainui Marsh has been influenced by changes in nutrient levels, water levels, and the introduction of exotic plant species. The marsh area was primarily used as a site for fish rearing, and taro farming, followed by rice cultivation and, lastly, sugarcane outside of the marsh.

In 1926, California grass was introduced as fodder for cattle. Since that time, the wetland vegetation pattern in the marsh has remained relatively stable although water level changes for irrigation purposes may have altered the relative size of the bulrush/sawgrass community and the California grass community. The bulrush community occupied 395 acres reaching 543 acres with higher water levels, and decreased to 247 acres during drawdown (Smith 1978). Four sewage treatment plants discharged secondary treated sewage into the marsh from the mid-sixties until the late 1980's. This nutrient contribution is believed to have contributed significantly to vegetation growth.

The long-term tendency of Kawainui Marsh plant succession, as with other marshes, is believed to be toward a wooded bog dominated by trees and sawgrass. The floating mats of vegetation act as substrate for debris and, through decomposition, deposit organic materials at the bottom. At the present time, the vegetation in Kawainui Marsh may be divided into three major categories (Figure 6):

a. Bulrush/Sawgrass Floating Mats. The floating mats of vegetation, primarily bulrush (*Schoenoplectus californicus = Scirpus californicus*), and sawgrass (*Cladium jamaicense*) interspersed with taro patch fern (*Thelypteris interrupta*) and common cattail (*Typha latifolia*), are the dominant forms of vegetation in this community and grow on peat deposition. This floating mat can support the weight of people and animals while covering deep areas of water.

b. California Grass Meadow. This major vegetation community is located in the southeastern and southwestern perimeter of the marsh, where it forms a bog meadow growing on mineral soil and detritus rather than peat. The California Grass (Brachiaria mutica) is interspersed with honohono (Commelina diffusa), and arrowhead (Sagittaria latifolia) and also grows on fine alluvial soils in the drier parts toward the southeast and southwest. It too forms thick, dense floating mats that produce a pseudo-terrestrial environment that can support the weight of several men or cows and allow for the growth of non-wetland plants such as paperbark (Melaleuca leucadendra) and wild sugarcane (Saccharum spontaneum).

c. Open Water Plants. Water hyacinth (Eichhornia crassipes) and water lettuce (Pistia stratiotes) are found in open water areas in the southern part of the marsh and its periphery. These floating plants are infamously known for clogging waterways elsewhere in the world and are posing the most serious threat to wildlife habitat in Kawainui Marsh. Water hyacinth presently covers approximately 27 acres, considerably more coverage than that occurring up until 1978. Emergent aquatic plants have almost completely covered the open water areas in less than 36 years (C&C FEIS 1990). Rates of evapotranspiration of water hyacinth are approximately 1.75 times the rate of open-water evaporation (C&C FEIS 1990). Nevertheless, water hyacinth acts as a food source for some waterbirds and is well known for its water cleansing abilities.

d. Other Plants. The levee side of Kaelepulu Drainage Canal fosters California grass on alluvial soil. In addition, because the stream's proximity to the levee varies, certain stretches of the stream bank are extremely dry, whereas other areas at a greater distance from the levee, maintain the great bulrush which is more adapted for water growth. The bank adjacent to Coconut Grove has patches of Indian pluchea (Pluchea indica) frequently found in wetlands, particularly salt marshes and brackish areas, but the majority of the Coconut Grove bank is predominately vegetation planted by residents. The upper slopes of the marsh are wooded, mainly with koa haole, guava, Chinese banyan, and monkey pod. No endangered plant species have been identified.

A fire in Kawainui Marsh in August of 1975 began on the Quarry Road side where the dominant vegetation was California grass and bulrushes. It appeared that the fire did not completely consume the vegetation mat even through 69 percent of the wetland burned, of which 24 percent was a complete burn with no vegetation left visible. Within weeks, new growth was evident from the existing root structures and may have been stimulated by the fire through release of nutrients into the water. Both sawgrass and paperbark trees and seedlings showed positive growth response to the fire (Smith 1978).

4.3.4.2. **Feral and Domestic Animals**. Mongoose are known to prey on the bird life of Kawainui Marsh from personal observations of visitors to the marsh and may be the primary predator of the birds. No quantification of this predation is available. Feral dogs, cats and rats are also found in the marsh and vicinity and are likely predators. Approximately 130 head of cattle presently graze on California grass near the Kailua Road side (southwest) of the marsh near the bridge on land leased from the State on a month to month basis.

4.3.4.3. **Birds**. Three major sources of information on the presence and abundance of bird species in Kawainui Marsh (*A Survey of Waterbirds of Kawainui Marsh* by S. Conant, 1981; *An Ornithological Survey of Hawaiian Wetlands* by Shallenberger, 1977; and the State Division of Forestry and Wildlife's *Waterbird Status in Kawainui Marsh*, Engilis, 1988) indicated that all four species of Hawaii's endangered waterbirds are found in Kawainui Marsh. These waterbirds are officially listed as endangered species under authority of Section 4 of the Endangered Species Act as well as in the State endangered species law and are resident, non-migratory species endemic to the Hawaiian Islands. A map noting their distribution is contained in Figure 7. The marsh is considered potential primary nesting habitat for these species. Although no wetland habitat has yet been designated as critical habitat for these endangered species, a Hawaiian Waterbirds Recovery Plan 1985 by the US Fish and Wildlife Service designated part of the marsh as essential habitat for the recovery of these waterbirds. Habitat in the marsh has steadily degraded due to the reduction of open water from vegetation growth.

The State of Hawaii Department of Land and Natural Resources conducts biannual wildlife surveys in the marsh for State-wide inventory purposes. The status of waterbird use in the marsh was summarized by Engilis in 1988 and again by the USFWS in its draft 2(b) report.

a. Hawaiian Stilt or Aeo (Himantopus mexicanus knudseni). The low counts of approximately 12 stilt residing at Kawainui represent a very small percentage of the over 1,000 that are estimated to make up their State-wide population. This may be due to the limited areas of mudflat habitat. The marsh does offer some nesting and feeding habitat on its mud flats and adjacent vegetated areas and young stilt have been seen frequenting the emergency ditch alongside the levee. Stilt feed on a wide variety of invertebrate and other aquatic organisms found in shallow water and mudflat habitats.

b. Hawaiian Coot or Alae keo keo (Fulica americana alai). The 1988 summer State-wide population of coots was estimated to be around 900. As long as open water is present, the birds use Kawainui, particularly for feeding; up to 20 have been counted there during floods when open water is most abundant. Adults with young coots have been seen there indicating that the area is used for nesting. Nesting sites are usually in or adjacent to vegetation within areas with stable water levels. Coots feed near the surface of the water, diving and foraging in sand or mud for seed and leaves of aquatic plants, snails, crustaceans, and aquatic and terrestrial insects.

c. Hawaiian Common Moorhen or Alae ula (Gallinula chloropus sandvicensis): This bird is a permanent resident in the marsh, inhabiting open waterways, channels, and densely vegetated areas. It prefers dense stands of marsh vegetation interspersed with areas of open water for nesting. Similar areas of cover are used as feeding and resting sites. Young have been observed, indicating that they nest there. The State's survey reported 35 moorhens from the area. In that the State-wide population may be in the low hundreds, the marsh represents a significant habitat for the maintenance and recovery of the species. The secretive nature of this species makes sitings difficult.

d. Hawaiian Duck or Koloa (Anas wyvilliana). The koloa is a permanent resident which is commonly observed around open waterways and channels; it is known to nest on the ground near water and feeds on snails, earthworms, rice, algae, seeds and leaf parts of wetland plants. According to the State's 1988 report, the "10 to 12 birds that can be regularly seen in Kawainui represent the largest known concentration on windward Oahu." The total population of the duck State-wide is estimated to number in the low hundreds. Feral mallards inhabiting the marsh apparently are capable of breeding with the Hawaiian duck altering the species genetically (Griffin and Brown 1990).

e. Other Birds. In addition to the endangered species of birds, the Black-crowned Night Heron, the Great Frigatebird, Cattle Egret, and a variety of seasonally migratory waterfowl are prevalent in the marsh. The reader is referred to the USFWS draft 2(b) report in Appendix E of this document.

4.3.4.4. **Aquatic Fauna.** The aquatic communities are dominated by exotic species. The omnivorous tilapia, top minnows and other "mosquito fish" clearly dominate the open water areas of the marsh. Species diversity is low and the absence of permanent deep water bodies has inhibited the migration and survival of desirable species such as mullet and aholehole in the marsh. A map showing the Generalized Wetland Boundary is shown on Figure 8.

Native diadromous species are those which require early development as marine plankton and later migrate into freshwaters to complete their cycles. These species are relatively rare in Kawainui although post-larval and juvenile forms of the endemic gobies and invertebrates, such as the native shrimp, opae kalaole (Atyoida bisulcata), may migrate through the marsh to reach suitable habitats in Maunawili Stream and its tributaries. Other native stream fauna including the endemic goby o'opu nakea (Awaous stamineus), the indigenous goby Stenogobius genivittatus, the endemic eleotrid Eleotris sandwicensis, the endemic flagtail Kuhlia sandvicensis and the indigenous mullet Mugil cephalus have been recorded in the vicinity of the estuary end of the Oneawa Channel but not within the marsh itself (Ford 1975). The estuary end of the Oneawa Channel is the most productive aquatic habitat with respect to fishery resources. Tilapia are abundant throughout the estuary. The rice eel Monopterus albus was observed within the dredge spoils from the excavation of the emergency ditch along the levee and the open channel created on the Quarry Road side of the marsh. These eels are docile and prefer to live in mud or thick submerged vegetation in stillwater environments such as marshes and paddy fields. Because of their secretive habits they are difficult to observe and capture.

The dominant invertebrates of the marsh are insect species which thrive on its aquatically fed environment. Other invertebrates include the Louisiana crayfish (Procambarus clarkii), the Tahitian prawn (Macrobrachium lar) and the snail (Physa).

4.3.5. **Water-Borne Health Concerns.** An abundant invertebrate species in the marsh proper is Physa, a snail which appears to be a secondary host for a bird parasite (schistosome) which infests the marsh (C&C FEIS 1990). This has human health implications. Leptospirosis is a potentially fatal bacterial disease which can survive for long periods in fresh water and mud that can be transmitted from animals to man. Rats, mice, and mongooses are the most important carriers of the disease in Hawaii. Leptospirosis is prevalent in Kawainui Marsh and its tributaries although it is not considered a "hot spot" due to the lack of significant recreational activity.

In August 1988, approximately 14 dead ducks were retrieved from the head of Oneawa Channel with clinical signs pointing to botulism. This outbreak was believed related to warm water conditions and lowered water levels in the marsh. Environmental factors that contribute to initiation of these outbreaks include water depth, water level fluctuations, water quality,rotting vegetation and high ambient temperatures.

4.3.6. **Marine Environment**. Environmental Consultants (now AECOS, Inc.) (1977) described the coastal and marine ecology of Kailua Bay fronting Kailua Beach Park. Additional information is also found in the Oahu Coral Reef Inventory and the Oahu Coral Reef Atlas (Corps 1979; 1981). The waters of the bay are Class A coastal waters. The shoreline of Kailua Bay between the Oneawa Channel outlet to the north and the Kaelepulu Stream/Canal outlet to the south is dominated by white sand beaches. Deep reef flats with some corals, plentiful algae, abundant sediment in suspension, sand accumulating in deep pockets, and some reef fish populations form the predominant *reef communities* immediately offshore from the beach. There is a relative paucity of macro-organisms, other than algae, which are the most diverse group. Shifting sand, general lack of topographic relief, as well as fishing pressure are believed to contribute to the relatively low numbers of species in the inner bay. An increase in abundance and diversity of fishes and larger invertebrates is expected further offshore. Well developed coral reef systems are not present.

The bay is heavily used for spear fishing, pole and line fishing, swimming, snorkeling, kayaking, canoeing, wind surfing, surfing and other water contact recreation. Kailua Bay to Lanikai Beach is windward Oahu's most heavily utilized beach system. Runoff and discharges from the canals have localized water quality effects, especially during heavy rainstorms. Soundings made of the channel in April 1988 (C&C FEIS 1990) confirmed that very little additional sediment had been deposited in the Oneawa Channel since construction.

4.3.7. **Resources of National Recognition**. A number of studies of the marsh have been made over the years - some of which focus on archaeological and/or geoarchaeology aspects (Allen-Wheeler 1981a; Athens and Ward 1991; Bordner 1977; Clark 1980a; Clark 1980b; Cordy 1977; Cordy 1978; Ewart and Tuggle 1977; Hammatt et al., 1990; Kelly and Clark 1980; Kikuchi 1976; Kraft 1980; McAllister 1933; Morgenstein 1978; Pantaleo and Cleghorn 1989; Watanabe 1988). Some of these studies indicate the marsh was evolved from a marine embayment to a lagoon to a marsh within the last 12,000 years. Researchers working in various portions of the marsh have offered a number of interpretations for the cause of the geomorphic changes and the time period in which they occurred. As yet, none of the explanatory models have been fully agreed upon by the scientific community. It is agreed, however, that the marsh and surrounding environs were intensively and extensively used by the Hawaiians prior to European contact and that the marsh and the numerous associated archaeological sites are significant cultural resources.

4.3.7.1. **National Register of Historic Places - Listed or Eligible Sites**. The marsh as a whole is a significant pre-European contact and historic site of Hawaiian occupation as evidenced by legend, historic documents, archaeological research, extant agricultural systems, ceremonial sites, and habitation areas. The State Historic Preservation Officer and the Keeper of the National Register have determined that the entire Kawainui Marsh is eligible to be listed on the National Register of Historic Places (Figure 9). This determination is based on the marsh's role as a major economic component of a larger prehistoric, historic, and cultural socio-economic unit (ahupua'a). Material evidence which verifies this role includes the presence of two large Hawaiian heiau (stone platform temples) Ulu po and Pahukini, which are in the vicinity of the marsh; extensive wetland agricultural systems; terraced hillslope dryland agricultural systems; habitation sites; walls; etc. Significant archaeological sites within and in the proximity of the marsh which have been identified thus far are presented in Table 1.

An intensive archaeological sediment coring study was undertaken during 1990 on behalf of the C&C of Honolulu (Hammatt et al., 1990). Ten core samples were removed at 1,000-foot intervals within wetland portions of the marsh (see Figure 9). No cultural material or deposits were encountered within the cores. Interested persons may review a copy of this report by sending a written request to C&C of Honolulu, Department of Public Works, 650 S. King Street, Honolulu, HI 96813.

Under contract to the Corps, archaeological research was conducted in 1990 in the vicinity of the present levee (Athens and Ward 1991). The research consisted of placing core/auger units within two research corridors, one on each side of the levee, and surface examination and excavation of test units along the hillslope at the southern terminus of the levee. In addition, cores were removed from central portions of the marsh and two areas of previously identified possible cultural deposits were examined (Figure 9). No cultural deposits or remains were encountered within the study area. Interested persons may review a copy of this report by sending a written request to the US Army Corps of Engineers at the address provided in the beginning of this document.

Archaeological subsurface research was conducted by Corps staff in 1991 within the Kawainui Neighborhood Park in the area designated in this document as a "temporary work and storage area" for the construction contractor (see Figure 15). The research consisted of surface examination and excavation of test units. No cultural deposits or remains were encountered. The deposits indicate the area consists of modern fill material to a depth of about 18 inches.

An analysis of Corps land survey data (U.S. Army Engineer District, Honolulu 1964) indicates the area designated "new wetland" (between Sta. 55+00 and 65+67) (see Figure 15) was formerly a wetland. This area was filled to its present elevation during the original construction of the channel and levee, ca. 1966. Removal of the fill will have no effect on any historic properties.

Table 1.
Kawai Nui Marsh Archaeological Sites

State Site No. (HPO) 80-11	Bernice P. Bishop Museum Site No. 50-0a-G6	Clark (1980b, 1980c) Cluster No.	Cordy (1977-1978) Site No.	Ewart & Tuggle (1977) Site No.	Site Name, Description and Location (TMK)
371	--	--	--	--	Ulu po Heiau. Religious structure. TMK 4-2-13: 2.
2022	32	1	1	1	Kawainui Terraces. Historic site, spring, and series of terraces continuing from marsh edge upslope. TMK 4-2-13: 38.
2023	33	10	--	--	Kawainui Cluster. Retaining walls, L-shaped alignments, terraces, road-bed. Level terrace or platform. TMK 4-2-13: 10.
2023	33	11	--	--	Kawainui Cluster. Two retaining walls. TMK 4-2-13: 10.
2024	34	7	--	4	Makalii Slope Cluster. Mounds terraces and wall remnants. TMK 4-2-13: 10.
2026	36	12	--	--	Kapaloa Agricultural Terrace. Large agricultural terrace. TMK 4-2-13: 10.
2027	37	15	--	--	Kukanono Habitation Site. Stone walled enclosures, linear pile of rocks, terraces. TMK 4-2-13: 38.
2028	38	14	--	--	Ulukahiki Walls. Two walls. TMK 4-2-6: 4 or 7.
2029	39	13	7	--	Kawainui Marsh Site. Large agricultural complex of rectangular fields, probable water channel. TMK 4-2-6: 13, 14, 16.
2030	40	--	--	--	Allen-Wheeler (1981b). Kihapai Occupation Site. Truncated cultural layer under modern fill and overlying beach sand. TMK 4-3-57: 65.
2031	41	--	--	--	Athens (1983). Kawainui Slope. Evidence for prehistoric occupation. TMK 4-2-13: 38.
3957	32	2	2	2	Kawainui Agricultural Complex. Dry-land agricultural terraces, mounds, c-shaped structures, walls, walled depression, historic structure. TMK 4-2-13: 31/38.
3958	32	3	3	--	Kukano Terraces. Terraces, walls. TMK 4-2-13: 31/38.

Table 1.
Kawai Nui Marsh Archaeological Sites
(continued)

State Site No. (HPO) 80-11	Bernice P. Bishop Museum Site No. 50-0a-G6	Clark (1980b, 1980c) Cluster No.	Cordy (1977-1978) Site No.	Ewart & Tuggle (1977) Site No.	Site Name, Description and Location (TMK)
3959	32	4	4	3	Miomio Agricultural & Habitation Complex. Dryland agricultural terraces, mounds, walls, historic house foundation. TMK 4-2-13: 38.
3960	32	5	5	–	Pohakapu Agricultural Cluster. Stone platform, mounds, stone-lined channel and a large agricultural pond (lo'i). TMK 4-2-13: 38.
3961	32	6	6	–	Kukanono Cluster. Stone terraces retaining walls, mounds and stone-lined canal. TMK 4-2-13: 38.
3962	32	8	–	5	Makalii Historic Site. Three historic buildings. TMK 4-2-13: 10.
3963	32	9	–	6	Makalii Mounds. Earth mounds TMK 4-2-13: 10.
3964	32	–	–	8, 9	Kaeleuli House Site. Michael Baldwin Trust. Recently abandoned houses. TMK 4-2-15: 6.
3965	32	–	–	7	Pohakea Terrace. Low stone terrace and stone wall. TMK 4-2-13: 10
2033	85	–	–	–	Panteleo and Cleghorn (1989). Kapa'a Ridge stepped terraces. TMK 4-2-14: 2, 4.
2034	86	–	–	–	Panteleo and Cleghorn (1989). Kapa'a Ridge historic wall. TMK 4-2-14: 2, 4.
2035	87	–	–	–	Panteleo and Cleghorn (1989) Kapa'a Ridge historic rock wall. TMK 4-2-14: 2,4.
2036	88	–	–	–	Panteleo and Cleghorn (1989) Kapa'a Ridge rock mound. TMK 4-2-14: 2,4.
2037	89	–	–	–	Panteleo and Cleghorn (1989) Kapa'a Ridge agricultural complex. TMK 4-2-14: 2,4.

4.3.7.2 **Hawaiian Cultural Significance.** Kawainui Marsh's significance to the Hawaiian culture has been documented in oral tradition, history, chanting and hula (Kelly and Nakamura, 1981). The productivity of the area was assumed by the presence of a mo'o or guardian spirit, the goddess, Hauwahine who looked after the welfare of the people by insuring plentiful food from the fish pond. A religious based respect for the natural environment manifested itself in the building and maintaining of heiau along the periphery of the marsh. The Kailua ahupua'a contained the nutrient rich waters, irrigation systems, and fish ponds of Kawainui, Kaelepulu, and Nuupia making this highly productive area the "capital of O'ahu" and associated with a number of prominent ali'i or Hawaiian royalty (Drigot and Seto, 1982).

Over the many years, the Hawaiians have seen the interior of the marsh transformed from fish pond and taro farming to rice culture, its waters drained for sugar cane culture and other agriculture, its borders filled with sediment, land fills, auto junk yards, rock quarries and urban development including sewage treatment facilities, elevated highway construction and a drive-in theater. The designation of the marsh as a flood storage basin in the 1960's has saved it from additional development.

4.3.7.3. **Wilderness Area and Wildlife Refuge**. The State of Hawaii Department of Land and Natural Resources (DNLR) is scheduled to take the lead in wildlife management in the marsh pending the transfer of marsh ownership from the C&C to the State following construction of the flood control measures and is working with an interagency and community committee in the development of a wildlife management plan for Kawainui Marsh. Kawainui Marsh is being considered for inclusion as a national park under the jurisdiction of the National Park Service.

4.3.8. **Aesthetics.** Kawainui Marsh, with its backdrop of the Koolau Mountains, is one of the most substantial aesthetic resources on the windward side of Oahu. The wide, flat expanses, isolated stands of paperbark trees, and the elevated forested fringe around the marsh provide a dramatic foreground viewplane for the spectacular foothills and steep volcanic slopes to the west. This serves as visual relief from the prominent urban character of the lands to the east and south of it.

Less than a dozen homes in Coconut Grove, whose properties are bounded by the Kaelepulu Drainage Canal, have relatively unrestricted views of the marsh and unobstructed views of the Koolau Mountains. Those homes with second stories have views unobstructed by the levee. All the other homes along the canal have views partially or completely blocked by vegetation or outbuildings. Mountain views can be seen between streets by motorists. Most of the homes in Coconut Grove have blocked views of the marsh and mountains and the best vantage points for viewing the marsh are from the levee, the model airplane field, the Ulu po and Pahukini *Heiau* and Pohaku o Hauwahine (Kridler's Rock).

4.3.9. **Land Use Policies, Plans and Controls**. At the present time, the following plans have been developed or are in an active status to improve the marsh for wildlife, recreational and cultural enhancement:

a. State of Hawaii Kawainui Marsh Resource Management Plan (DBED; being updated by DLNR). This 1983 State-sponsored plan involved the participation of all agencies and community groups interested in enhancement and restoration of the marsh. Upon completion of the plan, there was a general consensus among all contributors that this plan was the one which should be implemented or followed. At the time of plan development, however, it was implicitly agreed that flood control was an established non-negotiable function of the marsh and that flood control features as they existed in 1983 completely fulfilled this function.

b. Kawai Nui Heritage Foundation's Directional Plans (Appendix E)

c. Hawaii Waterbird Recovery Team Plan.

In Hawaii, land use planning and controls are vested with both state and local agencies. The State Land Use Commission is responsible for basic land use designations or districts including the conservation designation for the marsh and the urban designation for the residential and commercial lands to the east and south. Kawainui Marsh is in the Conservation District Subzone: Preservation. The State is also responsible for development and implementation of the State plan, and the DLNR is responsible for permits for the use or modification of conservation land and alteration of stream courses. The Office of State Planning includes the Coastal Zone Management (CZM) Office which is responsible for managing the State-level CZM program. The Federal CZM consistency statement is listed in Appendix E.

County level land use responsibilities include general planning and the implementation and modification of development plans by the Department of General Planning. Zoning of urban lands and administration of other County land use controls such as the Special Management Area (SMA) program and the shoreline setback ordinances are handled by the County Department of Land Utilization. Kawainui Marsh falls within the SMA boundaries and is zoned for preservation use in the County General Plan Designation.

All existing uses of the marsh and surrounding urban environmental are fully consistent with all County and State land use controls, policies, and plans. Flood control is an authorized and dedicated land use function of Kawainui Marsh and has been since the County agreed to manage and maintain the Federally-built project in 1966. Modifications to the existing project, however, would be subject to approval of the Assistant Secretary of the Army for Civil Works and certain land use and regulatory approvals described elsewhere in the environmental text of this document.

4.3.10. **Socio-Economic Resources.**

4.3.10.1. **Population**. Oahu, meaning *Gathering Place*, is the State's third largest island and the center of the State's population, commerce, and government. It has a land area of 593 square miles and a residential population including military residents of 836,000, or about 75 percent of the State's total population (1990 Census). Honolulu, the State capitol and County seat for the C&C of Honolulu, is on the southeast coast of Oahu adjacent to Honolulu Harbor. Kawainui Marsh is a large contiguous open space in the environment of the Kailua area and the overall Koolaupoko district on the southwest coast of Oahu. The population in this area has grown from 5,258 in 1930, to 92,219 in 1970 to 117,694 in 1990. The residential and commercial developments that extend from the existing flood control levee to the ocean include Coconut Grove which is the area most susceptible to flooding with 2,025 structures (9 commercial, 4 public, and 2,012 residential).

4.3.10.2. **Recreation**. Kawainui Marsh has many special features and uses. High among these features are hiking and jogging as well as passive recreation, research, and education. A current example of public use is the guided educational tours of the marsh that are regularly conducted by the Kawai Nui Heritage Foundation. A comprehensive educational source book, slide show and video have been developed which highlight the evolution, cultural significance, wetland values, flora, fauna and ethnobotanical features of the area. In addition, numerous neighbors of the marsh take walks, jog, and conduct incidental nature study along its boundaries including the levee, although the levee is posted "No Trespassing." There is considerable interest in increasing recreational opportunities in the marsh.

4.3.10.3. **Economics**. Strength in Hawaii's visitor and construction industries propelled the economy in Honolulu to its ninth year of expansion in 1990 and is expected to continue. Gross business receipts for Oahu increased by 15 percent from 1988 to 1990 totalling $35 billion. Oahu also had the lowest unemployment rate in the State. The average unemployment rate was at 2.6 percent in 1990. About 10,000 people out of 391,400 civilians in the labor force were unemployed. Jobs on Oahu rose by 4 percent last year to 439,400 positions. Oahu's visitor industry increased by 6 percent last year. Oahu's construction industry, the largest in the State, surpassed the $3 billion mark for the first time in 1990, a 25 percent increase over 1989.

The military continues to be a large contributor to the County's economy. As of July 1, 1989, there were 56,370 active military personnel in the State with 56,099 stationed on Oahu. Together with dependents, the military population on Oahu came to 116,126 people. Direct contributions to the State economy by the military came to $1.2 billion. A majority of these funds were spent on Oahu and makes the military the third largest contributor to economic growth in the State.

4.4. **Future Conditions (No Action)**. Should the no action alternative be selected, no Corps-funded construction would be implemented although floodplain management technical service could be provided to assist in reducing damages within the floodplain. The C&C of Honolulu is implementing the Kawainui Marsh Flood Damage Mitigation Project which is a marsh clearing project that would open channels into the marsh from the open water area at the southern end of the marsh (see Figure 4). About 20 acres of marsh vegetation have been removed for this purpose. This project, in combination with an existing ditch adjacent to the levee, would have reduced the peak stage of the New Year's 1988 flood near the Quarry Road end of the marsh by approximately 0.5 feet (C&C FEIS 1990, page A-77). The C&C intends to keep vegetation and sediments from encroaching into the existing ditch adjacent to the levee. The ditch is not part of the Federally-authorized or proposed flood control project. The C&C acknowledges that even with the marsh clearing project in place, the existing levee will continue to be overtopped (C&C FEIS 1990, page A-78).

Individual household efforts to reduce exposure to the risk of damage due to flooding may be taken, such as flood-proofing individual residences and purchasing flood insurance to reduce the financial impact of losses. The major impacts of the "without project" alternative are continued negative economic and psychological effects of periodic flooding from the levee overtopping from Kawainui Marsh in the residential and business areas of Coconut Grove. Without measures to reduce the severity and frequency of these flooding impacts, the private and public costs (estimated at $1.9 million annually) associated with these effects will continue in the foreseeable future.

4.5. **Planning Constraints**. The planning constraints of this study are established to guide the formulation and evaluation of alternative plans for flood control. These planning constraints, which are consistent with the Federal NED objectives, are based on the analyses of technical, economic, environmental, and social considerations, and the concerns and needs of the public and the C&C of Honolulu, the local sponsor. The planning constraints are as follows:

a. Develop alternative solutions to the flood problem in Coconut Grove.

b. Minimize alterations to the fresh water, marine and terrestrial environment and to the recreational, cultural, and archaeological resources of the study area.

c. Avoid impacts to endangered or threatened species.

d. Identify and evaluate the beneficial and adverse impacts of alternative plans and incorporate appropriate mitigation where necessary.

e. Evaluate alternatives on an engineering, economic, environmental, and social basis and recommend a plan for implementation.

f. Recommend the plan with the greatest net benefits (benefits less costs).

4.6. **Alternatives**. Alternative measures for flood control were developed and evaluated against the planning objectives defined in paragraph 4.1.2. Possible measures for flood control do not necessarily have to be within the authority or capability of the Corps to construct. For example, the C&C plan as presented in Figure 4 will be implemented without Corps participation. This channel will help to more evenly distribute floodwaters within Kawainui Marsh and provide a basis for selecting a starting marsh water surface elevation. All alternative plans evaluated in this report include the C&C plan as a base condition. If favorable or superior measures are available outside the range of Corps authorities, the final recommendation would also include these alternatives. The initial step in the formulation process was to identify the type of measures, both structural and non-structural, suitable to resolve the problems and meet the planning objectives. The next step was to screen potential alternatives that could be implemented with minimal adverse impacts. The alternative plans that met the planning objectives and were consistent with local desires and needs were then evaluated in detail.

4.6.1. **Available Measures for Flood Damage Reduction.**

a. Non-structural Measures. Non-structural alternative measures do not reduce or control flood waters, but are intended to minimize losses and damages during flood events. These alternatives provide protection by evacuating residents or by insuring, removing, floodproofing, or prohibiting damageable properties within the floodplain. Typical non-structural measures include:

(1) Incorporating floodplain restrictions on construction and on the use of affected lands;

(2) Improving maintenance of existing flood control and drainage structures;

(3) Relocating flood damageable structures to property outside the floodplains;

(4) Floodproofing existing structures;

(5) Flood forecasting, warning, and evacuation systems; and,

(6) Combinations of the above alternatives.

Although certain non-structural alternatives may contribute significantly to the reduction of flood damages to homes and other structures, damages to public facilities, yards, garages, cars, and other exposed property will still occur. Without structural flood control measures in place, clean up of debris and mud would still follow flood events. The inherent danger of flooding would not be eliminated.

b. Structural Measures. Structural alternatives for flood control include levees, dams and reservoirs, diversion structures, pump stations, and channel improvements.

4.6.2. **Considerations in Alternative Development.**

4.6.2.1. **Engineering Considerations.**

a. Provide a hydrologic analysis which reflects future development conditions in the marsh watershed.

b. The preferred flood control solution is one which is not dependent on marsh dynamics, but should consider future conditions and changes likely to occur within the marsh.

c. The floating vegetation mat on the marsh surface severely complicates flood control measures due to its instability and unknown/random behavior during flood events.

d. A levee raise alternative should consider future conditions and changes to flood storage within the marsh area.

e. Document the rationale for the antecedent water surface elevation in the marsh prior to the project design flood event.

f. Include a flood warning system in the final plan.

4.6.2.2. **Economic Considerations.**

a. Reduce property damage and other economic losses from flooding.

b. Contribute to the efficient use of the floodplain lands.

c. Develop alternative plans considered for implementation with a benefit-to-cost ratio (BCR) greater than one (i.e., the average annual NED benefits should exceed the average annual costs) and with average annual net benefits maximized. Alternative plans with a BCR less than one are generally not recommended for federal participation.

d. Express benefits in quantitative economic terms comparable to costs. Average annual cost will be based on an amortization period of 100 years and an 8-1/2 percent interest rate and annual maintenance costs. A 100-year amortization period for the earth levee or concrete floodwall was considered reasonable because vegetation progression and sedimentation in the marsh over the next 100 years would not change the proposed project design. Use of a 50-year instead of 100-year project life would not significantly change the project economics.

4.6.2.3. **Environmental and Social Considerations.**

a. Minimize significant adverse environmental impacts and consider proposed mitigation measures to minimize the impacts for each alternative where necessary.

b. Contribute to or maintain cultural, recreational and educational opportunities in the study area.

c. Avoid disturbance to known archaeological, cultural, and historical resources in the study area to the maximum extent possible, and consider mitigation measures where necessary.

d. Protect the beneficial values of wetlands within the project area for endangered waterbirds.

e. Provide relief from flooding and avoid relocation of residents and minimize adverse social, health, and safety impacts.

4.6.3. **Development of Alternative Plans.**

4.6.3.1. **Reconnaissance Phase.** The initial reconnaissance report for Kawainui Marsh Flood Control Project which was completed in November 1989 considered the following alternatives:

a. Raising the existing levee by filling or adding a concrete floodwall.

b. Widening the existing channel next to the levee on the marsh side.

c. Combining the above options.

d. Taking no action.

During the reconnaissance phase, the most feasible course of action identified was the consideration of raising the levee and widening and deepening the existing channel on the marsh side of the levee.

Raising the levee would provide a positive means of restoring flood control which would be unaffected by the unknowns of future marsh conditions. Raising the levee would be accomplished by increasing the levee section with fill material. Raising the levee with earthfill would increase the size of the levee section and would fill about 6.4 acres of wetland on the Coconut Grove side of the existing levee. Building a flood wall on top of the levee would serve the same purpose but would not fill any wetland. Modifying the levee with a floodwall would be accomplished using standard construction practices and would take place on the existing flood control structure. A combination levee raise and floodwall would improve the aesthetics of the floodwall plan and could avoid wetland fill by a retaining wall at the levee toe.

4.6.3.2. **Feasibility Phase**. Alternatives considered but dropped from further study during the initial feasibility phase included the following plans.

a. Dam. The Maunawili Valley was examined for locating a potential dam site. The most desirable location would control as much drainage area tributary to the marsh as possible. Locating a dam near the marsh would control the most drainage area, but the land tends to flatten and the structure would be larger than a structure located further up the valley. Urban development in the lower elevation areas also limited the number of potential sites. Extensive development near the confluence of Makawao, Olomana, Ainoni, Maunawili, and Omao streams precluded the construction of a dam at this optimum site. Of the three sites considered, the site located downstream of the Maunawili development just above Kalanianaole Highway was selected as being the best potential dam site. This site would require a structure about 5,500 feet long, 80 feet high, and would impound 5,100-acre-feet of water runoff from the Maunawili basin during the Standard Project Flood. The unregulated tributary areas to Kawainui Marsh would continue to drain to the marsh during flood events but would not pose a danger to the Coconut Grove area. The dam would have a construction cost of $35.8 million not including real estate and relocation costs.

b. Diversion Tunnel. The Diversion Tunnel alternative was considered to intercept flows upstream of the Pali Highway from the Maunawili Stream with a 2,200-foot-long control structure and tunnel. The control structure would be about 40 feet high and would include an emergency overtopping spillway in the event the design flow was exceeded. The diversion structure would require an area of about 13 acres. The diversion tunnel would be 24.5 feet in diameter, 7,000 feet long, and would extend from the control structure at Maunawili Stream to Kaelepulu Pond (Enchanted Lakes). Improvements from Kaelepulu Pond to Kailua Beach would include widening and deepening the existing Kaelepulu Stream. This plan would have a construction cost of $40.4 million not including real estate and relocation costs.

c. Pump Station. A pump station at Kawainui Marsh was investigated for flood control. The pump station design was based on using the marsh to store 2,200 acre-feet of water behind the existing levee and would consist of five stations, each with a capacity of 1,140 cfs with discharge lines to Oneawa Channel located on the existing levee. Flood water would reach the stations through an existing ditch along the marsh side of the levee. The construction cost of this alternative would be $29.3 million.

d. Marsh Clearing. A marsh clearing alternative was investigated based on input received from the Kawainui Marsh Heritage Foundation. The intent of this alternative was to allow floodwaters to more easily pass through the heavily vegetated marsh as well as provide additional open water habitat for endangered waterbirds. A total of 76 acres would be cleared. Representatives of the Aquatic Plant Control Program of the COE in Jacksonville, Mississippi visited the Kawainui Marsh site in 1989 and concluded that off-the-shelf items would be feasible for use in initial excavation (***Aquamog*** - or Jet Spray) and for follow-up maintenance of cleared waterways (*Cookie Cutter*). The plan included building a settling basin, weirs, drainage structures, and containment dikes for dredge material at the work and storage area. The plan incorporated the C&C disposal and unloading areas for the dredged materials which were built as a part of the C&C plan to build channels into the marsh. The marsh clearing plan would widen and connect the channels proposed by the C&C of Honolulu. About 372,000 cubic yards of vegetation from the 76-acre cleared area would be removed off the project site to a landfill in the leeward area of Oahu with the silts pumped to the disposal area. About 205,000 cubic yards of silt would be removed to a disposal area settling basin located in a work and storage area at the western side of the marsh. The alignment would be modified to incorporate the channels being constructed by the C&C. The marsh clearing plan incorporated the Quarry Road Channel as described in paragraph (e) below.

The cost of clearing the mat was estimated based on using similar equipment and methods that the C&C is using to clear a 50-foot wide channel in the marsh. Another method to clear the mat was with "***Jet Spray*** (TM)" equipment that grinds up the mat and sprays the effluent back into the marsh. The ***Jet Spray*** can potentially eliminate the cost of handling and disposal.

In addition to clearing vegetation in the marsh, this alternative would require a levee raise or flood wall to a top elevation of 13.8 feet msl near Kailua Road and reducing gradually to elevation 11.1 feet msl at the Oneawa Channel. This levee raise would be required because even with 110 acres of open water, the flood water would exceed the existing levee height of 9.5 feet. Additional clearing of marsh vegetation to eliminate a levee raise was not cost effective and would allow floodwaters to more quickly reach and overtop the Oneawa outlet channel.

In addition, the Oneawa Channel would require dredging about 1.5 feet of depth from channel station 90+00 to 60+00 and would require removing additional material between channel stations 21+00 and 50+00 (Plate 10, Appendix B). About 15,000 cubic yards of material would be dredged and removed off the project site by pumping the sediments to the disposal area settling basin at the work and storage area on the western side of the marsh. If suitable, the material could be used for levee fill since much of the original levee was constructed using this fill. The water control structure would be located just upstream of Oneawa Channel to prolong stable water levels in the marsh during dry periods. However, the water control structure could not prevent low water levels or even drying of the marsh because water levels ultimately depend on rainfall and runoff into the marsh. The control structure consisted of a sheet pile wall with a low level gate to allow fish and wildlife personnel to manage water levels as needed for fish and wildlife enhancement. The estimated cost for this alternative was $24.5 million using traditional construction methods. If a jet spray were used, the cost would be reduced to approximately $16 million.

e. Quarry Road Channel. The Quarry Road Channel alternative included a channel that paralleled the west side (Quarry Road side) of the marsh and would be dredged to elevation -4.0 feet msl from Oneawa Channel to the existing open water area at the southern end of the marsh for a total distance of 7,300 feet. The channel section would have a 40-foot bottom width, 200-foot top width, 10 horizontal to 1 vertical side slopes, and would create 33.5 acres of open water. The dike would consist of a structure with a 10-foot wide crest at 12.0 feet msl, 4 horizontal to 1 vertical grassed side slopes and would extend 2,500 feet into the marsh from the marsh's southern shoreline to the Quarry Road channel entrance. The dike would contain about 56,700 cubic yards of material and would cover 3.1 acres of wetland. The Quarry Road Channel alternative was modeled with and without a dike structure. The dike structure was included to guide flood flows into the channel yet have small openings to allow normal circulation in the marsh during non-flooding conditions. A channel through the marsh was not a fully effective flood control measure because of a minimal hydraulic gradient through the marsh and a 7,300-foot channel length. With this alternative, a levee raise would be required to provide a 100-year level of protection. The supplemental levee raise or floodwall required a top elevation of 14.8 feet msl at the Kailua Road end of the levee and would extend to elevation 10.7 feet msl at the Oneawa Channel. As in the marsh clearing plan, dredging 15,000 yards of material from the Oneawa Channel would be required to handle the flood flows passed through the marsh by the Quarry Road Channel. The estimated cost for this alternative was $15.4 million.

f. Back Levee and Channel. The back levee and channel plan included a new levee parallel to the existing levee and located adjacent to Coconut Grove. The new channel was designed to extend and utilize the existing Oneawa Channel to its 6,750 cfs capacity. The plan would extend the Oneawa Channel along the Coconut Grove side of the levee and use the existing levee as a block to the floating vegetation mat, yet enable water to pass through culverts in the levee to an extended Oneawa Channel. The right bank of the Oneawa Channel would form a new levee to prevent marsh flood flows from entering Coconut Grove. Kaelepulu Stream would be realigned to enable interior drainage waters from Coconut Grove to flow unimpeded to Kailua Bay. The existing levee would be raised from Kailua Road to the beginning of the extended channel to preclude overtopping of flows from the marsh at the southern end of the levee. Concrete double-box culverts 22.5 feet wide by 50 feet long and 7.7 feet high would be constructed with bottom elevation of 4.5 feet msl at fifteen locations through the existing levee to allow water to enter and leave the extended Oneawa Channel. Water would flow from the channel back to the marsh if downstream water levels in the Oneawa Channel were higher than in the marsh. Since the culvert inverts are at 4.5 feet msl, no salt water would enter the marsh during low flow periods and the channel would be flushed out with fresh water during high water levels in the marsh. The banks at the culvert ends would have riprap lining to guard against erosion from high velocity flows. A water control gate would be constructed through the left bank of the extended Oneawa Channel to allow manipulation of water levels below 4.5 feet msl in the marsh.

The new channel extended from Oneawa Channel would be 3 horizontal to 1 vertical side slopes and would increase the total length of the Oneawa Channel by 5,300 feet. The invert would vary from about elevation -8 feet msl near the existing Oneawa Channel to about elevation -4 feet msl at the uppermost end of the channel extension near Kailua Road. The bottom width would vary from 80 feet at Oneawa Channel to 40 feet at the uppermost end of the channel extension. The right bank of the extended channel would form a new "back levee" to protect Coconut Grove from marsh flood flows. The back levee would have 3 horizontal to 1 vertical side slopes and a 10-feet wide crest at elevation 12.5 feet msl sloping down to the existing bank elevation of 8.7 feet msl near Kainui Drive. Interior storm drain flow would pass to Enchanted Lakes area through a relocated Kaelepulu Stream along the Coconut Grove side of the back levee. The existing levee would be modified by addition of a floodwall to elevation 16.0 feet msl for 1,400 feet extending from Kailua Road to the upper most end of the extended Oneawa Channel. The estimated cost for this alternative was $16.8 million.

g. Floodproofing. Floodproofing homes in the Coconut Grove area was investigated as a non-structural alternative to provide flood protection to the affected areas. One of the most common techniques of retrofitting flood-prone residential structures is to raise the entire existing structure above the flood hazard. When properly done, the elevation of a house places the living area above all but the most severe floods. In general, the steps required for elevating a building are essentially the same in all cases. First, all utilities are disconnected. Next, a cradle of steel beams is inserted under the structure; jacks are used to raise both the beams and the structure to the desired height; a new elevated foundation for the house is constructed; the structure is lowered back onto the new foundation; and the house frame and utilities are reconnected. Finally, new stairs are constructed to accommodate the change in elevation.

An estimated 1,085 structures in the Coconut Grove floodplain have living areas below the base flood elevation of 10.0 feet msl. While the subdivision contains a few houses which have two stories and/or hollow tile walls, this analysis provides construction engineering data for only single-story wood wall structures. For cost estimating purposes, three houses with post and beam floors and three houses with slab-on-grade floors were picked as being representative of all the houses requiring elevation. The houses chosen for analysis provided a reasonable sampling of the structures in the subdivision. The six houses were of various sizes and shapes. Some of them included an addition to the original house which is typical of the older homes in the area. The estimated cost of this alternative was $27.7 million.

4.7. **Elimination of Alternative Plans from Further Consideration**. The dam, diversion tunnel, pump station, marsh clearing, Quarry Road channel, back levee and channel, and floodproofing alternatives were eliminated from further study for the following reasons:

a. Dam. The most appropriate site for a dam has already been developed for residential use. The remaining possible sites are costly to develop and the B/C ratio was less than 1.0. In addition, the project may impact the marsh and have adverse impacts on unidentified historic sites in the area.

b. Diversion Tunnel. This alternative could cause additional flooding in the Enchanted Lakes area unless extensive improvements are made to Kaelepulu Stream. Improvements could be disruptive to Enchanted Lakes area residents. This alternative was costly to develop and the B/C ratio was less than 1.0.

c. Pump Station. A rapid rise of water levels would overwhelm the pump station's capacity. Pump section capacity is limited to 6,750 cfs which is the design capacity of Oneawa Channel. Power failure during a flood would make the station useless. In addition, there was a high maintenance cost and the B/C ratio was less than 1.0.

d. Marsh Clearing and Quarry Road Channel. Most of Kawainui Marsh is covered by a floating mat of vegetation that rises and falls with changing water levels. This mat covers sections of the marsh that are more than 15 feet deep under low water conditions. Openings can be cut through the floating mat on the marsh but the mat can shift towards these openings and choke off the openings that were constructed to *provide flood control*. A danger area is located between the model airplane field and the entrance to the Oneawa Channel where water depths can exceed 25 feet during a flood event. The mat could shift in this region towards the Oneawa Channel which would choke off flow paths to the outlet channel and cause levee overtopping. The more meandering the channel, the greater the risk of mat shifting. Stable channels cannot be built in the middle of Kawainui Marsh. Extensive clearing of the mat throughout the marsh would allow water to quickly reach the Oneawa outlet channel and overtop its banks, thereby requiring extensive improvements to the Oneawa Channel. The plans may have a major adverse impact on the Kawainui Marsh Archaeological District. In addition water quality in Kailua Bay may have been degraded since wetlands with defined channels are less effective in retaining sediments (Morris, et. al. 1981). In addition, the Marsh Clearing and Quarry Road Channel plans were economically infeasible from a flood control benefits analysis with a B/C ratio of 0.6 and 0.9 respectively.

e. Back Levee Plan. This alternative may have adverse effects on unidentified historic sites and wetland areas along Kaelepulu Stream. Acquisition of private property along the Coconut Grove side of Kaelepulu Stream would be required. Although this alternative has a B/C ratio slightly exceeding 1.0, public review of the alternative was uniformly negative and the plan was dropped from further investigation and consideration.

f. Floodproofing. Floodproofing would involve major social disruption as over 1,000 homes would be raised from 3 to 5 feet. This alternative may have adverse effects on unidentified historic sites. The plan was economically infeasible with a B/C ratio of 0.6

4.8. **Description of Alternative Plans Carried Forward**. All plans except "No Corps Action" provide a 100-year level of protection for comparative purposes. Maintenance costs of all plans include $76,300 annually for interior channel maintenance by the City and County of Honolulu.

4.8.1. **Levee Raise**. An earth levee raise would consist of raising the levee for a distance of 6,300 feet on the Coconut Grove side of the existing levee (Figure 10) at least three feet higher than the design water surface. An earth levee raise to a one percent (100-year) level of protection would require a levee with a crest or top elevation (including three feet of freeboard) ranging from 17.4 feet msl at the Kailua Road end of the levee to 16.0 feet msl over a distance of 5,000 feet. The remaining 1,300 feet of levee would have crest elevations tapering from 16.0 feet msl to the existing levee elevation of 9.5 feet msl near the Oneawa Channel. On the basis of the slope stability analyses provided in Appendix C, Geology, Foundations, and Materials, a side slope of 3.5 horizontal to 1.0 vertical was selected for the Coconut Grove side of the levee having crest elevations higher than 16.0 feet msl. The side slope on the marsh side of the levee would remain at 3.0 horizontal to 1.0 vertical. Approximately 195,000 cubic yards of material would be required for levee fill. The levee would be constructed by first removing the gravel surface on the existing levee, benching the Coconut Grove side of the levee, and removing the vegetation, root mat, peat, and other organic material from a strip of low lying land between the existing levee and Kaelepulu Stream. New fill material would then be placed to construct a levee with a crest width of 10 feet and having the dimensions specified above. All slopes would be grassed and a gravel road would be constructed on the levee crest for maintenance purposes. About 6.4 acres of wetland would be filled by the new levee. Fill material for the levee is assumed to be brought in by truck from within approximately 5 miles from the project site. The estimated first cost for this alternative is approximately $11.9 million. Annual maintenance costs are estimated at $101,300.

4.8.2. **Floodwall**. A floodwall would extend from Kailua Road to Oneawa Channel. The floodwall would have the same top elevations as discussed above for the earth levee raise. In order to construct the floodwall, approximately one foot of the existing levee crest would be removed to form a base for an L-shaped concrete wall. Steel sheet piles would be driven into the existing levee at the marsh side to a maximum depth of about -7.5 feet msl in accordance with floodwall design criteria to preclude water seepage and subsequent undermining. A 16-foot wide concrete footing on the levee crest would allow maintenance and recreational access along the top of the levee. The vertical floodwall stem would be placed 11.5 feet back from the edge of the footing (see Figure 10). Landscaping would be provided on the Coconut Grove side of the wall to soften and obscure the outline of the wall. The floodwall would include about 1.2 million pounds of reinforcing steel and about 6,600 cubic yards of concrete. No wetland areas would be filled since the entire project would be placed on top of the existing levee (Figure 11). The estimated first cost for this alternative plan is $8.5 million. Annual maintenance costs are estimated at $101,300.

4.8.3. **Combination Earth Levee Raise and Floodwall**. This alternative (Plan 3A) (Figure 12) was developed combining earth levee raise and floodwall features to extend from Kailua Road to Oneawa Channel and would have the same profile as the earth levee raise and floodwall alternatives above. The floodwall would be set at four feet high and would be placed on top of the earth levee that would be raised to a lower height than the levee raise alternative. The floodwall would be placed on the Coconut Grove side of the levee top to allow maintenance access along the top of the levee. The floodwall would include 186,000 pounds of reinforcing bar and 3,570 yards of concrete. Earth fill of 129,000 yards would be placed beyond the footing of the new 4-foot high floodwall at the top of the levee to complete the levee raise. Wetland areas of 1.8 acres would be filled from the toe of the existing levee to the toe of the new levee structure. This alternative does not use sheet pile for the floodwall because the floodwall is less than four feet in height and uses a concrete cutoff wall for structural stability and seepage control. The estimated first cost of this alternative is $9.8 million. Annual maintenance costs are estimated at $98,300. A sub-alternative (Plan 3B) (Figure 13) to this design includes a levee retaining wall which would eliminate wetland filling. The cost of this sub-alternative is $12.2 million with an average annual maintenance cost of $108,300.

4.8.4. No Corps Action. The C&C marsh clearing plan as illustrated on Figure 4 is being implemented without Federal participation. The C&C has awarded the "basic bid" as shown on Figure 4 at a cost of $2.2 million. Additive bids items No. 1 and No. 2 were in the amounts of $1,068,350 and $179,600, respectively, but have not been awarded. This marsh clearing plan has increased the ability of the marsh to distribute and store stormwater runoff. The purpose of their action is to increase flood storage capacity. The action will create approximately 30 acres of open water by clearing vegetation and sediment from waterways and ponds. The estimated effect of the channels at full operation for the 1988 New Year's flood is a reduction in stage of approximately 0.5 feet at the upstream end (of the marsh) at the time of peak inflow in the marsh. For lower flood magnitudes (e.g., a hypothetical 50-year flood), the reduction effect will be greater (C&C FEIS 1990, page A-77). The total estimated cost of the C&C's work as proposed in their FEIS is $4.1 million. Maintenance costs have not been established by the C&C as of the date of this report.

4.9. Environmental Consequences and Mitigations.

4.9.1. Introduction. This section assesses the environmental consequences of the levee alternatives and identifies appropriate mitigation measures. The assessment of the potential for significance of the impacts from the alternatives was made using a three-step approach.

a. Describe the alternative in relationship to its environmental setting.

b. Compare the alternative to the environmental attributes described in the "Affected Environment" section and apply the assessment criteria.

c. Determine the potential that the proposed alternative has for causing significant impacts.

Components of the various alternatives were determined to have no potential for significant environmental consequences if they met all of the following assessment criteria using guidance contained in the Council on Environmental Quality Regulations (CEQ) (40 CFR, 1508.27):

a. The alternative or one or more if its component parts will not constitute a violation of Federal, State, or local laws or regulations imposed for the protection of the environment.

b. The alternative does not adversely affect public health or safety.

c. The alternative will not adversely affect or result in the loss of unique environmental, scientific, cultural, historical, aesthetic, or ecologically critical areas.

d. The alternative does not involve known risk.

e. The alternative does not result in irreversible and irretrievable commitments of unique or important environmental resources.

f. The alternative does not establish a precedent for future actions with significant effects.

g. The alternative does not result in effects on the quality of the human environment that are highly controversial.

If a proposed alternative was determined to present a potential for impact (i.e., if one or more the the preceding criteria were not met), then the potential for the proposed alternative to cause significant impacts was evaluated. The determination of significance included considering the intensity, extent, and context in which the impact occurs. Intensity refers to the severity of the impact which may be both beneficial and adverse. Extent is based on the relative amount of the change in the area/quantity and/or duration of recovery from the impact. Significance of an action must be analyzed in several contexts such as society as a whole, the affected region, the affected interests, and the locality.

As a result of the evaluation, consequences are categorized as insignificant, significant but mitigable, and significant, not mitigable. Environmental consequences are determined to be insignificant if, in the judgment of the preparers of this document or as concluded in existing environmental documents of similar actions, no potential for significant environmental impacts exists. Insignificance ranges from not detectable to maximum allowable limits. Consequences are deemed significant but mitigable if concerns exist but it is determined that all potential consequences can be readily mitigated to insignificant levels through standard procedures or by measures recommended in this document. In this final report, mitigation includes:

a. Avoiding the impact altogether by not taking action or parts of an action;

b. Minimizing impacts by limiting the degree or magnitude of the action and its implementation;

c. Rectifying the impact by repairing, recovering, rehabilitating, or restoring the affected environment;

d. Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; or,

e. Compensating for the impact by replacing or providing suitable resources or environments.

If consequences exist that can not be readily mitigated, the activity is determined to present significant environmental impacts. Federal environmental laws and regulations as well as public and agency input were reviewed to assist in determining the significance of environmental impacts.

4.9.2. Impacts of Alternatives Dropped from Further Consideration. Due to the great interest expressed by the community in the open water alternatives evaluated in the draft, the following summary of environmental impacts which contributed to the decision to drop in-marsh alternatives from final consideration is presented, although the primary reason was engineering. Community and scientific concern has been raised about the possibility that a dredged channel or channels, while expediting flood waters out of the marsh, could also drain the marsh during the low flow periods of the year or flush marsh sediments into Kailua Bay. The action could thus result in irreversible and irretrievable commitment of important and unique environmental resources. These possibilities were so great as to reject those alternatives from further analysis.

4.9.3. Environmental Risk Analysis. Excavation and movement of sediment and vegetation are likely to create turbid water conditions within the marsh in the vicinity of and downstream from construction of channels. Unknown quantities of sediment are likely to become mobilized and travel into and through Oneawa Channel, reaching Kailua Bay. The possibility exists that dredging activities within the marsh and in Oneawa Channel could have an adverse effect on the Oneawa Channel waters and the coastal beach area. Sediment reaching the bay from the marsh has the potential of impacting corals, recreational beaches, reducing light penetration and associated photosynthesis of algae, and other marine impacts. Silt curtains or other containment devices are not expected to prevent excessive turbidity and sedimentation from reaching Kailua Bay during periods of high flow. Frequent maintenance dredging of Oneawa Channel would likely be required. Additional concerns existed over the potential for reducing the cleansing capacity of the marsh waters into Oneawa Channel. Preliminary information from the Water Resources Research Center (WRRC) suggests that the streams which enter the marsh carry elevated bacterial levels which the marsh helps to filter. Research in other wetlands has shown that those with minimal defined channels which spread water as sheet flow across the wetland are most effective in retaining sediments. In addition, the effectiveness of nutrient removal in non-channelized systems approached that of conventional treatment (Morris et al 1981). Although the addition of open water will improve water quality in the marsh by improving circulation and creating deeper, more stable habitat for aquatic species, the risks to Kailua Bay appear to be great enough and the present sediment controls inadequate enough to support deletion of in-marsh alternatives.

4.9.4. Direct Effects. Direct effects are those which are caused by the action and which occur at the same time and place. Wetland may be lost or affected. Habitat for

Hawaii's endangered water birds may be decreased. Sediment placement and temporary access roads in the marsh may directly alter the topography and ground cover of the sites, even if temporarily. Water quality and air quality in the marsh may be temporarily affected during construction. Alternatives involving removal of vegetation may result in odors from rotting vegetation and leaching of heavy metals under acidic conditions. Depending upon design, alternatives may add or detract from the marsh aesthetics. Some recreational activities and functions of the marsh may be permanently or temporarily altered during the construction. Some view planes of the marsh and mountains will be blocked from a few residences of Coconut Grove. The levee and/or floodwall raises may visually intrude upon the wilderness character of the marsh. The appearance of a concrete floodwall atop the levee from the Ulu po Heiau and other culturally important locations around the marsh may be noticeable but not expected to be significant with concrete texturing and coloring. A moss rock veneer will be placed on the Coconut Grove side of the concrete floodwall. The most direct effect of the alternatives, however, is that flooding of Coconut Grove from Kawainui Marsh will have been eliminated.

4.9.5. **Indirect Effects**. Indirect effects are those which are caused later in time or further removed in distance, but are still reasonably foreseeable. The social and economic well being of former flood victims and others living in the flood-prone areas of Coconut Grove will be improved. After construction and depending upon the design and selected alternative, recreational use of the marsh may increase or decrease. Both direct and indirect impacts associated with individual levee modifications are described in greater detail in the following sections.

4.9.6. **Cumulative Impacts.** There are no cumulative impacts anticipated for the proposed actions, both federal and non-federal. The C&C open channels were completed in December 1991 prior to the construction of the levee modifications, and construction related impacts are similar. Maintenance of vegetation regrowth in channels in the marsh and along the levee will be performed by use of herbicides. The C&C presently uses Roundup, an approved herbicide for wildlife refuges. Herbicide spraying will be confined to the use of Roundup or other herbicide specifically approved by the Environmental Protection Agency for use in wetlands. The herbicide selected must not contain petroleum products or be mixed with a petroleum base solution for application. No adverse impacts are anticipated with continued use of this herbicide. Future impacts from implementation of marsh management plans will be covered in other environmental documentation.

4.9.7. **Operations and Maintenance Activities and Costs**. Regular maintenance programs associated with the levee alternatives will not result in major or long-term effects and will not affect the long term use and/or maintenance of the marsh for other functions. See Effects of No Action below.

4.9.8. **Effects of No Action**. The impacts of the proposed vegetation removal plans by the C&C of Honolulu are well documented in their 1990 FEIS. Much of its research and analyses have been utilized in evaluating impacts of the present flood control alternatives. The open waterways are considered the first phase of flood protection required. The C&C actions will change the water levels within Kawainui Marsh by reducing the magnitude of water level changes, but not eliminating the fluctuating water level necessary to sustain the ecosystem. By creating a more seasonally stable, yet moderately fluctuating water level, more protected vegetated wetland habitat for nesting as well as feeding will be provided. In addition, the vegetation control will result in more permanent areas of open water where open water feeding activities can occur. Waterfowl numbers should increase.

Continual maintenance activity is required to keep the open water areas open. Much difficulty has been experienced thus far in maintaining open water areas due to rapid regrowth of vegetation and rebound of sediments into open channels. Use of herbicides has historically controlled vegetation in the marsh. The use of the Jet-Spray, a relatively new, cost-effective and environmentally advantageous method for disposal of dredged material may be used to maintain open water channels in the marsh by the C&C. This or similar equipment does not physically remove sediment or vegetation from the marsh but spray casts it in a controlled manner out of the channel in contrast to the environmentally objectionable berms normally associated with placement of dredged material, or the expensive removal and disposal alternatives. Monitoring of this technique for impacts on water quality, waterbird habitat, and heavy metal release is recommended.

4.9.9. **Effects of Construction**. Although construction impacts will be addressed as *appropriate in other resource categories, the more general issues were singled out for* discussion in this section. Use of mechanical equipment such as cranes, dredges, pile drivers, and trucks will generate levels of noise and hydrocarbon emissions (air pollution) normally not experienced in the peaceful marsh environment or by residents of Coconut Grove. The trade winds would ameliorate this problem since they blow across Coconut Grove and then through the marsh most of the year. Filling of wetland areas is a particularly sensitive issue. This impact is evaluated separately in Section 4.9.10 (Wetland Fill). The environmental significance of construction related impacts were measured in terms of the effect on human health and safety associated with noise, air emissions, and sediment disposal quality. Levels of significance are defined as:

a. Insignificant. Little or no change in noise, air quality, land use or other construction-related activity relative to existing conditions.

b. Significant but Mitigable. Change from present conditions during construction which may exceed federal, State and local allowable limits or displace people for temporary periods. Traffic flow changes which lengthen traffic corridor times for temporary periods.

c. Significant, Not Mitigable. Change from present conditions that cannot be mitigated and which last for extended periods of time. Restriction on landfill disposal due to elevated levels of heavy metals which exceed landfill disposal requirements.

4.9.9.1. **Plan 1: Earthen Levee Raise**. Construction activities associated with this alternative such as truck movements and clearing equipment will generate dust, odors, exhaust fumes, disposal impacts and noise, but none of these are expected to be significant provided precautions are taken. Air emissions are regulated by applicable Federal and State air quality and noise control standards and procedures.

The bird population in the marsh will quickly habituate to the noise although birds that frequent the emergency ditch next to the levee will likely avoid it until construction activity there is completed. The temporary stockpiling of materials and equipment in the community park alongside the levee will be a temporary nuisance to those who use the park for soccer and baseball games. Construction activity may temporarily deprive individuals of this important recreational facility for up to 23 months.

Excavated vegetation and sediment may produce objectionable odors. However, it was noted that during the C&C emergency ditch excavation in early 1988, there were few if any objections raised by local residents despite the temporary stockpiling of vegetation into windrows on the levee. Disposal of dredged material in landfills will require movement of trucks laden with marsh vegetation and sediment. Some of the sediment may leak from the trucks and present an aesthetic problem but not a health hazard. Truck traffic associated with disposal of vegetation will be increased with 1-3 trucks per hour hauling material from Kailua to the Waimanalo Gulch landfill in Nanakuli. This would result in an insignificant impact to traffic patterns. Traffic-related impacts would be reduced if the Kapaa Landfill site is opened for disposal of vegetation and associated sediments. Sediments and vegetation removed from the marsh by the C&C were disposed in the nearby Kapaa landfill.

Mitigation. The least active breeding months of resident endangered waterbirds is *October to February. Since construction activities along the levee will also occur at* other times of the year, appropriate resource agencies should be consulted about ways to lessen the impact of construction on nesting birds. No significant impacts are anticipated, as long as precautions are taken to ensure that health and safety standards are enforced and that the general construction related mitigation identified at the end of this section is implemented.

4.9.9.2. **Plan 2: Floodwall**. The same construction related impacts have been identified for this alternative as in Plan 1; however, truck traffic associated with vegetation removal would not occur. The driving of sheet pile for the floodwall alternative will likely be a significant noise nuisance to about 20 homes in the immediate vicinity of construction (residences closest to the levee). Decibel levels of approximately 100 db at 50 feet away are anticipated. This temporary construction activity is expected to be largely unperceived by the rest of the Coconut Grove community. Sub-terrainean water movement beneath the levee is not expected to be hindered by the sheet pile since earlier studies detected minimal water flow beneath the levee (Swain and Huxel 1971). Nevertheless, if restriction of flow does occur, then alterations in the wetland vegetation next to the levee may occur.

Mitigation. Same as for Plan 1. Residents must be notified of the anticipated noise levels associated with the driving of sheet pile which must be confined to Monday-Friday between the hours of 9:00 - 5:30 pm. On site personnel must be available to handle complaints.

4.9.9.3. **Plan 3A: Combination Floodwall and Levee Raise**. The construction impacts associated with this combination alternative are less than for the floodwall because no sheet pile is required and noise is expected to be much reduced. Instead, a below surface concrete cutoff wall for structural stability and seepage control is required. Air quality impacts are expected to be similar to the floodwall alternative.

4.9.9.4. **Plan 3B: Combination Floodwall and Levee Raise with Sheet Pile and Retaining Wall.** The construction related impacts for this sub-alternative are expected to be increased due to noise from sheet pile driving. In addition, the pouring of additional concrete for the retaining wall will add significant truck-generated noise and air quality impacts, but of a temporary nature. No long-term changes to air quality are anticipated.

Mitigation. Noise monitoring during construction may help to avoid unnecessary high levels. The following construction related mitigation measures should be implemented with all construction activities:

a. To protect public safety, the construction contractor should be required to erect temporary warning signs, ropes and barricades to block off portions of the daily work area used by trucks and other equipment.

b. All construction equipment leaving the work site should be washed down and dewatered to prevent mud and debris on public roadways.

c. All construction equipment should be operated in accordance with applicable State and Federal air pollution (dust, exhaust emissions) and noise control regulations.

d. The construction contractor should take all measures to prevent the release of contaminants, especially petroleum derivatives, from mechanical equipment and storage areas.

4.9.10. **Wetland Fill.** Wetland losses are considered significant losses under the administration's policy of no net loss of wetlands. A Mitigation Memorandum of Agreement (MOA), February 1990 between the Department of the Army and the Environmental Protection Agency (EPA) (#9-328-02) discusses the issue of discharge of dredged or fill materials into waters of the United States including wetlands. Levels of significance of impacts are as follows:

a. Insignificant. Sediment disposal in the marsh does not occur. No wetland areas are modified. No listed species are affected.

b. Significant, but Mitigable. Placement of uncontaminated fill occurs in selected wetland areas that are determined less valuable habitat . Listed species may be disrupted from daily activities.

c. Significant, Not Mitigable. Listed species are permanently affected by placement of fill resulting in a predicted decline in their numbers. Valuable wetland acreage is destroyed.

4.9.10.1. **Plan 1: Levee Raise.** Significant but mitigable impacts are expected with this alternative. Uncontaminated fill material would be relocated within the marsh for the levee raise alternative and 6.4 acres of wetland would be filled to achieve a 100-year level of flood protection. This computes to 195,000 cubic yards of fill. Permanent change to the wetland characteristics in that area would occur. All of the wetland fill created by the levee raise alternative would be on the Coconut Grove side of the existing levee which is considered less valuable waterbird habitat than other wetland areas of the marsh. The continuing existence of listed species found at the site will not be jeopardized. The wetland area to be filled contains exotic (non-native) vegetation.

Mitigation. Compensatory wetland mitigation can occur by conversion of fastland to wetland. Impacts associated with wetland fill can also be mitigated through selection of other alternatives which fill less wetland.

4.9.10.2. **Plan 2: Floodwall**. No wetland fill or sediment disposal is associated with this levee modification. The structure is to be placed atop the existing levee.

Mitigation. Since no significant impacts are identified with respect to wetland fill, no mitigation is proposed.

4.9.10.3. **Plan 3A: Combination Floodwall and Levee Raise**. This alternative will fill 1.8 acres of wetland to achieve the 100-year level of flood protection. This alternative was developed as a result of public input and serves to reduce the amount of both wetland filled and the degree of concrete floodwall needed.

Mitigation. Wetland fill can be mitigated by creating new wetland from fastland bordering the marsh. The area to be created is shown in Figure 15.

4.9.10.4. **Plan 3B: Combination Floodwall and Levee Raise with Sheet Pile and Retaining Wall.**. This combination alternative will not fill any wetland. The sheet pile and retaining wall provide the structural support that would otherwise be provided by an increased base width.

Mitigation. Since no wetland is to be filled for this sub-alternative, no mitigation for wetland fill is proposed.

4.9.10.5. **Sedimentation - General Concerns**. Based on a sediment analysis contained in Appendix B, sediment infilling of the marsh will not compromise the flood control capabilities of the project. However, the wetland should not be relied on for sediment control if other approaches can prolong the life of the marsh. Efforts to control sedimentation in the marsh should be pursued. In addition to the *Best Management Practices* (BMPs) identified in the State's *Nonpoint Source Water Pollution Management Plan (1989)*, the following actions would reduce the rate of marsh infilling:

a. Implement erosion and sedimentation control plans for watershed development by use of onsite sediment ponds, plantings or biofilters, filter fabric fences, mulching, hydroseeding, etc.

b. Use sediment retention basins upstream from the marsh to control sediment loading.

c. Vegetation harvesting could occur on a regular basis at the end of the growing season, but prior to plant decay. Compost or dispose of the cuttings where they cannot reenter the surface or ground water.

d. Grazing of cattle and horses within the marsh and near its tributaries should be suspended until information can be obtained to determine the extent of nutrient and bacterial contamination from this source.

e. Agricultural practices in upper Maunawili Valley should be evaluated for their impact on sedimentation.

4.9.11. **Water Quality.** Water quality parameters that may be affected by the alternatives are temperature, dissolved oxygen, suspended solids, salinity, nutrients (dissolved and organic forms of nitrogen and phosphorous) hydrocarbons, heavy metals, pH, turbidity, and other organic and inorganic pollutants, dissolved or suspended. The ranges of these parameters determine the suitability of marsh water, Oneawa Channel water, and coastal waters to support various resources (e.g., wildlife, fisheries, public health, aesthetics). The following definitions are used to define significance:

a. Insignificant. Little or no change in water quality parameters, water levels, groundwater influences, or other water quality effects within the range of natural variability; no temperature elevations; turbidity increases caused by construction are temporary, localized, and do not exceed 5 nephelometric turbidity units (NTU) above ambient at 500 feet from the site.

b. Significant but Mitigable. Measurable change in water quality parameters for temporary periods but less than levels allowed for freshwater and marine receiving waters by the US Environmental Protection Agency (EPA) water quality guidelines or by State Water Quality Standards. Water level changes in the marsh above and beyond those experienced under normal conditions but which are considered beneficial to wildlife. Turbidity increases between 5 and 10 ntu above ambient at 500 feet from the site.

c. Significant, Not Mitigable. Changes in water quality parameters which exceed State and Federal guidelines for extended periods of time. Water level changes in the marsh that create conditions which alter the normal successional process. Turbidity increases greater than 10 ntu and accumulation of marsh borne sediments in Kailua Bay.

4.9.11.1. **Plan 1: Levee Raise.** This alternative will fill approximately 6.4 acres of wetland on the coconut Grove side of the existing levee. The fill required for this alternative shall be free of contaminants and should not impact water quality.

Mitigation. Since no potentially significant impacts are identified with respect to water quality, no mitigation is proposed.

4.9.11.2. **Plan 2: Floodwall.** No significant impacts are anticipated with the floodwall.

Mitigation. Since no potentially significant impacts are identified with respect to water quality, no mitigation is recommended.

4.9.11.3. **Plan 3A: Combination Levee Raise Floodwall.** No potentially significant impacts are identified with respect to water quality.

Mitigation. None recommended.

4.9.11.4. **Plan 3B: Combination Levee Raise and Floodwall with Sheet Pile and Retaining Wall.** No impacts to water quality are anticipated

Mitigation. None recommended.

4.9.12. **Impacts to Biological Resources.**

4.9.12.1. **Vegetation Control.** Most of the vegetation in the marsh is non-native introduced species. Vegetation next to the levee on the Coconut Grove side is primarily California grass. Very little information exists on productivity estimates of Kawainui Marsh. See C&C FEIS for a summary of this information. Consequently, few definitive statements can be made about how much vegetation should be removed, how often it should be removed, and from what areas of the marsh. Professional opinions range from 0 up to 300 acres of vegetation can be removed without jeopardizing the wetland values of the marsh. Alternatives associated with partial removal of the floating mats of vegetation are of concern due to their unknown movement under flooding conditions. Aerial photos taken following the New Year's flood clearly show dramatic movement of the mat and compression of it throughout much of the northeastern part of the marsh. Levels of significance of impacts are as follows:

a. Insignificant. Marsh wetland vegetation is removed or impacted to a degree which has no effect on the natural processes of the marsh such as food supply, sediment trap, water quality.

b. Significant, but Mitigable. Marsh wetland vegetation is removed or impacted in such a way as to modify the functioning of the marsh as we know it today but which prolongs early successional stages of the marsh.

c. Significant , Not Mitigable. Wetland vegetation of the marsh is removed in such a way as to permanently hinder the natural processes of the marsh.

4.9.12.2. **Plan 1: Levee Raise.** The levee raise will destroy approximately 6.4 acres of wetland vegetation on the Coconut Grove side of the existing levee. Wetland vegetation on the Coconut Grove side of the levee is non-native and is not considered prime habitat for native waterbirds This impact is considered significant but mitigable.

Mitigation. Creation of new wetland from fastland bordering the marsh is recommended as mitigation for wetland loss as a result of an increased levee raise. A portion of this new wetland area is shown in Figure 15. Additional areas would be considered after consultation with the U.S. Fish and Wildlife Service.

4.9.12.3. **Plan 2: Floodwall**. Marsh vegetation will not be impacted with this alternative. Vegetation for landscaping purposes is covered under aesthetics.

Mitigation. None recommended.

4.9.12.4. **Plan 3A: Combination Flood Wall and Levee Raise**. Approximately 1.8 acres of wetland will be lost by construction of this alternative. This wetland is on the Coconut Grove side of the existing levee and is not considered prime waterfowl habitat. This is a significant but mitigable loss of wetland.

Mitigation. Same as Plan 1.

4.9.12.5. **Plan 3B: Combination Floodwall and Levee Raise with Sheet Pile and Retaining Wall**. This alternative was designed to avoid filling of wetland.

Mitigation. Monitoring of vegetation during regular maintenance inspections is recommended to determine if changes in vegetation are occurring from sheet pile and retaining wall construction. Should loss of wetland occur, then, compensatory wetland mitigation should result.

4.9.13. **Endangered Bird Species**. The loss of open water habitat due to vegetation growth has had the greatest impact on the waterbirds of Kawainui Marsh (Conant 1982). Other problems which limit existing and potential waterbird use include human disturbance, construction noise, predation, fluctuating water levels, limited access to food, public attitudes, and sedimentation (DPED 1983). The greatest significant impact of a flood control project on the waterbirds of Kawainui would take place if drainage of the marsh occurred.

Levels of significance of impacts are as follows:

a. Insignificant. No endangered species of birds are disturbed. No habitat is created or destroyed.

b. Significant, but Mitigable. Activities such as noise, human intrusion, predation, loss of habitat, drainage of marsh, or loss of food resources associated with construction and operation of the alternative that are of a temporary nature and do not jeopardize the continuing existence of the marsh population.

c. Significant, Not Mitigable. Activities such as noise, human intrusion, predation, loss of habitat, drainage of marsh, or loss of food resources associated with construction and operation of the alternative that could jeopardize the continued existence of the marsh population.

4.9.13.1. **Plan 1: Levee Raise**. The impact of construction activity and noise from any levee modification may be perceived by the wildlife of the marsh but is not expected to be significant. Some birds may be initially frightened by noise and activity but are likely to quickly habituate and return unharmed to their activity. Coots, stilts, moorhens and ducks are known to frequent the open water area of the emergency ditch next to the levee and may stay away during construction of the levee modification.

Mitigation. The compensatory wetland mitigation recommended for this alternative will result in improved wading areas for birds.

4.9.13.2. **Plan 2: Floodwall**. Same as Plan 1.

Mitigation. Same as Plan 1.

4.9.13.3. **Plan 3A: Combination Floodwall and Levee Raise**. Same as Plan 1.

Mitigation. Same as Plan 1.

4.9.13.4. **Plan 3B: Combination Floodwall and Levee Raise with Sheet Pile and Retaining Wall**. Same as Plan 1.

Mitigation. Same as Plan 1.

4.9.14. **Feral and Domesticated Animals**. Feral animals enter the marsh from its periphery and are known to prey on the bird life there and serve as a source of Leptospirosis. Cattle and horses graze on California grass near Kailua Road and may contribute both pathogens and relatively high nutrient levels into the marsh. Wild pigs and other animals in the upper Maunawili Valley contribute pathogens and nutrients to stream waters. Levels of significance of impacts are as follows:

a. Insignificant. A decrease in grazing domestic animal populations and in feral animal access.

b. Significant, but Mitigable. Feral and domestic animal populations have increased opportunities to enter the marsh but can be captured or hindered from doing so.

c. Significant, not Mitigable. Increased populations of feral and domestic animals have increased unlimited access to the marsh.

4.9.14.1. **Plan 1: Levee Raise**. The levee raise will have no effect on access of feral animals from Coconut Grove.

Mitigation. None recommended.

4.9.14.2. **Plan 2: Floodwall.** The floodwall should serve to effectively eliminate access of feral animal populations from the Coconut Grove side of the marsh both to and from the marsh.

Mitigation. None recommended.

4.9.14.3. **Plan 3A: Combination Floodwall and Levee Raise.** The four feet high floodwall associated with this alternative should be effective in eliminating access of feral animals from Coconut Grove.

Mitigation. None recommended.

4.9.14.4. **Plan 3B: Combination Floodwall and Levee Raise with Sheet Pile and Retaining Wall.** This alternative has a retaining wall as well as a floodwall associated with it and is likely to be the most effective in preventing access to the marsh by feral animals. from Coconut Grove.

Mitigation. None recommended.

4.9.15. **Recreation and Public Access.** Access to the levee is controlled by the City and County of Honolulu. Although officially "off limits" to the public, the levee is used for jogging, walking, and other recreational activities. Levee modifications, particularly the eight-foot high floodwall, may detract from the present recreational use of the levee. The community park next to the levee will be required for temporary storage of construction equipment. Levels of significance of impacts are as follows:

a. Insignificant. Existing access and recreational use of the marsh, community park and levee remain unchanged, or change is temporary.

b. Significant, but Mitigable. Existing access and recreational use of the marsh, community park and levee is altered somewhat from present conditions but mitigation is provided.

c. Significant, Not Mitigable. Permanent loss of existing access and recreational use of the marsh, community park and levee.

4.9.15.1. **Plan 1: Levee Raise.** An earthen levee raise will not alter the present access or use of the levee and may provide improved viewing of the marsh. A temporary loss of the community park during construction for storage of equipment is anticipated but this is considered insignificant.

Mitigation. None recommended.

4.9.15.2. **Plan 2: Floodwall.** A concrete floodwall with maximum height of eight feet atop the existing levee is expected to alter the present recreational use of the levee by blocking tradewinds and reducing 360 degree viewing although access to the levee will remain unchanged. Additional privacy to the residents bordering the levee will result with this alternative. Temporary loss of use of the community park is anticipated during construction of the floodwall.

. **Mitigation**. None recommended.

4.9.15.3. **Plan 3A: Combination Earth Levee Raise and Floodwall**. This alternative will have a reduced impact on recreation and public access due to the four feet height of the floodwall. Nevertheless, the recreational experience may not be as enjoyable from the levee as is presently the case or with Plan 1.

Mitigation. None recommended.

4.9.15.4. **Plan 3B: Combination Earth Levee Raise and Floodwall with Sheet Pile and Retaining Wall**. Same as Plan 3A.

Mitigation. None recommended.

4.9.16. **Aesthetics**. Some will feel that the raising of the levee or the placement of a flood wall on the levee will detract from their ability to view the marsh and mountains or enjoy the present view that they have. Others will feel reassured with a larger protecting structure despite any visual change. Levels of significance are as follows:

a. *Insignificant*. *Present view planes of the marsh and mountains remain* unchanged. Wilderness character of the marsh remains unchanged.

b. Significant, but Mitigable. Loss of less than 50% of the existing viewplane of the marsh or mountains. Wilderness character of the marsh is altered somewhat on periphery only by new structures.

c. Significant, Not Mitigable. Loss of greater than 50% of the existing viewplane of the marsh or mountains from Coconut Grove homes. Wilderness character of the marsh is altered permanently by new structures.

4.9.16.1. **Plan 1: Levee Raise**. Less than 50% of the existing views of the marsh and mountains from homes bordering the levee will be lost. This is not a significant loss for these homes. Most of the homes in Coconut Grove will be unaffected by the levee raise. The levee will be planted with landscaping materials to soften its appearance and help it blend into the surrounding landscape from virtually all view points.

Mitigation. Tree planting is feasible in some areas, but must not interfere with the structural integrity of the levee. Landscaping materials should be chosen that are compatible with a flood control levee and that soften the effect of a modified levee. The present activity associated with herbicidal spraying of vegetation on the levee should be altered once a selected landscaping material has been chosen.

4.9.16.2. **Plan 2: Floodwall**. The concrete floodwall will block the views of the marsh and mountains to the same extent as a levee raise for homes bordering the levee.

Mitigation. Appropriate landscaping materials will be planted to soften the effect of the wall (e.g., climbing vines) from the Coconut Grove side. Aesthetic mitigation will include pigmentation and texturing of the concrete.

4.9.16.3. **Plan 3A: Combination Levee Raise and Floodwall**. The combined aesthetic impact of this combination alternative should be reduced over the individual impacts associated with the separate alternatives due to the reduced nature of the individual components.

Mitigation. Same as Plans 1 and 2 except that a moss rock facade will be placed on the Coconut Grove side of the floodwall instead of landscaping.

4.9.16.4. **Plan 3B: Combination Levee Raise and Floodwall with Sheet Pile and Retaining Wall**. The aesthetic impact associated with this alternative would be increased from the Coconut Grove side of the levee due to the addition of a retaining wall as well as a floodwall. As a result, two concrete faces would require mitigation. The same view loss, however, would result with this alternative as in all the alternatives.

Mitigation. The same as Plans 1 and 2 with the additional landscaping of the retaining wall.

4.9.16.5. **Land Use Conflicts**. Flood control improvements in the marsh are fully compatible with the dedicated government function of reserving Kawainui Marsh for flood storage. Improvements to flood control features have no impact on other marsh functions and values as spelled out in County, State and community plans for the marsh. However, flowage easements on 107.25 acres of land are being obtained which may conflict with some private development plans.

4.10. **Adverse Environmental Impacts that Cannot Be Avoided**. Some harassment or disturbance to nesting endangered waterbird populations may be unavoidable, even with precautions. Temporary noise, dust, odor, and sedimentation impacts during construction are unavoidable. The recommended plan will fill 1.8 acres of wetland. The raising of a levee, and/or the addition of a floodwall will alter the aesthetics and appearance from some homes in the Coconut Grove community. With the implementation of appropriate mitigation, these impacts can be reduced to nonsignificant levels. Flood water levels in the marsh will be raised by about three feet, flooding some vacant lands that are not now in the flood zone (see Figure 14 - Flood Inundation Limits).

4.11. **Relationship between Short Term Uses of Man's Environment and the Maintenance and Enhancement of Long Term Productivity**. None presently identified.

4.12. **Irreversible and Irretrievable Commitment of Resources.** Considerable fuel, funds, and construction resources will be consumed by implementation of any of the alternatives. The No Action alternative could result in the long-term commitment of similar resources for emergency response and disaster relief. Lives could be lost during floods if the No Action alternative is selected .

4.13. **Other Interests and Considerations of Government Policies thought to Offset the Adverse Effects of the Proposed Action.** None presently identified.

4.14. **Comparison of Environmental Effects Among all Feasible Alternatives.** Table 2 summarizes and compares the positive and negative effects of the alternatives studied. The floodwall alternative has the least costs associated with it for the level of protection provided and minimal environmental impacts other than blockage of some residents' views (as do all alternatives) and the need for landscaping. An earthen levee raise will be most compatible with the wilderness character of the marsh and existing maintenance and recreational usage but fills more wetland habitat. The combination earth levee raise and floodwall reduces the amount of wetland filled by utilization of a smaller floodwall, and appears to accommodate concerns of residents on both issues (i.e., wetland fill and aesthetics). Implementation of mitigation for wetland loss by creation of new wetland from fastland around the marsh may ultimately be of greater value than avoiding the impact to the wetland by building a floodwall atop the levee. There are areas that would benefit from restoration efforts and provide better habitat than the strip of wetland that would be filled. Levee construction is a "water dependent activity" as meant by Section 404(b)(1) guidelines.

4.15. **Construction Considerations.**

4.15.1. **Construction Material Sources.** Practically all materials will have to be imported from outside the project limits. The various materials available at designated quarry sites are discussed in detail in Appendix C, Geology, Foundations and Materials.

4.15.2. **Dredge Material and Disposal Site.** If the Standard Project Flood Level of Protection is selected, then material dredged from the Oneawa Channel will be tested for use as levee fill. Much of the existing levee was originally constructed using this Oneawa Channel material. If the material is unsuitable for levee fill, it will be disposed of in an approved manner. Proposed disposal sites for non-contaminated material include the Kapaa Landfill which is close to the project site and the Waimanalo Gulch Landfill which is located 20 miles away in Nanakuli.

4.15.3. **Borings.** Twelve borings were completed by the Corps between May to August 1990 to supplement previous borings completed prior to construction of the existing flood control project. These borings generally confirm the findings of the earlier subsurface investigations by Walter Lum Associates. Detailed analyses and discussion are contained in Appendix C, Geology, Foundations and Materials.

4.15.4. **Plans and Specifications.** Construction plans and specifications will be prepared by the Corps in coordination with the local sponsor. During this stage, the following will also be conducted:

a. Process the Local Cooperation Agreement (LCA) for signature by the project sponsor (City and County of Honolulu), and the District Engineer.

b. Complete all Federal, State and County compliance documents and obtain all necessary permits for construction.

4.15.5. **Construction Schedule**. Construction schedule for the selected plan is as follows:

Date	Activity
August 1992	Initiate Plans and Specifications
November 1992	Project Approval/Record of Decision
November 1992	Construction Approval
December 1992	Execute Local Cooperation Agreement
December 1992	Advertise for Bids
February 1993	Construction Award
July 1995	Complete Project

Construction will be accomplished by contract through competitive bidding. Upon construction approval, the Corps will execute the Local Cooperation Agreement, solicit bids, award, and supervise and administer the project construction.

4.15.6. **Operation and Maintenance**. The C&C of Honolulu, the local sponsor, will be responsible for operation and maintenance of the completed project. A detailed discussion of maintenance requirements is contained in Appendix B, pp. B-11 to B-12.

4.16. **Economic Analysis.** Economic evaluations were conducted in accordance with the procedures and standards prescribed by the Water Resources Council's Principles and Guidelines and Corps of Engineers policy. The computations summarized in Tables 3 to 6 are based on a 8-1/2 percent interest rate and a 100-year economic life. The sensitivity of the benefit to cost ratios for a 50-year or 100-year economic life is negligible. The average annual costs for purposes of the benefit-to-cost comparison for the final array of four alternatives hereafter referred to as alternative plans, include interest (8-1/2 percent) and amortization (100 years) of the project first cost and the estimated annual maintenance costs associated with the project. Detailed analyses are presented in Appendix D, Damages and Benefits.

4.16.1. **Costs**. The estimated project first costs for the alternative plans were developed using October 1991 price levels, assumptions based on prevailing physical conditions, and allowances for contingencies, engineering and design, supervision and administration, and interest during construction. Cost breakdowns and assumptions are provided in Appendix B, Design and Cost Estimates.

4.16.2. **Benefits**. Benefits are the measured difference between conditions with and without a flood protection project. Damages to structures and contents are the primary source of major flood-associated costs which can be assigned dollar values in evaluating alternative plans for flood control. In addition to reducing damages to structures and contents, benefits resulting from the alternatives would also consist of reducing emergency relief costs, yard damages, operating costs of the National Flood

Insurance Program, automobile damages, and the lag in market performance of home prices in the floodplain. These damage reductions are expressed as average annual benefits for a project.

4.16.3. Benefits and Damage Analysis. The benefit and cost comparisons of the alternative plans for storm events of 10-year, 50-year, 100-year, and Standard Project Flood (see Appendix A, paragraph 13) are shown in Tables 3 to 6. Detailed analyses of the benefits and costs are presented in Appendix D, Damages and Benefits.

4.17. Rationale for Designation of NED Plan. The National Economic Development (NED) plan is the alternative flood control plan where project benefits exceed costs and is the plan with the greatest net benefits (benefits less costs) of all plans investigated. The project benefits and costs are compared at a common point in time (October 1991). A comparison of plans is shown on Table 2. Based on the maximum net benefits of all plans shown, the 100-year Concrete Floodwall alternative (Plan 2) is the NED plan. Additional information on the NED plan selection is contained in Appendix D, Damages and Benefits.

4.18. Evaluation of Final Array of Plans. The evaluation of the economic, social, and environmental effects of each alternative is described in Table 2. This table displays the significant contributions, the beneficial and adverse effects, and the extent to which various planning objectives and evaluation criteria were met by each plan.

4.19. Trade-Off Analyses. All the alternative plans made net contributions to NED. Plan 2 made the maximum net contributions to NED. In addition to national and regional economic or monetary factors analyzed for each alternative plan, trade-off analysis must also include environmental and social effects associated with each alternative plan. Table 2 facilitates the evaluation and comparison of these considerations for each alternative plan.

4.20. Flood Risk. Floods greater than the 10-year event overtop the southern end of the existing levee due to the heavy vegetation severely restricting the flow of water from the southern end of the marsh to the Oneawa outlet channel. Levee overtopping carries a risk of levee failure because the levee is not designed for overtopping. A levee failure would cause the flooding of large areas of Coconut Grove. Therefore, flood control is critical and should be implemented as soon as possible .

TABLE 2. SUMMARY COMPARISON OF ALTERNATIVE PLANS AND SYSTEM OF ACCOUNTS

DESCRIPTION	WITHOUT PROJECT CONDITION	PLAN 1 LEVEE RAISE	PLAN 2 FLOODWALL	PLAN 3A COMBINATION	PLAN 3B COMBINATION
A. PLAN DESCRIPTION	Most likely condition to exist in the future in the absence of any federal plan but including any known changes in law or public policy. The C&C of Honolulu is constructing channels into the marsh from the open water area at the southern end of the marsh.	An earth levee raise would require a raise from the Kailua Road end of the levee to Oneawa Channel, a total of 6,300 feet. The maximum raise would be 8.0 feet.	Floodwall constructed on the existing levee would extend from Kailua Road to Oneawa Channel, a total distance of 6,300 feet. The average wall height would be 8.5 feet.	Floodwall constructed on an earth levee raise would extend from Kailua Road to Oneawa Channel, a total distance of 6,300 feet. The average levee raise would be 4.0 feet and the wall height would be 4 feet.	Floodwall constructed on an earth levee raise would extend from Kailua Road to Oneawa Channel, a total distance of 6,300 feet. The average levee raise would be 4.0 feet and the wall height would be 4 feet. A concrete sheetpile wall would be added to the Coconut Grove side.
B. IMPACT ASSESSMENT					
1. Economic					
a. Public Facilities and Services, Urban Flood Damage Reduction ($000)	Flooding would continue periodically. Future damages will be incurred to existing properties.	Plan would reduce average annual damages by $1,900.	Plan would reduce average annual damages by $1,900.	Plan would reduce average annual damages by $1,900.	Plan would reduce average annual damages by $1,900.
b. Land Use	C&C Honolulu's participation in the Federal Insurance Program would impose land use restrictions in the 100-year flood limit.	Flowage easements required on 107.5 acres.	Same as Plan 1.	Same as Plan 1.	Same as Plan 1.
c. Commitment of Economic Resources ($000)	Public resources in equipment, manpower and money would need to be committed for post-flood cleanup operations by private and County, State and Federal agencies.	First Cost: $11,930 Annual Cost: $1,199	First Cost: $8,480 Annual Cost: $876	First Cost: $9,900 Annual Cost: $1,026	First Cost: $12,200 Annual Cost: $1,267
d. Regional Growth	Economic efficiency of Coconut Grove and surrounding area would be diminished. Housing shortage would increase for residents.	Increased economic efficiency and safety of Coconut Grove area and surrounding areas.	*Same as Plan 1.*	*Same as Plan 1.*	*Same as Plan 1.*
e. Local Government Finance Requirements	C&C FEIS indicates cost is $4.1 million.	Requires cost sharing in accordance with PL 99-662.	Same as Plan 1.	Same as Plan 1.	Same as Plan 1.
2. Environmental					
a. Ecological; Terrestrial, Marine, Water Quality, Fish & Wildlife	Increased water bird habitat, water circulation and improved wetland characteristics.	Loss of 6.4 acres of wetland. Temporary adverse impacts during construction; not expected to be significant.	No wetland loss. Reduced access to marsh by feral animals. Temporary adverse impacts during construction; not expected to be significant.	Loss of 1.8 acres of wetland. Temporary adverse impacts during construction; not expected to be significant.	Possible minor wetland loss due to change in subterranean flow.
b. Recreation	Construction of channels into the marsh by the C&C may allow increased access to interior areas.	Shape of existing levee would be maintained. Continued use of levee for walking, hiking, etc.	Access from levee to Kaelepulu Stream side would be restricted. Use of levee for walking and hiking would be retained at reduced level of enjoyment.	Access from levee to Kawainui Marsh would be restricted. Four-ft floodwall would allow 360 degree view.	Same as Plan 3A.
c. Cultural, Historical, and Archaeological	Marsh will continue to fill with sediment and continue to bury subsurface archaeological sites.	Same as without project.	Same as Plan 1.	Same as Plan 1.	Same as Plan 1.
d. Aesthetic, Noise	Quiet, rural scene except for 2-lane highway noise. Ambient noise levels will rise with increased traffic.	Temporary construction noise, possibly significant at times.	Same as Plan 1.	Increased over Plan 1.	Increased over Plan 3A.
e. Visual	View from high points would show open water channels in marsh.	Would reduce view of mountains and eliminate marsh view from some first and second row of houses in Coconut Grove. Little change from other points around the marsh.	Same as Plan 1. Floodwall on Coconut Grove side would be landscaped to soften wall outline and would be colored and textured.	Same as Plan 1. Floodwall on Coconut Grove side would have moss rock veneer and would be colored and textured on the marsh side.	Same as Plan 1. Floodwall on Coconut Grove side would be landscaped. Retaining wall face would be colored and textured.
f. Air, Noise, and Traffic	Blasting noise and dredging creates temporary impacts.	Temporary increases in air and noise pollution during construction.	Increased over Plan 1.	Same as Plan 2.	Increased over Plan 1.
3. Social					
a. Adverse Employment Effects and Tax and Property Value Losses	Property tax value decreased by flood hazard restrictions and flooding.	No displacement of people and business.	PROPERTY TAX VALUE INCREASE. NO MEASURABLE EFFECTS ON EMPLOYMENT LEVELS.		

TABLE 2. SUMMARY COMPARISON OF ALTERNATIVE PLANS AND SYSTEM OF ACCOUNTS
(CONTINUED)

DESCRIPTION	WITHOUT PROJECT CONDITION	PLAN 1 LEVEE RAISE	PLAN 2 FLOODWALL	PLAN 3A COMBINATION	PLAN 3B COMBINATION
3. Social (continued)					
b. Injurious Displacement of People, Business, and Farms	People and business displacement and possible loss of life by frequent flooding.	No displacement of people and business.	Same as Plan 1.	Same as Plan 1.	Same as Plan 1.
C. PLAN EVALUATION					
1. Contribute to the Planning Objectives					
a. Contribute to the Reduction of Property Damages by Floodwaters	Reduction of flood levels by 0.5 feet will cause a reduction in levee overtopping frequency.	Reduces average annual damages by $1,900,000.	Reduces average annual damages by $1,900,000.	Reduces average annual damages by $1,900,000.	Reduces average annual damages by $1,900,000.
b. Contribute to the Efficient Use of the Lands Consistent w/Local Land Use and Development Plans and FPM Policy	N/A	ALL PLANS IMPLEMENT FLOODPLAIN MANAGEMENT MEASURES COMPATIBLE WITH COUNTY'S PARTICIPATION IN THE FEDERAL FLOOD INSURANCE PROGRAM.			
c. Contribute to the Improvement of Water Quality	Yes	No effect.	No effect.	No effect.	No effect
d. Protect and/or Enhance the Beneficial Values of Wetlands within the Project Area	C&C plan identified earlier will enhance wetland values of marsh.	Will fill 6.4 acres of wetland.	No effect.	Will fill 1.8 acres of wetland.	No effect.
e. Minimize Land Acquisition Impacts to Land Owners	N/A	Lands within the project area are owned by the local sponsor. Flowage easement required on two private parcels.	Same as Plan 1.	Same as Plan 1.	Same as Plan 1.
2. Response to Evaluation Considerations					
a. Effectiveness	Distributes water more evenly within the marsh and reduces peak water levels by less than 0.5 feet.	Effective	Effective	Effective	Effective
b. Efficiency	Less efficient	Most efficient	Most efficient	Most efficient	Most efficient
c. Acceptability	Does not meet Corps standards.	Acceptable	Acceptable	Acceptable	Acceptable
3. Relationship to National Accts (100-year plan shown)	($000)	($000)	($000)	($000)	($000)
a. Avg Anl Benefits	N/A	$1,900	$1,900	$1,900	$1,900
b. Avg Anl Costs	N/A	$1,199	$876	$1,028	$1,267
c. Net Avg Benefits	N/A	$701	$1,024	$872	$633
d. BCR	N/A	1.58	2.17	1.85	1.50
4. Response to Formulation Criteria					
a. Technical					
1) Contribute to the reduction of property damage by floodwaters from Kawainui Marsh	Yes	Yes	Yes	Yes	Yes

TABLE 2. SUMMARY COMPARISON OF ALTERNATIVE PLANS AND SYSTEM OF ACCOUNTS
(CONTINUED)

DESCRIPTION	WITHOUT PROJECT CONDITION	PLAN 1 LEVEE RAISE	PLAN 2 FLOODWALL	PLAN 3A COMBINATION	PLAN 3B COMBINATION
4. Response to Formulation Criteria (continued)					
a. Technical (continued)					
2) Avoid severe dislocations of residents and minimize adverse social, health, and safety impacts	No	Yes	Yes	Yes	Yes
3) Contribute to the efficient use of lands and floodplain management policy	Yes	Yes	Yes	Yes	Yes
b. Economical					
1) BCR > 1	N/A	Yes	Yes	Yes	Yes
2) Economically Sound	No	Yes	Yes	Yes	Yes
3) Maximizes Net Benefits	No	No	Yes	No	No
c. Environmental					
1) Contribute to the improvement of water quality	Yes	No	No	No	No
2) Protect and/or enhance the beneficial values of wetlands within the project area	Yes	No	Yes	No	Yes
3) Minimize impact on all affected forms of wildlife and vegetation.	Yes	Yes, with mitigation	Yes	Yes, with mitigation	Yes
4) Avoid impacts to archaeological, cultural, and historical resources.	Yes	Yes	Yes	Yes	Yes
5) Minimize long-term disturbances to physical environment.	No	Yes	Yes	Yes	Yes
D. IMPLEMENTATION RESPONSIBILITIES					
1. Corps of Engineers	None	Provide first cost share of $5.0 million.	Provide first cost share of $5.0 million.	Provide first cost share of $5.0 million.	Provide first cost share of $5.0 million.
2. C&C of Honolulu	Provide estimated cost of $4.1 million for channels into the marsh.	Provide first cost share of $7.3 million; all project costs exceeding $5.0 million, and cost of without project condition.	Provide first cost share of $3.8 million, all project costs exceeding $5.0 million, and cost of without project condition.	Provide first cost share of $5.2 million, all project costs exceeding $5.0 million, and cost of without project condition.	Provide first cost share of $7.5 million, all project costs exceeding $5.0 million, and cost of without project condition.

Table 3. Benefit to Cost Comparison: Levee Raise - Alternative 1
October 1991 Price Levels

	10-Year	50-Year	100-Year	Standard Project Flood
Total Federal First Cost [1]	$2,975,000	$ 4,675,000	$ 4,675,000	$ 4,675,000
Total Non-Federal First Cost [2]	$ 995,000	$ 4,895,000	$ 7,255,000	$14,775,000
TOTAL FIRST COST	$3,970,000	$ 9,570,000	$11,930,000	$19,450,000
Interest During Construction	$ 224,000	$ 681,000	$ 983,000	$ 2,509,000
TOTAL PROJECT COST	$4,194,000	$10,251,000	$12,913,000	$21,959,000
AVERAGE ANNUAL COST				
Interest & Amortization	$ 357,000	$ 872,000	$ 1,098,000	$ 1,867,000
Maintenance Cost	$ 101,300	$ 101,300	$ 101,300	$ 101,300
TOTAL AVERAGE ANNUAL COSTS	$ 458,300	$ 973,300	$ 1,199,300	$ 1,968,300
AVERAGE ANNUAL BENEFITS	$ 300,000	$ 602,000	$ 1,900,000	$ 1,957,000
BENEFIT/COST RATIO	.65	.62	1.58	.99
NET NED BENEFITS	($ 158,300)	($ 371,300)	$ 700,700	($11,300)

[1] Excludes federal preauthorization study costs of $325,000. In accordance with the Water Resources Development Act of 1986, the Federal statutory limit is $5.0 million under Section 205 authority.
[2] Excludes non-federal preauthorization study costs of $280,000.

Table 4. Benefit to Cost Comparison: Concrete Floodwall - Alternative 2
October 1991 Price Levels

	10-Year	50-Year	100-Year	Standard Project Flood
Total Federal First Cost [1]	$2,465,000	$ 4,675,000	$ 4,675,000	$ 4,675,000
Total Non-Federal First Cost [2]	$ 825,000	$ 2,585,000	$ 3,805,000	$ 8,175,000
TOTAL FIRST COST	$3,290,000	$ 7,260,000	$ 8,480,000	$12,850,000
Interest During Construction	$ 162,000	$ 486,000	$ 635,000	$ 1,059,000
TOTAL PROJECT COST	$3,452,000	$ 7,746,000	$ 9,115,000	$13,909,000
AVERAGE ANNUAL COST				
Interest & Amortization	$ 293,000	$ 654,000	$ 775,000	$ 1,183,000
Maintenance Cost	$ 98,300	$ 101,300	$ 101,300	$ 101,300
TOTAL AVERAGE ANNUAL COSTS	$ 391,300	$ 755,300	$ 876,300	$ 1,284,300
AVERAGE ANNUAL BENEFITS	$ 300,000	$ 602,000	$ 1,900,000	$ 1,957,000
BENEFIT/COST RATIO	.77	.80	2.17	1.52
NET NED BENEFITS	($ 91,300)	($ 153,300)	$ 1,023,700	$ 672,700

[1] Excludes federal preauthorization study costs of $325,000. In accordance with the Water Resources Development Act of 1986, the federal statutory limit is $5.0 million under Section 205 authority.
[2] Excludes non-federal preauthorization study costs of $280,000.

Table 5. Benefit to Cost Comparison: Levee/Floodwall Combination - Alternative 3A
October 1991 Price Levels

	10-Year	50-Year	100-Year	Standard Project Flood
Total Federal First Cost [1]	$2,465,000	$ 4,675,000	$ 4,675,000	$ 4,675,000
Total Non-Federal First Cost [2]	$ 825,000	$ 4,065,000	$ 5,225,000	$12,325,000
TOTAL FIRST COST	$3,290,000	$ 8,740,000	$ 9,900,000	$17,000,000
Interest During Construction	$ 162,000	$ 787,000	$ 1,043,000	$ 2,058,000
TOTAL PROJECT COST	$3,452,000	$ 9,527,000	$10,943,000	$19,058,000
AVERAGE ANNUAL COST				
Interest & Amortization	$ 293,000	$ 810,000	$ 930,000	$ 1,620,000
Maintenance Cost	$ 98,300	$ 98,300	$ 98,300	$ 98,300
TOTAL AVERAGE ANNUAL COSTS	$ 391,300	$ 908,300	$ 1,028,300	$ 1,718,300
AVERAGE ANNUAL BENEFITS	$ 300,000	$ 602,000	$ 1,900,000	$ 1,957,000
BENEFIT/COST RATIO	.77	.66	1.85	1.14
NET NED BENEFITS	($ 91,300)	($306,300)	$ 871,700	$ 238,700

[1] Excludes federal preauthorization study costs of $325,000. In accordance with the Water Resources Development Act of 1986, the federal statutory limit is $5.0 million under Section 205 authority.

[2] Excludes non-federal preauthorization study costs of $280,000.

Table 6. Benefit to Cost Comparison: Levee/Floodwall Combination
with Levee Retaining Wall - Alternative 3B
October 1991 Price Levels

	10-Year	50-Year	100-Year	Standard Project Flood
Total Federal First Cost [1]	$2,465,000	$ 4,675,000	$ 4,675,000	$ 4,675,000
Total Non-Federal First Cost [2]	$ 825,000	$ 6,025,000	$ 7,525,000	$15,825,000
TOTAL FIRST COST	$3,290,000	$10,770,000	$12,200,000	$20,500,000
Interest During Construction	$ 162,000	$ 1,177,000	$ 1,429,000	$ 2,726,000
TOTAL PROJECT COST	$3,452,000	$11,947,000	$13,629,000	$23,226,000
AVERAGE ANNUAL COST				
Interest & Amortization	$ 293,000	$ 1,016,000	$ 1,159,000	$ 1,975,000
Maintenance Cost	$ 98,300	$ 108,300	$ 108,300	$ 108,300
TOTAL AVERAGE ANNUAL COSTS	$ 391,300	$ 1,124,300	$ 1,267,300	$ 2,083,300
AVERAGE ANNUAL BENEFITS	$ 300,000	$ 602,000	$ 1,900,000	$ 1,957,000
BENEFIT/COST RATIO	.77	.54	1.50	.94
NET NED BENEFITS	($ 91,300)	($522,300)	$ 632,700	($126,300)

[1] Excludes federal preauthorization study costs of $325,000. In accordance with the Water Resources Development Act of 1986, the federal statutory limit is $5.0 million under Section 205 authority.
[2] Excludes non-federal preauthorization study costs of $280,000.

5. PLAN SELECTION

5.1. **Rationale for Selection and Deviation from the NED Plan.** The selection of the most desirable plan of improvement involved comparison among the alternative plans. A comparison of the alternative plans was performed on the basis of the beneficial and adverse effects of each alternative; relative contribution to the planning objectives; and, response to associated evaluation criteria as listed in Table 2. Plan 2 is the NED plan (Figure 11) but was not selected for implementation because of community and local sponsor objections to the aesthetics of a large, concrete wall in the park-like setting of Kawainui Marsh. The additional cost of $1,420,000 to construct a levee raise with a lower, less objectionable floodwall of four feet in height will be paid by the local sponsor. The State of Hawaii, Department of Land and Natural Resources was authorized by the State Legislature in 1990 to accept the completed project from the C&C of Honolulu.

5.2. **Selected Plan Components.** The selected Plan (Plan 3A, 100-year) consists of a 6,100-foot long levee raise of up to 4.5 feet and a 6,300-foot long concrete floodwall up to 4.0 feet in height on top of the raised levee. The concrete floodwall will have a moss rock veneer on the Coconut Grove side and will be textured on the marsh side. About 1.8 acres of wetlands will be created to replace the area filled by the levee raise section. Flowage easements will be acquired on lands not owned or controlled by the local sponsor or the State of Hawaii DLNR. See Figure 15.

6. PLAN IMPLEMENTATION

6.1. **Apportionment of Costs.** The apportionment of costs is based on the Water Resources Development Act of 1986 (WRDA 1986) which requires the non-Federal sponsor to cost share at least 25 percent of the construction cost with a minimum five percent cash contribution. Apportionment of the costs is subject to the controlling Federal statutory limitation of $5 million under the Section 205 authority of the 1948 Flood Control Act, as amended, and is shown on Table 7.

6.2. **Federal Funding.** The initiation of construction must be approved and authorized by the Assistant Secretary of the Army for Civil Works. US Army Corps of Engineers' priority for funding of construction under the continuing authorities program is based on a comparison of the needs and merits of similar projects nationwide and the availability of funds.

6.3. **Views of the Sponsor.** The local sponsor supports plan 3A, the combination Earth Levee Raise and Floodwall. A Letter of Support from the local sponsor is provided in Appendix F, Public Involvement. The local sponsor has agreed to pay the incremental increase in cost for Plan 3A that is currently estimated at $1,420,000.

Table 7. Cost Apportionment

	Locally Preferred Plan (3A)	NED Plan (2)
FEDERAL COST		
Construction Cost	$ 8,880,000	$ 7,533,000
Engineering & Design	260,000	200,000
Construction Management	555,000	542,000
Preauthorization Cost	325,000	325,000
Sub-Total	$10,020,000	$ 8,600,000
Less Local Cash Contribution	5,020,000	3,600,000
TOTAL FEDERAL COST	$ 5,000,000	$ 5,000,000
NON-FEDERAL COST		
Lands, Easements, Rights-of-Way and Relocations (flowage easements)	$ 200,000	$ 200,000
DPR Cost Sharing	280,000	280,000
Cash Contribution in Excess of Statutory Limit	5,020,000	$ 3,600,000
TOTAL NON-FEDERAL COST	$ 5,500,000	$ 4,080,000
TOTAL PROJECT COST	$10,500,000	$ 9,080,000
Increment Between the NED Plan and Locally Preferred Plan (Sponsor Cost)	$ 1,420,000	
Project B/C Ratio	1.9	2.2
BCR for Authorization and Budgeting [1]	2.2	2.2

[1] ER 1105-2-100, para 5-16d.(2) states "... the increment between the federally supportable plan and the locally preferred plan should not be reflected in the BCR used for authorization and budgeting".

Table 8. Planning, Engineering, and Design Costs

Item	Cost
Plans and Specifications	
FM&S Investigations	$ 17,000
Design	$ 70,000
Project Management	$ 50,000
Value Engineering Studies	$ 10,000
Technical Engineering Division	$ 5,000
Contracts Division	$ 2,000
Construction Division (review)	$ 3,000
Real Estate	$ 8,000
Environmental Clearances	$ 15,000
Sub-Total	$180,000
Engineering During Construction	80,000
Total	$260,000

6.4. **Local Cooperation Requirements**. Section 221 of the Flood Control Act of 1970, Public Law 91-661, as amended, provides that the construction of any water resources project by the Secretary of the Army shall not begin until each non-federal interest has entered into a written agreement to furnish its required cooperation for the project. Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, specifies the cost-sharing requirements applicable to the project construction. These requirements are listed in Section 10 of this document.

When a final project selection is made, then in accordance with Public Laws 99-662 and 91-661, a Local Cooperation Agreement (LCA) is required to be executed between the City and County of Honolulu and the Department of the Army.

6.5. **Ability to Pay**. In accordance with Public Law 99-662, as amended, an "ability to pay" test must be applied to the local sponsor to determine if the project may be cost-shared at a lower level than would be required under normal provisions of Public Law 99-662. The following analysis of the City and County of Honolulu addresses this policy. The Eligibility Factor (EF) must be between zero and one to quality for a partial reduction in cost share:

$$EF = a - b_1 \times (\text{State Factor}) - b_2 \times (\text{County Factor})$$

$a = 14.24129$ State Factor $= 82.07$
$b_1 = 0.06104$ County Factor $= 87.88$
$b_2 = 0.012208$

$$EF = 14.24129 - 0.06104 \times 82.07 - 0.12208 \times 87.88$$

$$EF = -1.49665$$

Since the EF is less than zero, this project does not qualify for a reduction in cost share.

6.6 **Floodplain Management**. The primary purpose of Executive Order 11988 (EO) is to avoid the long and short term adverse impacts associated with the occupancy and modification of floodplains. The EO seeks to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. The EO requires Federal agencies to:

a. Avoid the base floodplain unless the floodplain is the only practicable alternative;

b. Reduce the hazard and risk of flood loss;

c. Minimize the impact of floods on human safety, health, and welfare; and,

d. Restore and preserve natural and beneficial floodplain values.

The only practical flood control alternative is one which modifies the existing levee and protects the base floodplain within Coconut Grove. The proposed flood control project will reduce the hazard and risk of flood loss and will minimize the impact of floods on human safety, health, and welfare. The existing floodplain within Coconut Grove is fully developed for residential and commercial use and cannot be economically restored to its original, natural condition.

7. **PUBLIC INVOLVEMENT, REVIEW AND CONSULTATION.** This paragraph describes the process whereby the Corps and the City and County of Honolulu solicited input from the public once it became apparent that additional flood protection would be required following the New Year's 1988 flood. Several meetings were held to scope out issues, alternatives, designs, and other advice that were considered during planning and designing.

7.1. **Public Involvement Program**

7.1.1. **7 January 1988 Meeting**. The Corps arranged a meeting in the week following the New Year's catastrophe. Invited were representatives of key community organizations active in the marsh and selected government officials. The Corps explained that floodwaters over-topping the levee caused the disaster and that remedial measures were urgently needed due to dangerously high water levels remaining in the marsh. The reasons for the overtopping were discussed including excessive vegetation and floating mats blocking the movement of floodwaters towards Oneawa Channel. A Corps recommendation to cut an emergency ditch along the marsh side of the levee to relieve the marsh of excess water levels was discussed at length. Although there was general agreement, attendees urged proponents not to act hastily and to coordinate with various state and county regulatory agencies. Potential opportunities to incorporate environmental objectives into future flood mitigation measures were mentioned, including fish and wildlife enhancement and recreational enhancement. The Corps agreed to assign on-site archaeologists to monitor the County's excavation of the emergency ditch.

7.1.2. <u>Informal Public Opinion Surveys and Follow-up Meeting</u>. Within weeks of the flood, the Corps learned that it lacked authority and funds to implement emergency and other remedial measures. Management and maintenance of the Corps-built flood control project was transferred to the County upon project completion in 1966. The City and County took the lead.

Despite the lack of funds, an undergraduate volunteer student at the University of Hawaii in February 1988 agreed to an environmental class project under Corps supervision involving public involvement for future remedial action for the flood control project. The student (Swers, 1988) completed an environmental report based upon interviews and returned questionnaires involving a number of community and government environmental officials. This report was circulated to the participants and a meeting at the Corps was held on 23 April 1988. The report and meeting discussions focused on the opportunities to incorporate fish and wildlife, recreation, cultural and other environmental values into a flood control plan. There was general agreement reached on a central open waterway theme with meanders and additional open water habitat. There were also concerns expressed over drainage of the marsh. Representatives of the Kawai Nui Heritage Foundation agreed to consider modification of their directional plan #5 to incorporate flood control purposes. An official of the State Dept. of Land and Natural Resources (DLNR) announced its leadership role in implementing the state's Resource Management Plan for Kawainui Marsh and developing a State flood mitigation plan for the marsh. Thus, DLNR agreed to coordinate with the other residents and officials, and hold meetings as necessary to develop a multipurpose state plan for Kawainui Marsh.

7.1.3. <u>Meetings Involving Government Emergency Management and Flood Control Agencies</u>. The Corps received limited funds for preliminary topographic surveys and engineering analyses in April 1988. Several interagency meetings were held to discuss progress in the ongoing analyses and studies. After surveys were completed, a large meeting was held on 2 May 1988 involving many state, local, and federal officials. It was reaffirmed that water movement through the marsh was substantially impeded by the vegetation and floating mats. Removal of vegetation using specialized mechanical equipment was raised as an option at the meeting.

7.1.4. <u>Public Seminar by a Corps Aquatic Plant Control Specialist From Florida and Application to Kawainui Marsh</u>. On 16 June 1988 a Jacksonville Engineer District representative (William Zattau) presented an overview of aquatic plant control approaches at a meeting widely attended by the community groups and the government. Zattau concluded that a larger commercially available machine, Aquamog, was capable of excavating sediment, vegetation, or both to depths of 20 feet but would require off site disposal of materials. A smaller machine, the Cookie Cutter, would be capable of removing vegetation to depths of 30 inches and function as a floating lawn mower. The latter would be suitable for keeping waterways open as part of a maintenance program. Zattau made it clear that mechanical removal of vegetation from the marsh was feasible. The City and County is presently considering the use of a jet spray machine for maintaining and opening additional waterways.

7.1.5. **Draft Environmental Assessment (EA) and Public Meeting on Proposed Kawainui Marsh Flood Mitigation**. At the end of July 1988, the Corps completed preliminary engineering analyses for excavating an open waterway through the marsh and the Corps circulated a Draft EA prior to a public meeting convened by the Corps and County DPW and held on 10 August 1988. The Corps analysis and supporting draft EA were based upon the premise that an emergency situation existed with only limited opportunity to evaluate a full range of feasible alternatives. At the public meeting over 60 oral and written comments were received with a majority of commentors objecting to the proposed waterway plan, questioning the basis of the emergency, and demanding a full EIS including full evaluation of all feasible flood control alternatives. A number of commentors, including the New Year's Day flood victims, urged that remedial action take place without delay.

An emergency declaration resulting from flood damages was never formally declared at that time. As a result of public and agency review of the draft EA and testimony at the meeting, the Corps, (as federal permitting agency) and the County DPW (as project proponent) made a proposal to process a joint federal and state EIS for flood mitigation. However, the Corps recommended that the City begin preparation of its own State EIS which resulted in the 1990 FEIS for blasting of open water channels.

7.1.6. **State EIS Preparation Notice and Notice of Intent to Prepare a Federal EIS**. Both the City and County DPW and Corps have published notices to prepare EISs. The Preparation Notice was published in the OEQC Bulletin on April 8, 1991. The Corps published its Notice in the Federal Register on October 11, 1988.

7.1.7. **21 February 1990 Scoping Workshop**. This workshop was held at the Kailua Intermediate School. Presentations were made by the District Engineer, project engineer and EIS preparer. A number of issues were identified including concerns over the floating mat, flooding to residents, possible alternatives, time tables, costs and other environmental issues. Due to limited attendance the District Engineer recommended an additional scoping meeting to receive more community input.

7.1.8. **19 April 1990 Scoping Workshop**. This workshop was held at the Kailua Elementary School. Additional input was received about marsh drainage concerns, herbicidal spraying, flooding to residents, and other environmental issues. The City and County presented a preliminary analysis of marsh blast testing.

7.1.9. **Combined Federal and State Draft EIS**. Both the federal and Hawaii state government have passed laws and regulations on preparing and coordinating environmental impact statements (EIS). The National Environmental Policy Act of 1969 and implementing regulations (40 CFR 1500-1508 and 33 CFR 230 and 325) govern Corps and Federal EIS procedures while the Hawaii State EIS Law Chapter 343, Hawaii Revised Statutes govern the State EIS procedures.

A combined draft detailed project report and draft environmental impact statement (Draft DPR/EIS) was prepared according to requirements identified in ER 1105-2-100. These two documents, under a single cover, reflect a format used consistently by the Corps for most of its feasibility reports.

A formal public meeting was held during the review stage for the Draft DPR/EIS on May 28, 1991 in Kailua. The public comment period closed on 22 June 1991. Over 50 written comments were received The transcript from the public meeting is in the Public Involvement Appendix F.

The Corps and the City and County of Honolulu have evaluated all comments and alternatives and have selected one for implementation. The recommended plan is Plan 3A, the combined levee raise and floodwall. The present document, which includes a final EIS, constitutes a principal action to comply with state and federal EIS laws. This final EIS has been prepared and coordinated, taking into consideration the advice of the general public, agencies, and community groups. This final integrated report/EIS differs from the format in the draft in that the organization and content of two previously separate documents have been integrated together. This document will be submitted to the Mayor and the Governor for acceptance in accordance with state procedures. Federal EIS procedures shall be completed including the 30-day wait period and staffing of a record of decision to be signed by the Director of Civil Works. This FEIS recommends mitigation measures and monitoring requirements that should be carried forward and implemented during the construction and maintenance of the flood control improvements.

7.2. **REQUIRED COORDINATION**: The Corps and the City and County of Honolulu must comply with the provisions of various federal acts and local regulations. Executive Order 12372, Intergovernmental Review of Federal Programs, provides that federal agencies shall rely upon the coordination and review processes establisheed by each state. A table showing the status of compliance with environmental statutes is shown in Appendix E, Environmental Appendix. The following federal and local regulations and associated agency coordination have been completed.

7.2.1. **Clean Water Act**. Alternatives involving the discharge of dredged or fill materials into waters of the United States require the preparation of a Section 404 (b)(1) evaluation by the Corps. The Corps has complied with the provisions of the Clean Water Act by preparing a Section 404 evaluation which is included in the Environmental Appendix. A 401 Water Quality Certificate will be obtained prior to construction from the State Department of Health, Clean Water Branch.

7.2.2. **Endangered Species Act**. The following list of waterbird species constitutes the federal endangered and threatened species which use Kawainui Marsh for feeding, resting or nesting habitat:

The Hawaiian coot or 'alae ke'oke'o
The Hawaiian common moorhen or gallinule or 'alae 'ula
The Hawaiian duck or koloa maoli
The Hawaiian stilt or ae'o

Pursuant to Section 7 of the Endangered Species Act, the Corps reinitiated formal consultation with the U.S. Fish and Wildlife Service on March 6, 1990. This process identifies the species, habitats, and extent of possible impacts, and the measures to conserve listed species if they are affected by the proposed project. The Corps received the Biological Opinion from the USFWS on 12 July 1990 (Environmental Appendix). The information provided in a Biological Opinion includes determinations on whether each alternative would jeopardize the continued existence of an endangered or threatened species.

The State Department of Land and Natural Resources (DLNR) has comparable State endangered species regulations and this project has been coordinated with DLNR to obtain the latest bird surveys and requirements for state endangered species. All four federally listed species are listed as state endangered species.

7.2.3. National Historic Preservation Act (NHPA). The entire Kawainui Marsh was determined eligible for listing on the National Register of Historic Places in 1979. Pursuant to Section 106 of the NHPA of 1966 (as amended), and its implementing regulations (36 CFR 800), alternatives which might affect this historic property are subject to the provisions of this act. Compliance with Section 106 is ongoing. In consultation with the State Historic Preservation Officer (SHPO) the Corps contracted for an archaeological surface and subsurface survey within two corridors along the existing levee and on the southern hill slope between the levee and Kailua Road. No archaeological, historic, and/or cultural resources will be impacted by the alternatives.

7.2.4. Coastal Zone Management Act. Compliance with the Federal Coastal Zone Management Act is required. In accordance with Sections 305 and 306 of the CZMA, the State prepared and had approved a CZM plan. The proposed project area is in the coastal zone jurisdiction of the plan and federal actions must be consistent with the State CZM plan. Consistency is achieved by the federal agency first preparing a consistency determination and the state agency concurring with the Federal consistency determination. The Corps has determined that all alternatives regarding flood mitigation at Kawainui/Coconut Grove are consistent with and will be conducted in a manner which is consistent to the maximum extent practicable with the Program. The State's CZM office has not formally concurred with this determination and is being asked again by way of this FEIS to evaluate whether the project is consistent with the Hawaii CZM Program (Appendix E).

The State of Hawaii has also enacted State level coastal zone management legislation and regulations. The County Dept. of Land Utilization is the key agency managing state CZM procedures through its special Management Area (SMA) regulations. The marsh falls within the Oahu SMA, and County actions in the marsh are subject to SMA approvals including Dept. of Public Works flood control improvements. Coordination with the County Dept. of Land Utilization has been initiated.

7.2.5. Fish and Wildlife Coordination Act (FWCA). The FWCA requires that proposed Army Corps of Engineers actions be coordinated with the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), and the appropriate head of the State agency (Department of Land and Natural Resources, Division of Aquatic Resources) exercising administration over fish and wildlife resources. This coordination has been ongoing. The USFWS has submitted a draft 2(b) report (Environmental Appendix). A final 2(b) report will be forwarded pending input from DLNR and receipt of this FEIS.

7.2.6. **Presidential Executive Order 11988, Floodplain Management.** The executive order requires the responsible federal agency to evaluate the proposed action with respect to flood plain management and related controls. This project is located in the base (coastal) flood plain of Kawainui Marsh. As this action is remedial in nature to restore existing, Congressionally-authorized and constructed flood control protection, there is no other practicable alternative to siting the project in the base flood plain. The potentially adverse effects will be avoided or minimized by the appropriate mitigation measures identified. This action is not expected to induce any other direct or indirect land use development on the lands immediately adjacent to the marsh in Coconut Grove, Kailua, Oahu. The public has had an opportunity to comment on this action.

7.2.7. **State Conservation District Use Application (CDUA).** Kawainui Marsh lies within land which is designated Conservation by the State of Hawaii. Activities on such lands are normally subject to approval by the State of Hawaii Board of Land and Natural Resources (DLNR) through the CDUA process. The DLNR approved an emergency temporary variance for the prior emergency flood control measures in the marsh in January, 1988, subject to various conditions. The City and County of Honolulu sponsoring the construction of the proposed flood control activities will request a CDUA permit.

7.3. **Summary of Comments Received:** Forty written comment and fifteen no-comment letters were received during the public review period of the Draft document. Most of the reviewers were opposed to the NED plan or concrete floodwall. Preference was given to an earthen levee raise over the floodwall. The majority of reviewers preferred a combination of alternatives that include in-marsh as well as levee modification to reduce the height of any levee raise as well as to benefit wildlife in pursuit of environmental enhancement. A summation of key concerns is listed by reviewer below. Detailed responses to each letter are printed in Appendix F.

7.3.1. **Fifteen No-comment letters received from:**

Soil Conservation Service (24 May 1991)
City and County Fire Dept.(4 June 1991)
City and County Dept.of Transportation Services (30 May 1991)
Department of the Navy, Pearl Harbor (28 May 1991)
Hawaiian Electric Co.(22 May 1991)
State of Hawaii Dept. of Defense Office of the Adjutant General (16 May 1991)
State of Hawaii Dept.of Defense Office of the Director of Civil Defense (13 May 1991)
State Public Works Engineer (16 May 1991)
City and County Building Dept. (16 May 1991)
State of Hawaii Dept.of Education (21 May 1991)
City and County of Honolulu Police Dept. 7 June 1991
Kazu Hayashida, Bd. of Water Supply (14 June 1991)
Joseph Conant, Housing Finance & Dev. (17 June 1991)
Documents Library, Ft.Collins, CO (20 June 1991)
State of Hi.Housing Authority (20 June 1991)

7.3.2. **Forty Comment letters received from:**

7.3.2.1 **Walter Ozawa, City and County Dept.Parks and Rec.**(9 May 1991): Opposes floodwall as aesthetically undesirable. Recommends earthen levee raise.

7.3.2.2. **Mr. Robert Merriam, Chair of State Kawainui Advisory Committee** (10 May 1991): Recommends open marsh clearing or combination of vegetation removal and levee modification. Finds fault in various calculations and estimates.

7.3.2.3. **Mr. Ron Walker-DLNR Division of Forestry and Wildlife** (20 May 1991) Recommends Marsh Clearing Alternative for environmental reasons and because it addresses issue of vegetation.

7.3.2.4. **Mr. Robert Lopes** (25 May 1991): Flood victim. Recommends either of the two levee modifications since they provide maximum protection factor, low construction cost, minimum maintenance, and eligible for federal funds.

7.3.2.5. **Mr. Bill Paty, DLNR, Office of Conservation and Environmental Affairs**. (12 June 1991). Concerned about the reliance on engineering solutions to the flood control problem with little understanding of the marsh. No objections if undertaken in consonance with the Kawainui Marsh Resource Management Plan. Further archaeological inventories required if four of the alternatives are pursued.

7.3.2.6. **Mr. Bill Paty, DLNR-Div.of Aquatic Resources** (28 May 1991): Recommend marsh clearing alternative despite costs which are justifiable in light of past mistakes. Fisheries values were not weighted in benefits to cost comparisons. Rare case where flood control measures can be taken in concert with beneficial fisheries management.

7.3.2.7. **U.S. Representative Patsy Mink** (29 May 1991): Recommends earth levee raise.

7.3.2.8. **Ms. Camille Woodruff** (29 May 1991): Flood victim. Recommends earth levee raise and speedy decision.

7.3.2.9. **Ms. Muriel Seto**, **Hawaii's Thousand Friends** (29 May 1991): Preliminary comments presented during public meeting. Not happy with format, missing studies, "bureaucratese". No recommendation made.

7.3.2.10. **Ms. Dorothy Rose Babineau, Kailua Neighborhood Bd. Member** (29 May 1991): Remove excess growth of vegetation for wildlife. Consult with Ducks Unlimited.

7.3.2.11. **Ms. Annetta Kinnicutt and Ms. Bonnie Heim, Kailua Neighborhood Board No.31** (29 May 1991): Recommends marsh clearing. Consistent with Resource Management Plan. Opposes levee raises as temporary solutions necessitating building a higher one in future if plans for vegetation removal are not implemented.

7.3.2.12. **Mr. Bill Paty, DLNR-SHOPO** (30 May 1991): The "back levee" and flood-proofing alternatives would likely entail extensive archaeological excavations to mitigate probable adverse effects. The two in-marsh alternatives would require an archaeological inventory survey if pursued.

7.3.2.13. **Mr. Richard Paglinawan, Office of Hawaiian Affairs** (30 May 1991): Floodwall is least preferred. Recommends marsh clearing or back levee alternatives (possible error here) while recognizing potential impact to unidentified burial or archaeological sites.

7.3.2.14. **State Rep. Cynthia Thielen** (31 May 1991): Reject concrete floodwall. Recommends earth levee raise to provide immediate action to prevent future flooding with minimal impact upon the environment. Supplement by other actions to open up more channels and water areas. Show drawing of floodwall in FEIS.

7.3.2.15. **Dr. Roger Fujioka-University of Hawaii Water Resources Research Center** (WRRC) (3 June 1991): The marsh is a natural sedimentation basin. Recommends against allowing water to be quickly transported into the ocean before the marsh has had an opportunity to improve the quality of the water. The WRRC is in process of monitoring water quality in and around the marsh.

7.3.2.16. **Dr. Bruce Anderson, Department of Health** (4 June 1991): The DOH is in basic agreement with our general comments and description on water quality.

7.3.2.17. **Dr. Edward Margulies, M.D. Kainui Estates Assoc**. (5 June 1991): Recommends open marsh clearing. Concerns are environmental/ecological first and recreational second. Earthen dam is third choice, if absolutely necessary.

7.3.2.18. **Mr. Todd Hendricks** (6 June 1991): Flood Victim. Strong support for earth levee raise. Feels flooding is still paramount.

7.3.2.19. **Mr. Ed Bybee** (7 June 1991) Letter to Sun Press: Recommends marsh clearing. Raising the levee "without keeping the drain outlets unplugged" will mean a much larger body of water will eventually flood Coconut Grove.

7.3.2.20. **Mr. Leo Burns** (Rec.21 June) (14 June1991): Recommends marsh clearing alternative. Rejects the cost/benefit analysis used and economic assumptions which exclude lower cost alternatives such as burning of the marsh vegetation. Public input should not be ignored.

7.3.2.21. **Mr. Robert Herlinger**, **Planning Consultant for Kawainui Heritage Foundation** (17 June 1991): Prefers marsh clearing. Questions planning methodology used and a proper identification of the resource "patient" that needs "healing". Requests improved reproduction to his Directional Plan #5 in our appendix.

7.3.2.22. **Mr. Benjamin Lee, City and County Dept. of General Planning.** (18 June 1991): This office will act as the accepting agency at the State level for the FEIS. Request copies of all public comments regarding this document. The project conforms to their Development Plans. Request more detailed explanation for mitigating visual impacts of floodwall and a retouched photograph showing proposed floodwall. Reject concept of a blank concrete face as inappropriate and subject to graffiti, access and security problems.

7.3.2.23. Ms. Patricia Sanderson Port, U.S. Dept. of Interior Office of Environmental Affairs (Rec.24 June)(20 June1991): Addresses cultural resources only. Requests archaeological surveys for all alternative plans or not in compliance with section 106 of National Historic Preservation Act.

7.3.2.24. Mr. John Naughton, NMFS (20 June 1991): Recommends the floodwall alternative and rejects in-marsh alternatives because of potential environmental impacts to Kailua Bay and its resources.

7.3.2.25. Dr. John Stimson Associate Prof.Zoology at UH (20 June 1991): Rejects need for additional structures in the marsh. In favor of marsh clearing alternative. Calculates storage volume and Oneawa Channel capacity to suggest that the marsh can contain 3 times the runoff of the New Year's 88 event if its water level were at 2.5 feet above mean sea level. Suggests vegetation handling methods.

7.3.2.26. Harold Masumoto, Office of State Planning (CZM) (20 June 1991): Corps may not have considered the marsh as a dynamic system. Effective flood control must consider both flood control and resource management. Recommend combination of the alternatives be pursued and mitigation to reduce effects of sediment flushing into Kailua Bay. Also consider combining levee and floodwall to reduce the area of wetland and have fewer impacts to wildlife, access, and recreational opportunities. Discuss status of and need for emergency ditch.

7.3.2.27. Ms. Muriel Seto, Hawaii's Thousand Friends (20 June 1991): Requests a reissued draft and a subsequent public workshop to be led by a trained behavioral scientist to clarify alternatives. Gives qualified approval for marsh clearing alternative with modifications. Requests revised cost/benefit figures. Fears that intent is to remove flood basin from governmental responsibility. The project did not fail, governmental agencies failed by allowing construction and other impacts to increase insiltation and water degradation. If flood control exempts basin considerations, how long would it take for the new barrier to be breached due to infilling? Wants creative management. Wants more emphasis on archaeological and cultural resources with Hawaiian names for species, gods and goddesses used throughout and cultural significance documented. Cites evidence that silts are clearly a problem in the marsh and that they cover four to six feet of lo'i or walls. Requests a re-work of the planning effort.

7.3.2.28. Ms. Sandra Braun for Hope Miller, Lani-Kailua Outdoor Circle(Rec 1 July) (21 June 1991): Requests a public workshop. Difficulty with DPR and EIS as supporting documentation. No archaeological report appears. Questions assumptions regarding insiltation rates. Can't raise sides of basin and ignore the basin itself. NED plan not in keeping with Resource Management Plan. Requests re-evaluation of cost/benefit considerations. Enhance the marsh resources.

7.3.2.29. U.S. EPA Region IX (Rec 27 June) (21 June 1991): 20-page letter of recommendations. Insufficient specificity and data to conduct side by side evaluation of alternatives presented. Insufficient information to fully assess potential impacts except the flood proofing alternative. Recommend fully developing the range of flood control alternatives within the context of their comments and establish a position for recommending a preferred course of action. Closely examine marsh nutrient and sediment loading and incorporate actions to minimize such loading into ultimate plans for flood control. Recommend inclusion of sediment reduction alternative in FEIS.

7.3.2.30. Dr. Diane Drigot, Kawainui Heritage Foundation.(21 June 1991): Requests revised draft and public workshop. Expresses difficulty with format of DPR and DEIS in single document. Equates a raised levee to the Teton Dam which if collapsed would be devastating. Raising the height of the "bath-tub walls to keep rising "bath-water" from overflowing ignores a "clogged drain". Requests substantiating evidence from consulted experts with expertise in botany, marshes, floating mat behavior, cultural values, archaeology, economics, sedimentation flows and rates, etc. Recommends the original eligibility determination and map be included to make an assessment of affect on historic property. Requests copy of our archaeological survey report. "Treat the disease" that caused the last flood- the overgrowth of vegetation. Requests acknowledgement of role of U.S. Marine Corps Amphibious Assault Vehicles.

7.3.2.31. Dr. Diane Drigot, Kawainui Heritage Foundation (21 June 1991): Draft is so inadequate as to preclude meaningful analysis. Requests revised draft and another public meeting, preferably a two-way workshop.

7.3.2.32. Ms. Carol Wilcox(Rec 7 July) (22 June 1991): Recommends marsh clearing alternative since it is the "only alternative which has environment and habitat enhancement built into the goal of flood control".

7.3.2.33. Mr. Andrew Yanoviak (22 June 1991): Fundamental flaw in only addressing flood control and not environmental control. Against channelizing, fragmenting, or desecrating the wetlands further. Must maintain "sponge" type marsh mat. Requests re-initiating of planning. Requests composite overlay of all maps. Recommends condemnation, removal, replacement or reconstruction of homes that may be misplaced in Coconut Grove or surrounding the marsh.

7.3.2.34. Mr.& Mrs.James Kalawa(Rec.24 June) (21 June 1991): Flood victims. Against increasing the height of levee at all. Recommend marsh clearing. Treat disease not symptom.

7.3.2.35. Dr. John Harrison, University of Hawaii, Environmental Center(22 June 1991): Lack of sufficient information and documentation on sedimentation, water budgeting, archaeology, aesthetics, costs and benefits. Request holistic new approach. Recommend full length archaeological report as an appendix to FEIS. Request sediment balance in FEIS. Major deficiency of document is its inadequate assessment of the sediment balance. Cite contradictions in water balance rates. Note discrepancies, contradiction, and inconsistencies in the analyses and costs of various alternatives. Request visual impact including colors of wall in final document. Request visual impact assessment analysis on floodwall. Request aesthetic assessment comparing varying wall heights. Lack of analysis of pre-Hawaiian vegetation. Unspecified commitment to mitigation. Prefer use of terms "will" or "would" instead of "should". Confusing format with Main Report vs DEIS. Duplicity of information and seeming differences of purposes of the DEIS and Main Report. Recommend different binding. Applaud use of recycled paper. Lack of consideration for the future, Request comparison of goals between NED plan, Hawaii Waterbird Recovery Team plan, CZM and Kawainui Marsh Resource Management Plans. Request plan which is sound from both engineering and environmental perspectives.

7.3.2.36. Mr. Bill Paty,DLNR,WRM (25 June 1991): Flood wall is most economical but provides opportunities for graffiti, undesirable aesthetics. Raised earth levee also acceptable. None of these alternatives will reduce the need to maintain vegetation and sedimentation in the marsh. An open waterway to Oneawa Canal with or without a water control structure is needed to direct water to the Canal. Design for greater flood events than the 100-year event as an added safety factor. Limited funding and time are constraints that should not prevent implementation. Some flood control now is better than none.

7.3.2.37. Mr. Bill Paty to Mr. S.Callejo (8 July 1991): Either the floodwall or levee raise alternatives are acceptable for they both accomplish flood control directly at comparatively lower capital and recurring maintenance costs. Recommend greater than 100-year design flood. If considered a dam, new dam safety law requires 250 year protection. Clearing portions of marsh or excavating the Quarry Road. Channel could also meet flood control objective and be environmentally beneficial but has higher operating and maintenance cost coupled with limited capacity of Oneawa Channel and uncertainty regarding behavior of floating mat. Prefer not to rely upon these within-marsh improvements for long-term flood control. The retention of the emergency channel alongside the levee or opening of new waterways in the marsh can be pursued as wildlife habitat enhancement measures, but we would not want to count on them as necessary components for food control purposes.

7.3.2.38. USFWS Draft 2(b) Report (12 July 1991) Represents an excellent opportunity to support the new environmental goals and initiatives of the Corps Final design features, plans, and specificiation for protection of fish and wildlife resources shall be developed in consultation with USFWS and DLNR as required by the Fish and Wildlife Coordination Act. Recommendations include abandon emergency ditch as an active flood control feature, do not decrease water quality or water levels below pre-project levels, monitor water quality, heavy metals, and water levels if marsh clearing is implemented. Consider re-initiating Section 7 consultation if marsh clearing is pursued. Final 2 (b)report will include recommendations of the DLNR.

7.3.2.39. Centers for Disease Control (30 July 1991) Reviews the report from a human health perspective. Requests better indication if mosquitos are a problem or not including the concern for vector-borne diseases. Interest in the potential for Leptospriosis and whether potential increases in recreational activity might impact the spread of this illness.

7.4. **Report Recipients.** A detailed listing of recipients and their mailing addresses is provided in Appendix F, Public Involvement. These agencies and public-at-large were sent copies of the *Draft Detailed Project Report and Draft Environmental Impact Statement* in April 1991 and will receive this final report as well. In addition, other Federal agencies are being sent copies of this final report for environmental review.

8. LIST OF PREPARERS.

US ARMY CORPS OF ENGINEERS

Name	Expertise	Experience	Title
Dr. Patricia Beggerly	Archaeology	State Historic Preservation Office Archaeologist; US Navy; Army Corps of Engineers; Private Contractor (17 years); BA; MA; PhD.	Archaeologist
Mr. William Chang	Hydrology	BS; Registered Professional Registered Engineer (Hawaii); 24 years Army Corps of Engineers.	Hydrologist
Ms. Jessie Dobinchick (Report Preparation and Coordinator)	Civil Works Tech.	15 years Army Corps of Engineers	Civil Engineering Technician
Mr. David Goldman	Hydrology	Hydrologic Engineering Center, Davis, CA	Hydrologist
Mr. Russell Iwamura	Economics	BA, Economics; MA, Economics; 3 years Army Corps of Engineers.	Economist
Mr. William Lennan	Ecology	BS, Pol Sci, BA, Zoology; 2 years Grad Studies, 11 years Army Corps of Engineers	Supervisory Environmental Biologist
Mr. James Pennaz (Project Engineer)	Hydraulic Engineer; Flood Control Design	BSCE; MSCE; Post Grad. Studies; Registered Professional Engineer (Hawaii; Minnesota) 18 years Army Corps of Engineers;	Hydraulic Engineer
Ms. Margo Stahl (EIS Preparer)	Ecology; Marine Biology; Environmental Assessments	BA, Biology; MS, Marine Biology; Certified Environmental Professional; Fisheries Biology Environmental Consultant (15 years)	Ecologist
Mr. Tony Thomas	Hydraulics, computer modelling	Waterways Experiment Station, Vicksburg, MS.	Research Hydraulic Engineer
Dr. William C. Zattau	Aquatic Plants	Aquatic Plant Control Operations Support Center, Jacksonville District	Biologist

CITY AND COUNTY OF HONOLULU

Name	Expertise	Experience	Title
Ms. Laverne Higa	Project Manager	10 years experience; B.S.C.E.	Civil Engineer

CONSULTANTS

Name	Expertise	Experience	Title
Dr. Stephen Athens	Archaeology	Arch. Res. Arch. Svcs.	Archaeologist
Ms. Marion Kelly	History	UofH Instructor	Historian

9. INDEX, REFERENCES AND APPENDIXES

The Recommended Plan
Concrete Floodwall on Raised Levee

Statutory Limit	p. 52
Unresolved Issues	Summary Sheet
Without Project Condition (No Action)	p. 21, p. 31, System of Accounts (Table 2)

10. CONCLUSIONS AND RECOMMENDATIONS

10.1. **Conclusions**. After careful consideration of all planning criteria, a modification to the existing levee was identified as the only alternative that would meet these criteria. Four levee modification alternatives were evaluated in detail in this final report. The NED plan is Plan 2, a 6,300-foot long, 8-foot high concrete floodwall on top of the existing levee. This alternative has a project first cost of $8,480,000, has a benefit-to-cost ratio of 2.2, and is located entirely on top of the existing levee structure. However, as a result of negative reaction to the aesthetics of a concrete floodwall by the local community and the local sponsor, this alternative was rejected. The local sponsor has agreed to pay all additional costs associated with implementing Plan 3A. The additional costs are presently estimated at $1,420,000.

10.2. **Recommendations**. I have given appropriate consideration to all economic, social, environmental, cultural, and engineering aspects of the flood control plans in the Coconut Grove area. *I recommend that Plan 3A, the concrete floodwall on raised levee*, be selected with such modifications thereof as in the discretion of the Commander, HQUSACE may be advisable. The project first cost is estimated at $9,900,000 with average annual maintenance costs of $98,300, a benefit-to-cost ratio for authorization and budgeting purposes of 2.2, and net benefits of $1,024,000. The City and County of Honolulu shall, before implementation, agree to execute a Local Cooperation Agreement (LCA) and agree to do the required items of local cooperation as specified below:

a. Provide a cash contribution equal to at least five percent of total project costs. Assume all project costs over the $5,000,000 statutory federal limitation under Section 205 of the Flood Control Act of 1948, as amended. The cash contribution is presently estimated at $5,020,000;

b. Provide all lands, easements, rights-of-way, relocations, and dredged material disposal areas, presently estimated at $200,000;

c. Operate, maintain, repair, replace, and rehabilitate the completed project including, but not limited to levees, channels, and other improvements within the marsh according to regulations or directions prescribed by the federal government;

d. Hold and save the federal government free from all damages arising from the construction, operation, and maintenance of the project, except damages due to the fault or negligence of the federal government or its contractors;

e. Prevent future encroachments that might interfere with proper functioning of the project and secure Corps of Engineers' review and written approval of any planned marsh modification including resource management plans for hydraulic compatibility with existing improvements;

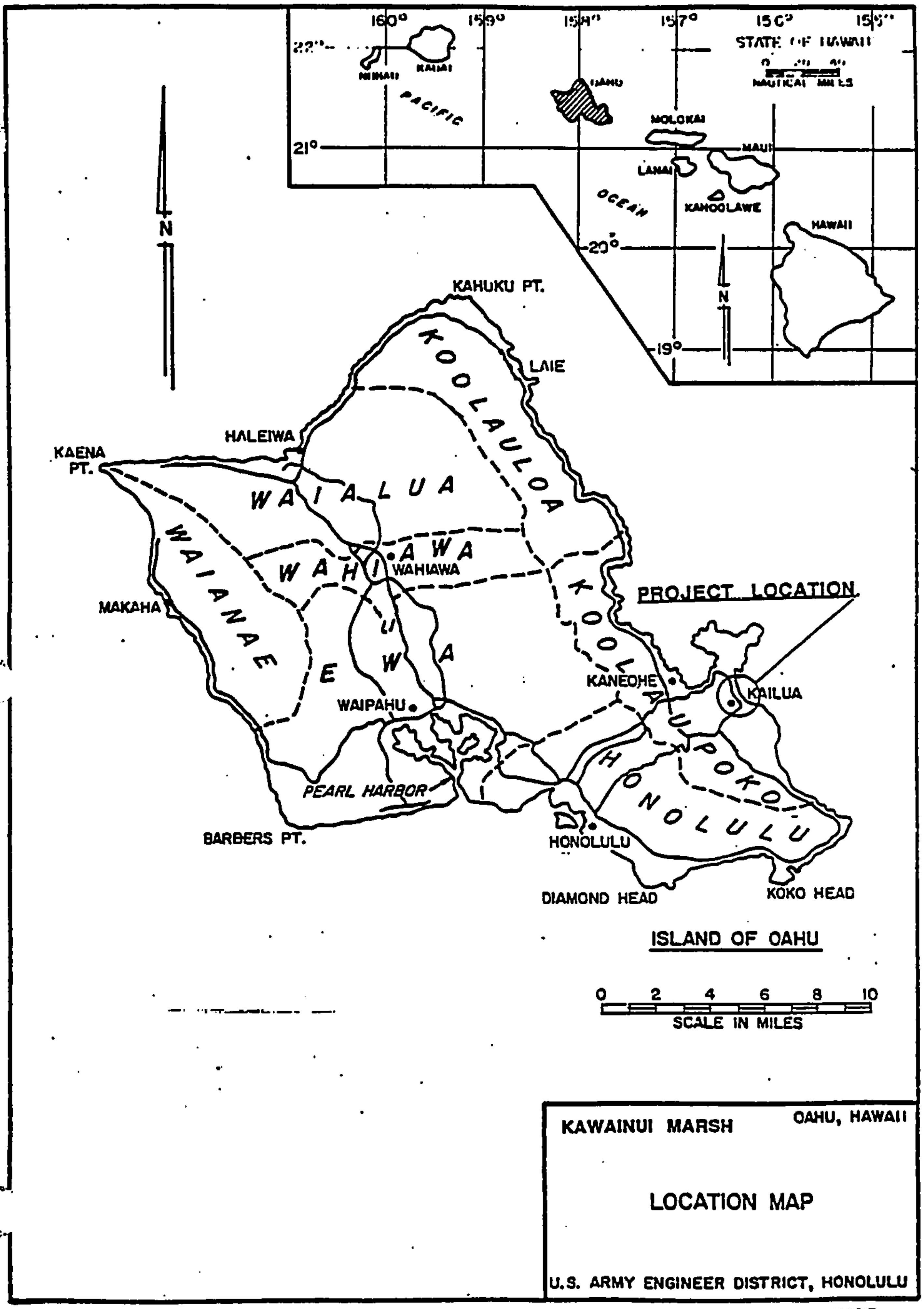
f. Participate in and comply with applicable federal floodplain management and flood insurance programs, pursuant to Section 402, Public Law 99-662;

g. Perform such environmental investigations as determined necessary by the Federal government to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 USC 9601-9675, on lands necessary for project construction and maintenance;

The recommended plan differs from the NED plan because of community and local sponsor objections to an 8-foot high concrete floodwall in the Kawainui Marsh area. The local sponsor will pay the estimated additional first cost of $1,420,000 for Plan 3A. The Federal share of the project first cost will remain at $4,675,000 (excluding the $325,000 preauthorization cost) for Plan 3A because total Federal project cost cannot exceed $5,000,000 under Section 205 project authority.

11. **Disclaimer**. *The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels. Consequently, the recommendations may be modified before they are transmitted to the Chief of Engineers as proposals for authorization and/or implementation funding.*

JAMES MURATSUCHI
Lieutenant Colonel, U.S. Army
District Engineer



KAWAINUI MARSH — OAHU, HAWAII

LOCATION MAP

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 1

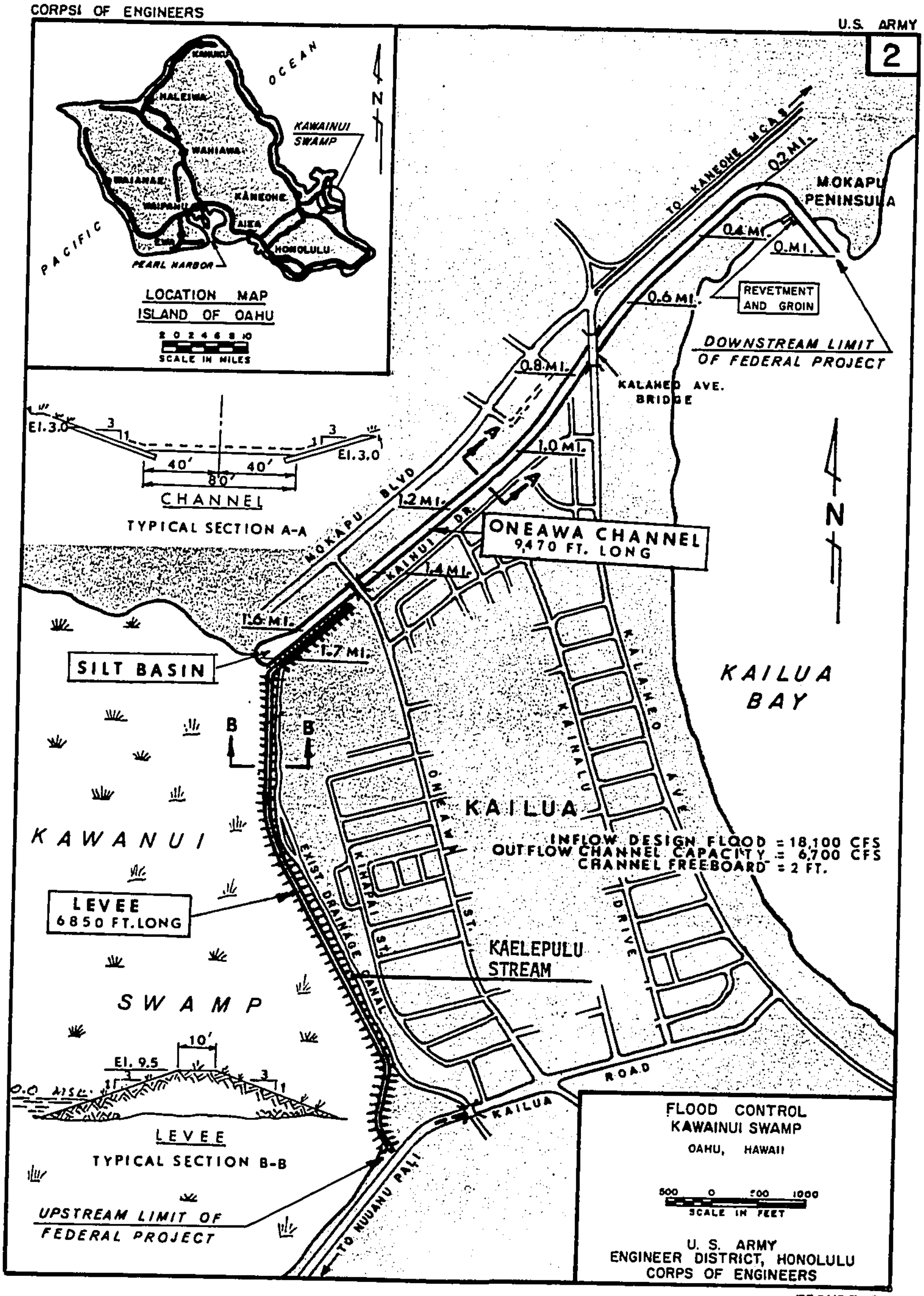

CORPS OF ENGINEERS
U.S. ARMY
2
OCEAN
PACIFIC
KAWAINUI SWAMP
LOCATION MAP
ISLAND OF OAHU
SCALE IN MILES
PEARL HARBOR
HONOLULU
KANEOHE
HALEIWA
WAHIAWA
WAIANAE
AIEA
TO KANEOHE M.C.A.S.
0.2 MI.
MOKAPU PENINSULA
0.4 MI.
0 MI.
REVETMENT AND GROIN
0.6 MI.
DOWNSTREAM LIMIT OF FEDERAL PROJECT
0.8 MI.
KALAHEO AVE. BRIDGE
El. 3.0
3
1
40'
40'
80'
CHANNEL
TYPICAL SECTION A-A
1.0 MI.
1.2 MI.
MOKAPU BLVD
KAIHUI DR.
ONEAWA CHANNEL
9,470 FT. LONG
1.4 MI.
1.6 MI.
1.7 MI.
SILT BASIN
KAILUA BAY
KALAHEO AVE.
KAINALU DRIVE
B
B
KAILUA
KAWANUI
INFLOW DESIGN FLOOD = 18,100 CFS
OUTFLOW CHANNEL CAPACITY = 6,700 CFS
CHANNEL FREEBOARD = 2 FT.
ONEAWA ST.
KIHAPAI ST.
EXIST. DRAINAGE CANAL
LEVEE
6850 FT. LONG
KAELEPULU STREAM
SWAMP
10'
El. 9.5
0.0 MSL
LEVEE
TYPICAL SECTION B-B
ROAD
KAILUA
UPSTREAM LIMIT OF FEDERAL PROJECT
TO NUUANU PALI
FLOOD CONTROL
KAWAINUI SWAMP
OAHU, HAWAII
500 0 500 1000
SCALE IN FEET
U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

FIGURE 2

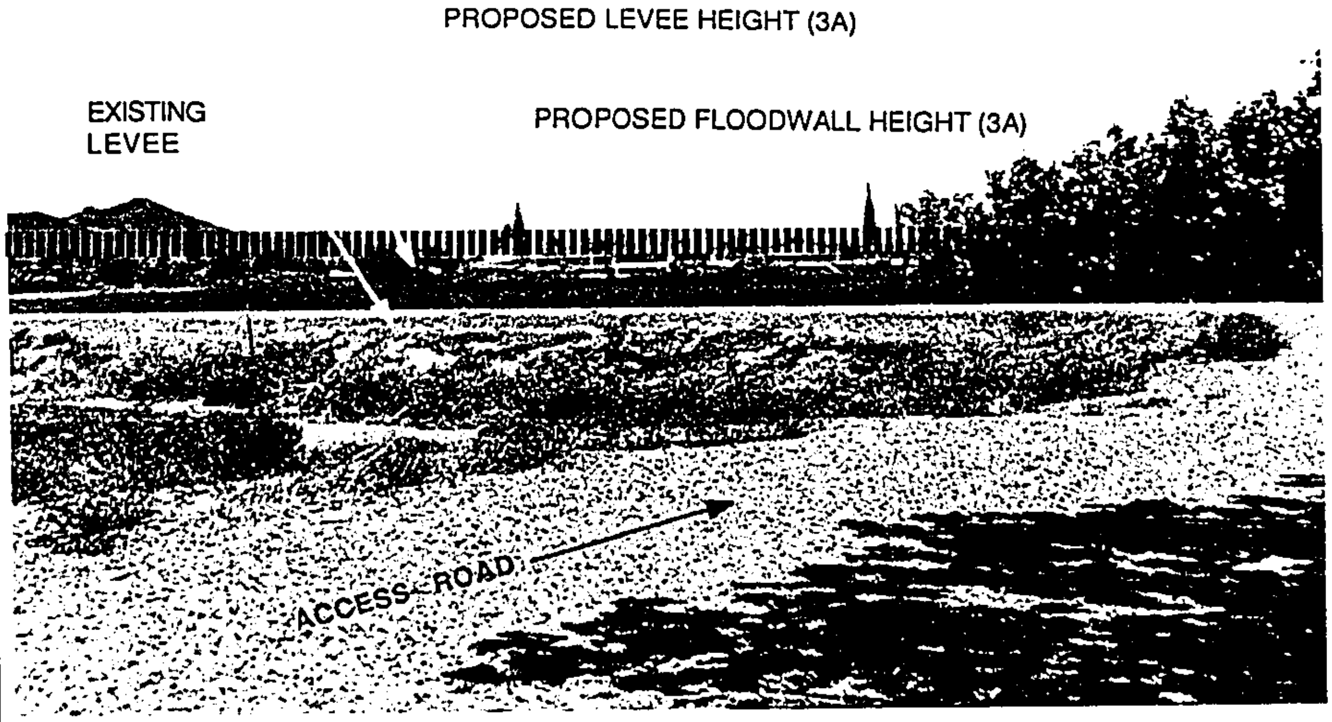


PHOTO 1: VIEW OF ACCESS ROAD AND LEVEE WITH COCONUT GROVE IN BACKGROUND

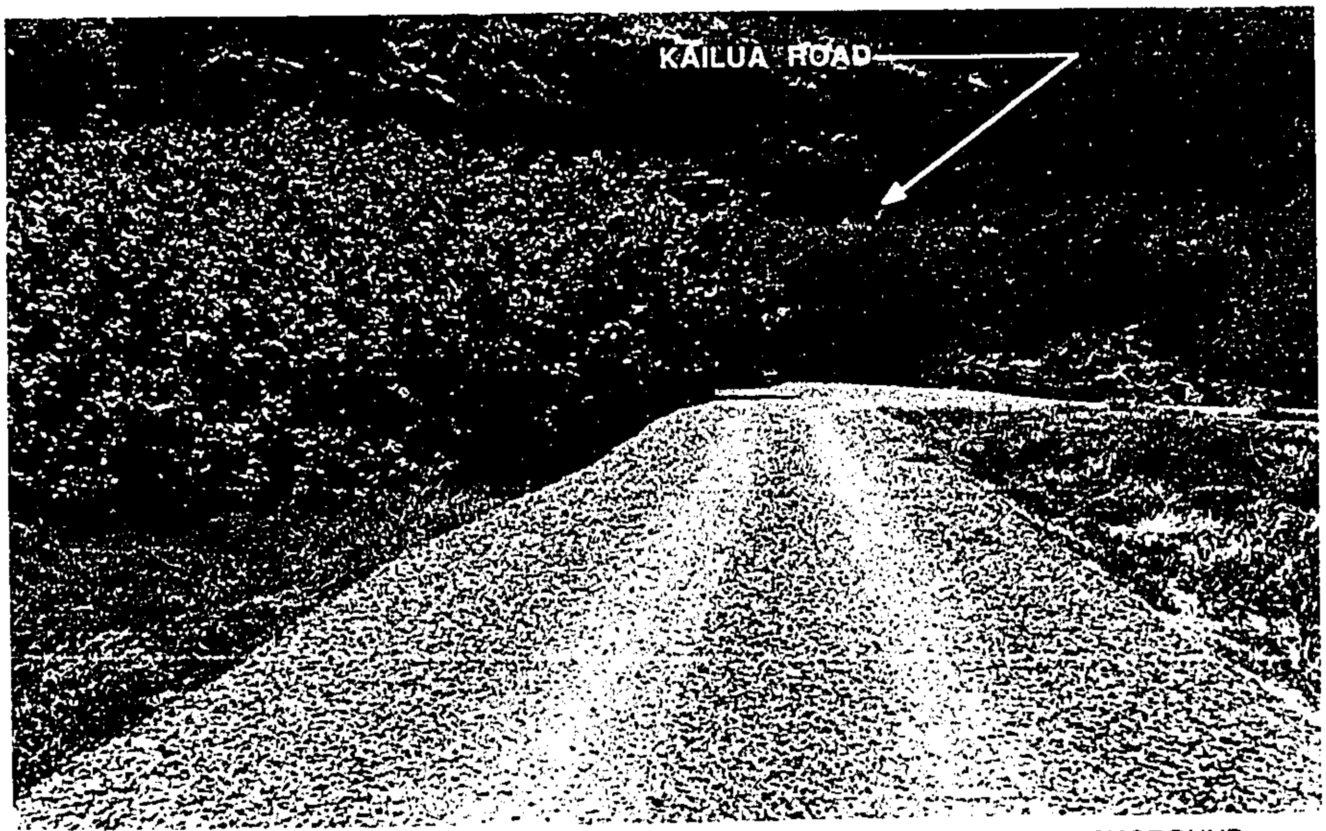


PHOTO 2: SOUTHERN VIEW FROM LEVEE STATION 3+00 WITH KAILUA ROAD IN BACKGROUND.

FIGURE 3 (Sheet 1 of 5)

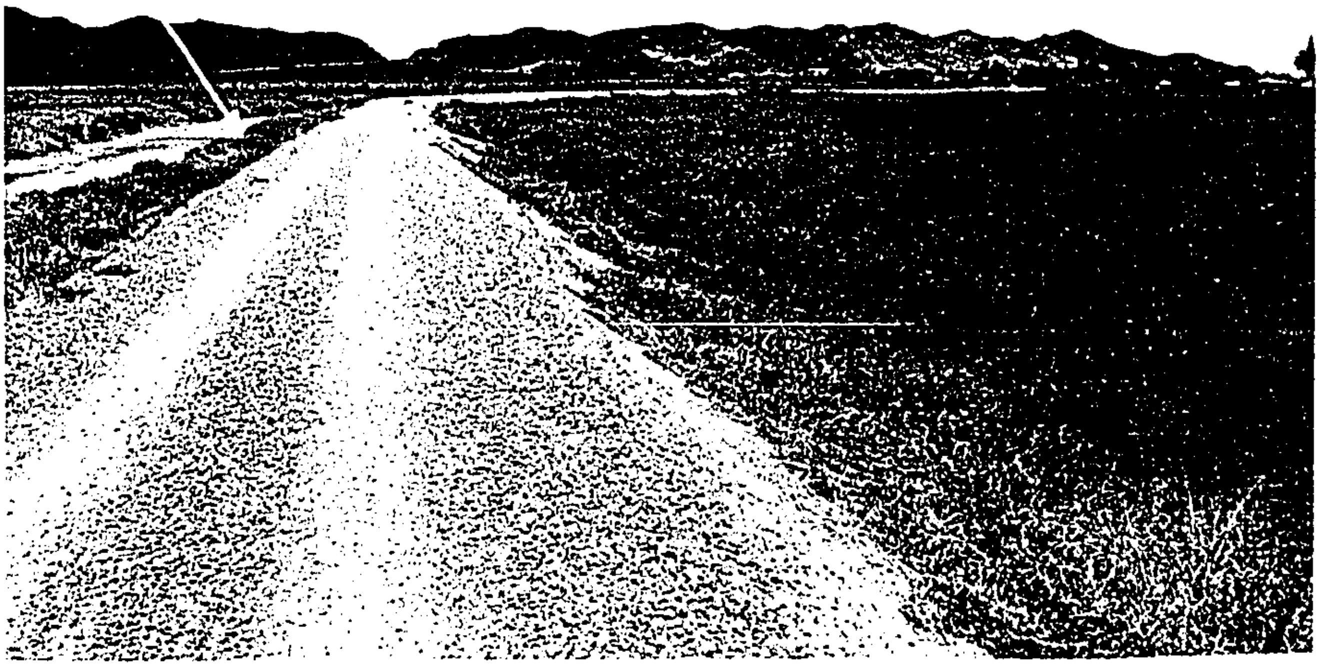


PHOTO 3: NORTHERN VIEW FROM LEVEE STATION 3+00 WITH KALAHEO HILLSIDE IN BACKGROUND.

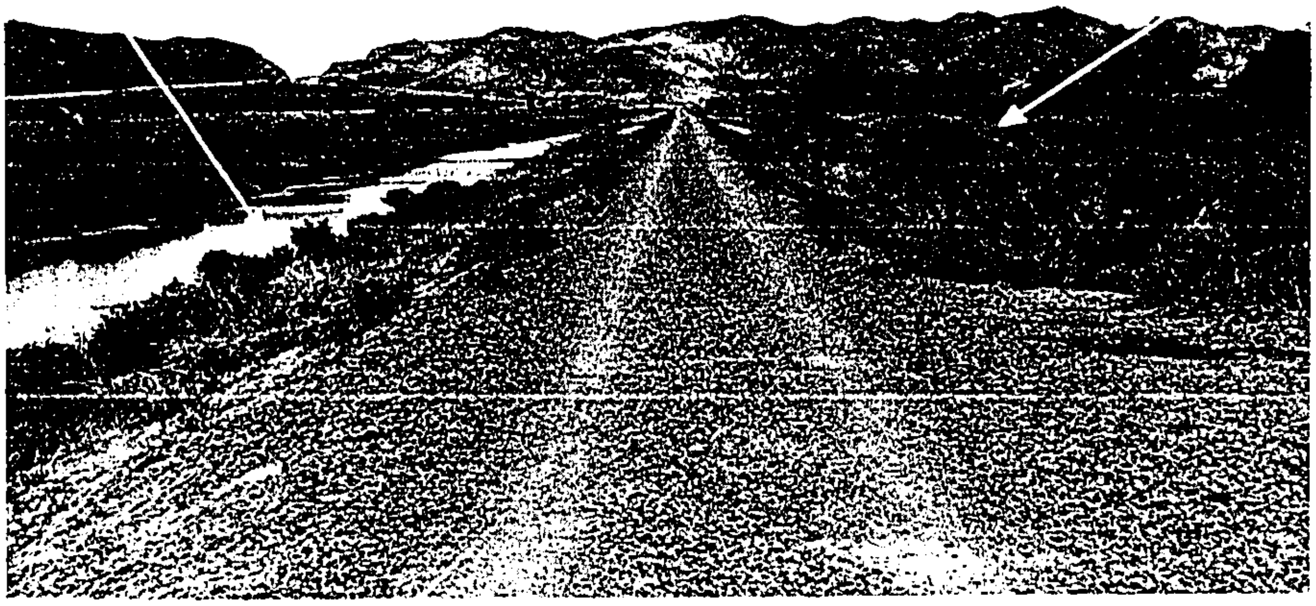


PHOTO 4: NORTHERN VIEW FROM LEVEE STATION 22+00

FIGURE 3 (Sheet 2 of 5)

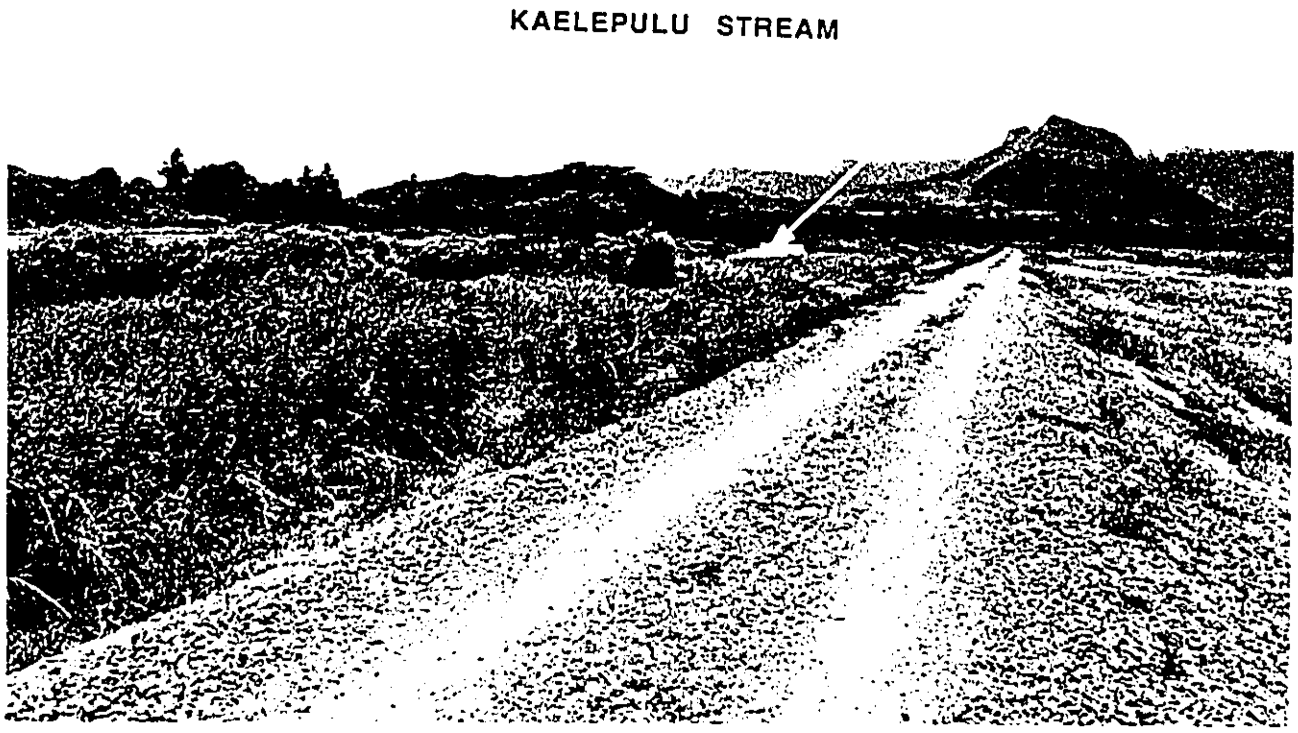


PHOTO 5: SOUTHERN VIEW FROM LEVEE STATION 65+00.

PHOTO 6: SOUTHERN VIEW FROM LEVEE STATION 65+00.

FIGURE 3 (Sheet 3 of 5)

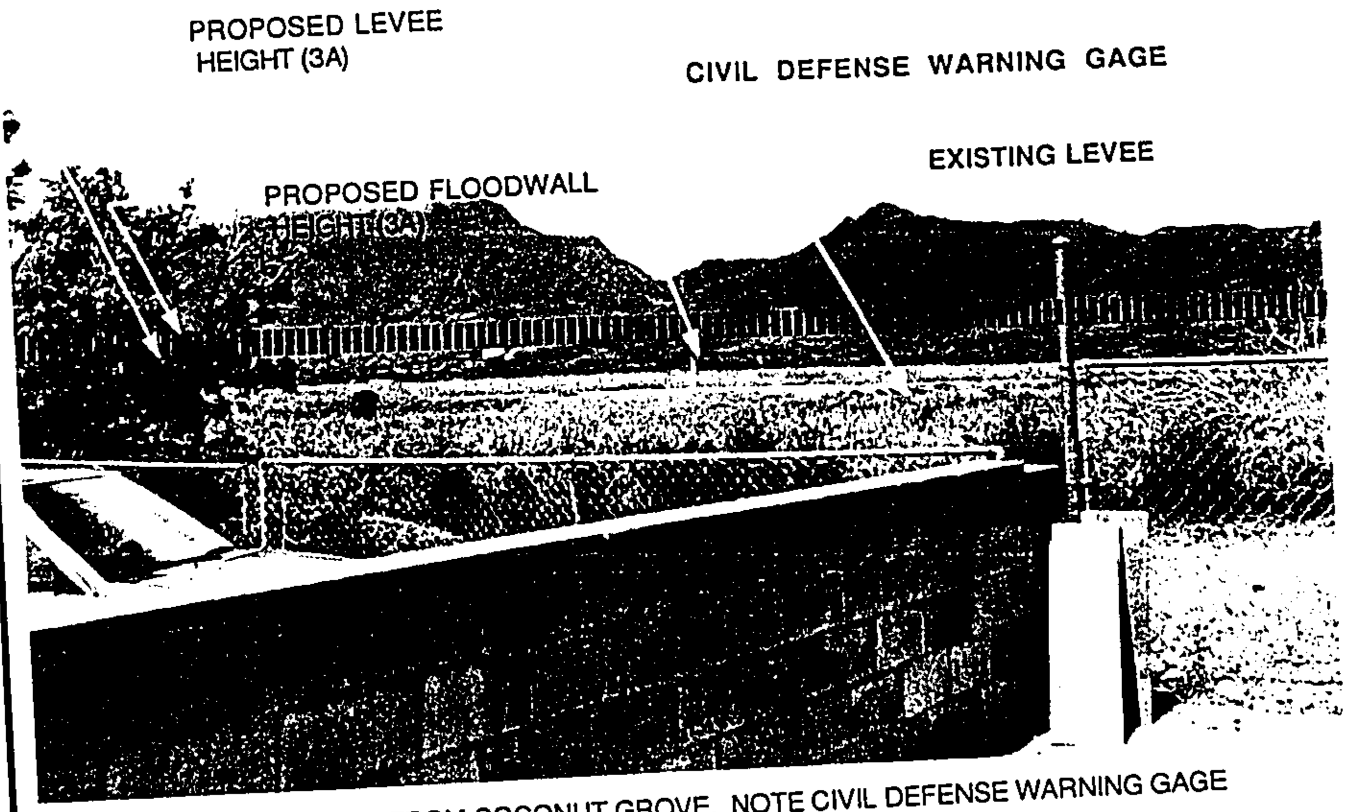


PHOTO 7: WESTERN VIEW FROM COCONUT GROVE. NOTE CIVIL DEFENSE WARNING GAGE IN CENTER OF PHOTO.

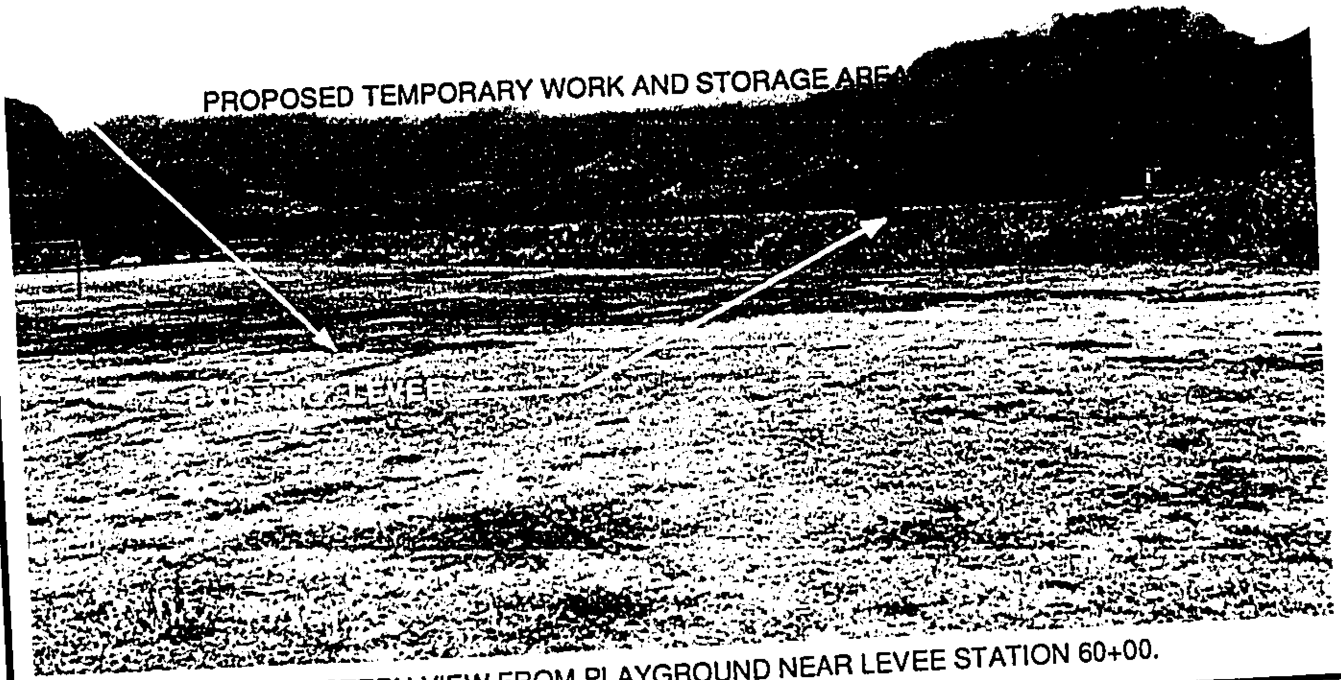


PHOTO 8: SOUTHWESTERN VIEW FROM PLAYGROUND NEAR LEVEE STATION 60+00.

FIGURE 3 (Sheet 4 of 5)

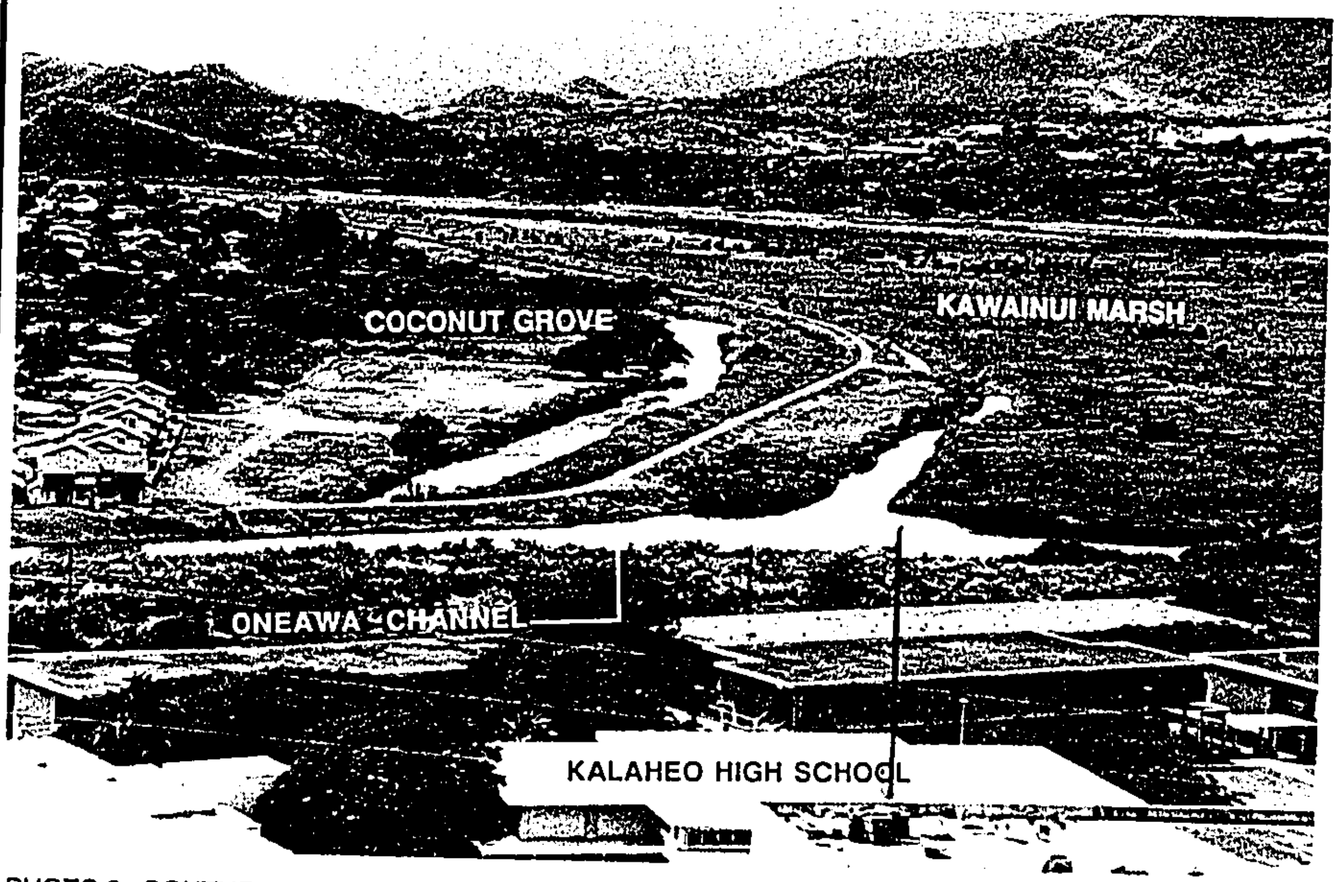


PHOTO 9: SOUTHERN VIEW FROM KALAHEO HILLSIDE. ONEAWA CHANNEL IN FOREGROUND.

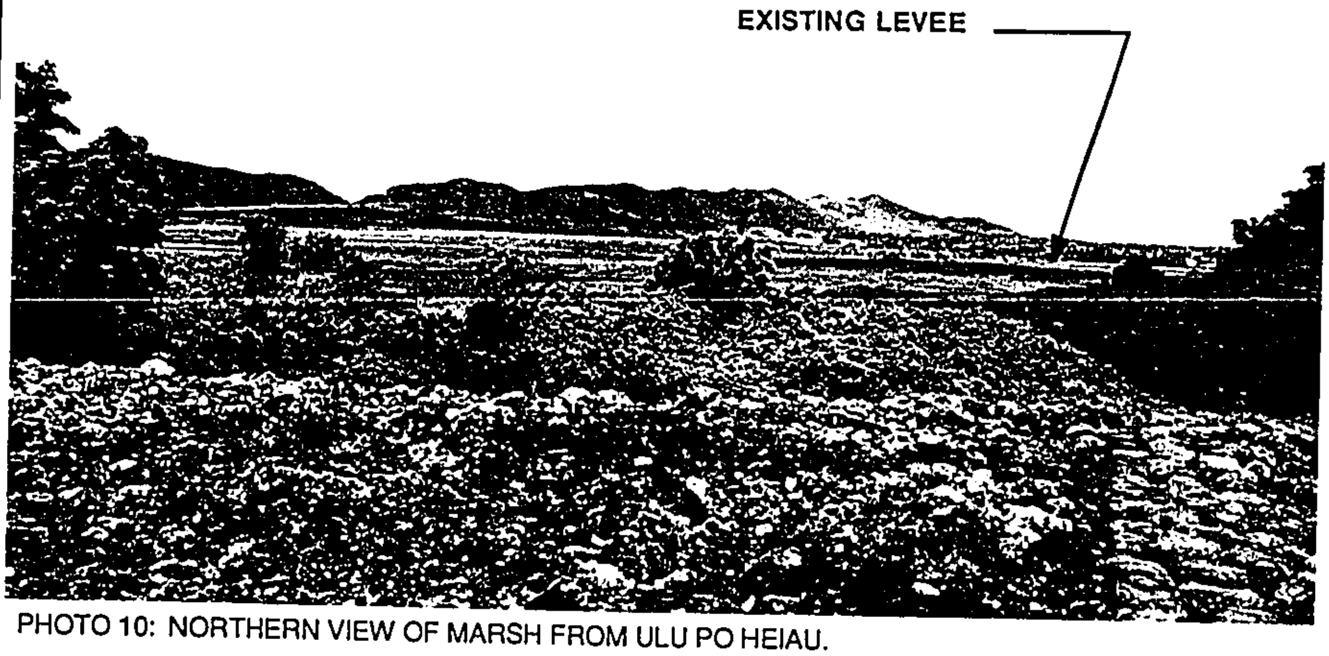
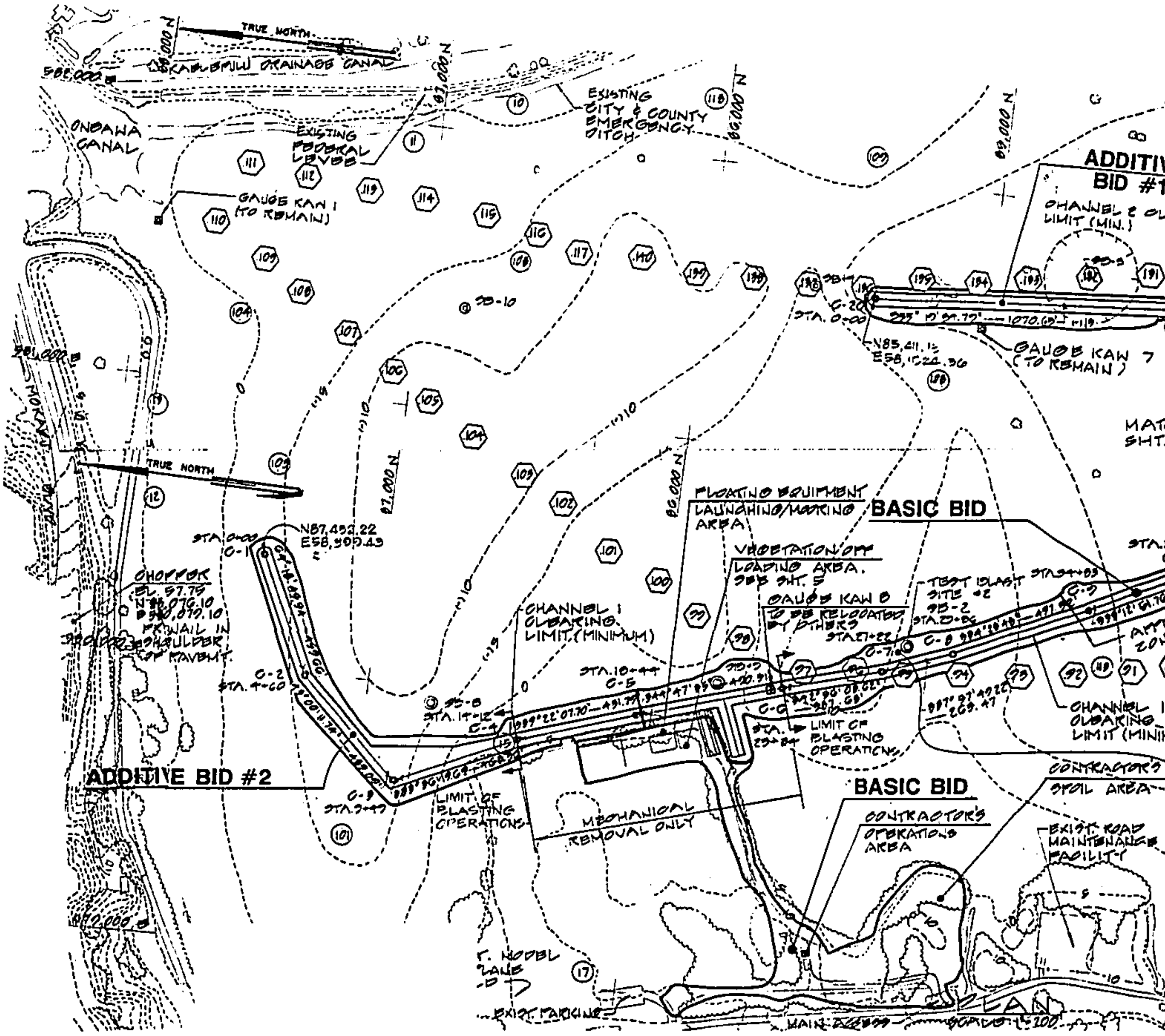


PHOTO 10: NORTHERN VIEW OF MARSH FROM ULU PO HEIAU.

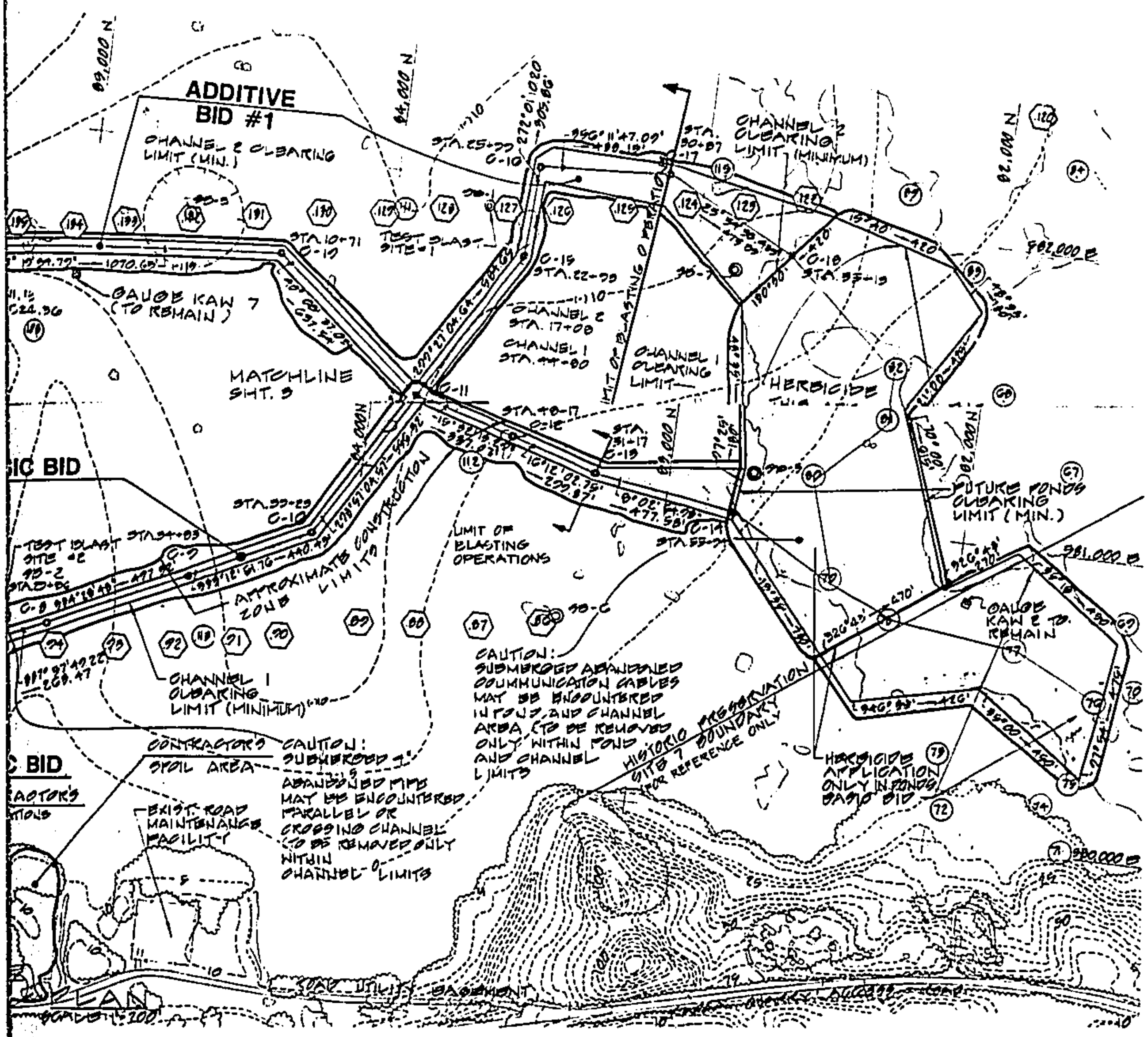
FIGURE 3 (Sheet 5 of 5)



NOTES:

1. ADDITIVE BID #1 AND ADDITIVE BID #2 WE

2. BASIC BID AREA COMPLETED DEC. 91.



...ID #1 AND ADDITIVE BID # 2 WERE NOT AWARDED.

AREA COMPLETED DEC. 91.

GRAPHIC SCALE

0 200 400 600 800 1000

KAWAINUI MARSH OAHU, HAWAII

CITY AND COUNTY
MARSH CLEARING

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 4

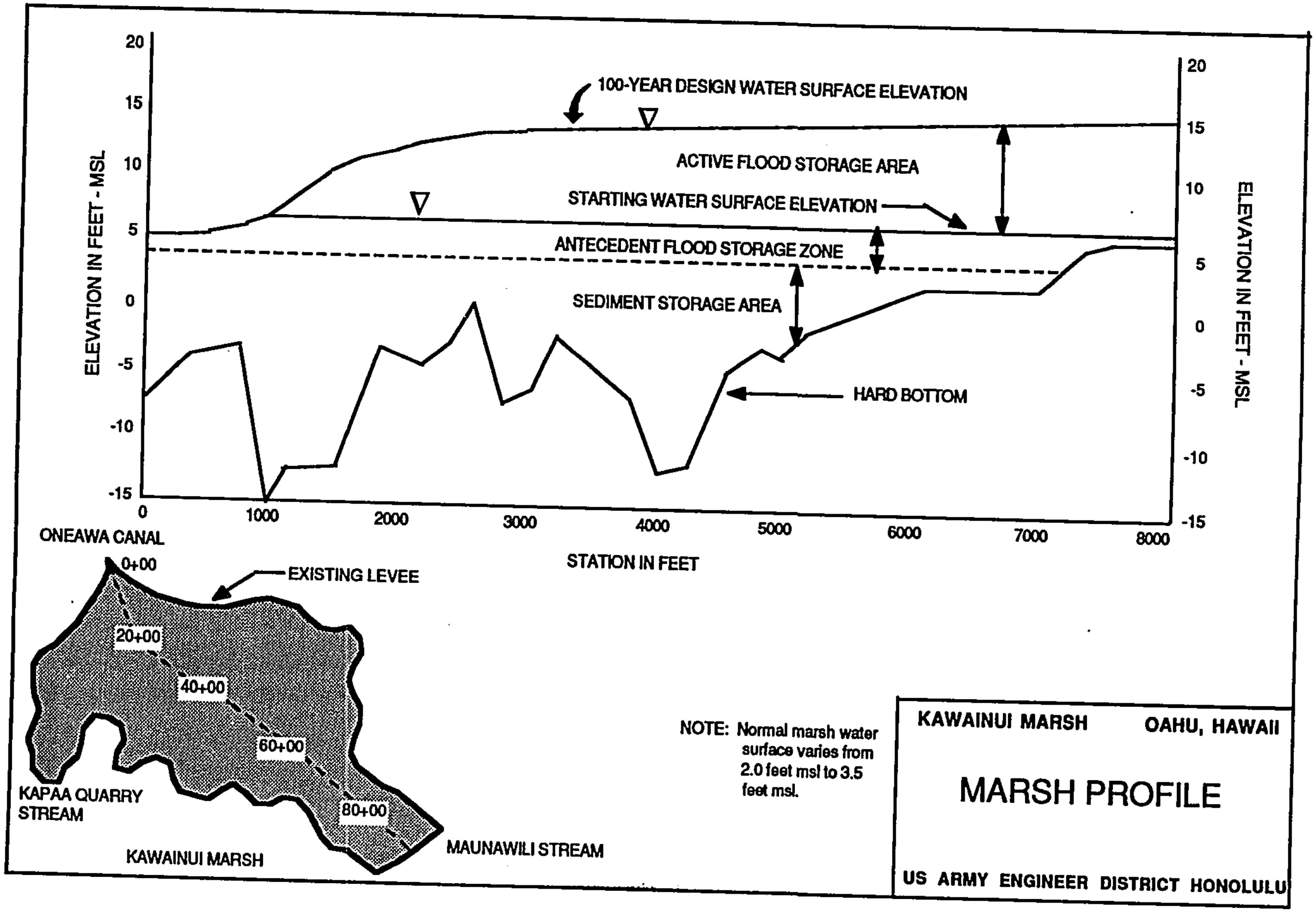
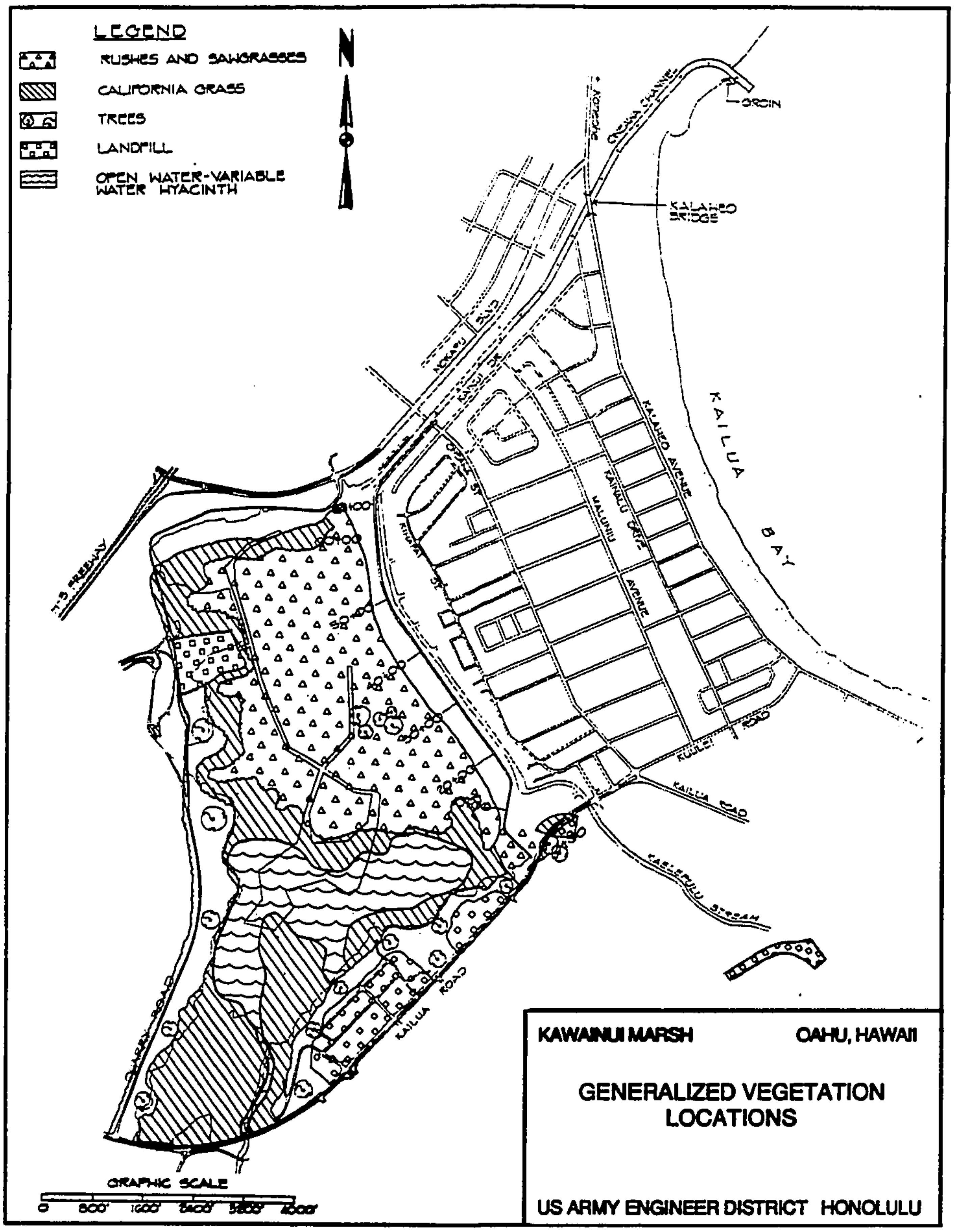


FIGURE 5

FIGURE 5



KAWAINUI MARSH **OAHU, HAWAII**

GENERALIZED VEGETATION LOCATIONS

US ARMY ENGINEER DISTRICT HONOLULU

FIGURE 6

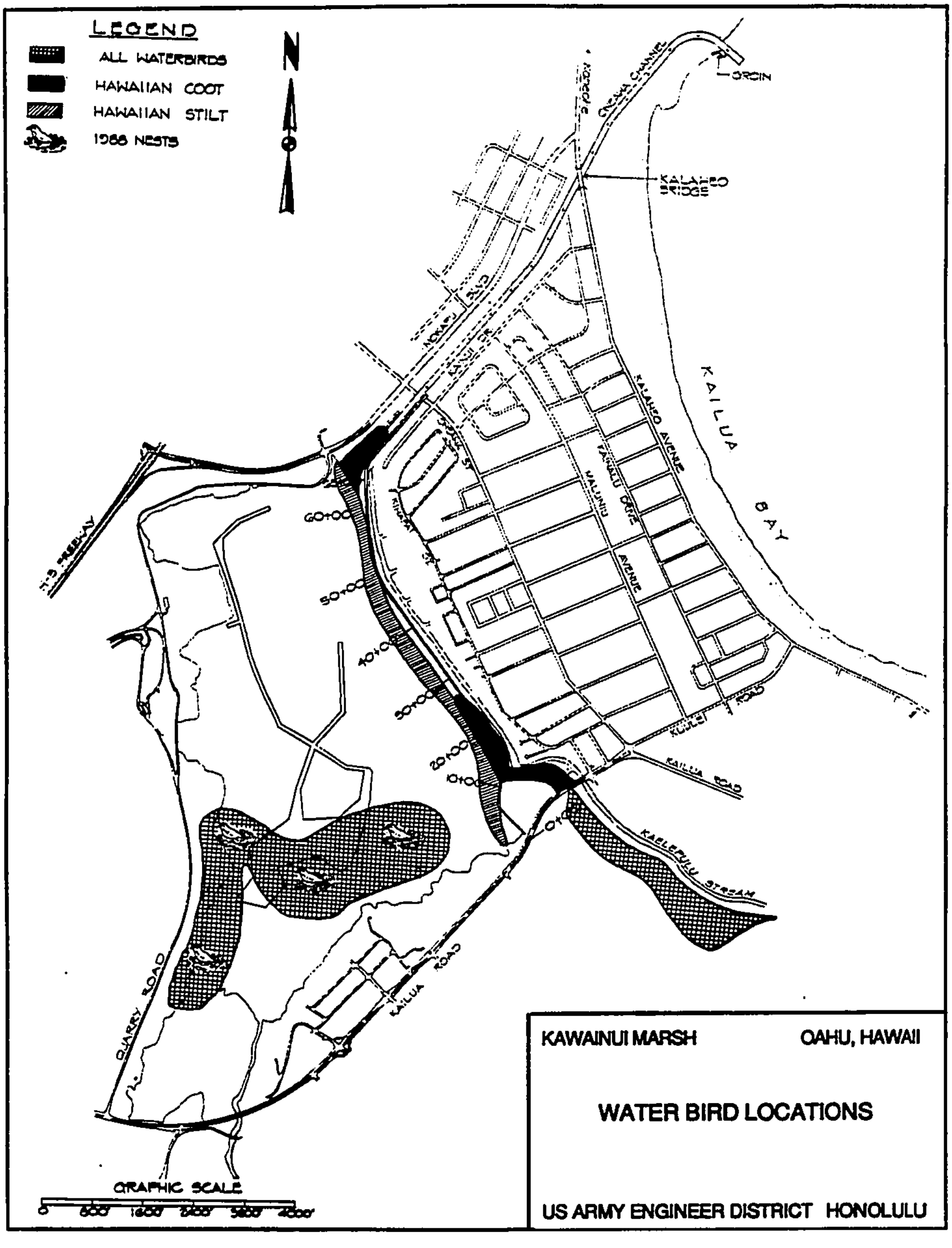
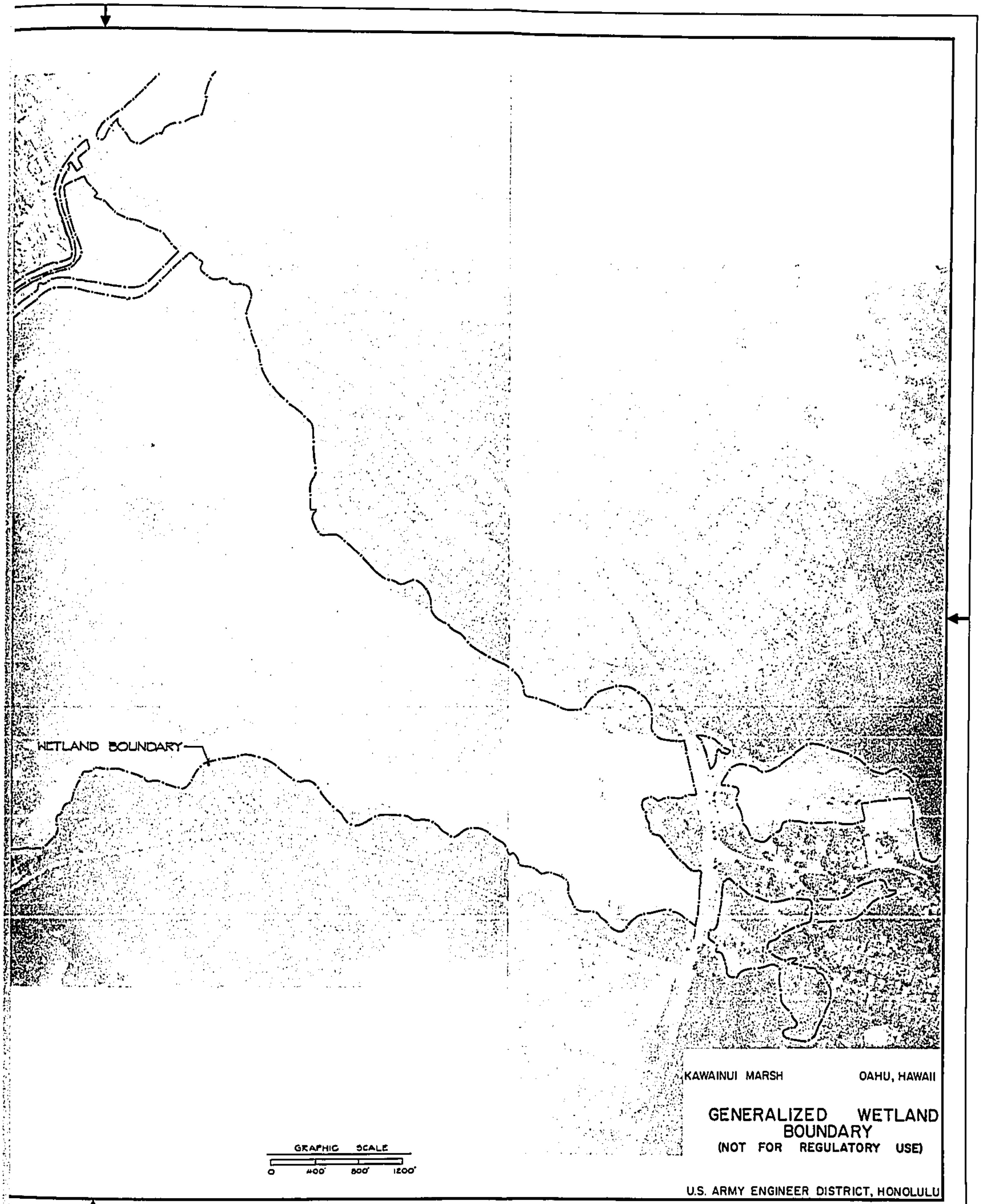

LEGEND
ALL WATERBIRDS
HAWAIIAN COOT
HAWAIIAN STILT
1988 NESTS
N
KALAHEO BRIDGE
KAILUA BAY
KAILUA ROAD
KAELEPULU STREAM
QUARRY ROAD
GRAPHIC SCALE
KAWAINUI MARSH
OAHU, HAWAII
WATER BIRD LOCATIONS
US ARMY ENGINEER DISTRICT HONOLULU

FIGURE 7

N
WETLAND BOUNDARY
WETLAND BOUNDARY

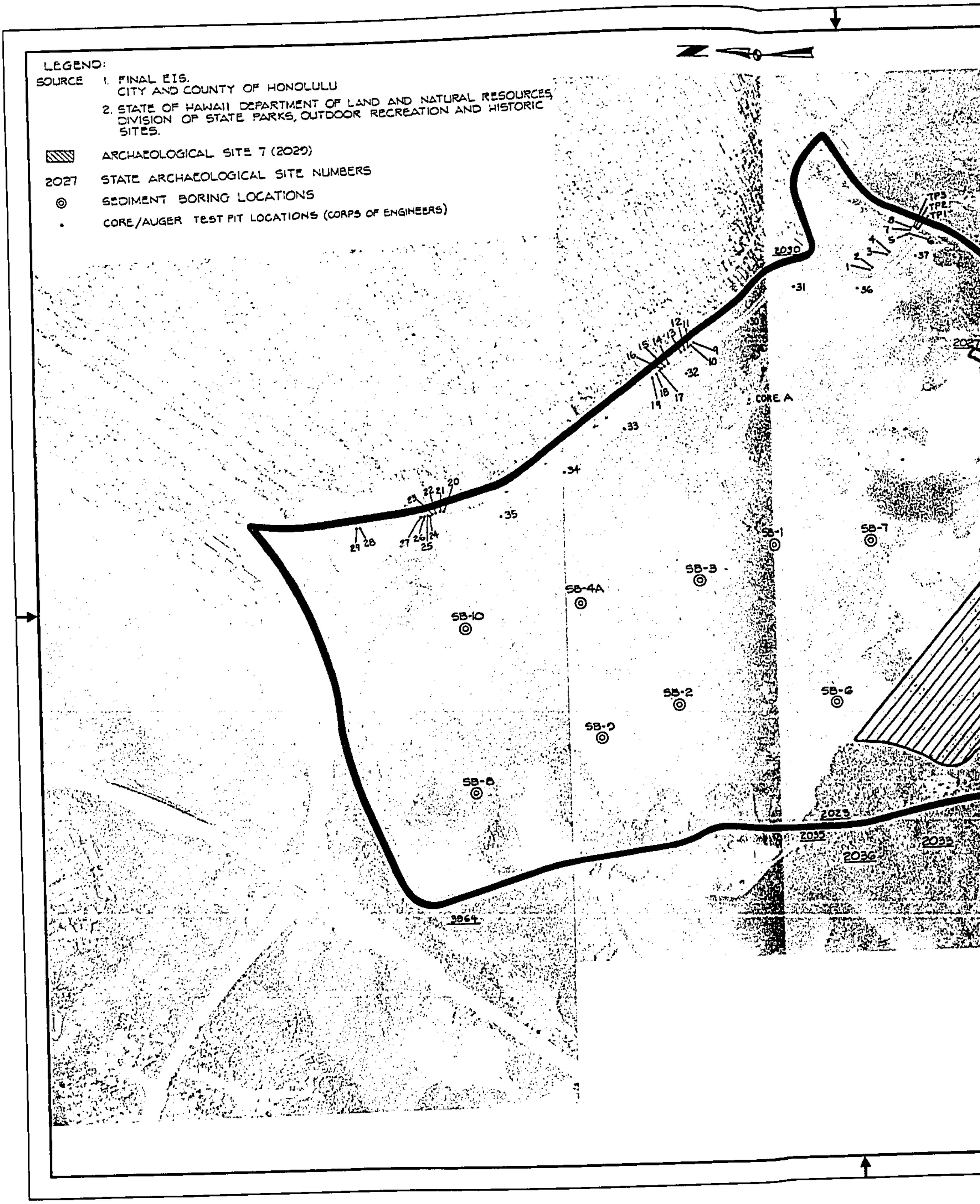


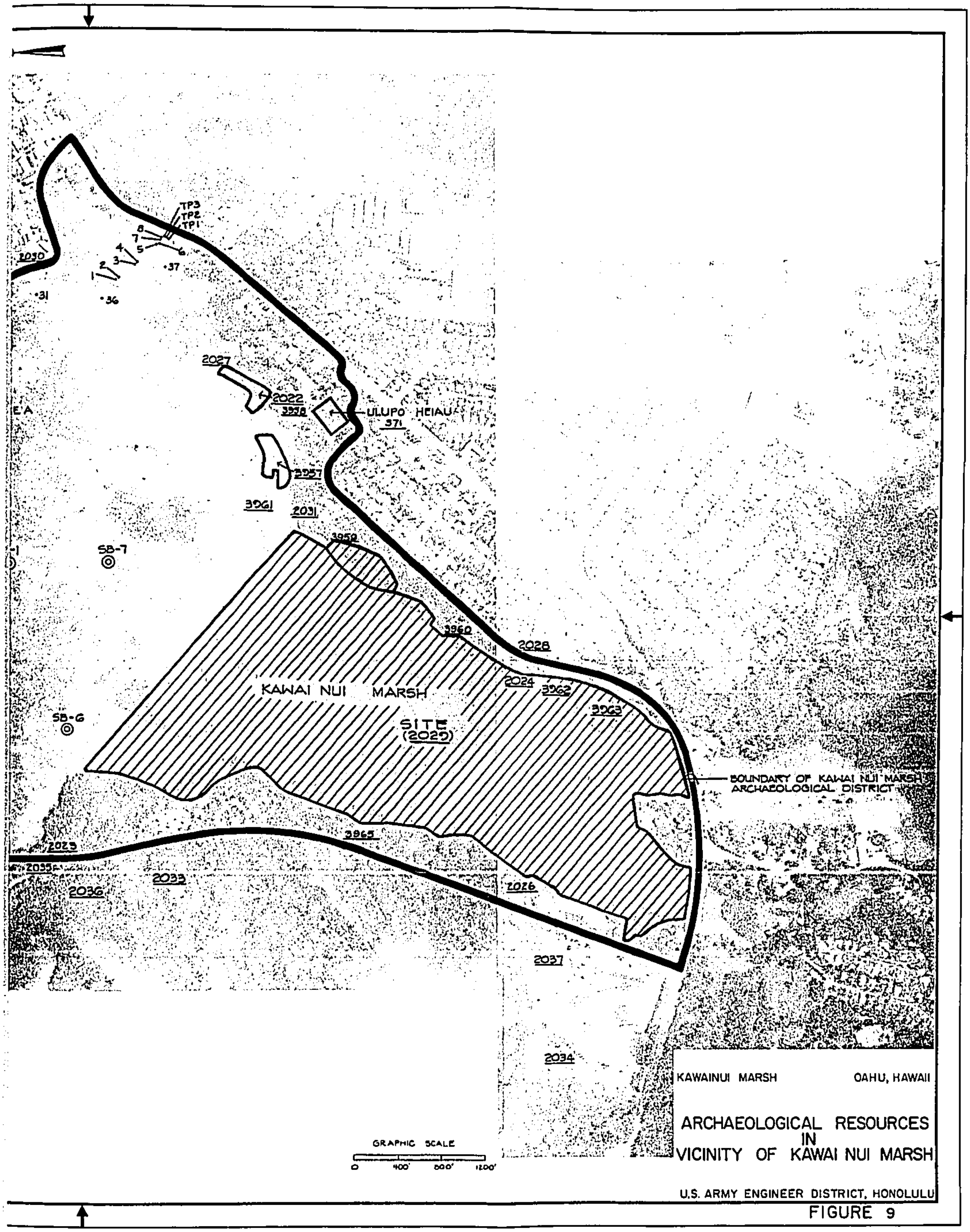
KAWAINUI MARSH OAHU, HAWAII

GENERALIZED WETLAND BOUNDARY
(NOT FOR REGULATORY USE)

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 8


LEGEND:
SOURCE 1. FINAL EIS.
CITY AND COUNTY OF HONOLULU
2. STATE OF HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF STATE PARKS, OUTDOOR RECREATION AND HISTORIC SITES.
ARCHAEOLOGICAL SITE 7 (2029)
2027 STATE ARCHAEOLOGICAL SITE NUMBERS
SEDIMENT BORING LOCATIONS
CORE/AUGER TEST PIT LOCATIONS (CORPS OF ENGINEERS)
2030
2027
2023
2035
2036
2033
3964
CORE A
SB-1
SB-2
SB-3
SB-4A
SB-6
SB-7
SB-8
SB-9
SB-10
TP3
TP2
TP1

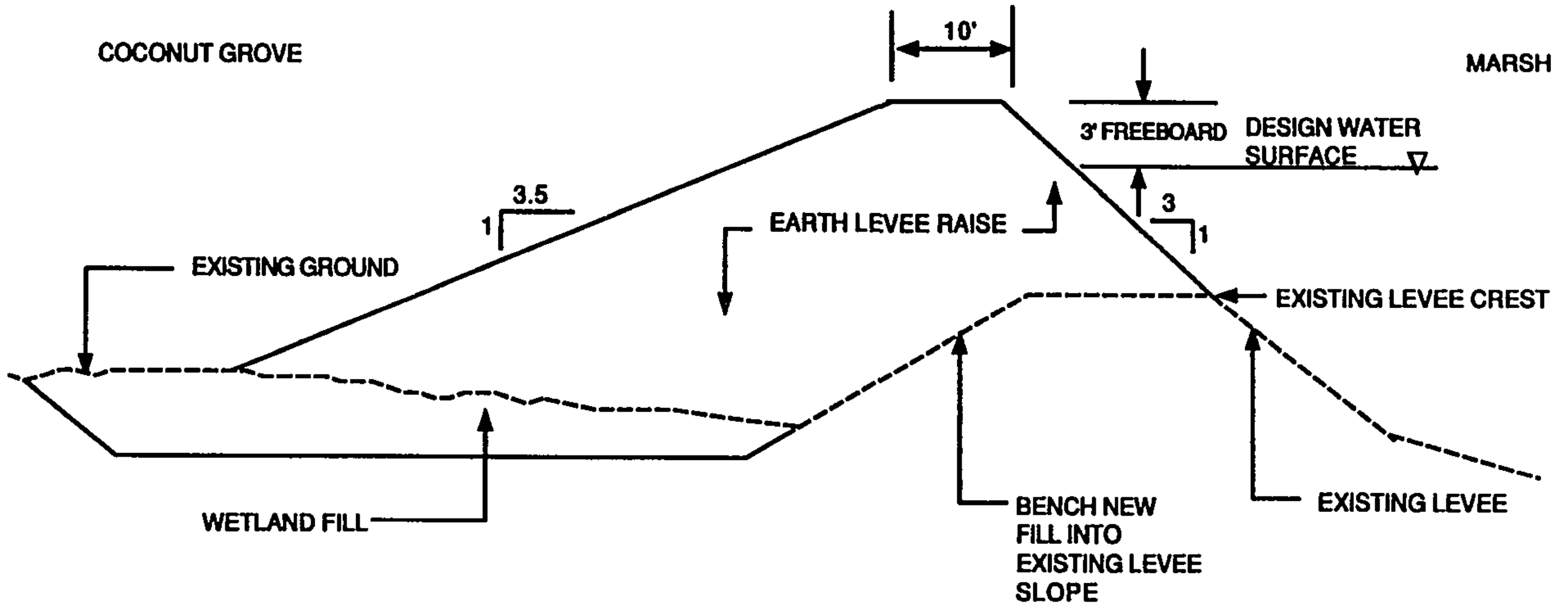


KAWAINUI MARSH OAHU, HAWAII

ARCHAEOLOGICAL RESOURCES IN VICINITY OF KAWAI NUI MARSH

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 9



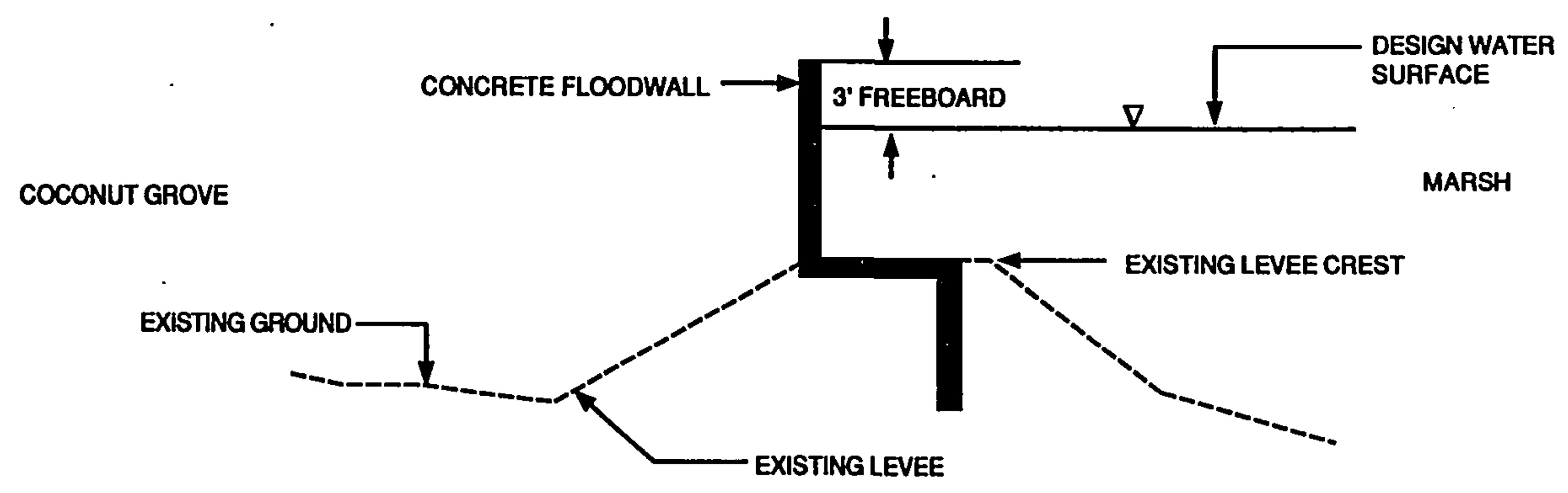
NUMBER OF ACRES OF WETLAND FILLED = 6.4

November 1991

KAWAINUI MARSH	OAHU, HAWAII
PLAN 1 LEVEE RAISE	
US ARMY ENGINEER DISTRICT	HONOLULU

FIGURE 10

FIGURE 10



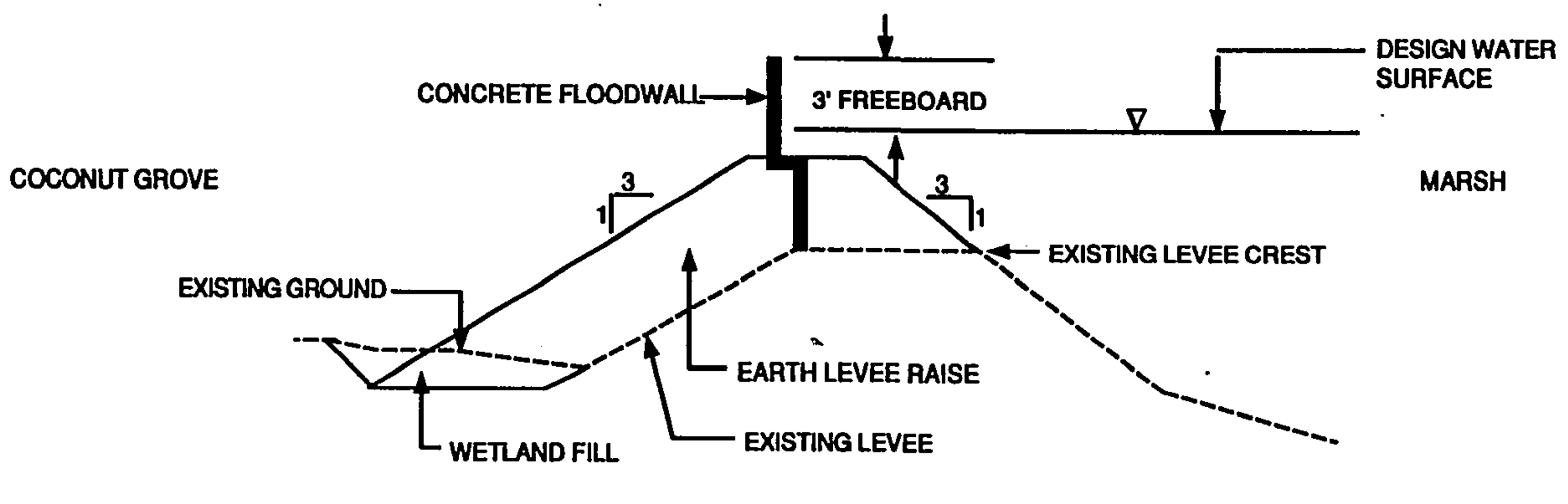
NUMBER OF ACRES OF WETLAND FILLED = 0

November 1991

KAWAINUI MARSH		OAHU, HAWAII
	PLAN 2 CONCRETE FLOODWALL	
US ARMY ENGINEER DISTRICT		HONOLULU

FIGURE 11

FIGURE 11



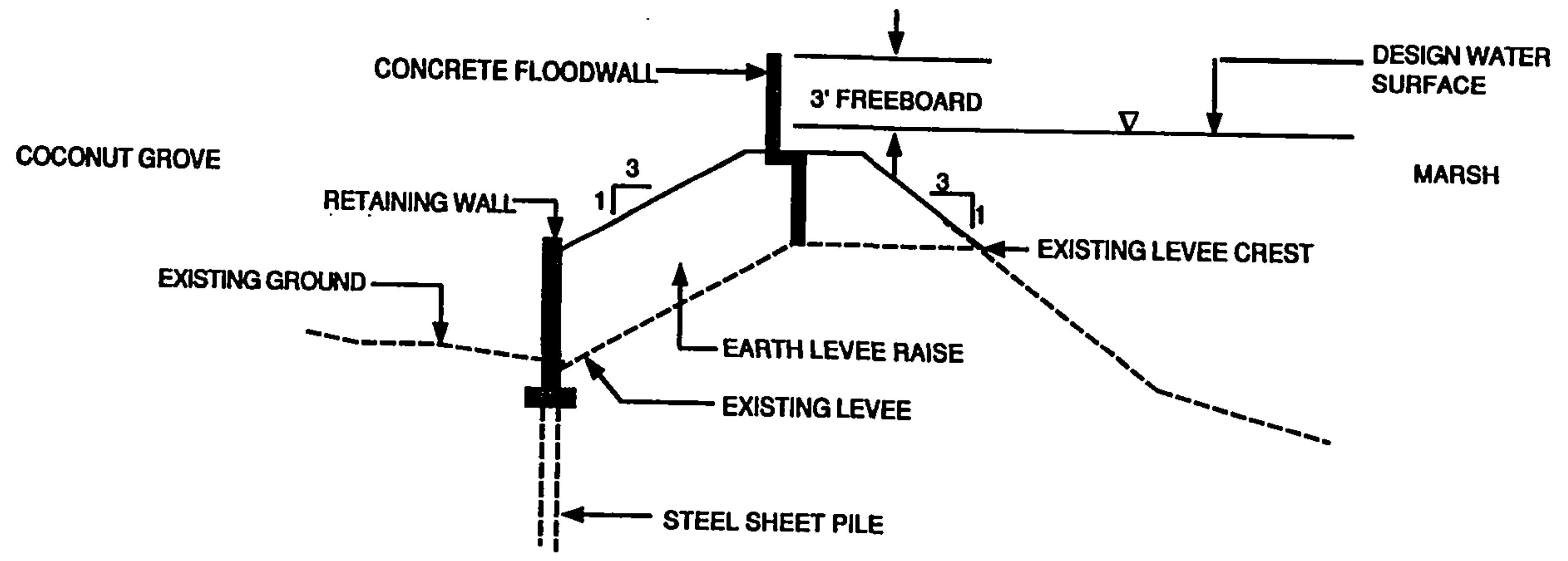
NUMBER OF ACRES OF WETLAND FILLED = 1.8

November 1991

KAWAINUI MARSH	OAHU, HAWAII
PLAN 3A COMBINATION EARTH LEVEE RAISE AND CONCRETE FLOODWALL	
US ARMY ENGINEER DISTRICT	HONOLULU

FIGURE 12

FIGURE 12



NUMBER OF ACRES OF WETLAND FILLED = 0

KAWAINUI MARSH — OAHU, HAWAII

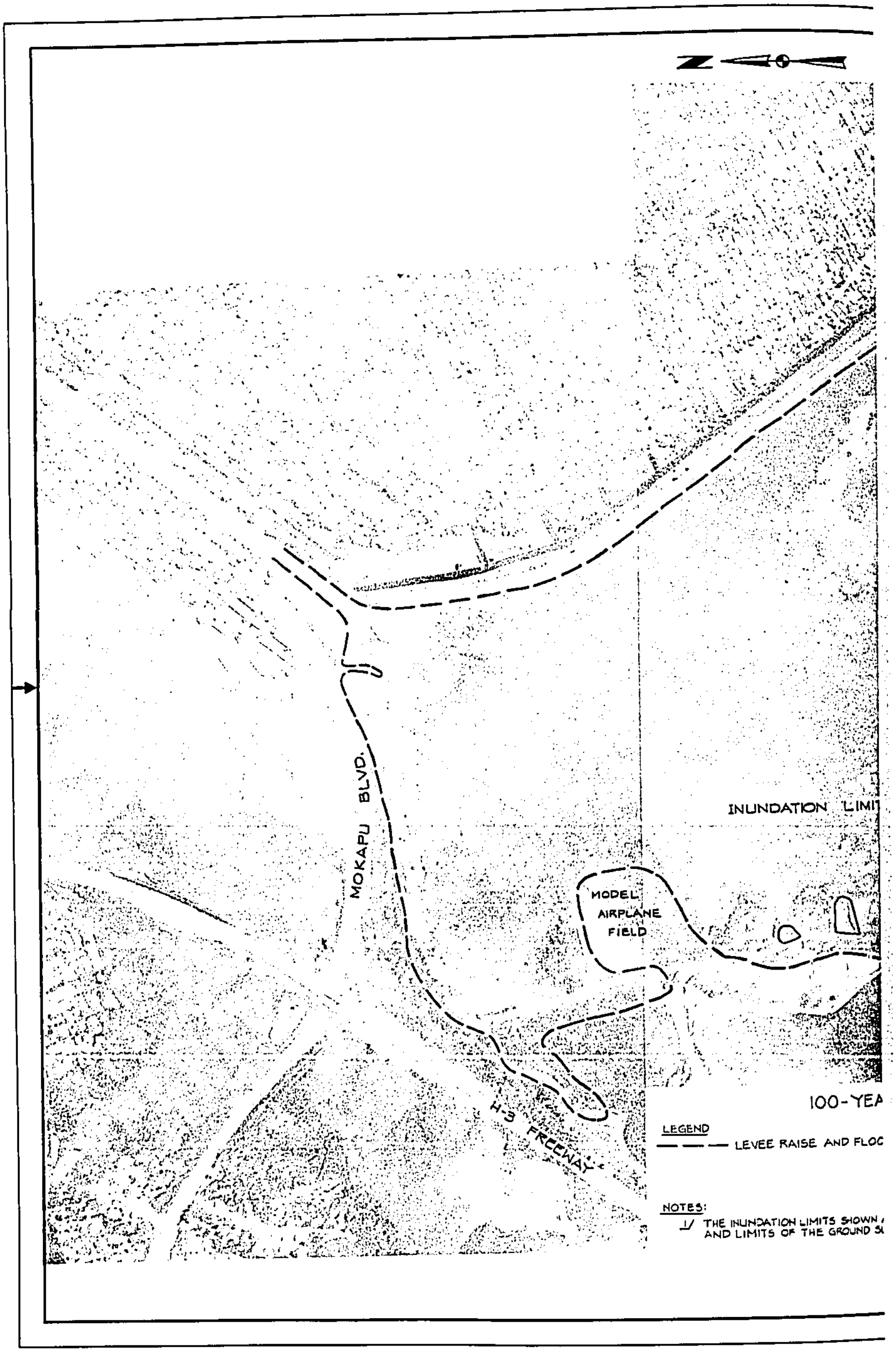
PLAN 3B
COMBINATION EARTH LEVEE RAISE
AND FLOODWALL WITH RETAINING WALL

November 1991

US ARMY ENGINEER DISTRICT — HONOLULU

FIGURE 13

FIGURE 13



MOKAPU BLVD.
INUNDATION LIMIT
MODEL AIRPLANE FIELD
H-3 FREEWAY
100-YEA
LEGEND
LEVEE RAISE AND FLOC
NOTES:
1/ THE INUNDATION LIMITS SHOWN
AND LIMITS OF THE GROUND S

CORRECTION

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

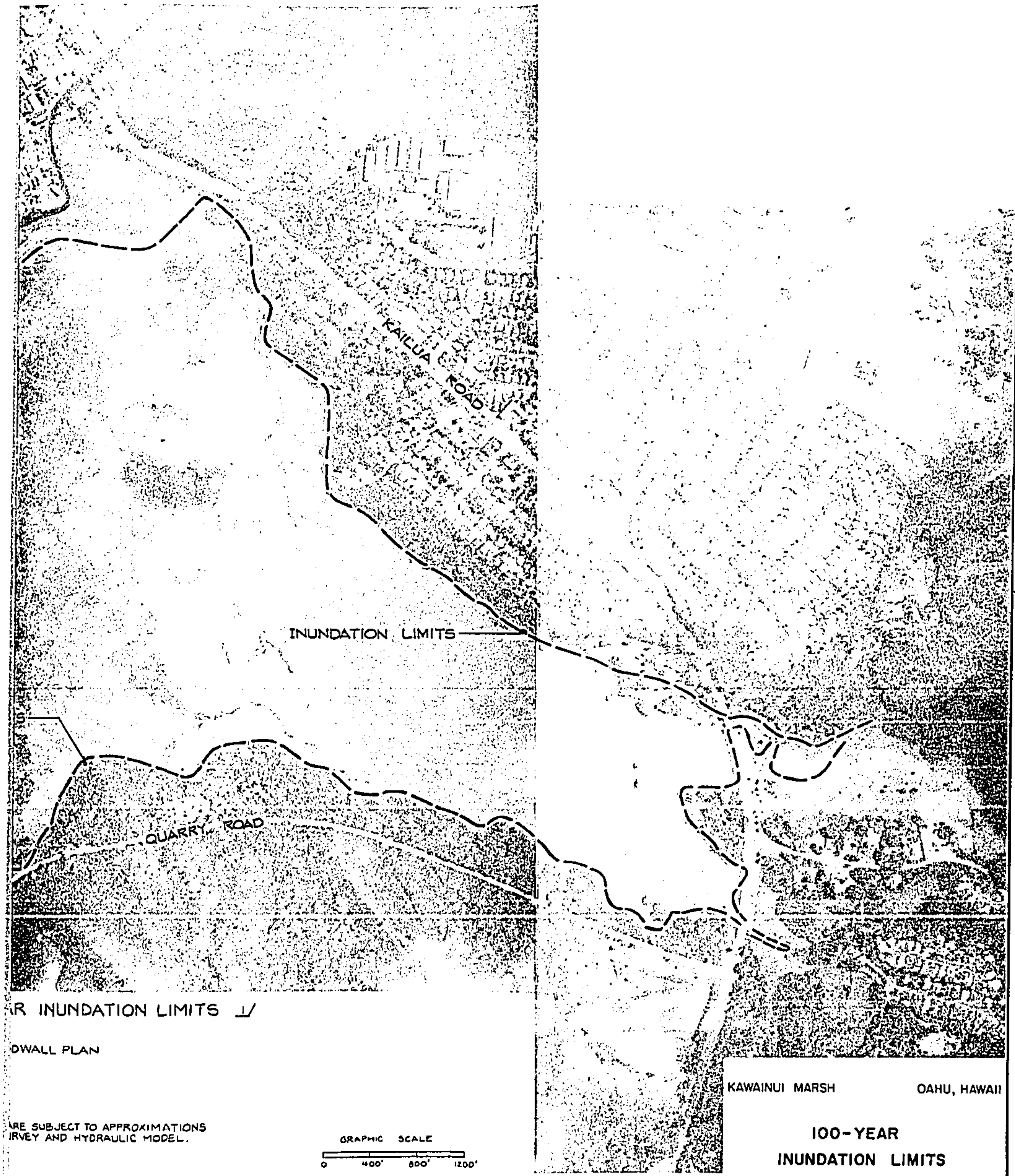
100-YEAR INUNDATION LI

LEGEND

— — — LEVEE RAISE AND FLOODWALL PLAN

NOTES:

1/ THE INUNDATION LIMITS SHOWN ARE SUBJECT TO APPROXIMAT
AND LIMITS OF THE GROUND SURVEY AND HYDRAULIC MODE



R INUNDATION LIMITS 1/

DWALL PLAN

ARE SUBJECT TO APPROXIMATIONS
IRVEY AND HYDRAULIC MODEL.

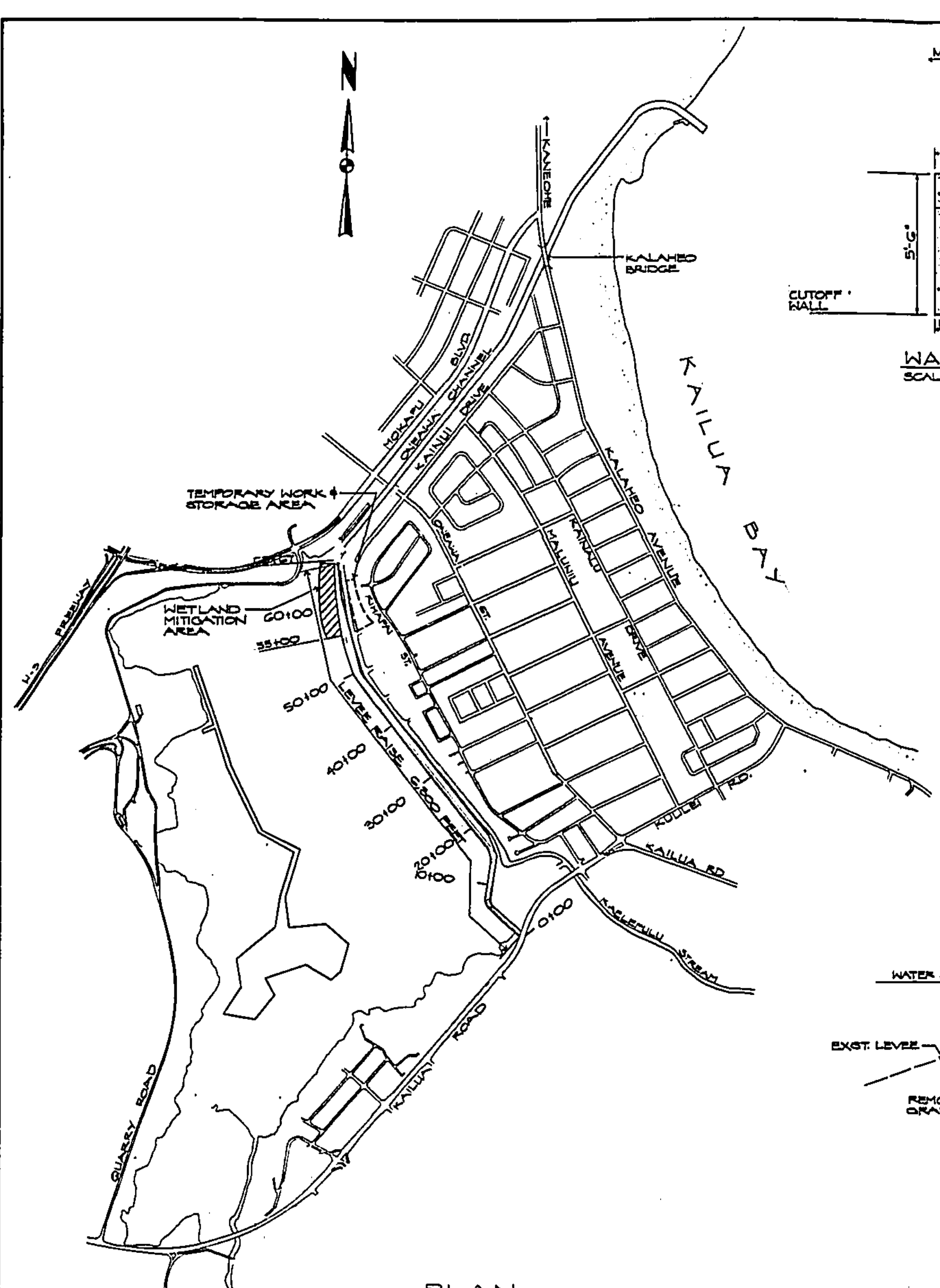
GRAPHIC SCALE
0 400' 800' 1200'

KAWAINUI MARSH OAHU, HAWAII

100-YEAR
INUNDATION LIMITS

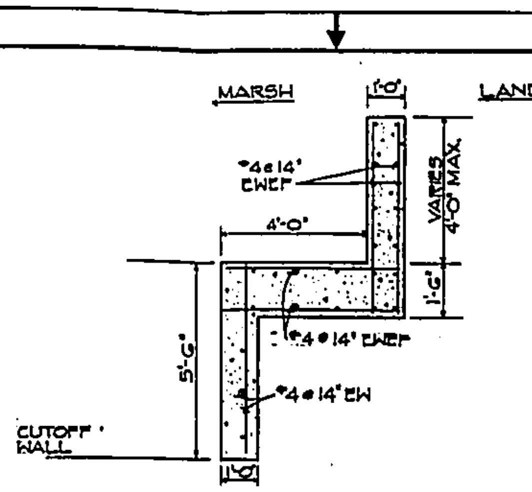
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 14

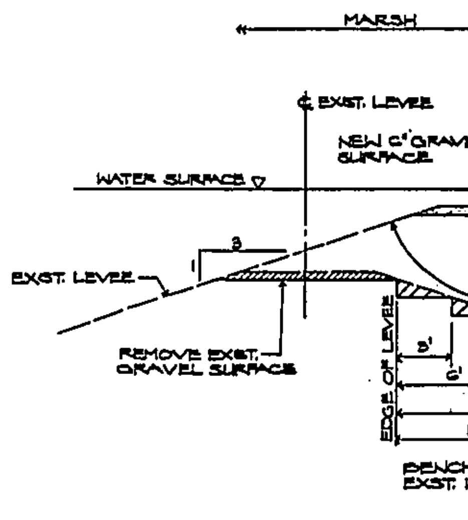


PLAN
SCALE: 1" = 800'

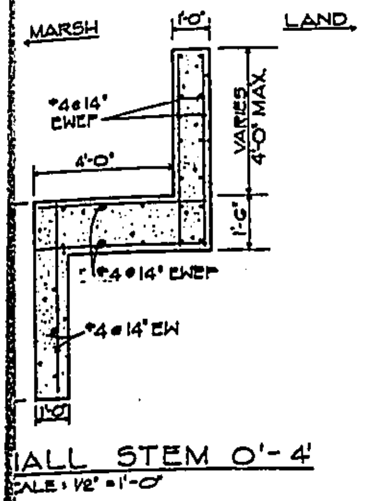
0 800' 1600' 2400' 3200'
GRAPHIC SCALE: 1"=800'

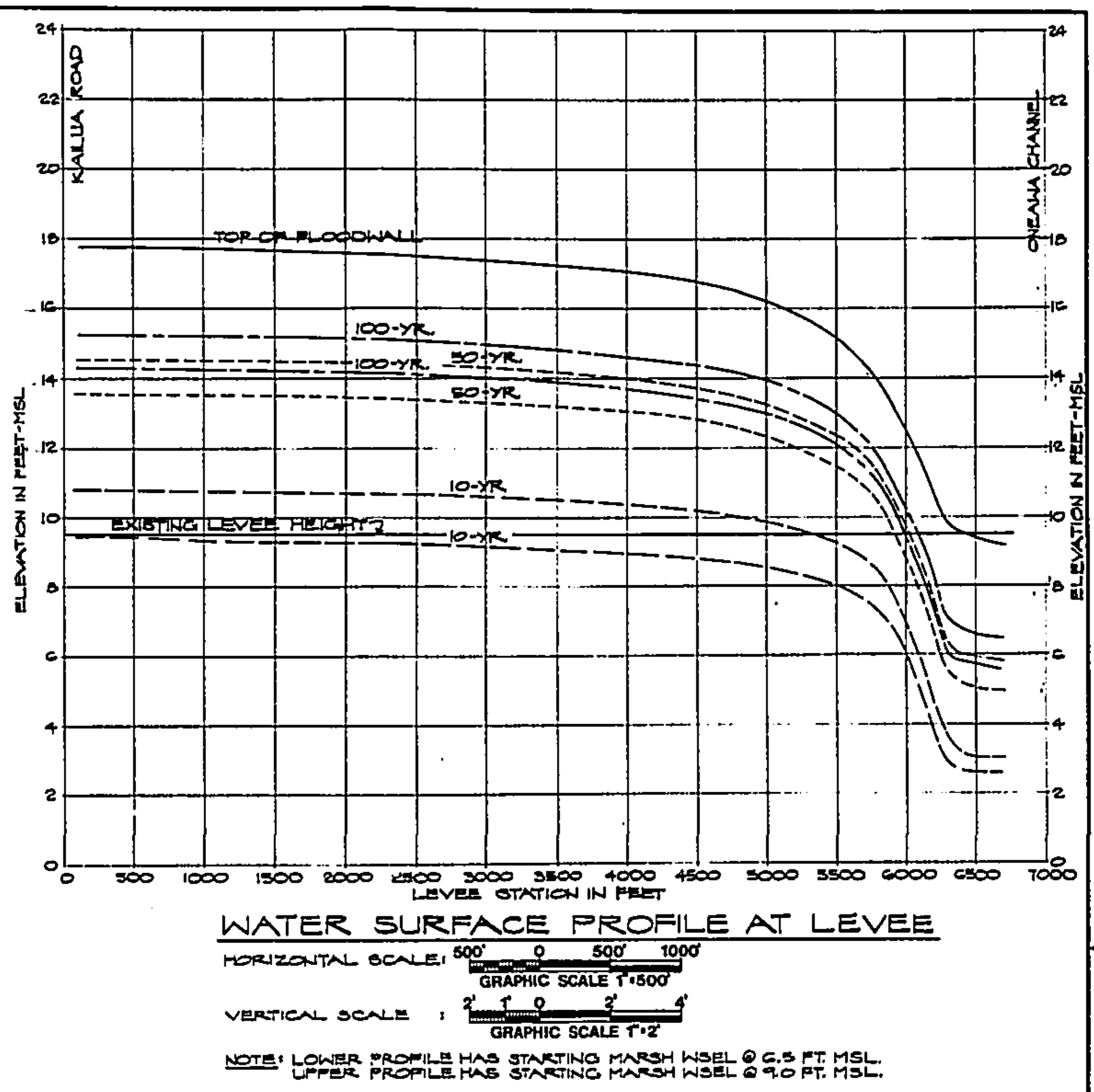


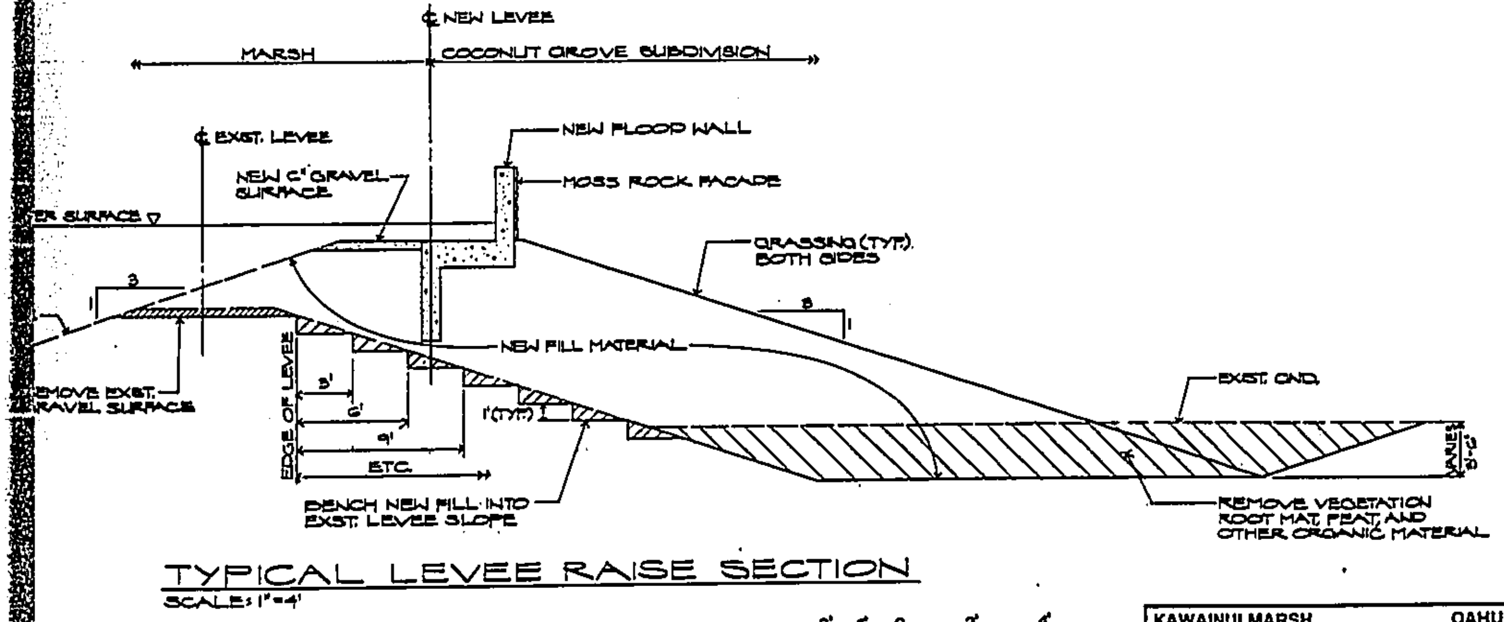
WALL STEM 0'-4'
SCALE: 1/2" = 1'-0"

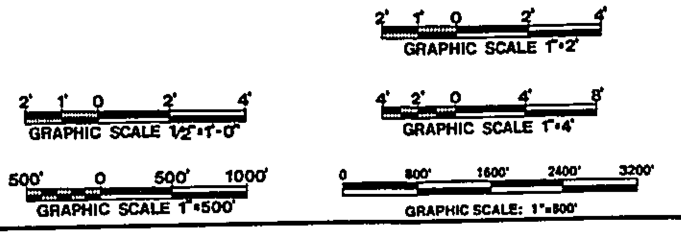


TYPICAL
SCALE: 1"=4'







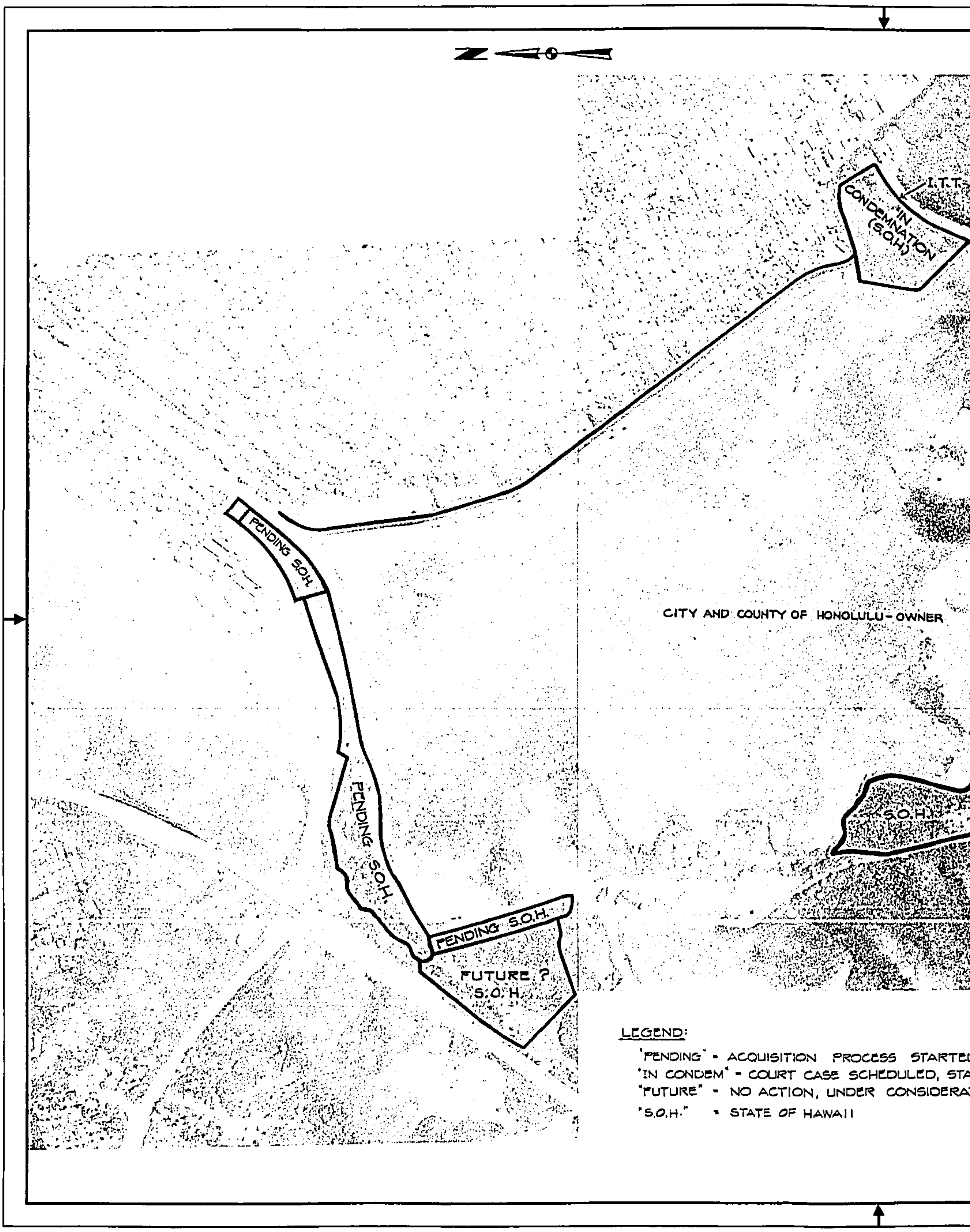


KAWAINUI MARSH OAHU, HAWAII

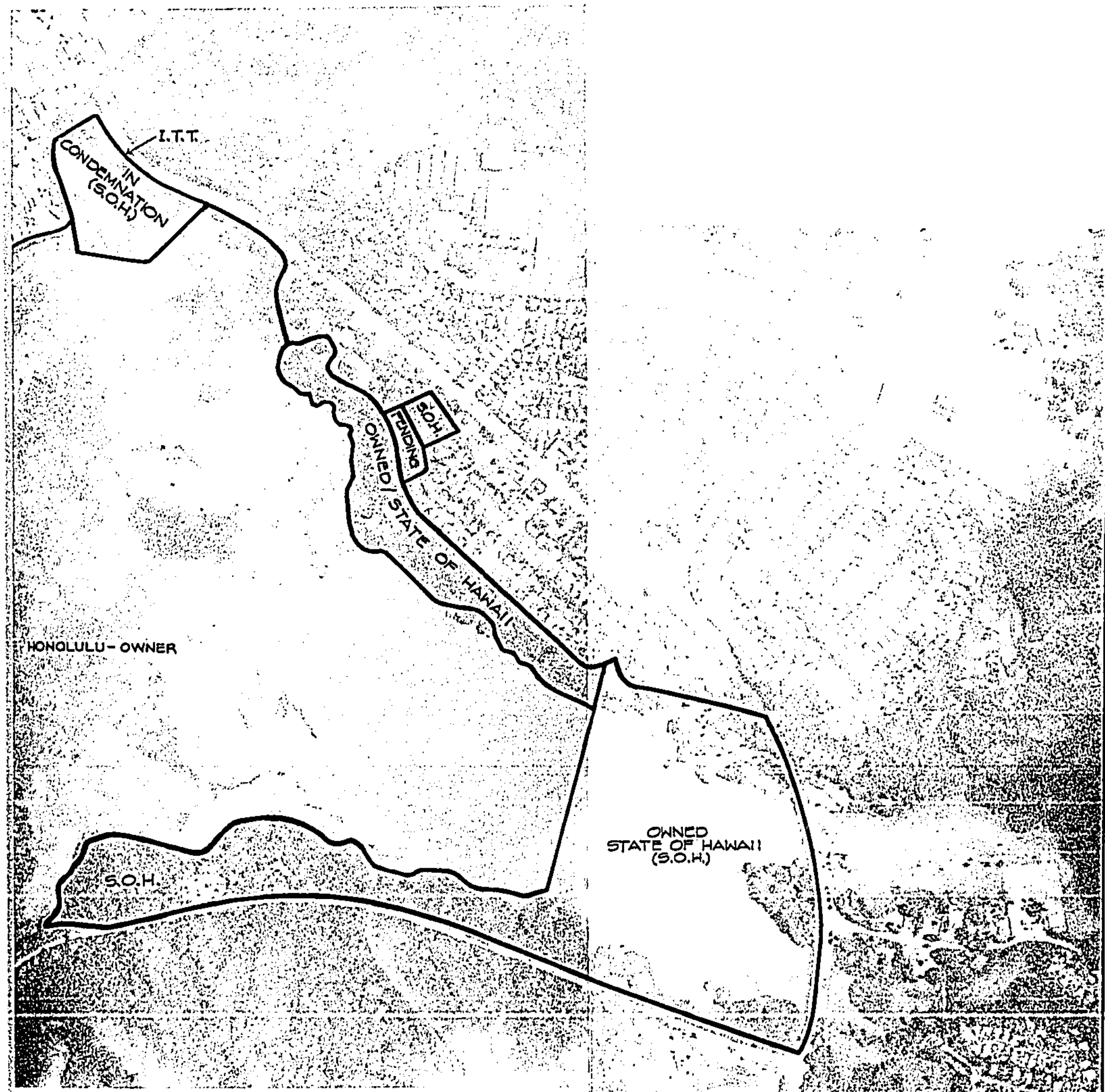
PLAN OF IMPROVEMENT

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 15



I.T.T.
IN CONDEMNATION (S.O.H.)
PENDING S.O.H.
PENDING S.O.H.
PENDING S.O.H.
FUTURE ? S.O.H.
CITY AND COUNTY OF HONOLULU - OWNER
S.O.H.
LEGEND:
"PENDING" - ACQUISITION PROCESS STARTE
"IN CONDEM" - COURT CASE SCHEDULED, STA
"FUTURE" - NO ACTION, UNDER CONSIDERA
"S.O.H." - STATE OF HAWAII



ɔN PROCESS STARTED (10/15/90)
CASE SCHEDULED, STATE HAS "POSSESSION" (10/15/90)
N, UNDER CONSIDERATION
HAWAII

KAWAINUI MARSH OAHU, HAWAII

LAND OWNERSHIP

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 16

KAWAINUI MARSH
FLOOD CONTROL PROJECT
OAHU, HAWAII

APPENDIX A - HYDROLOGY

KAWAINUI MARSH FLOOD CONTROL PROJECT
OAHU, HAWAII
APPENDIX A - HYDROLOGY
TABLE OF CONTENTS

KAWAINUI MARSH FLOOD CONTROL PROJECT
OAHU, HAWAII
APPENDIX A - HYDROLOGY
TABLE OF CONTENTS
(continued)

KAWAINUI MARSH FLOOD CONTROL PROJECT
OAHU, HAWAII
APPENDIX A - HYDROLOGY
TABLE OF CONTENTS
(continued)

LIST OF TABLES

(Tables follow page A-14)

KAWAINUI MARSH FLOOD CONTROL PROJECT, OAHU, HAWAII
APPENDIX A - HYDROLOGY
TABLE OF CONTENTS (continued)
LIST OF FIGURES
(Figures follow page A-36)

FIGURE NO.

LIST OF FIGURES
(Figures follow page A-36)

KAWAINUI MARSH FLOOD CONTROL PROJECT
HYDROLOGY APPENDIX A

1. Purpose and Scope. This hydrology report presents the results of the detailed project report hydrologic studies for the Kawainui Marsh Flood Control Project. The Hydrologic Engineering Center (HEC) participated in development of the rainfall-runoff modeling and in review of this Appendix. A thorough investigation of the runoff process and compilation of hydrologic data was made in preparing this study. The main objectives of this report were to:

a. Present the basic meteorologic and hydrologic characteristics of the study area.

b. Outline the methods and techniques used to model the rainfall-runoff process.

c. Develop design inflow hydrographs for Kawainui Marsh for use in the RMA-2V hydraulic model described in Appendix B.

d. Present interior drainage analysis for the Coconut Grove community.

2. Previous Reports.

a. 1957 Design Memo. Prior hydrology studies were discussed in the District Engineer's report "Design Memorandum, Kawainui Swamp, Oahu, T.H.", 1957. The important hydrologic parameters established in the 1957 Design Memo included the following:

(1) The total drainage area of the basin is 11.2 square miles.

(2) The Standard Project Flood (SPF) was the design flood. The SPF had a peak inflow of 18,100 cubic feet per second (cfs) into the marsh and a volume of runoff of approximately 4,000 acre-feet. The loss rate used was a constant 1.1 inches per hour. The rainfall used in calculating the SPF for a 5 hour duration was 13.3 inches.

b. 1989 Reconnaissance Report. A "Reconnaissance Report for Kawainui Marsh Flood Mitigation Project-Kailua, Oahu, HI." June 1989, established the need for this report.

3. Basin Description. The drainage area for this Kawainui Marsh project is 10.62 square miles (Figure 1), measured from the lower end of the marsh at the upper end of Oneawa Channel to the summit of the Koolau Mountain Range, and is located in Windward Oahu in the southeast sector of Oahu. The 10.62 square miles is the total drainage area contributing to marsh inflows that drain into Oneawa Channel. The major tributaries that flow into the marsh are Maunawili Stream, drainage area 5.45 square miles and Kahanaiki Stream, drainage area 1.91 square miles. Maunawili and Kahanaiki Streams join at a confluence about 2,000 feet downstream from Kalanianaole Highway in the marsh and comprise the major inflow into the marsh (about 70% of the total drainage area). The next largest tributary stream is unnamed

but for this report will be referred to as the Kapaa Quarry Stream, draining an area of 1.19 square miles. The remaining drainage areas consist of numerous small riverlets that drain into the marsh. All of these riverlets were grouped into three separate areas for use in this study. The most northerly area drains 0.20 square mile and is referred to as Stream A. The most southerly of these 3 areas is referred to as the Urban Area and drains an area of 0.45 square mile. The last of these 3 areas drains 0.33 square mile and is referred to as Stream B. The marsh itself has a surface area of 1.09 square miles. The existing levee at Kawainui Marsh was designed so that the marsh would function like a reservoir. The storage curve for the marsh, is shown on Figure 2, assuming the bottom elevation at 3.5 feet (the normal standing water level in the marsh) above mean sea level (msl), based on topographic surveys taken by Austin, Tsutsumi, and Associates in March 1988. The stream slopes are very steep in the upper portion of the basin, somewhat flatter in the central basin area and very flat through the marsh. The stream profiles for the major streams in the basin are shown on Figure 3. The maximum elevation of the basin is Konahuanui Peak, which rises 3,105 feet above mean sea level. Table A-1 summarizes the pertinent sub-basin characteristics used in this study.

4. Climatology. The following climatological data was extracted from the National Oceanic and Atmospheric Administration (NOAA) publications. Oahu, on which Kawainui Marsh is located, is the third largest of the Hawaiian Islands. The Koolau Range, at an average elevation of 2,000 feet parallels the northeastern coast. Kawainui Marsh lies in the windward side of the Koolau Range. The climate of Hawaii is unusually pleasant for the sub-tropics. Its outstanding features are the persistence of the tradewinds, the remarkable variability in rainfall over short distances, the sunniness of the leeward lowlands in contrast to the persistent cloudiness over nearby mountain crests, and the equable temperature. The prevailing wind throughout most of the year is the northeasterly trade wind. Because of the trade winds, even the warmest months are usually comfortable. The dominance of the trades mixed with the terrain highly influences the climate. Spatial and temporal distributions of rainfall are pronounced on Oahu. The cause of this variability is principally the orographic rains which form within the moist trade wind air as it moves in from the sea and passes over the steep and high terrain. But when the trades diminish or give way to southerly winds, a situation known as "kona weather" occurs in which the humidity may become oppressively high. The moderate temperature range is associated with the small seasonal variation in the energy received from the sun and the tempering effect of the surrounding ocean. The average temperature as measured at the Kailua Fire Station (see Figure 1) is about 73° F. Intense rains from the October to April winter season sometimes causes serious flash flooding. Median annual rainfall over the basin ranges from 39 inches in the lower reaches to about 110 inches at the headwaters. The median annual rainfall isohyetal map is shown on Figure 4. Active rainfall stations within the basin are shown in Figure 1 and listed in Table A-2.

5. Discharge-Frequency Curves. There is one continuous stream gage recorder in the basin, Makawao Stream, Station 2540, operated by the U.S. Geological Survey (USGS), with a drainage area of 2.04 square miles. This Makawao gage, started in 1958, is part of and within the Maunawili Stream basin (Figure 1). There is a crest-stage gage located on Maunawili Stream at Kalanianaole Highway, Station 2605 (Figure 1). This crest-stage gage (drainage area 5.34 square miles) records peak

flows only and has also been in operation since 1958. In addition, there is another crest-stage gage located on Oneawa Channel, Station 2648, Kawainui Canal at Kailua. Station 2648 is different from Station 2605 as it functions strictly as a stage gage with no discharge reported by the USGS. The period of record for Station 2648 ranged from 1957-1960, 1963-1964, and 1967-present. Discharge-frequency curves for Makawao and Maunawili Streams were determined following the procedures outlined in the Water Resources Council Bulletin No. 17B, "Guidelines for Determining Flood Flow Frequency," March 1982. The computer printout of the final results are shown on Tables A-3 to A-4 and Tables A-5 to A-6 for Makawao and Maunawili Streams, respectively. The discharge-frequency curves are shown on Figures 5 and 6 for Makawao and Maunawili, respectively. The computed curves were developed using the log Pearson Type III equation recommended by Bulletin 17B. The .05 and .95 confidence limit curves illustrate the reliability of the computed curves. Statistically, there is one chance in 20 that the true values for any given frequency is greater than that indicated by the .05 curve and one chance in 20 that it is smaller than the value indicated by the .95 curve. There are, therefore, nine chances in ten that the true value lies between the .05 and .95 confidence limit curves. The expected probability curves (recommended by Headquarters, DAEN-CWE-HY, letter dated 16 November 1978) are shown in Figures 5 and 6. The expected probability adjustment to the computed curves makes allowances for the fact that statistical analyses, because of the uncertainties that flood frequency estimates pose, are biased toward the low-side, i.e., the estimated discharges for a given frequency are generally too low for the frequencies of interest.

6. Past Storms. Severe storms have occurred in the Kawainui Marsh basin.

a. Storm of January 16, 1921. This storm produced 20.15 inches of rain at the Maunawili Ranch, Station 787, rain gage for a 24-hour period. The average rainfall over the basin was estimated at 14 inches.

b. Storm of March 26-27, 1951. The storm center passed over the island of Oahu on the morning of the 26th, reversed its direction and passed over the island again on the following day. The Maunawili Ranch, Station 787, rain gage recorded 24-hour rainfalls of 15.25 and 13.00 inches on the 26th and 27th, respectively. The average rainfall over the Kawainui Marsh drainage area during this storm was 10.23 and 9.38 inches, respectively, on the 26th and 27th.

c. Storm of February 4, 1965. A deep, low pressure trough above intensely cold and unstable air produced violent thunderstorms. Heavy rainfall on Oahu fell over the windward slopes of the Koolaus near Kahuluu, about 7 miles northwest from Kawainui Marsh. Although the rainfall amount was estimated at less than 3 inches in twenty-four hours near the marsh, the USGS Makawao Stream gage Station 2540 recorded it's peak discharge of record, 6,000 cfs.

d. Storm of December 31, 1987-January 1, 1988 (New Year's Storm). This is the storm of record. Maunawili rain gage, Station 787.1, recorded 22 inches of rain in a 24-hour period, causing flooding in many areas, including the Coconut Grove area adjacent to the existing flood control levee. Damages were estimated at more than $10 million. The flooding of Coconut Grove was caused by water overtopping the flood control levee near its southern end. Extracted from the "Post Flood Report, New Year's Eve Storm, December 31, 1987-January 1, 1988, Windward and Leeward East Oahu" Circular C119, State of Hawaii Department of Land and Natural Resources, July 1988, is a brief description of the storm. The month of December 1987 was very wet, producing large amounts of rainfall prior to the New Year's storm. Rainfall amounts were 7.9, 1.3, 1.9, 1.6, and 4.3 inches for December 12, 13, 17, 18, and 19th, respectively at raingage 787.1, Maunawili NWS. Rainfall during the day of December 31, totaled 2.1 inches prior to 3:00 p.m. Raingage Station 787.1, Maunawili NWS, recorded 15.7 inches of rain from 4:00 p.m. through 10:00 p.m. when the raingage stopped functioning. The highest one-hour rainfall intensity was 4 inches between 8:00 and 9:00 p.m. on 31 December.

e. Storm of April 4, 1989. The Maunawili raingage 787.1 recorded heavy rainfall from 1 p.m. through 10 p.m. Total rainfall during this period totaled 4.7 inches with the highest 1 hour amount of 2 inches occurring between 4 and 5 p.m.

f. Storm of April 8, 1989. The Maunawili raingage 787.1 recorded heavy rainfall from 1 a.m. through 11 a.m. Total rainfall during this period was 2.9 inches with the highest 1 hour amount of 0.6 inch occurring between 1:30 and 2:30 a.m.

7. Land Use.

a. General. The different land uses that contribute runoff to this study are: open areas consisting of preservation (forest), agricultural and a small fraction of suburban land uses, and urban areas. For this study, sub-basins which are categorized as being in the open areas include Maunawili Stream, Kahanaiki Stream, Kapaa Quarry Stream, Stream A, and Stream B (see Figure 1). The urban area (hereafter referred to) is the small residential area of 0.45 square mile also shown in Figure 1.

b. Degree of Steepness. The headwater areas are mainly very steeply sloping tropical forests containing highly permeable soils according to the report, "Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii," August 1972, by the U.S. Department of Agricultural Soil Conservation Service (SCS). At lower elevations, land uses exist on mild to steep slopes on permeable to highly permeable soils. The marsh itself is flat and is impermeable, as it is completely saturated with water.

c. Land Use Map. The existing land use map is shown on Figure 7. Currently, a 36-hole golf course is under construction. The Consultant's report (Community Planning, Inc., 1989) to the City and County of Honolulu on the golf course states that 67 acres will be directly affected by construction of the first 18 holes of the golf course. The increased runoff volume due to the 100-year flood event is estimated to be less than 10.0 acre-feet based on the Consultant's report. This increase in runoff volume is insignificant when compared to the 7,600 acre-feet calculated to inflow into the marsh for the 100-year event for this project. Increased urbanization within the watershed can have a significant impact on runoff for the projected future (without) condition as well as for project conditions. Hydrologic analysis for future without condition as well as for project conditions included consideration of projected basin development including the golf courses (see Figure 8). Based on the latest adopted plan of development by the County, no further urbanization is planned for the future. Therefore, the future without condition and project condition is the same as the existing condition.

8. Determination of Rainfall-Runoff Relationships.

a. Unit Hydrograph Analysis. A unit hydrograph is a hydrograph resulting from 1-inch of direct runoff from rainfall of a specific unit duration and areal distribution. The unit hydrograph concept is a useful tool in that it provides a linear description of runoff from a watershed and facilitates the generation of synthetic flood hydrographs for basins which are ungaged. The procedure used for determination of synthetic unit hydrographs was derived from Snyder's unit hydrograph relations outlined in EM 1110-2-1405 (Flood-Hydrograph Analyses and Computations). The unit hydrograph method was used to derive necessary hydrologic parameters for use in this study. The base gage used was USGS streamgage Station 2540, Makawao Stream. The unit hydrograph parameters derived from calibration from the base gage were then transferred to the Maunawili Stream sub-basin, Kahanaiki Stream sub-basin, Kapaa Quarry Stream sub-basin, Stream A sub-basin, and Stream B sub-basin using Snyder's synthetic unit hydrograph procedures.

b. Basic Data Used. The Makawao Stream gage, Station 2540, and the Maunawili raingage, Station 787.1, was used for unit hydrograph derivation since these gages are within the study basin and had complete data. Three storm events were chosen for unit hydrograph derivation. The three storm events were the December 31, 1987, April 4, 1989, and April 8, 1989 events. These events were selected because the rainfall and runoff data were complete and are considered to be typical for this basin.

c. HEC-1 Computer Program. The HEC-1 Flood Hydrograph Package computer program was used to calculate unit hydrograph and loss rates for use in this study. HEC-1 has the capability to determine unit hydrograph and loss rate parameters that "best" reconstitute an observed runoff event for a basin given the basin average rainfall and observed runoff. The "best" reconstitution is considered to be that which minimizes the weighted square deviations between the observed hydrograph and a reconstituted hydrograph.

d. December 31, 1987 (New Year's) Event.

(1) The USGS provided the record of stream discharge for the Makawao gage for the December 31, 1987 event (see Table A-7). The rainfall record for the Maunawili raingage, Station 787.1, was provided by the State of Hawaii Department of Land and Natural Resources Division of Water and Land Development and is published in the 1988 Post Flood Report (see Table A-8). The Maunawili raingage recorded 15.7 inches of rainfall from 4 p.m. through 10 p.m. Unfortunately, the recorder stopped after 10 p.m. The amount of rainfall after 10 p.m. was estimated using a nearby recording raingage, Luluku NWS, Station 781.7, (see Table A-8). As shown on Table A-8, the contributing rainfall for the December 31, 1987 event occurred in the eleven hour period from 4 p.m. to 3 a.m., January 1, 1988 and totaled

18.7 inches for the Maunawili raingage. This rainfall amount and distribution was used for the December 31, 1987 unit hydrograph HEC-1 run.

(2) Based on the 24-hour rainfall isohyetal map from the 1988 Post Flood Report (see Figure 9), the 24-hour average rainfall for the December 31, 1987 storm for Makawao stream gage, Station 2540, was calculated at 21.97 inches. Similarly, the 24-hour average rainfall calculated for the other sub-basins were 21.24 inches for Maunawili, 19.81 inches for Kahanaiki, 13.57 inches for Kapaa Quarry, 8.13 inches for Stream A, 12.63 inches for Stream B, 11.64 inches for the Urban Area, and 9.93 inches for the marsh.

(3) Using Makawao watershed as the base, rainfall for the other sub-basins within the study area was calculated to reproduce the amount and distribution in the 11-hour period from 4 p.m. on December 31, 1987 through 3 a.m. on January 1, 1988 for use in the HEC-1 unit hydrograph model. Thus, 11-hour rainfall amounts for the other sub-basins were reduced from that used for Makawao, 18.7 inches, based on the ratio (correction factors) of the 24-hour average rainfall between Makawao and the other sub-basins. The rainfall distribution correction factors calculated were 0.97, 0.90, 0.62, 0.37, 0.57, 0.53, and 0.45 for the Maunawili sub-basin, Kahanaiki sub-basin, Kapaa Quarry sub-basin Stream A sub-basin, Stream B sub-basin, Urban Area sub-basin, and the Marsh sub-basin respectively. The corresponding 11-hour rainfall amounts were calculated to be 18.2, 16.8, 11.6, 7.0, 10.6, 10.0, and 8.4 inches respectively for Maunawili, Kahanaiki, Kapaa Quarry, Stream A, Stream B, Urban Area, and the Marsh.

e. April 4 and April 8, 1989 Events. The rainfall-runoff data for the April 4, 1989 and April 8, 1989 events were extracted from the report "Final Environmental Impact Statement, Kawainui Marsh Flood Damage Mitigation Project," June 1990, prepared for the City and County of Honolulu by M&E Pacific, Inc., Consulting Engineer, and are shown on Tables A-9 and A-10, respectively. The rainfall-runoff information were inputted into the HEC-1 program to determine unit hydrograph and loss rate parameters.

9. Determination of Basic Unit Hydrograph Parameters and Loss Rates.

a. Results from Reconstitution. The results of the HEC-1 reconstitution of the December 31, 1987, April 4, 1989, and April 8, 1989 storm events are shown on Figures 10, 11, and 12 respectively. As shown in Figures 10-12, the comparison between the observed flow and that of the HEC-1 reconstituted flow as a whole were very good. The April 4, 1989 event, Figure 11, shows the observed peak discharge and the observed peak rainfall burst occurring concurrently, probably because of timing errors, instead of the usual case in which the rainfall occurs much sooner than the peak discharge. Because of this, the April 4, 1989 event was not used in determining Snyder's unit hydrograph parameters (lag time and peaking coefficient) but was used in determining loss rates. Snyder's lag time is defined as the time from the midpoint of the unit rainfall duration to the peak of the unit hydrograph.

b. Snyder's Unit Hydrograph Parameters.

(1) A summary of results from the HEC-1 computer runs displaying the unit hydrograph parameters and loss rates for Makawao Stream are shown on Table A-11 for the December 31, 1987, April 4, 1989, and April 8, 1989 events. As shown on Table A-11, there is a wide disparity between the lag time (t_p) determined for the December 1987 event, 1.48 hours, and the April 8, 1989 event, 0.4 hour. The lag time for the December 31, 1987 event is unreasonably high compared to past studies done on Oahu (i.e., the Kaneohe-Kailua Flood Control Study, 1972, which had a lag of about 0.4 hour). This basin is adjacent to the Kawainui Marsh project. Consequently, the lag time of 0.4 hour determined for the April 8. 1989 event (Table A-11) was used as the lag time for Makawao Stream, Station 2540, drainage area 2.04 square miles.

(2) The Snyder's peaking coefficient, C_p, for Makawao Stream was determined as an average value equal to 0.35 based on the December 31, 1987 event and the April 8, 1989 event (Table A-11). The other Snyder's peaking coefficient, C_t, was calculated to be 0.29 for Makawao Stream based on Snyder's formula in which C_t equals the lag (t_p) divided by $(L \times L_{ca})^3$ where L is the stream length of 2.8 miles and L_{ca} is the length to the centroid, 1.1 miles (see Table A-1).

c. Lag Time for Other Sub-basins. Using Snyder's synthetic unit hydrograph procedures, *the lag time,* t_p, *was calculated* for other sub-basins within the study area. With Makawao Stream as the base station, lag time (tp) of 0.4 hour, peaking coefficient (C_p) of 0.35 and peaking coefficient (C_t) of 0.29, the results from Makawao Stream were then transferred to the other sub-basins. The lag times for the other sub-basins were calculated using Snyder's formula in which the lag time, t^P, equals C_t times $(L \times L_{ca})^3$. See Table A-1 for the L and L_{ca} for the other sub-basins for substitution into the equation. The lag times (t_p) calculated for Maunawili Stream, Kahanaiki Stream, Kapaa Quarry Stream, Stream A, and Stream B were 0.59 hour, 0.34 hour, 0.33 hour, 0.12 hour, and 0.17 hour, respectively, based on the above equation.

10. Determination of Loss Rates for Use in Design Floods. Loss rates were determined based on analysis of both observed runoff hydrographs and calibration to peak-discharge frequency curves to make maximum use of available data. The loss rates from the observed hydrographs, Table A-11, were used to place an upper bound on the loss rates that were determined from the frequency curves. The upper bound was employed because the frequency curves are not a perfect indicator of loss rates. Adjustments to the initial and constant loss rates were made to account for initial moisture conditions (i.e., the initial amount of water in the soil profile) to reproduce a frequency curve estimated from systematic observed peak discharges with a HEC-1 generated frequency curve.

a. Constraints. The adjustment of the loss rates had certain constraints. For one, the systematic flood frequency curves estimated from the gages were developed and influenced by statistical samplings, model specifications and flow measurements. Given these limitations of calibrating to the systematic flood frequency curves, loss rates were adjusted so that the HEC-1 generated frequency curves were within the 5%

and 95% confidence limits and the adjustments were also kept commensurate with the loss rates values shown in Table A-11.

b. Makawao Stream. The loss rates were adjusted from an initial loss of 0.7 inch and a constant loss of 0.7 inch/hour to an initial loss of zero and a constant loss of 0.2 inch/hour to reproduce the discharge-frequency curves at both Makawao and Maunawili gages. The reduction in loss rates is interpreted as a change in antecedent moisture conditions from relatively dry conditions for frequent floods to relatively wet conditions for rare floods. The unit hydrograph parameters used were a peaking coefficient, CP = 0.35 and a lag time of 0.4 hour discussed previously. A comparison of the HEC-1 generated and systematic flood frequency curve for the Makawao gage is shown in Figure 13 and the loss rates used for each return period is shown in Table A-12. The resulting peak discharges agreed reasonably well with the frequency curve estimated from gage data, except the 2-year event which slightly exceeded the value from that of the confidence limit.

c. Maunawili Stream. The reproduction of the frequency curve at the Maunawili gage (see Figure 14) had more significance since it comprised a major portion of the watershed (drainage area about 5.34 square miles). The loss rates shown in Table A-12 were used in the HEC-1 model in determining how well the estimated frequency curve at Maunawili would be reproduced.

(1) A HEC-1 sub-basin model was developed for the drainage area above the Maunawili gage based on the parameters estimated from the Makawao gage (Table A-11). The loss rates were assumed to be the same for both the Makawao and Maunawili basins, as was Snyder's peaking coefficient, as both basins have similar hydrologic characteristics. Using the results obtained for lag of 0.4 hour and a c^t of 0.29, the corresponding lag for the drainage above Maunawili was calculated to be 0.59 hour based on Snyder's synthetic unit hydrograph formulas.

(2) The comparison between the HEC-1 computed and the systematic observed frequency curves at the Maunawili gage shown in Figure 14 was very good and even better than the results for the Makawao gage, particularly at the higher return intervals (i.e., lower exceedance frequencies). The resulting peak discharges were all within the confidence limits except the 2-year which slightly exceeded it. The calibration at the 2-year event could have been improved by increasing the loss rate but this would have exceeded the upper bound on the loss rates determined from calibration to the observed hydrographs.

d. Summary. In summary, loss rates were determined based on analysis of both observed runoff hydrographs and calibration to peak-discharge frequency curves. The loss rates for the 2-year, 10-year, 50-year, and 100-year design floods were determined by reproducing the frequency curves estimated from observations at the Makawao and Maunawili stream gages as shown in Table A-12. Adjustments to the loss rates were made until a reasonably good match between the HEC-1 generated discharge-frequency curves were achieved with that of the observed discharge-frequency curves. A reasonably good match was achieved using a uniform loss rate of 0.20 inch per hour for the 50-year and 100-year frequencies, and an initial and constant loss rate of 0.7 inch and 0.7 inch/hour respectively for the 10-year frequency.

For the 2-year frequency, an initial loss of 0.70 inch and a uniform loss rate of 0.70 inch per hour produced adequate results. Thus the loss rates mentioned above and summarized in Table A-12 were used to calculate the 2-year, 10-year, 50-year, and 100-year design floods.

11. Design Storm Rainfall

a. General. Since the marsh has storage capacity (Figure 2), a long storm rainfall duration of 24-hours was used to represent the duration of the design storm rainfall used for this study. When projects involve flood storage, flood volumes rather than peak discharges becomes the dominant hydrologic parameter. Thus, for this project, emphasis is placed on flood volumes rather than peak discharges.

b. 24-hour Rainfall. Twenty-four hour rainfall depth duration curves were determined for the 10.62 square miles Kawainui Marsh drainage basin. Rainfall publication "Rainfall Frequency Study for Oahu," Report R-73, 1984, State of Hawaii, Department of Land and Natural Resources, Division of Water and Land Development, was used to derive the 2-year, 10-year, 50-year, and 100-year storm rainfalls. Figure 15 shows the 24-hour rainfall depth duration curves. Twenty-four hour rainfall amounts for the 2-year, 10-year, 50-year, and 100-year events are 6.7 inches, 10.9 inches, 15.1 inches, and 16.1 inches, respectively.

12. Urban Area

a. General. The Urban Area, as discussed in Paragraph 7, is the small drainage area, 0.45 square mile, that drains the residential subdivisions (Pohakupu area) shown in Figure 1. A different hydrologic model in the HEC-1 program was used to determine runoff for the Urban Area instead of the unit hydrograph model used for the Maunawili Stream sub-basin, Kahanaiki Stream sub-basin, Kapaa Quarry Stream sub-basin, Stream A sub-basin, and Stream B sub-basin. A different model was used to determine the inflows into the Marsh from the Urban Area because of the obvious differences in land use compared to the other sub-basins. Runoff from the Urban Area was determined by using the SCS curve number technique to compute loss rates and runoff excess and the kinematic wave model to route the runoff excess to the sub-basin outlet as described in the HEC-1 program user's manual.

b. Kinematic Wave Model. Basically the kinematic wave model requires information on the roughness and slopes for land surfaces, drainage pipes and streams. From this information, a connection of kinematic wave elements consisting of two overland flow planes, a collector channel and a main channel were used to represent runoff from the Urban Area sub-basin. One overland flow plane was used to represent runoff from the previous area (i.e., lawns) and a second for the impervious area (i.e., roads and driveways). A collector channel represented the major street drainage pipes. A main channel represented the major conveyance that enter the marsh. The data used in the kinematic wave model and the SCS curve number technique are shown in Table A-13. The resulting flood hydrographs for the 2-year, 10-year, 50-year, 100-year, SPF, and New Year's flood from the Urban Area are shown in Figures 16 and 17.

13. Synthesis of Standard Project Flood.

a. General. The standard project flood represents the flood that would result from the most severe combination of meteorologic and hydrologic conditions considered reasonable characteristic of the region. It normally is larger than any past recorded flood in the area and can be expected to be exceeded in magnitude only on rare occasions. It thus constitutes a standard for design that will provide a high degree of flood protection.

b. Standard Project Storm (SPS). The SPS rainfall was obtained from OCE Memorandum for Record, "Standard Project Storm Determinations, Hawaiian Islands," 19 September 1962. The index rainfall for the Kawainui Marsh basin is 27.2 inches in 24 hours. Rainfall depth values were computed by applying percentages extracted from the above memorandum based on drainage area and storm period to the rainfall index. A 24-hour depth-duration curve was computed and is shown in Figure 15, with a 24-hour value of 25.8 inches.

c. Loss Rates and Base Flow. Preliminary studies in connection with Civil Works Project ES-182, Hydrologic Relations in Hawaii indicate that Kalihi Valley, which lies across the divide from Kawainui Marsh and which has similar watershed characteristics, shows a wide variation in hourly loss rate, from 0.2 to 1.2 inches per hour. For this detailed project report, a constant loss rate of 0.2 inch per hour was assumed with initial losses assumed to be satisfied prior to the period of excess rainfall. This 0.2 inch per hour loss rate is consistent with those obtained by calibrating the 100-year event to observed frequency curves as explained in paragraph 10. Base flow is negligible and was not used in the determination of the standard project floods.

d. Determination of Standard Project Flood. The standard project floods for the sub-basins in the study area were determined by the following procedures: (1) determination of an appropriate time increment of rainfall for each sub-basin; (2) determination of the effective rainfall by subtraction of loss rates; (3) determination of sub-basin runoff hydrographs; and (4) determination of total hydrograph by combining sub-basin hydrographs.

14. Design Inflows.

a. General. The Corps of Engineers Waterways Experiment Station (WES) used the RMA-2V finite element model (discussed in Appendix B) to hydraulically model the marsh and to simulate the effects of rainfall falling directly on the marsh.

b. Total Contribution of Design Inflows to the Marsh. The sum of the design inflows for the project were derived by combining the inflows from three sub-sectors (groups) that comprise the total drainage area for the project for input into the RMA-2V model. The first group consisted of the Maunawili Stream sub-basin, Kahanaiki Stream sub-basin, and the Urban Area sub-basin. The second group consisted of the Kapaa Quarry Stream sub-basin, Stream A sub-basin, and Stream B sub-basin. The third input source was the marsh itself. For the first group, the design inflows for the 10-year 50-year, and 100-year flows are shown tabulated in Table A-14. Table A-15 shows the tabulation of the inflows for the SPF and New Year's 1988 flood for the first group. For the second group, the tabulation of inflows for the 10-year, 50-year, 100-year, SPF, and the New Year's 1988 flood are shown in Table A-16. For the marsh itself, the rainfall excess is tabulated in units of cubic feet per second every 30 minutes for the 10-year, 50-year, 100-year, SPF, and the New Year's 1988 flood and are shown in Table A-17. The total inflow hydrographs for the project for the 100-year and SPF are shown in Figure 18 and Figure 19, respectively, for illustration.

c. Flood Volumes. Adding the flood volumes from the 3 groups discussed in paragraph b above results in the total runoff volume for the Kawainui Marsh project. Total runoff volumes for the 10-year, 100-year, and SPF events are 2,200, 7,600, and 12,500 acre-feet, respectively. From this, a volume-frequency curve for the marsh was constructed and is shown on Figure 20. The volume-frequency curve shows that the New Year's flood was slightly larger than a 100-year frequency flood.

15. Hydrologic Analysis of Interior Ponding.

a. Purpose.

(1) The hydrologic study procedure used in evaluating the interior drainage area (see Figure 21), follows the guidance and criteria of EM 1110-2-1413, "Engineering and Design, Hydrologic Analysis of Interior Areas," dated January 15, 1987. The four objectives of this section were to: (a) define the existing interior area; (b) develop hydrographs for the existing interior system; (c) perform storage routing using the Modified Puls method for various storm events; and (d) determine the ponding limits and elevations for the with and without project conditions and to verify the modeled results.

(2) The hydrologic study of the interior drainage area is formulated on the premise that:

(a) future land development of the interior area will be negligible and that the hydrologic characteristics of the study area will remain unchanged. This scenario is confirmed by the City and County of Honolulu Kailua District Base Map, which indicate that the study area has undergone maximum residential development. Based on the assumption, the future "with" and "without" project condition analysis will be considered the same as the existing condition assessments; and

(b) complete coincidence occurs between the exterior event (high stage conditions which would produce levee overtopping) with the interior event (ponding due to interior runoff).

b. General.

(1) The interior area defined for this study is a residential community located in Kailua, Oahu and has a total land surface area of approximately 820 acres. It is bordered by Kailua Bay, Oneawa Channel, Kawainui Marsh levee and Kuulei Road (see Figure 21). The area is comprised of three development sectors: (a) Coconut Grove tract, which extends from the marsh levee to Maluniu Avenue; (b) Kalama tract, which continues from Maluniu Avenue to North Kalaheo Avenue; and (c)

Kalaheo Beach tract, which continues from North Kalaheo Avenue out to the shoreline. A study of the topographic contours reveal that the interior area is divided by a ridgeline occurring along Maluniu Avenue between the intersections with Kuulei Road and Manono Street, then continuing along North Kalaheo Avenue and ending at the Oneawa Channel bridge (Figure 21). This ridgeline divides the study area into two natural drainage areas. The southwestern drainage area, consisting of 550 acres (0.85 square mile), contribute runoff into Kaelepulu Stream, while the northeastern section drains toward Kailua Bay. Only the southwestern drainage area, which comprises the Coconut Grove tract, was considered as the main focus for hydrologic analysis.

(2) The existing City and County of Honolulu storm drain system, which was installed in 1973, is located at the southwestern end of Coconut Grove and discharges runoff into Kaelepulu Stream. The system, which consists of nine drain lines and servicing an area of 271 acres, was designed to discharge the 10-year storm with one foot of freeboard. In low-lying areas where the elevation difference between the existing ground and ground water are less than one foot, the pipes were sized to discharge the 50-year storm with no freeboard. The total design discharge for the storm drains, into Kaelepulu Stream, is 705 cfs, as determined in the report, "Hydrologic Study for Coconut Grove Improvement District, Kailua, Oahu, Hawaii," prepared for the City and County of Honolulu by R. M. Towill Corporation, March 1969.

c. <u>Interior Inflows</u>.

(1) Rainfall estimates for the 10-year, 50-year, and 100-year frequencies were determined using isohyetal maps obtained from the publication "Rainfall Frequency Study for Oahu," Report R-73, and the Standard Project Storm (SPS) rainfall was obtained from the OCE Memorandum for Record, "Standard Project Storm Determination, Hawaiian Islands," 19 September 1962. The 1988 New Year's rainfall isohyetal map, Figure 9, was obtained from the 1988 Post Flood Report. Rainfall depth-duration curves were plotted (Figure 22) and a unit time interval of 10 minutes was used to describe the inflow hydrograph into Coconut Grove. A unit time interval of 10 minutes was considered the most practical for storm computations to adequately define the computed hydrograph. The 25-year rainfall-depth duration curve was interpolated following the procedures outlined in Report R-73.

(2) Infiltration losses were considered negligible in determining interior runoff because of the following reasons:

(a) Initial loss estimates for the 100-year frequency storm using the SCS loss method ("Computer Assisted Floodplain Hydrology and Hydraulics," Daniel H. Hoggan, 1989) yielded an average loss of 0.11 inch per hour, which would have a minimal effect on the total rainfall; and

(b) during periods of heavy rainfall, ponding occurs in low lying areas along Kihapai Street due to the rapid rise of the shallow water table ("Relation of Drainage Problems to High Ground Water Levels, Coconut Grove Area, Oahu, Hawaii," United States Department of the Interior, Geological Survey, 1971).

Infiltration in this area is retarded because of the high soil saturation and the capillary rise of soil moisture.

(3) The amount of water overtopping the existing Kawainui Marsh levee was developed by the Corps of Engineers Waterways Experiment Station (WES) using the RMA-2V model (discussed in Appendix B). Discharges for the 25-year, 50-year, and 100-year flood frequencies as well as the 1988 New Year's flood and the Standard Project Flood were presented as inflow hydrographs into Coconut Grove and inputted for storage routing.

(4) The total inflow hydrograph for the existing without project conditions of Coconut Grove, consists of combining the runoff from the interior drainage rainfall with the levee overtopping hydrograph developed by WES. This combination simulates the worst case scenario by assuming 100 percent coincidence for both interior and exterior events. For the with project flooding conditions, only the runoff from interior rainfall was utilized in the storage routing program.

d. Interior Storage Routing.

(1) Storage routing was accomplished by the Modified Puls method, which calculates storage, elevation, and outflow. The information required to accomplish the storage routing are the inflow hydrographs, area-storage curve, and discharge rating curves.

(2) The area-storage curve was determined from a topographic map obtained from the R. M. Towill study and shown on Figure 23. The area-storage curve was derived by computing increments of volume from intervals of 1 foot elevations using the average-end-area method.

(3) Runoff from Coconut Grove is conveyed by two primary modes, via the existing storm drains which discharges into Kaelepulu Stream or by overflowing the low-lying right bank into Oneawa Channel (between Oneawa Street and Kainalu Drive), during high flood condition. Discharge rating curves for both were developed using the water surface profile program, HEC-2. The rating curve for Kaelepulu Stream, Figure 24, was developed at a cross section fifty feet upstream of Kawainui bridge using channel and overbank roughness of 0.045, and contraction and expansion coefficients of 0.3 and 0.5, respectively. The starting water surface elevation of 2.2 feet mean sea level (msl), assuming the highest tidal conditions, was used based on the U.S. Department of Commerce, Environmental Science Services Administration's "Coast and Geodetic Survey" of November 1, 1956, for Waimanalo Landing, Waimanalo Bay, Oahu Island.

(4) The rating curve for discharge into Oneawa Channel, Figure 25, was developed at an interior section, 2,000 feet southeast from Oneawa Channel. Manning's roughness value of 0.20 and contraction and expansion coefficients of 0.3 and 0.5, respectively, were used to model the residential conditions. Cross sections for the right bank of Oneawa Channel were obtained from as-built drawings of the Kawainui Flood Control Project dated October 1966 and is shown on Figure 21. Water surface profiles were computed using critical depth as the starting elevation along the

Oneawa Channel right bank. Critical depth was used because of the rapid change in grade along the right bank.

e. Verification of Flooding Results.

(1) The 1988 New Year's flood of Coconut Grove was used to verify the accuracy of the computed results. High water marks in Coconut Grove were obtained from the American Red Cross Damage Assessment Reports conducted on January 2, 1988. Together with randomly surveyed residential floor elevations conducted by the Corps of Engineers, flood heights along Kihapai Street ranged in elevations from 10.0 to 11.0 feet above msl, compared to the storage routing model result of 10.6 feet which is considered for this report to be the maximum water surface elevation for the New Year's event.

(2) During the 1988 New Year's flood, it was observed that: (a) runoff from Coconut Grove was conveyed into Oneawa Channel over its right bank; and (b) the USGS stage gage #2648 located at Oneawa Channel (Station 93+00), reported a maximum tailwater elevation of 2.5 feet (msl) from high water marks. To verify the computed outflow from the storage routing model of 3370 cfs, and obtain the observed Oneawa Channel tailwater elevation, water surface profiles of Oneawa Channel (Figure 26) modeling the New Year's flood condition were calculated using HEC-2. The highest tide during the 1988 New Year's flood of 1.2 feet (msl) which occurred at 1:40 a.m., January 1, 1988, was used as the starting water elevation. Channel roughness of 0.025 and contraction and expansion coefficients of 0.1 and 0.3, respectively, were utilized throughout the Oneawa Channel reaches. From the water surface profiles, a maximum discharge of 3500 cfs was calculated, verifying the computed outflow from storage routing.

(3) The flood and ponding limits for the existing without and with project conditions of Coconut Grove are shown on Figures 27 and 28. During the New Year's flood, it was observed that the maximum flood limit of inundation followed the 9.0-foot contour line (1988 Post Flood Report). However, flood heights along Kihapai Street near the vicinity of the levee, reached elevations as high as 11.0 feet (msl). To account for this observed backwater effect, which occurred from the Coconut Grove interior (elevation 9 feet) to the levee, a reduction factor of 15 percent was computed and applied to the modeled 50-year, 100-year and SPF water surface elevations to determine the limits of flooding. This reduction factor was based on the modeled 1988 New Year's flood elevation of 10.6 feet and the 9.0-foot contour line flood limit.

(4) The flooding elevations and discharge results using the Modified Puls storage routing method for both the existing without and with project conditions are shown in Table A-18.

TABLE A-1
SUB-BASIN CHARACTERISTICS

CONCENTRATION POINTS	DRAINAGE AREA IN SQ MILES	STREAM LENGTH L IN MILES	L_{CA} IN MILES
MAKAWAO STREAM AT USGS GAGE 2540	2.04	2.8	1.1
MAUNAWILI STREAM AT THE CONFLUENCE WITH KAHANAIKI STREAM	5.45	4.17	2.62
KAHANAIKI STREAM AT THE CONFLUENCE WITH MAUNAWILI STREAM	1.91	2.31	0.73
KAPAA QUARRY STREAM	1.19	1.9	0.80
STREAM A	0.20	0.35	0.13
STREAM B	0.33	0.55	0.27

NOTE: L_{CA} is the length on the stream from the beginning to the centroid of the sub-basin.

TABLE A-2

ACTIVE RAINFALL STATIONS IN BASIN

Station Number	NAME	Elevation (feet)	Year Established	Frequency of Reading
787	Maunawili Ranch	250	1895	Weekly
787.1	Maunawili NWS	410	1951	Continuous
788	St. Stephens Ste.	490	1943	Daily
790.1	Kailua Fld Lab	120	1928	Daily
790.6	Maunawili Circle	110	1955	Daily
838	Kaneohe Ranch	365	1944	Daily

TABLE A-3

-PLOTTING POSITIONS- 2540 MAKAWAO STRM NR KAILUA DA= 2.04 SQ MI

EVENTS ANALYZED				ORDERED EVENTS			
MON	DAY	YEAR	FLOW,CFS	RANK	WATER YEAR	FLOW,CFS	MEDIAN PLOT POS
3	5	1958	2140.	1	1965	6000.	0.0223
1	17	1959	319.	2	1985	3940.	0.0541
3	5	1960	681.	3	1988	3100.	0.0860
1	26	1961	500.	4	1971	3000.	0.1178
5	5	1962	460.	5	1968	2490.	0.1497
3	6	1963	2140.	6	1963	2140.	0.1815
12	12	1963	665.	7	1958	2140.	0.2134
2	4	1965	6000.	8	1977	2060.	0.2452
11	13	1965	1920.	9	1966	1920.	0.2771
9	16	1967	608.	10	1981	1810.	0.3089
12	18	1967	2490.	11	1979	1470.	0.3408
2	1	1969	766.	12	1980	1410.	0.3726
1	26	1970	596.	13	1974	988.	0.4045
11	26	1970	3000.	14	1982	936.	0.4363
1	23	1972	362.	15	1969	766.	0.4682
2	25	1973	35.	16	1960	681.	0.5000
2	5	1974	988.	17	1986	668.	0.5318
1	12	1975	286.	18	1964	665.	0.5637
11	27	1975	272.	19	1987	612.	0.5955
5	12	1977	2060.	20	1967	608.	0.6274
5	23	1978	375.	21	1970	596.	0.6592
2	4	1979	1470.	22	1961	500.	0.6911
1	8	1980	1410.	23	1962	460.	0.7229
5	7	1981	1810.	24	1978	375.	0.7548
1	20	1982	936.	25	1972	362.	0.7866
10	28	1982	212.	26	1959	319.	0.8185
3	2	1984	178.	27	1975	286.	0.8503
2	14	1985	3940.	28	1976	272.	0.8822
9	30	1986	668.	29	1983	212.	0.9140
11	10	1986	612.	30	1984	178.	0.9459
12	31	1987	3100.	31	1973	35.	0.9777

TABLE A-4

-FREQUENCY CURVE- 2540 MAKAWAO STRM NR KAILUA DA= 2.04 SQ MI

FLOW, CFS COMPUTED	FLOW, CFS EXPECTED PROBABILITY	EXCEEDANCE PROBABILITY	CONFIDENCE LIMITS 0.05 LIMIT	CONFIDENCE LIMITS 0.95 LIMIT
14300.	19200.	0.002	32400.	8250.
10500.	13100.	0.005	22100.	6370.
8210.	9740.	0.010	16200.	5140.
6260.	7110.	0.020	11600.	4030.
4180.	4520.	0.050	7050.	2870.
2950.	3080.	0.100	4590.	2100.
1920.	1960.	0.200	2770.	1420.
862.	862.	0.500	1140.	649.
395.	386.	0.800	531.	272.
265.	253.	0.900	369.	170.
191.	178.	0.950	276.	114.
104.	90.	0.990	164.	54.

FREQUENCY CURVE STATISTICS		STATISTICS BASED ON	
MEAN LOGARITHM	2.9411	HISTORIC EVENTS	0
STANDARD DEVIATION	0.4076	HIGH OUTLIERS	0
COMPUTED SKEW	0.1607	LOW OUTLIERS	1
GENERALIZED SKEW	-0.0500	ZERO OR MISSING	0
ADOPTED SKEW	0.0836	SYSTEMATIC EVENTS	31

TABLE A-5

-PLOTTING POSITIONS- 2605 MAUNAWILI STR HWY 61 NR KAILUA DA= 5.3

EVENTS ANALYZED				ORDERED EVENTS			
MON	DAY	YEAR	FLOW,CFS	RANK	WATER YEAR	FLOW,CFS	MEDIAN PLOT POS
3	5	1958	2550.	1	1965	9690.	0.0223
2	13	1959	619.	2	1988	5710.	0.0541
3	6	1960	1050.	3	1985	4850.	0.0860
1	26	1961	866.	4	1977	4630.	0.1178
3	12	1962	836.	5	1966	4100.	0.1497
3	6	1963	1560.	6	1980	4050.	0.1815
12	12	1963	1040.	7	1971	3880.	0.2134
2	4	1965	9690.	8	1968	3720.	0.2452
11	14	1965	4100.	9	1981	3640.	0.2771
9	16	1967	1750.	10	1979	3380.	0.3089
12	18	1967	3720.	11	1958	2550.	0.3408
2	1	1969	2360.	12	1969	2360.	0.3726
1	26	1970	940.	13	1982	2060.	0.4045
11	26	1970	3880.	14	1978	1930.	0.4363
1	23	1972	1250.	15	1967	1750.	0.4682
2	25	1973	334.	16	1987	1670.	0.5000
2	5	1974	1400.	17	1963	1560.	0.5318
11	21	1974	1400.	18	1986	1550.	0.5637
11	27	1975	1200.	19	1974	1400.	0.5955
5	12	1977	4630.	20	1975	1400.	0.6274
5	23	1978	1930.	21	1972	1250.	0.6592
2	4	1979	3380.	22	1976	1200.	0.6911
1	6	1980	4050.	23	1960	1050.	0.7229
5	7	1981	3640.	24	1964	1040.	0.7548
1	20	1982	2060.	25	1970	940.	0.7866
10	28	1982	400.	26	1961	866.	0.8185
3	2	1984	420.	27	1962	836.	0.8503
2	14	1985	4850.	28	1959	619.	0.8822
9	30	1986	1550.	29	1984	420.	0.9140
11	10	1986	1670.	30	1983	400.	0.9459
12	31	1987	5710.	31	1973	334.	0.9777

TABLE A-6

-FREQUENCY CURVE- 2605 MAUNAWILI STR HWY 61 NR KAILUA DA= 5.3

FLOW, CFS COMPUTED	FLOW, CFS EXPECTED PROBABILITY	EXCEEDANCE PROBABILITY	CONFIDENCE LIMITS 0.05 LIMIT	CONFIDENCE LIMITS 0.95 LIMIT
17200.	21300.	0.002	33600.	10900.
13700.	16100.	0.005	25400.	8980.
11400.	12900.	0.010	20100.	7650.
9220.	10200.	0.020	15600.	6390.
6720.	7150.	0.050	10600.	4860.
5060.	5260.	0.100	7480.	3770.
3560.	3640.	0.200	4950.	2740.
1790.	1790.	0.500	2310.	1400.
885.	866.	0.800	1150.	638.
606.	581.	0.900	814.	408.
442.	412.	0.950	616.	278.
241.	207.	0.990	365.	132.

FREQUENCY CURVE STATISTICS		STATISTICS BASED ON	
MEAN LOGARITHM	3.2475	HISTORIC EVENTS	0
STANDARD DEVIATION	0.3595	HIGH OUTLIERS	0
COMPUTED SKEW	-0.1413	LOW OUTLIERS	0
GENERALIZED SKEW	-0.0500	ZERO OR MISSING	0
ADOPTED SKEW	-0.1081	SYSTEMATIC EVENTS	31

TABLE A-7
STATION 2540, MAKAWAO STREAM
DECEMBER 31, 1987 - JANUARY 1, 1988 STREAMFLOW IN CFS

HOUR	USGS STREAMFLOW
1600	20
1630	105
1700	480
1730	383
1800	418
1830	640
1900	1670
1930	1220
2000	1170
2030	1960
2100	2250
2130	2040
2200	2350
2230	2630
2300	2690
2330	2590
2400	1380
0030	1740
0100	1810
0130	1820
0200	274
0230	67
0300	20

TABLE A-8
HOURLY RAINFALL (INCHES)
DECEMBER 31, 1987

Hourly Interval	787.1 Maunawili NWS	781.7 Luluku NWS
1 A.M.	0	0
2	0	0.16
3	0.2	0.03
4	0.1	0.06
5	0.3	0.11
6	0.2	0.11
7	0.5	0.08
8	0.1	0.02
9	0	0.03
10	0.2	0.07
11	0.1	0.08
NOON	0.2	0.09
1 P.M.	0.1	0
2	0.1	0.01
3	0	0
4	0	0.03
5	0.9	0.30
6	1.8	0.46
7	3.0	0.81
8	3.4	0.58
9	4.0	2.01
10	2.6	1.41
11 P.M.	1.2 *	2.38
MIDNIGHT	0.7 *	1.72
1 A.M. JAN 1	0.6 *	1.23
2	0.3 *	0.71
3	0.2 *	0.64
4	0	0.26
5		0.15
6		0.33
7		0.29

NOTE: FROM REPORT, CIRCULAR C119, "POST FLOOD REPORT, NEW YEAR'S EVE STORM, DEC 31, 1987 - JAN 1, 1988 WINDWARD AND LEEWARD EAST OAHU," STATE OF HAWAII, DEPARTMENT OF LAND AND NATURAL RESOURCES

* ESTIMATED FROM LULUKU NWS STA. 781.7 SINCE THE MAUNAWILI RECORDER STOPPED AFTER 10 P.M.

TABLE A-9
APRIL 4, 1989 STORM
STATION 2540, MAKAWAO STREAM

	TIME	TOTAL RAINFALL (IN/30MIN)	USGS STREAMFLOW (CFS)
APR 4/89	12:00 p.m.	0	9
	12:30	0.1	9
	1:00	0.2	11
	1:30	0.8	533
	2:00	0.1	185
	2:30	0	81
	3:00	0.3	91
	3:30	0.6	408
	4:00	0	149
	4:30	0.7	992
	4:45		1730
	5:00	1.3	1520
	5:30	0.2	342
	6:00	0	169
	6:30	0	101
	7:00	0	76
	7:30	0.1	64
	8:00	0	55
	8:30	0.2	52
	9:00	0	98
	9:30	0	96
	10:00	0.1	62
	10:30	0	49
	11:00	0	50
	11:30	0	45
	12:00	0	38

NOTE: RAINFALL FROM MAUNAWILI RAIN GAGE, STATION 787.1

TABLE A-10
APRIL 8, 1989 STORM
STATION 2540, MAKAWAO STREAM

	TIME	TOTAL RAINFALL (IN/30 MIN)	USGS STREAMFLOW (CFS)
APR 8/89	0:30 a.m.	0	17
	1:00	0.2	21
	1:30	0.1	39
	2:00	0.3	81
	2:30	0.3	296
	3:00	0.2	230
	3:30	0.3	326
	4:00	0.1	163
	4:30	0.1	161
	5:00	0.2	172
	5:30	0.1	155
	6:00	0.1	145
	6:30	0.2	149
	7:00	0.2	178
	7:30	0.1	146
	8:00	0	118
	8:30	0.1	99
	9:00	0	77
	9:30	0.1	67
	10:00	0	115
	10:30	0.2	132
	11:00	0	99
	11:30	0	76
	12:00 p.m.	0	69
	12:30	0	60
	1:00	0	86

NOTE: RAINFALL FROM MAUNAWILI RAIN GAGE, STATION 787.1

TABLE A-11
HEC-1 CALIBRATION RESULTS FOR SELECTED STORMS AT STA. 2540 MAKAWAO STREAM GAGE (D.A. = 2.04 SQ MI)

	Snyer's Unit Hydrograph Parameters		Loss Rates		
Events	Lag t_p (hrs)	Peaking Coefficient C_p	Initial (in)	Constant (in/hr)	% Runoff
December 31, 1987	1.48	0.40	0.51	0.68	66
April 4, 1989	--	--	0.62	0.76	65
April 8, 1989	0.4	0.29	0.38	0.20	68

TABLE A-12
COMPARISON OF FREQUENCY CURVE ESTIMATES
ANDSNYDER'S UNIT HYDROGRAPH PARAMETERS FOR
MAUNAWILI AND MAKAWAO SUB-BASINS

Makawao Sub-basin, D.A. = 2.04 sq mi
$t_p = 0.40$, $c_p = 0.35$, $c_t = 0.29$

Return Interval	Q Estimated From Gage (cfs)	Q HEC-1 (cfs)	Loss Initial (in)	Rates Constant (in/hr)	% Runoff
2 yr	860	1346	0.70	0.70	29
10 yr	2930	2691	0.70	0.70	33
50 yr	6260	4875	0.00	0.20	71
100 yr	8210	5397	0.00	0.20	73

Maunawili Sub-basin, D.A. = 5.45 sq mi
$t_p = 0.59$, $c_p = 0.35$, $c_t = 0.29$

2 yr	*1790	2588	0.70	0.70	22
10 yr	5260	5353	0.70	0.70	31
50 yr	10200	10212	0.00	0.20	71
100 yr	12900	11322	0.00	0.20	73

* NOTE: GAGE AREA 5.34 SQ. MI., BASIN AREA 5.45 SQ. MI.

TABLE A-13
RUNOFF PARAMETERS FOR URBAN WATERSHED

Drainage Area = 0.45 sq mi

Pervious Area
Loss Rates
Curve Number (avg. AMC) = 70
Curve Number (wet AMC) = 85

Kinematic Wave Parameters

Overland Flow Planes	Length (ft)	Slope (ft/ft)	N-Value	% of Area
pervious	260	0.07	0.3	75
impervious	50	0.02	0.2	25

	Length (ft)	Slope ft)	N-Value	Contributing Area (sq mi)	Diameter (ft)
collector channel	1000	0.02	0.015	0.03	2.0

				Shape	Side Slope
main channel	2000	0.02	0.03	Triangular	1:1

NOTES: AMC = Antecedent Moisture Content

Runoff Parameters described in the HEC-1 manual

TABLE A-14

TABULATION OF INFLOWS FOR Q10, Q50, AND Q100
FROM MAUNAWILI STREAM, KAHANAIKI STREAM AND URBAN AREA

	Q10			Q50			Q100		
Time in Hours	Maunawili and Kahanaiki (cfs)	Urban Area (cfs)	Total Q10 (cfs)	Maunawili and Kahanaiki (cfs)	Urban Area (cfs)	Total Q50 (cfs)	Maunawili and Kahanaiki (cfs)	Urban Area (cfs)	Total Q100 (cfs)
0		0	0	0	0	0	0	0	0
.5		11	11	188	41	229	188	53	241
1.0		13	13	757	48	805	757	60	817
1.5		23	23	1,145	55	1,200	1,145	67	1,212
2		26	26	1,396	61	1,457	1,396	75	1,471
2.5		31	31	1,560	68	1,628	1,560	81	1,641
3		41	41	1,669	74	1,743	1,669	89	1,758
3.5		53	53	1,743	82	1,825	1,743	99	1,842
4		66	66	1,792	91	1,883	1,792	110	1,902
4.5		90	90	1,826	101	1,927	1,826	122	1,948
5		112	112	1,848	113	1,961	1,848	139	1,987
5.5	0	143	143	1,863	128	1,991	1,863	162	2,025
6	482	192	674	1,874	150	2,024	1,945	191	2,136
6.5	1,203	235	1,438	2,163	177	2,340	2,756	254	3,010
7	4,864	1,482	6,346	3,021	236	3,257	3,508	437	3,945
7.5	5,583	394	5,977	3,607	405	4,012	5,032	646	5,678
8	4,416	244	4,660	4,846	602	5,448	9,491	2,976	12,467
8.5	3,209	236	3,445	9,868	2,777	12,645	14,539	756	15,295
9	2,105	187	2,292	11,555	711	12,266	12,518	535	13,053
9.5	1,397	165	1,562	9,550	503	10,053	10,176	361	10,537
10	935	147	1,082	7,857	339	8,196	8,223	232	8,455
10.5	630	120	750	6,716	218	6,934	6,216	197	6,413
11	420	110	530	5,225	185	5,410	4,760	173	4,933
11.5	286	102	388	4,101	162	4,263	3,812	153	3,965

TABLE A-14
(Continued)

Time in Hours	Q10 Maunawili and Kahanaiki (cfs)	Q10 Urban Area (cfs)	Total Q10 (cfs)	Q50 Maunawili and Kahanaiki (cfs)	Q50 Urban Area (cfs)	Total Q50 (cfs)	Q100 Maunawili and Kahanaiki (cfs)	Q100 Urban Area (cfs)	Total Q100 (cfs)
12	196	96	292	3,369	143	3,512	3,181	139	3,320
12.5	135	91	226	2,877	130	3,007	2,758	128	2,886
13	94	82	176	2,559	120	2,679	2,483	119	2,602
13.5	63	52	115	2,348	111	2,459	2,297	111	2,408
14	41	45	86	2,203	104	2,307	2,168	105	2,273
14.5	13	42	55	2,102	98	2,200	2,080	101	2,181
15	5	40	45	2,035	94	2,129	2,015	96	2,111
15.5	1	38	39	1,985	90	2,075	1,961	91	2,052
16	0	37	37	1,934	86	2,020	1,792	87	1,816
16.5		35	35	1,723	82	1,805	1,146	84	1,230
17		34	34	1,145	78	1,223	751	80	831
17.5		33	33	751	75	326	496	78	574
18		32	32	496	73	569	331	75	406
18.5		30	30	331	70	401	222	72	294
19		0	0	222	68	290	149	70	219
19.5			30,988	149	66	215	99	68	167
20			cfs -	99	64	163	66	0	66
20.5			30 min	66	0	66	44		44
21			1,280	44		44	28		28
21.5			a-f	28		28	18		18
22				18		18	10		10
22.5				10		10	5		5
23				5		5	2		2
23.5				2		2	0		0
24				0		0			132,274 cfs -
						121,550 cfs -		30 min	5,466 a-f
						30 min			
						5,023 a-f			

NOTE: VOLUME CONVERSION; MULTIPLY CFS - 30 MIN. BY FACTOR OF .0413 TO GET ACRE-FEET

TABLE A-15

TABULATION OF INFLOWS FOR SPF AND NEW YEAR'S FLOOD
FROM MAUNAWILI STREAM, KAHANAIKI STREAM AND URBAN AREA

	SPF			1988 NEW YEAR'S STORM		
Time in Hours	Maunawili and Kahanaiki (cfs)	Urban Area (cfs)	Total SPF (cfs)	Maunawili and Kahanaiki (cfs)	Urban Area (cfs)	1988 New Year's Flood (cfs)
0	0	0	0	0	0	0
.5	188	72	260	630	53	683
1	757	76	833	1,501	63	1,564
1.5	1,145	80	1,225	2,839	161	3,000
2	1,396	85	1,481	4,250	299	4,549
2.5	1,560	89	1,649	6,278	632	6,910
3	1,669	95	1,764	8,399	710	9,109
3.5	1,743	101	1,844	10,168	859	11,027
4	1,792	107	1,899	11,597	894	12,491
4.5	1,826	114	1,940	13,070	1,079	14,149
5	1,848	127	1,975	14,435	1,097	15,532
5.5	1,863	162	2,025	14,029	722	14,751
6	1,874	176	2,050	12,845	722	13,567
6.5	1,881	189	2,070	10,884	341	11,225
7	2,465	206	2,671	8,751	335	9,086
7.5	3,248	226	3,474	6,886	202	7,088
8	3,752	256	4,008	5,330	197	5,527
8.5	4,079	306	4,385	4,213	171	4,384
9	4,365	351	4,716	3,405	168	3,573
9.5	5,312	431	5,743	2,626	94	2,720
10	6,663	586	7,249	1,912	85	1,997
10.5	8,946	828	9,784	1,339	62	1,401
11	17,946	4,521	22,467	888	56	944
11.5	20,131	941	21,072	588	19	607
12	16,996	647	17,643	384	7	391
12.5	13,848	486	14,334	244	0	244
13	11,118	377	11,495	154		154
13.5	8,958	325	9,283	95		95
14	7,556	283	7,839	59		59
14.5	6,631	239	6,870	36		36
15	5,927	217	6,144	22		22
15.5	4,717	199	4,916	13		13
16	3,769	184	3,953	7		7
16.5	3,150	171	3,321	3		3
17	2,738	155	2,893	1		1
17.5	2,460	123	2,583	0		0
18	2,268	113	2,381			156,909 cfs -
18.5	2,107	106	2,213			30 min
19	2,022	100	2,122			6,484 a-f
19.5	1,973	94	2,067			

Table A-15
(continued)

	SPF				1988 NEW YEAR'S STORM		
Time in Hours	Maunawili and Kahanaiki (cfs)	Urban Area (cfs)	Total SPF (cfs)	Maunawili and Kahanaiki (cfs)	Urban Area (cfs)	1988 New Year's Flood (cfs)
20	1,942	89	2,031			
20.5	1,923	84	2,007			
21	1,910	80	1,990			
21.5	1,854	76	1,930			
22	1,312	73	1,385			
22.5	857	69	926			
23	568	0	568			
23.5	379		379			
24	254		254			
.5	170		170			
1	114		114			
1.5	75		75			
2	50		50			
2.5	33		33			
3	21		21			
3.5	13		13			
4	7		7			
4.5	3		3			
5	0		0			
			218,597 cfs - 30 min 9,033 a-f			

NOTE: VOLUME CONVERSION; MULTIPLY CFS - 30 MIN. BY FACTOR OF .0413 TO GET ACRE-FEET

TABLE A-16

TABULATION OF INFLOWS FROM
KAPAA QUARRY STREAM, STREAM A, AND STREAM B COMBINED

Time in Hours	Q10 (cfs)	Q50 (cfs)	Q100 (cfs)	SPF (cfs)	1988 New Year's Flood (cfs)
0		0	0	0	0
.5		110	110	104	154
1.		283	283	287	272
1.5		366	366	346	551
2		406	406	384	745
2.5		426	426	402	1,168
3		435	435	411	1,463
3.5		440	440	415	1,697
4		442	442	417	1,834
4.5		442	442	417	2,070
5		442	442	417	2,229
5.5	0	442	442	417	1,930
6	288	442	494	417	1,683
6.5	449	607	800	417	1,180
7	2,004	866	1,012	680	834
7.5	1,467	991	1,559	876	541
8	995	1,490	3,530	970	365
8.5	540	3,530	4,070	1,016	263
9	261	3,042	2,953	1,088	212
9.5	126	2,112	2,070	1,393	121
10	59	1,593	1,519	1,815	56
10.5	25	1,288	972	2,609	26
11	6	861	696	6,082	12
11.5	2	642	556	5,024	5
12	0	532	484	3,652	2
12.5	6,162	476	458	2,652	1
13	cfs -	456	447	1,894	0
13.5	30 min	447	443	1,459	19,414 cfs -
14	255 a-f	443	442	1,246	30 min
14.5		442	442	1,137	802 a-f
15		442	442	1,030	
15.5		442	442	719	
16		442	332	560	
16.5		332	159	484	
17		159	76	448	
17.5		76	36	431	
18		36	16	422	
18.5		16	7	418	
19		7	2	417	
19.5		2	0	417	
			28,693 cfs -		
			30 min		
			1,186 a-f		

Table A-16
(continued)

Time in Hours	Q10 (cfs)	Q50 (cfs)	Q100 (cfs)	SPF (cfs)	1988 New Year's Flood (cfs)
20		0		417	
20.5		26,458 cfs -		417	
21		30 min		417	
21.5		1,093 a-f		417	
22				417	
22.5				417	
23				417	
23.5				245	
24				117	
—					
.5				56	
1				26	
1.5				12	
2				5	
2.5				1	
3				0	
3.5				47,151 cfs -	
4				30 min	
4.5				1,948 a-f	
5					

NOTE: VOLUME CONVERSION; MULTIPLY CFS - 30 MIN. BY FACTOR OF .0413 TO GET ACRE-FEET

TABLE A-17

TABULATION OF INFLOWS FROM
MARSH ITSELF

Time in Hours	Q10 (cfs)	Q50 (cfs)	Q100 (cfs)	SPF (cfs)	1988 New Year's Flood (cfs)
0		0	0	0	0
.5	281	281	281	281	281
1.	422	422	422	422	281
1.5	422	422	422	422	562
2	422	422	422	422	562
2.5	422	422	422	422	984
3	422	422	422	422	984
3.5	422	422	422	422	1,055
4	422	422	422	422	1,055
4.5	422	422	422	422	1,265
5	422	422	422	422	1,265
5.5	422	422	422	422	844
6	844	422	562	422	844
6.5	984	703	844	422	352
7	2,812	844	984	844	352
7.5	844	844	1,547	844	211
8	844	1,547	4,640	844	211
8.5	422	3,796	1,968	844	211
9	422	1,406	1,265	984	211
9.5	422	844	844	1,265	70
10	422	844	703	1,687	70
10.5	422	703	422	2,671	70
11	422	422	422	6,468	70
11.5	422	422	422	2,250	0
12	422	422	422	1,574	11,810
12.5	422	422	422	1,265	cfs - 30
13	422	422	422	844	min.
13.5	281	422	422	844	488 a-f
14	0	422	422	844	
14.5	15,330	422	422	844	
15	cfs - 30	422	422	703	
15.5	min.	422	422	422	
16	633 a-f	422	141	422	
16.5		141	0	422	
17		0	22,641	422	
17.5		21,237	cfs - 30	422	
18		cfs - 30	min.	422	
18.5		min.	935 a-f	422	
19		877 a-f		422	
19.5				422	

Table A-17
(continued)

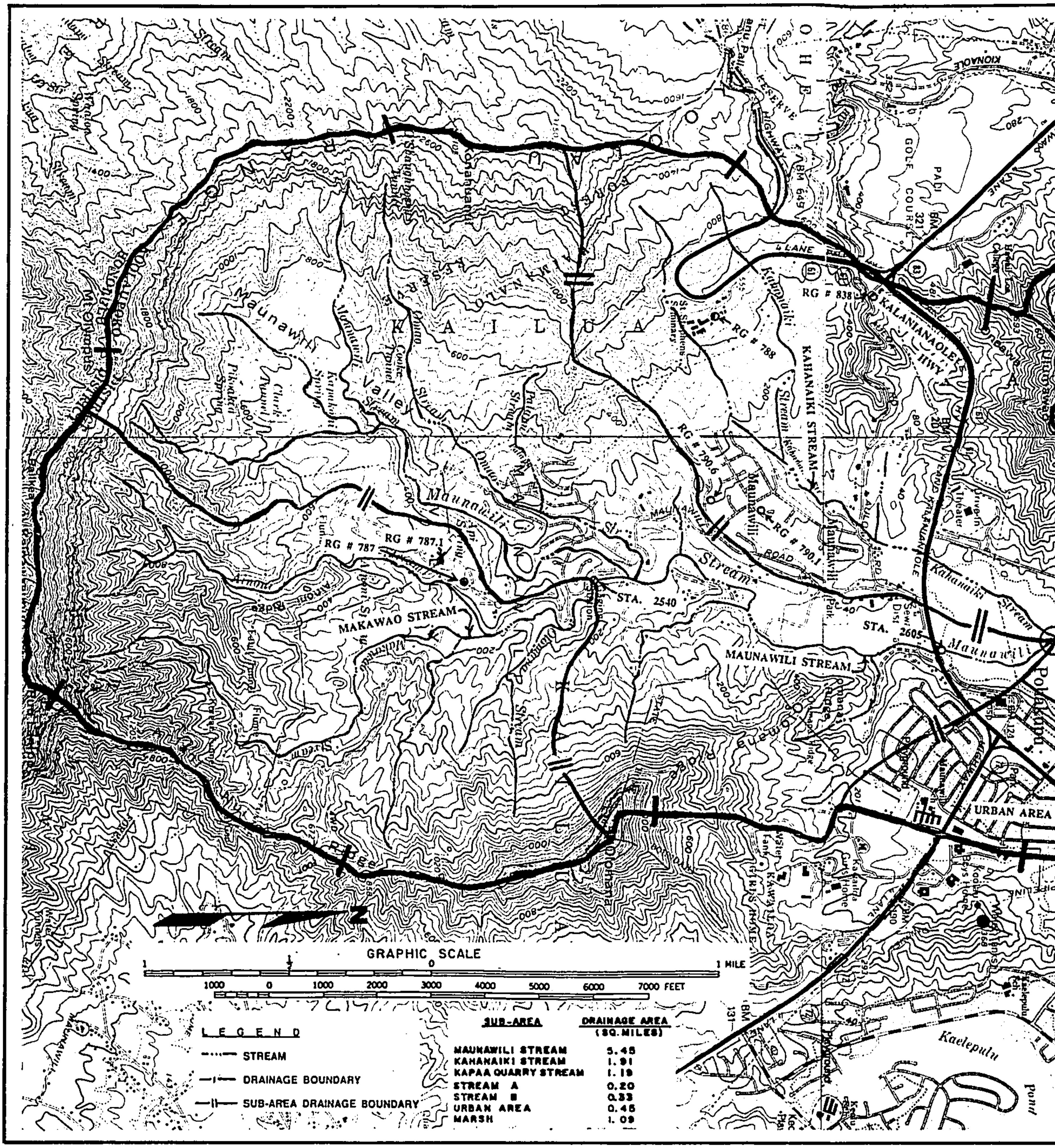
Time in Hours	Q10 (cfs)	Q50 (cfs)	Q100 (cfs)	SPF (cfs)	1988 New Year's Flood (cfs)
20				422	
20.5				422	
21				422	
21.5				281	
22				0	
22.5				36,282	
23				cfs - 30	
23.5				min.	
24				1,498 a-f	
.5					
1					
1.5					
2					
2.5					
3					
3.5					
4					
4.5					
5					

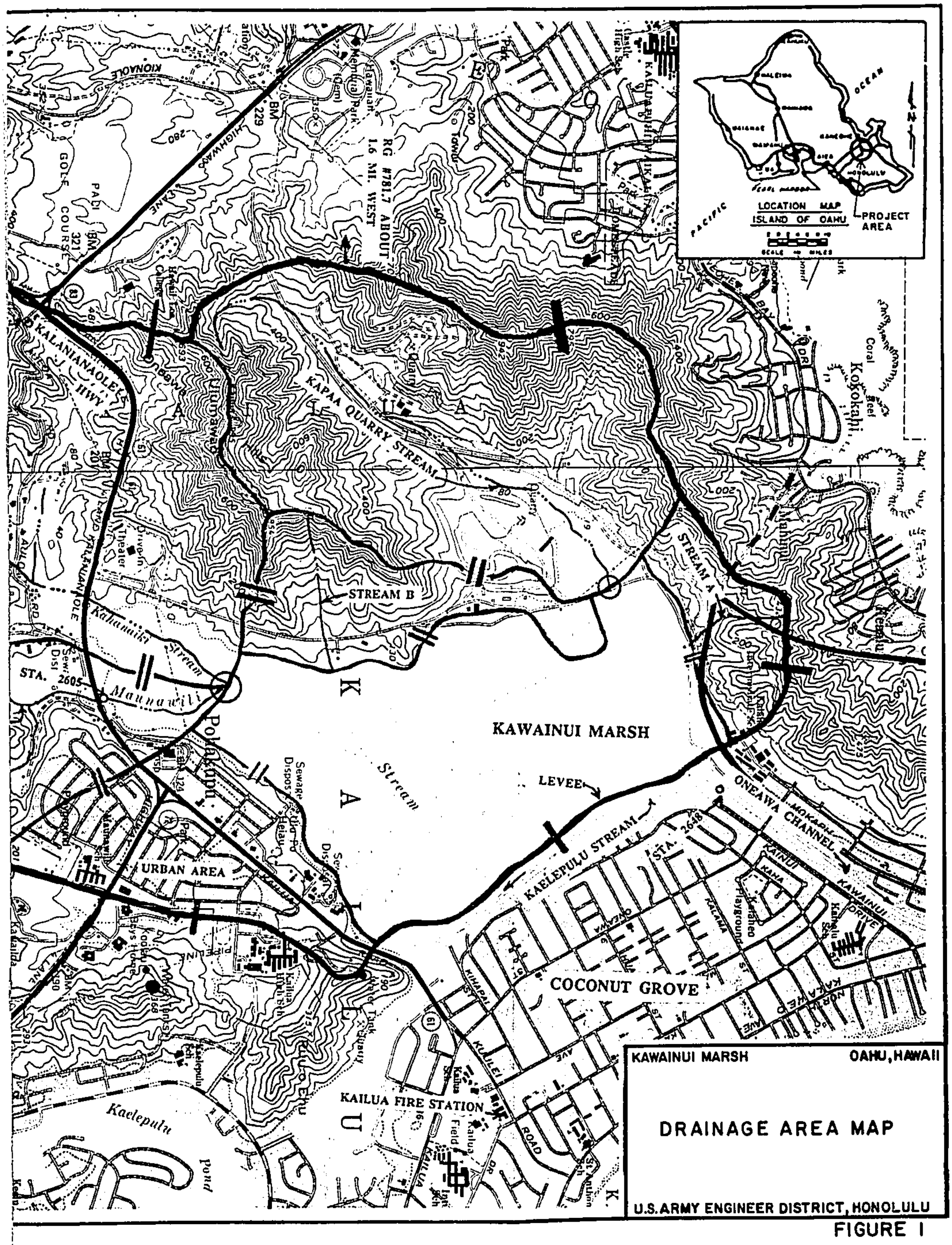
NOTE: VOLUME CONVERSION; MULTIPLY CFS - 30 MIN. BY FACTOR OF .0413 TO GET ACRE-FEET

TABLE A-18
FLOODING ELEVATIONS AND DISCHARGES

	Existing Without Project			Existing With Project	
Flood Event	Peak Elevation (ft. msl)	Flood Limit Elevation (ft. msl)	Total* Outflow (cfs)	Flood Limit Elevation (ft. msl)	Total Outflow (cfs)
SPF	11.9	10.1	10,600	7.3	1,100
Jan 1, 1988	10.6	9.0	5,270	—	—
100-yr	10.3	8.7	4,370	5.8	710
50-yr	9.9	8.4	3,480	5.7	690

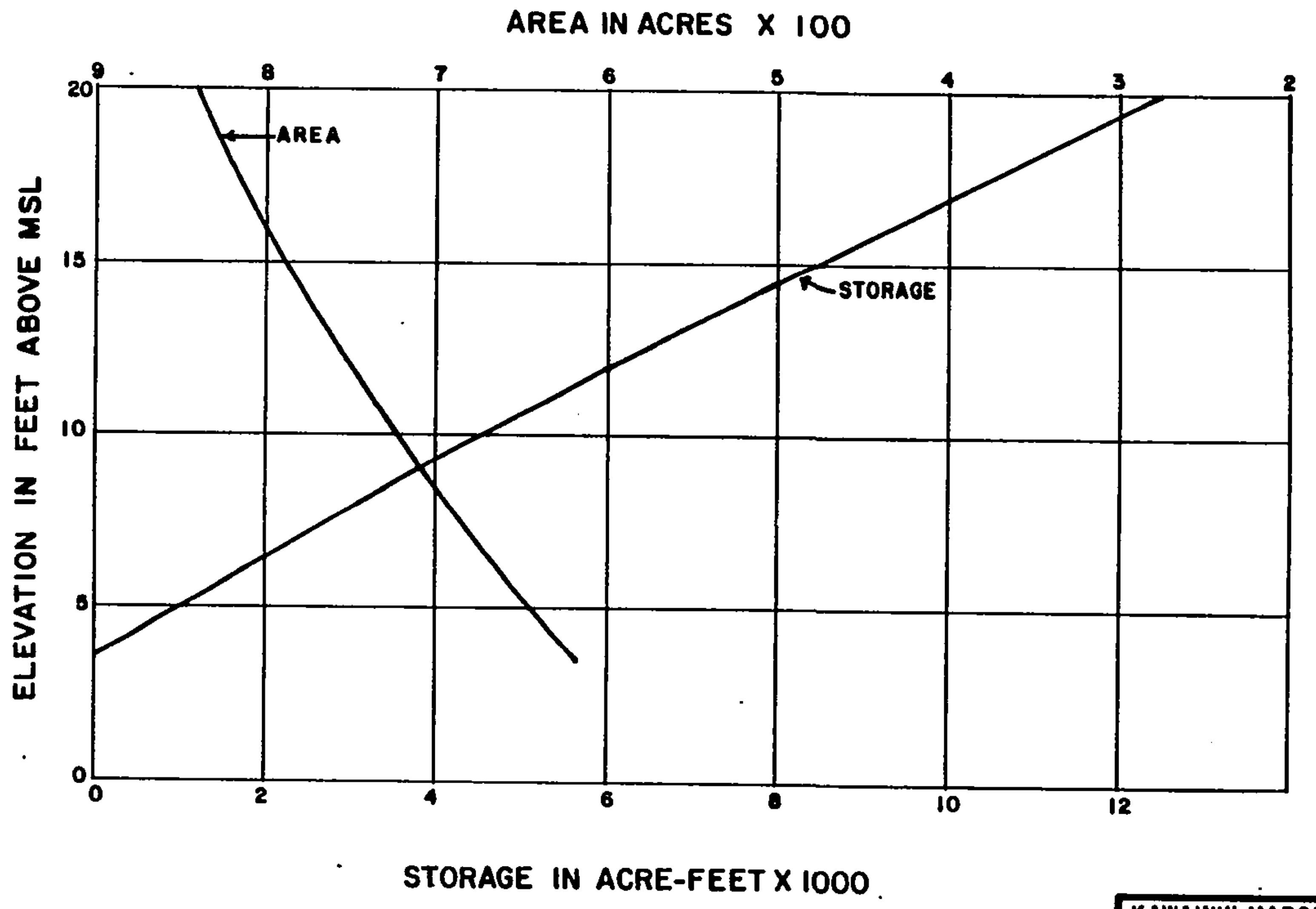
* Total outflow thru the Oneawa Channel and Kaelepulu Stream.


KAILUA
Maunawili Valley
Maunawili Stream
KAHANAIKI STREAM
MAUNAWILI STREAM
MAKAWAO STREAM
KALANIANAOLE HWY
RG # 787
RG # 787.1
RG # 788
RG # 790.1
RG # 790.6
RG # 838
STA. 2540
STA. 2605
URBAN AREA
Kaelepulu
GRAPHIC SCALE
1 ½ 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
LEGEND
STREAM
DRAINAGE BOUNDARY
SUB-AREA DRAINAGE BOUNDARY
SUB-AREA
DRAINAGE AREA (SQ. MILES)
MAUNAWILI STREAM 5.45
KAHANAIKI STREAM 1.91
KAPAA QUARRY STREAM 1.19
STREAM A 0.20
STREAM B 0.33
URBAN AREA 0.45
MARSH 1.09



KAWAINUI MARSH
LEVEE
STREAM A
STREAM B
KAPAA QUARRY STREAM
KAELEPULU STREAM
ONEAWA CHANNEL
STA. 2605
STA. 2648
URBAN AREA
COCONUT GROVE
KAILUA FIRE STATION
RG #781.7 ABOUT 1.6 MI. WEST
KALANIANAOLE HWY
LOCATION MAP
ISLAND OF OAHU
PROJECT AREA
PACIFIC
OCEAN
KAWAINUI MARSH
OAHU, HAWAII
DRAINAGE AREA MAP
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 1



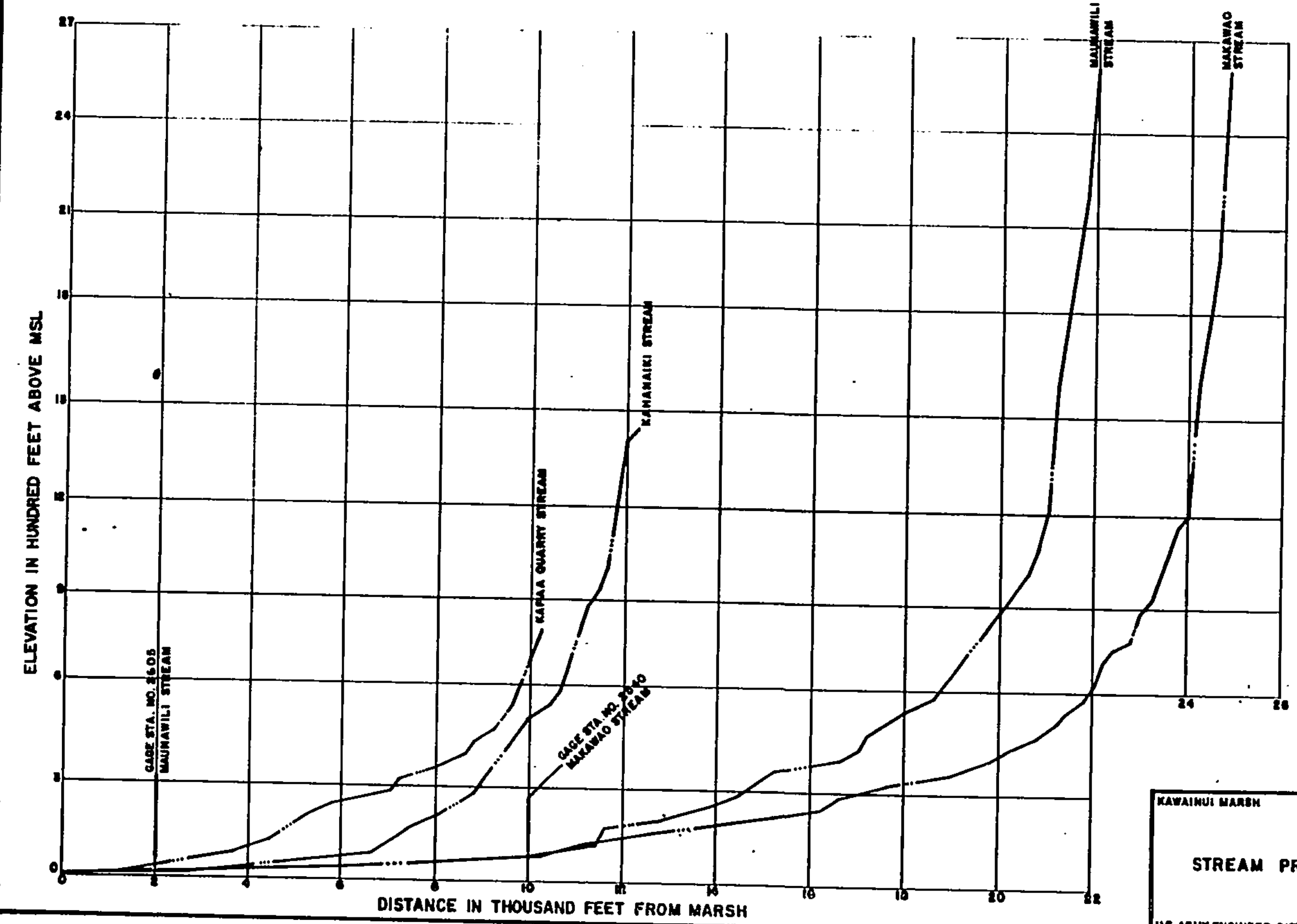
REFERENCE " SURVEY FOR KAWAINUI SWAMP FLOOD CONTROL PROJECT "
MARCH 1968, 1" = 200', 5' CONTOURS, BY
AUSTIN, TSUTSUMI, & ASSOCIATES

KAWAINUI MARSH — OAHU, HAWAII

AREA-STORAGE CURVES
KAWAINUI MARSH

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 2

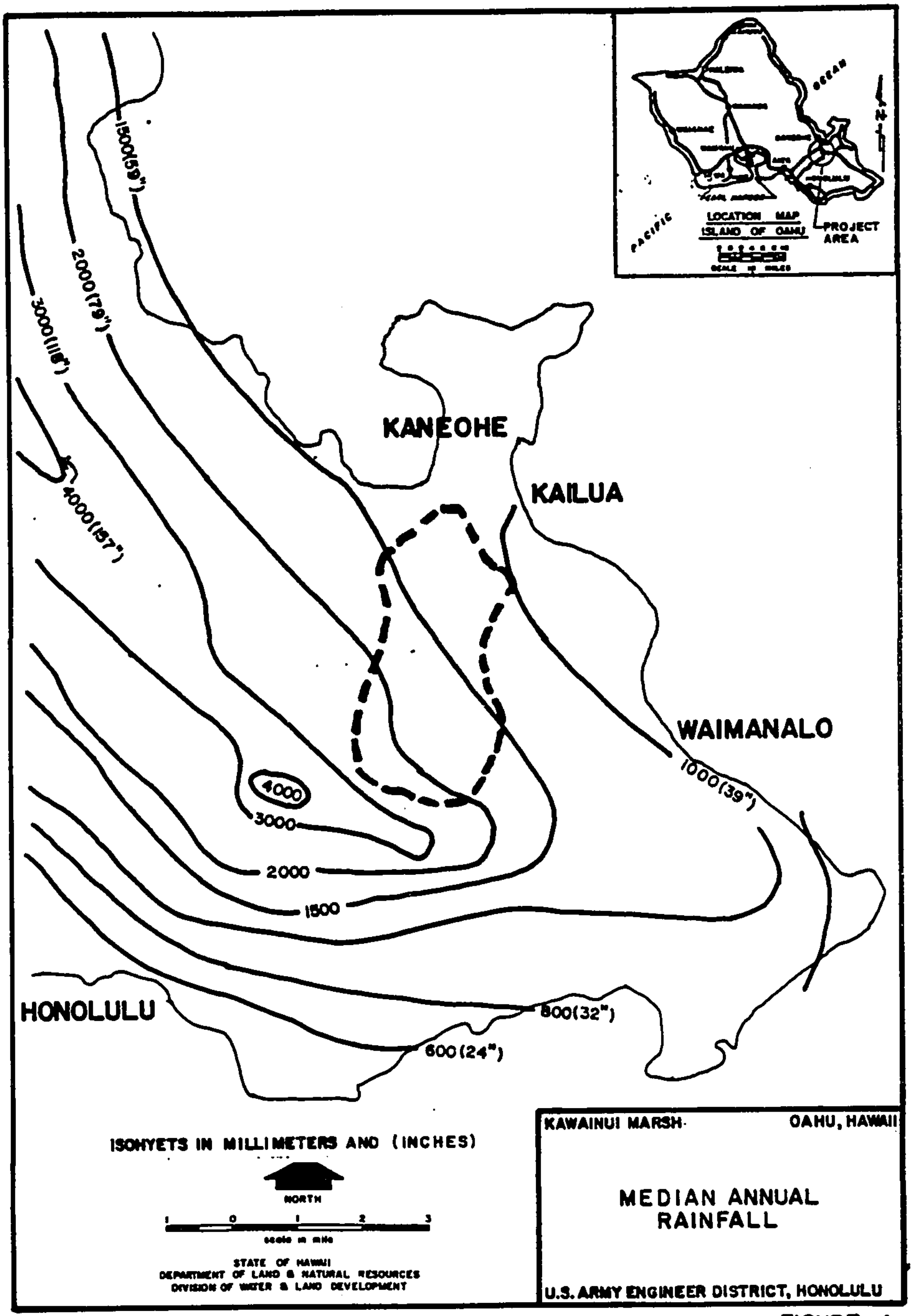


KAWAINUI MARSH — OAHU, HAWAII

STREAM PROFILES

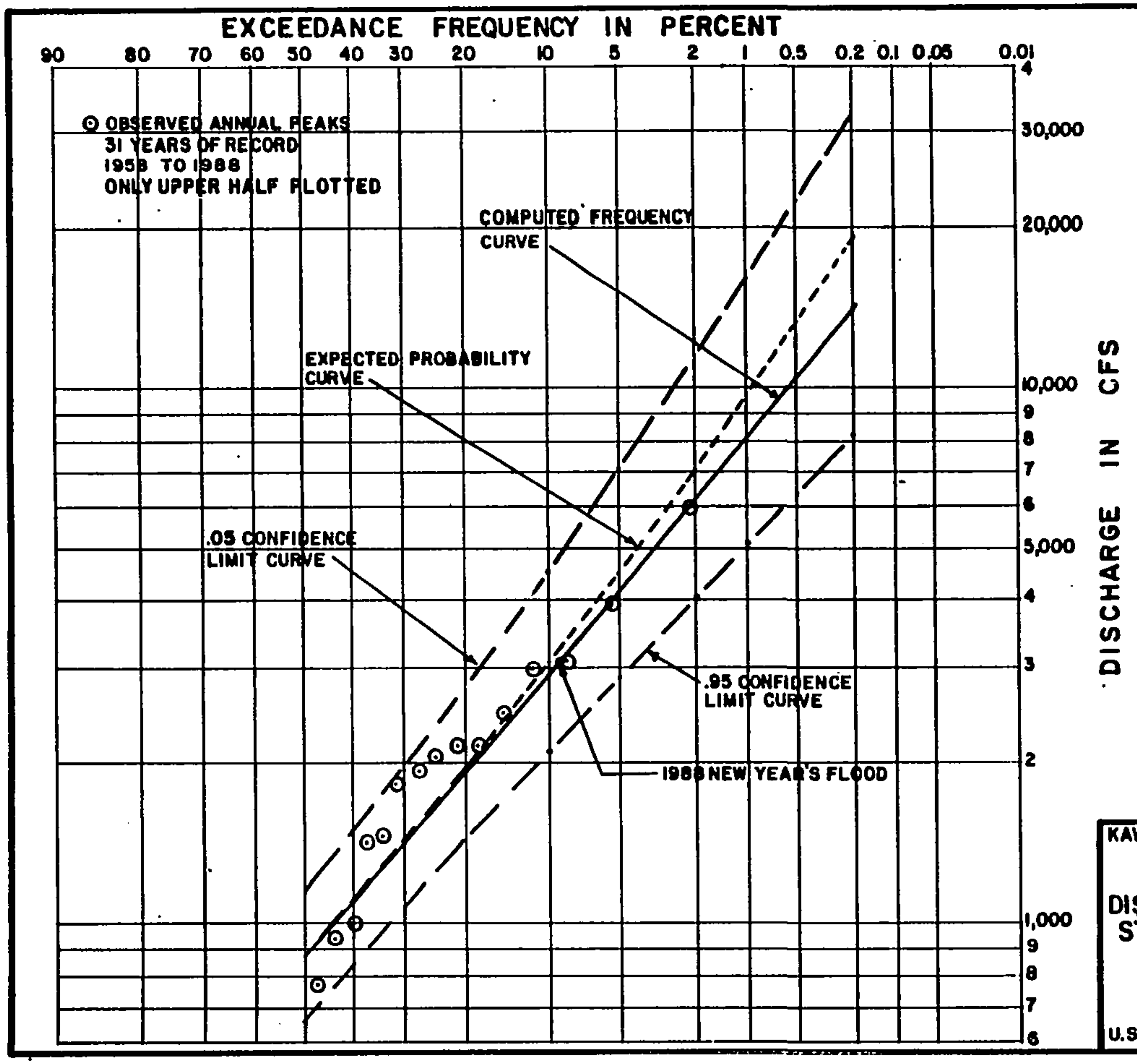
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 3



LOCATION MAP
ISLAND OF OAHU
PACIFIC
OCEAN
PROJECT AREA
KANEOHE
KAILUA
WAIMANALO
HONOLULU
1500(59")
2000(79")
3000(118")
4000(157")
4000
3000
2000
1500
1000(39")
800(32")
600(24")
ISOHYETS IN MILLIMETERS AND (INCHES)
NORTH
1 0 1 2 3
scale in mile
STATE OF HAWAII
DEPARTMENT OF LAND & NATURAL RESOURCES
DIVISION OF WATER & LAND DEVELOPMENT
KAWAINUI MARSH
OAHU, HAWAII
MEDIAN ANNUAL RAINFALL
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 4

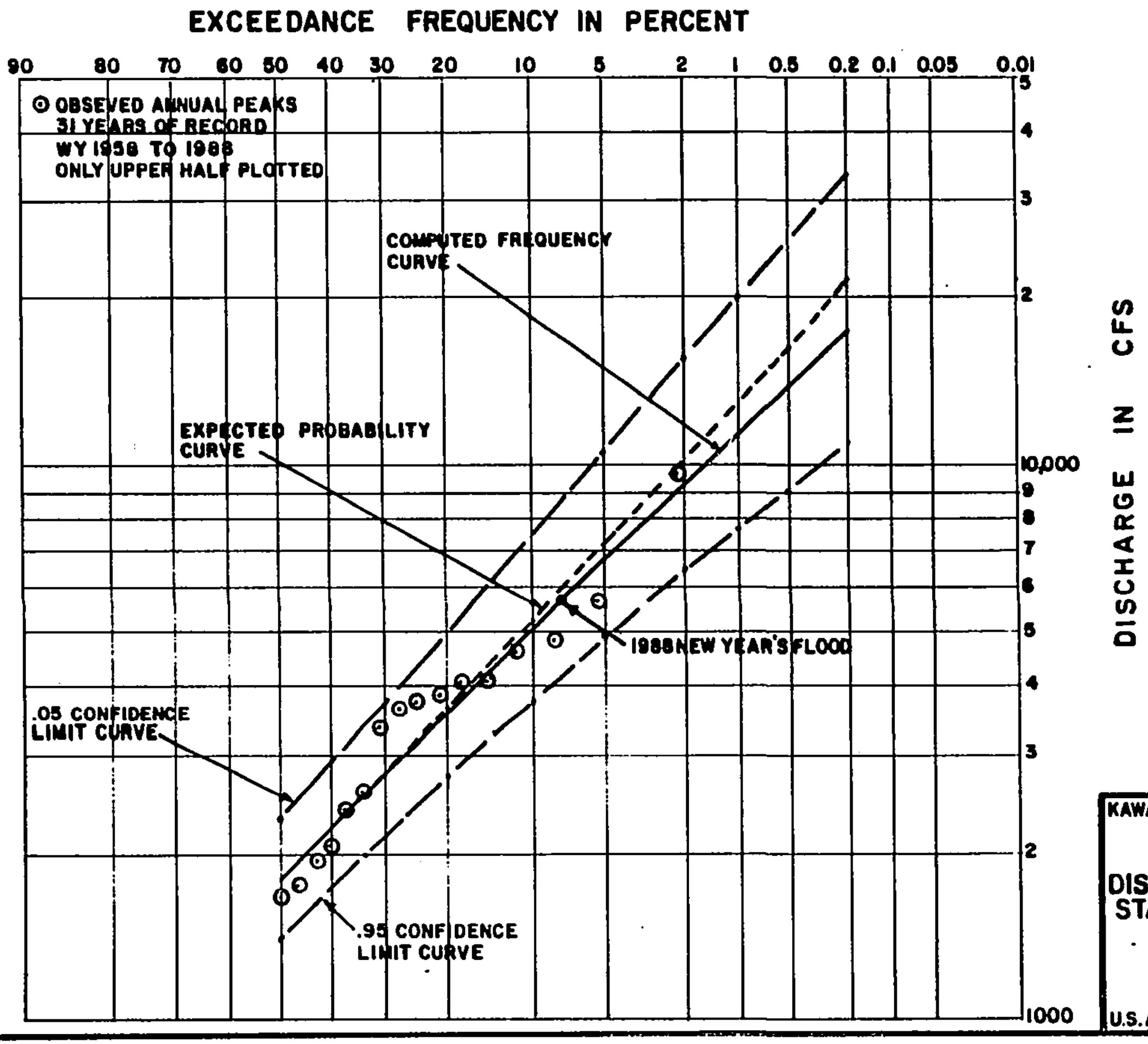


KAWAINUI MARSH OAHU, HAWAII

DISCHARGE-FREQUENCY CURVES
STA. 2540 MAKAWAO STREAM
D.A. = 2.04 SQ. MI.

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 5

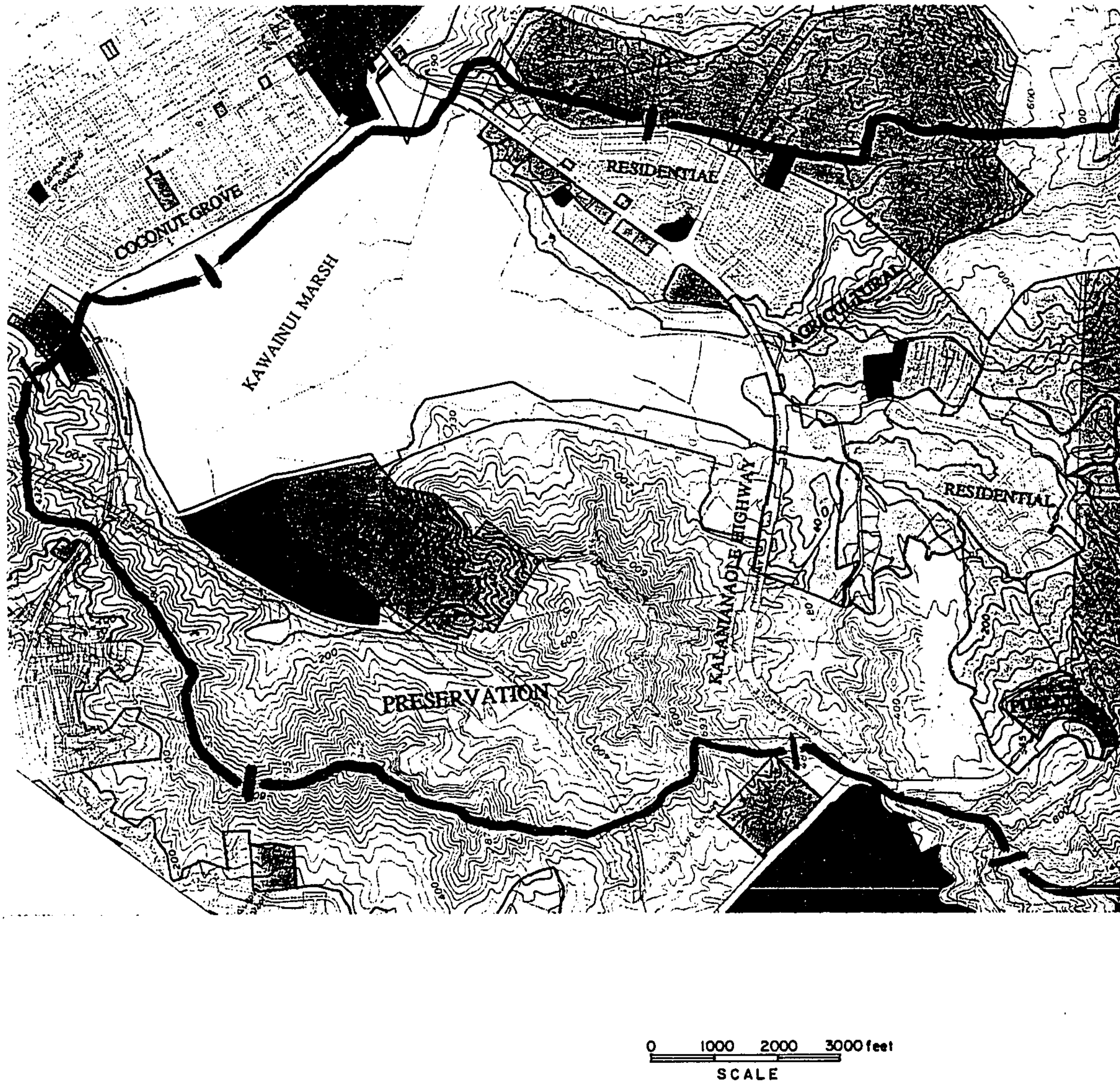


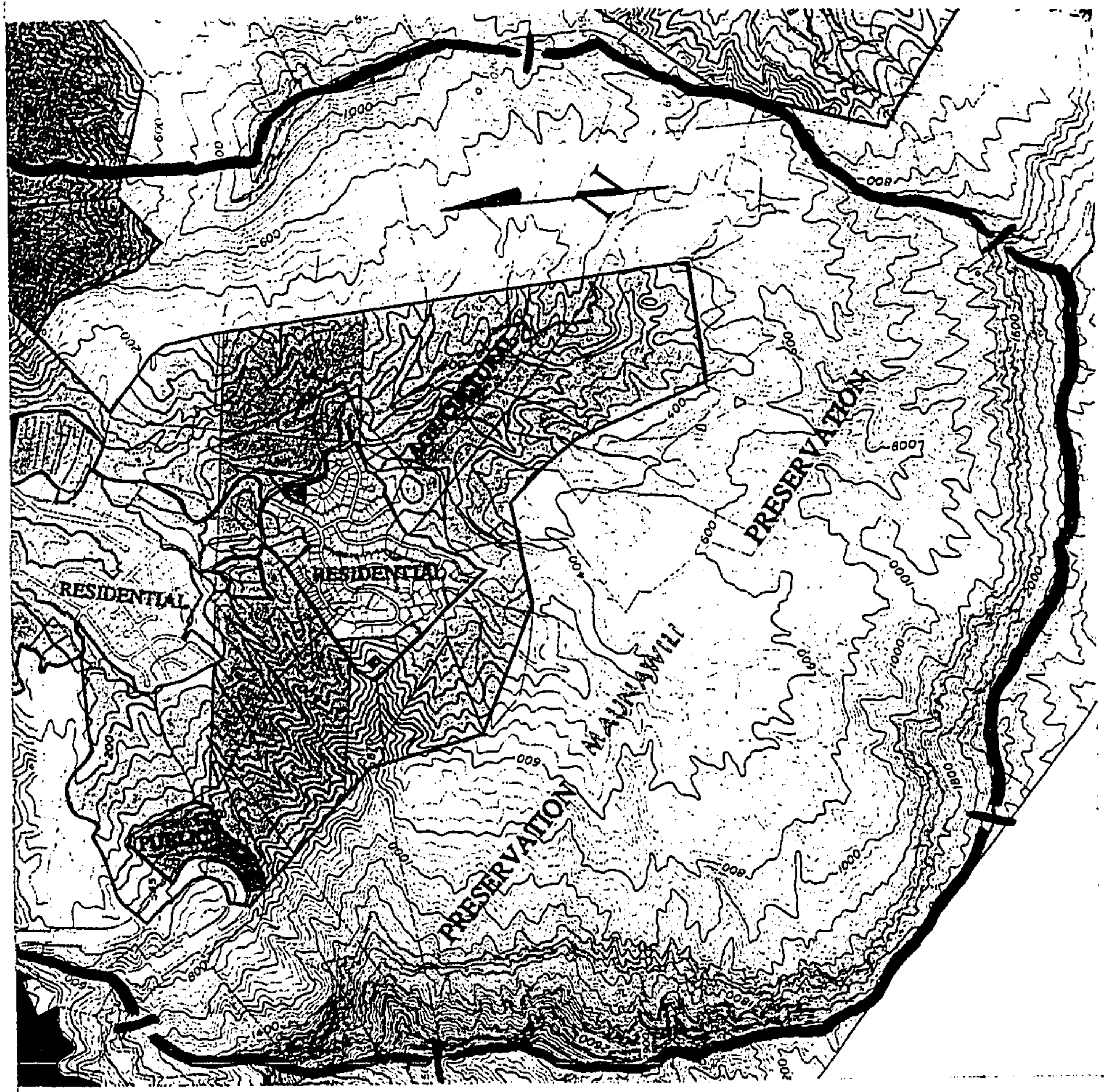
KAWAINUI MARSH — OAHU, HAWAII

DISCHARGE-FREQUENCY CURVES
STA. 2605 MAUNAWILI STREAM
DA = 5.34 SQ. MI.

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 6


COCONUT GROVE
KAWAINUI MARSH
RESIDENTIAL
AGRICULTURAL
RESIDENTIAL
KALANIANAOLE HIGHWAY
PRESERVATION
0 1000 2000 3000 feet
SCALE

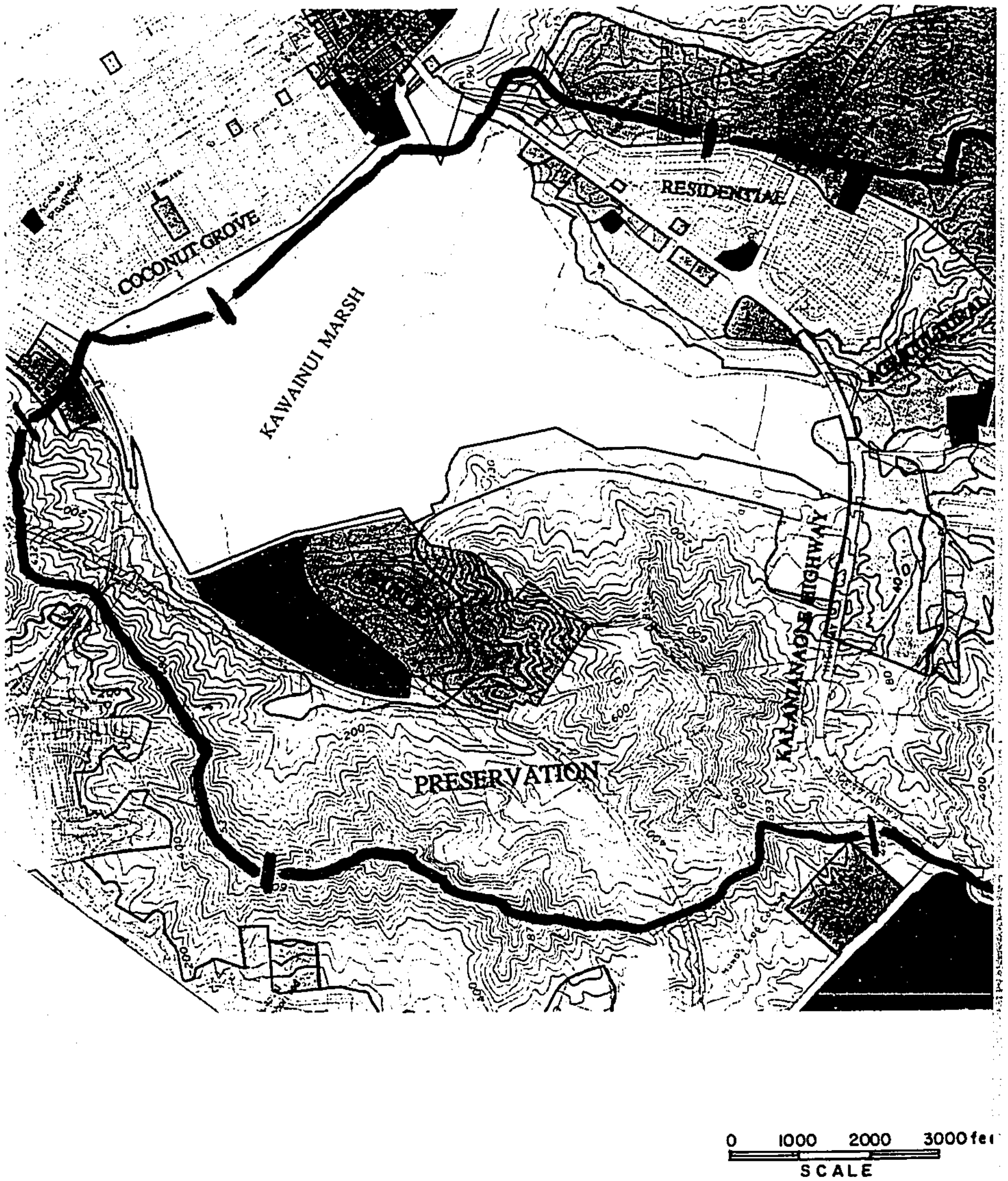


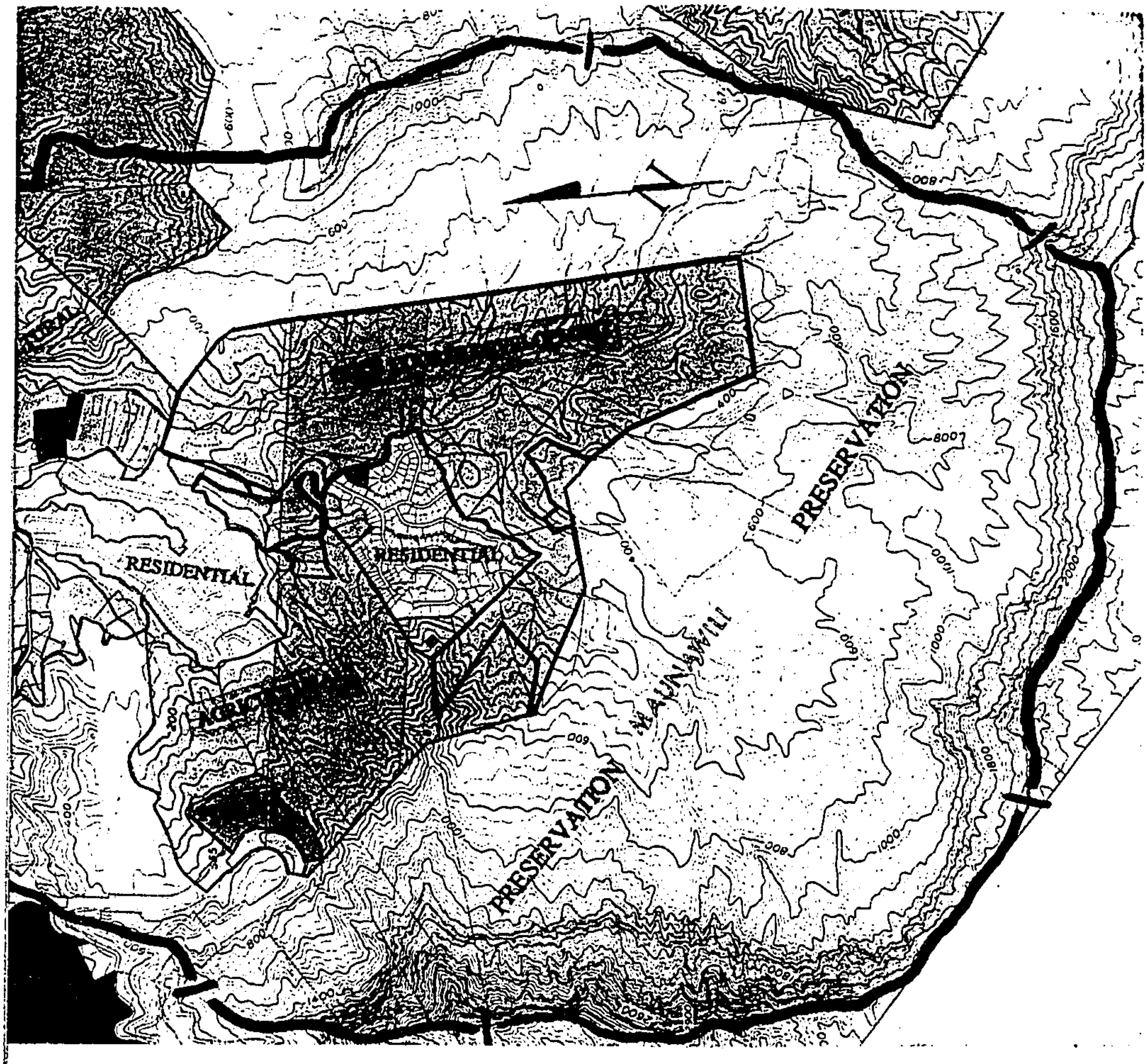
KAWAINUI MARSH OAHU, HAWAII

EXISTING LAND USE MAP

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 7


COCONUT GROVE
KAWAINUI MARSH
RESIDENTIAL
PRESERVATION
KALANIANAOLE HIGHWAY
0 1000 2000 3000
SCALE



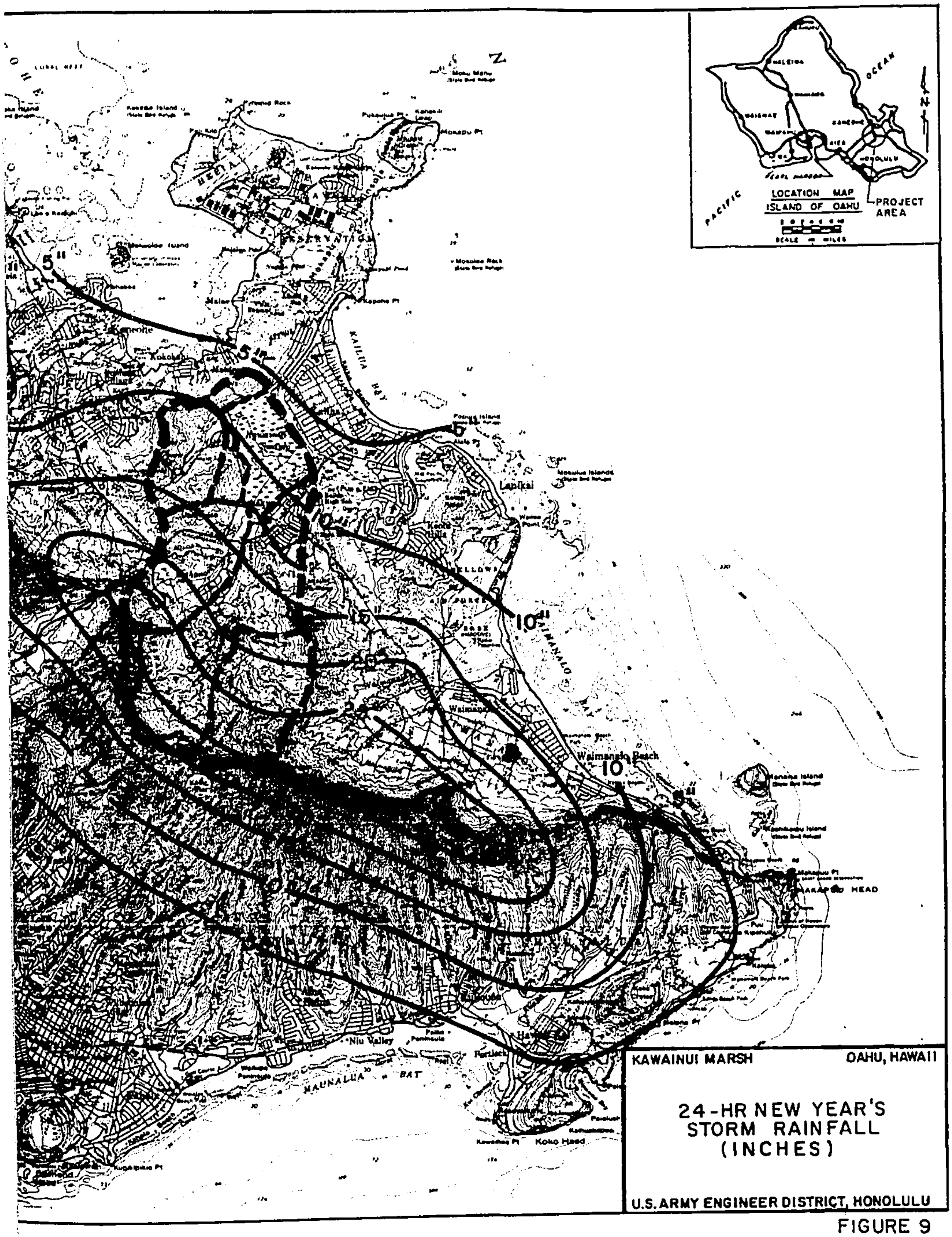
KAWAINUI MARSH OAHU, HAWAII

FUTURE LAND USE MAP

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 8

SOURCE: "POST FLOOD REPORT, NEW YEAR'S EVE STORM DECEMBER 31, 1987 - JANUARY 1, 1988 WINDWARD AND LEEWARD EAST OAHU", CIRCULAR C119 STATE DEPARTMENT OF LAND AND NATURAL RESOURCES JULY 1988

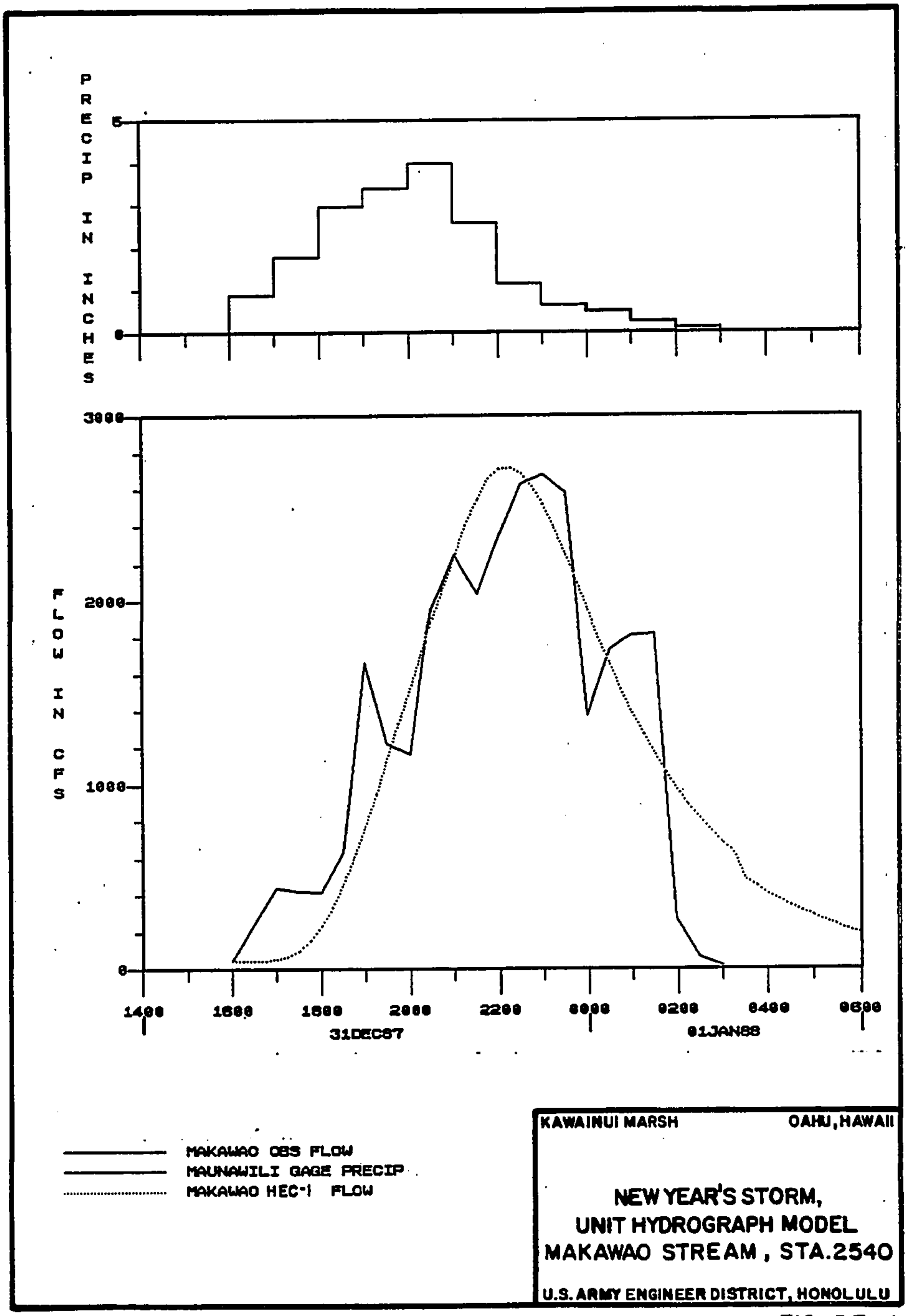


KAWAINUI MARSH — OAHU, HAWAII

24-HR NEW YEAR'S STORM RAINFALL (INCHES)

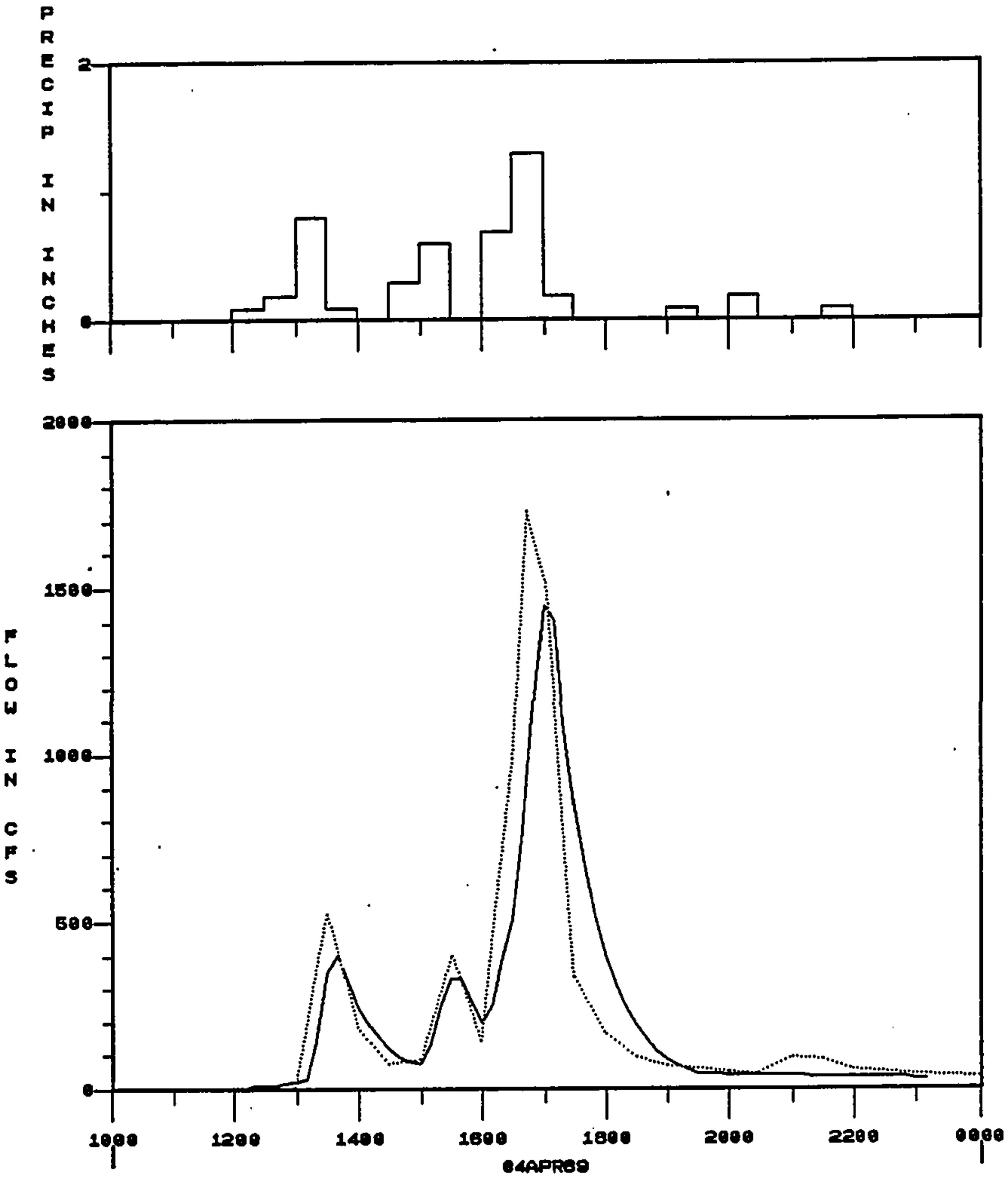
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 9



PRECIP IN INCHES
5
0
FLOW IN CFS
3000
2000
1000
0
1400
1600
1800
2000
2200
0000
0200
0400
0600
31DEC87
01JAN88
MAKAWAO OBS FLOW
MAUNAWILI GAGE PRECIP
MAKAWAO HEC-1 FLOW
KAWAINUI MARSH
OAHU, HAWAII
NEW YEAR'S STORM, UNIT HYDROGRAPH MODEL MAKAWAO STREAM, STA.2540
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 10

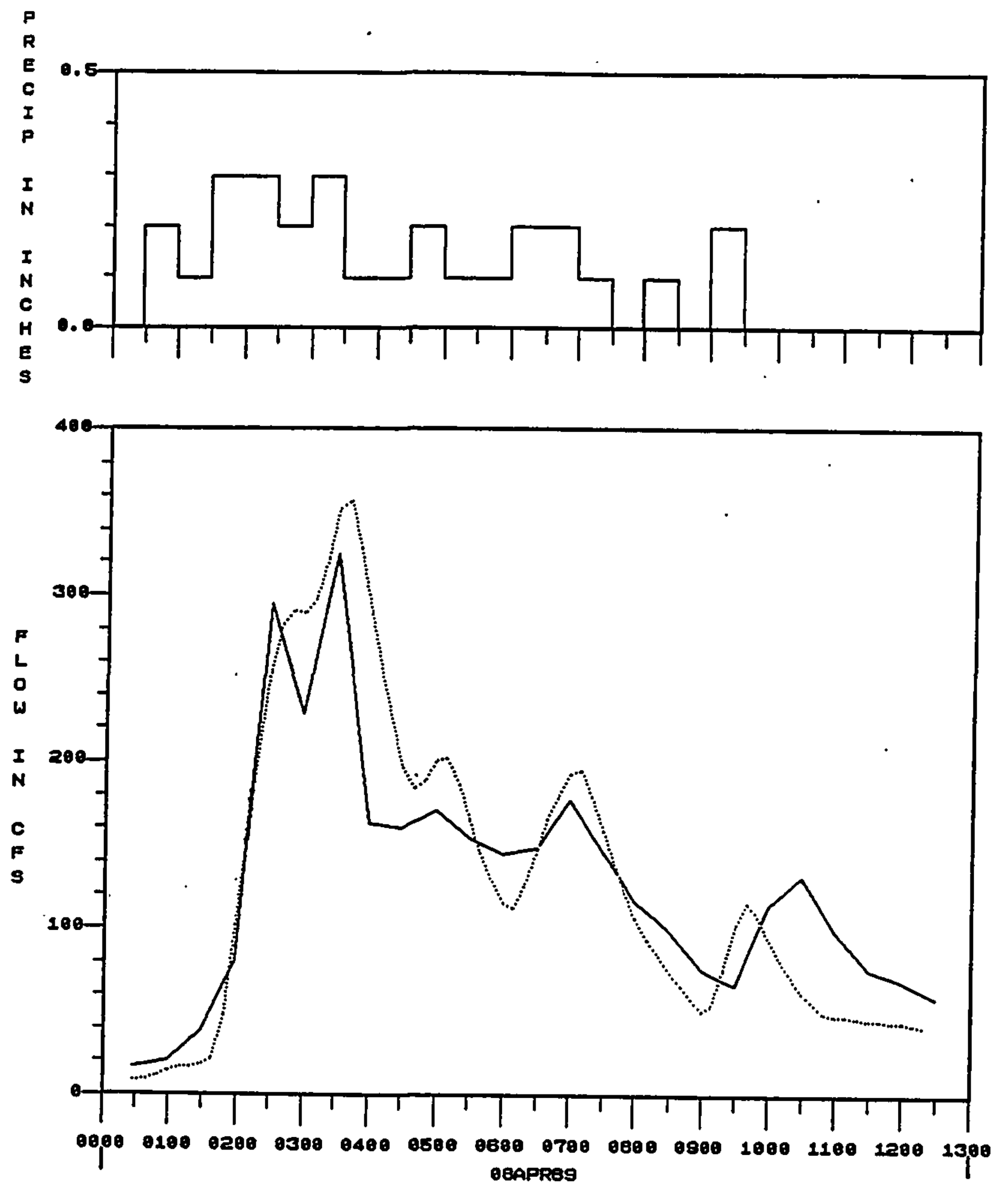


KAWAINUI MARSH OAHU, HAWAII

APRIL 4, 1989 STORM,
UNIT HYDROGRAPH MODEL
MAKAWAO STREAM, STA. 2540

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 11



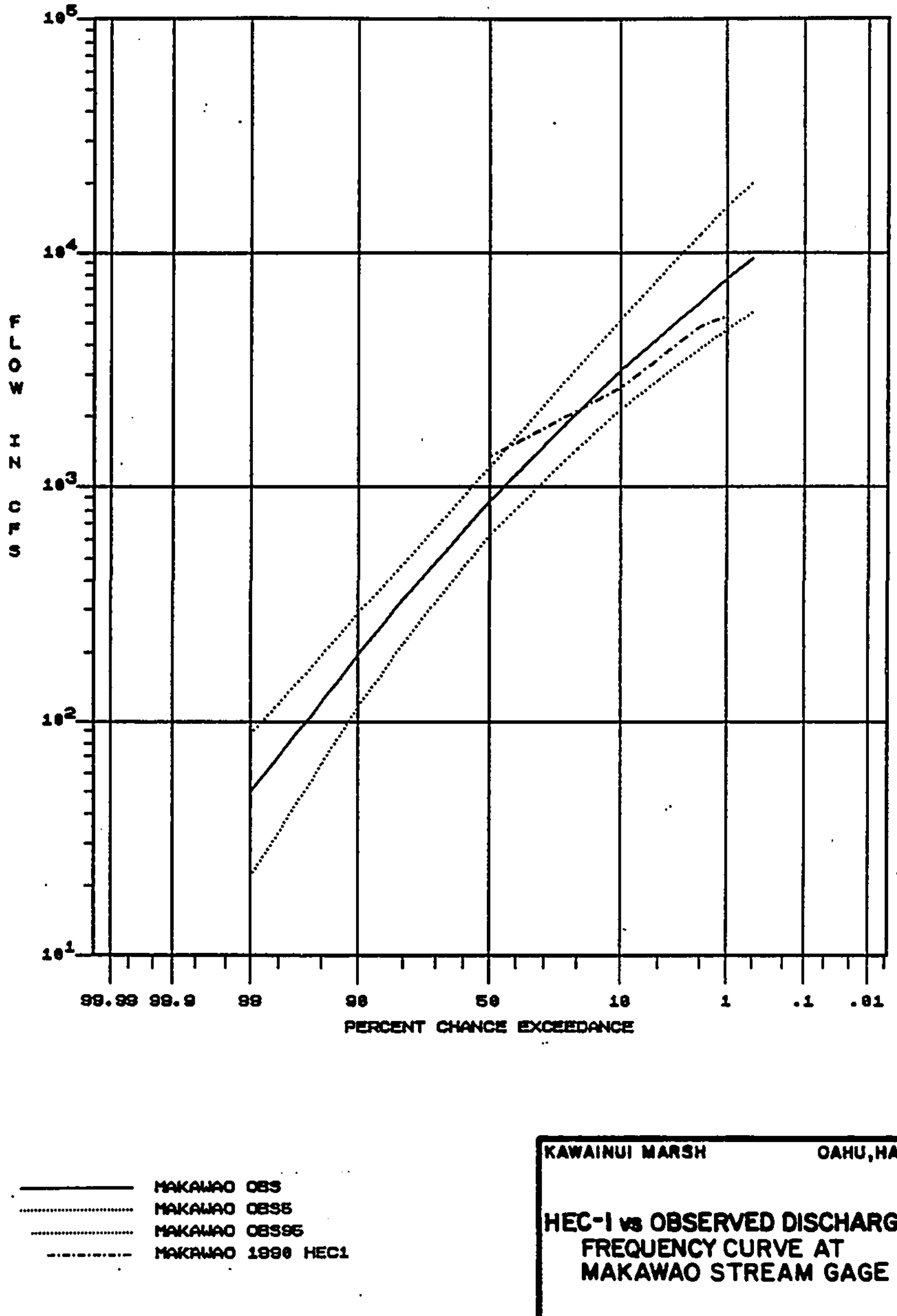
MAKAWAO OBS PRECIP
MAKAWAO OBS FLOW
MAKAWAO HEC-1 FLOW

KAWAINUI MARSH OAHU, HAWAII

APRIL 8, 1989 STORM,
UNIT HYDROGRAPH MODEL
MAKAWAO STREAM, STA. 2540

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 12

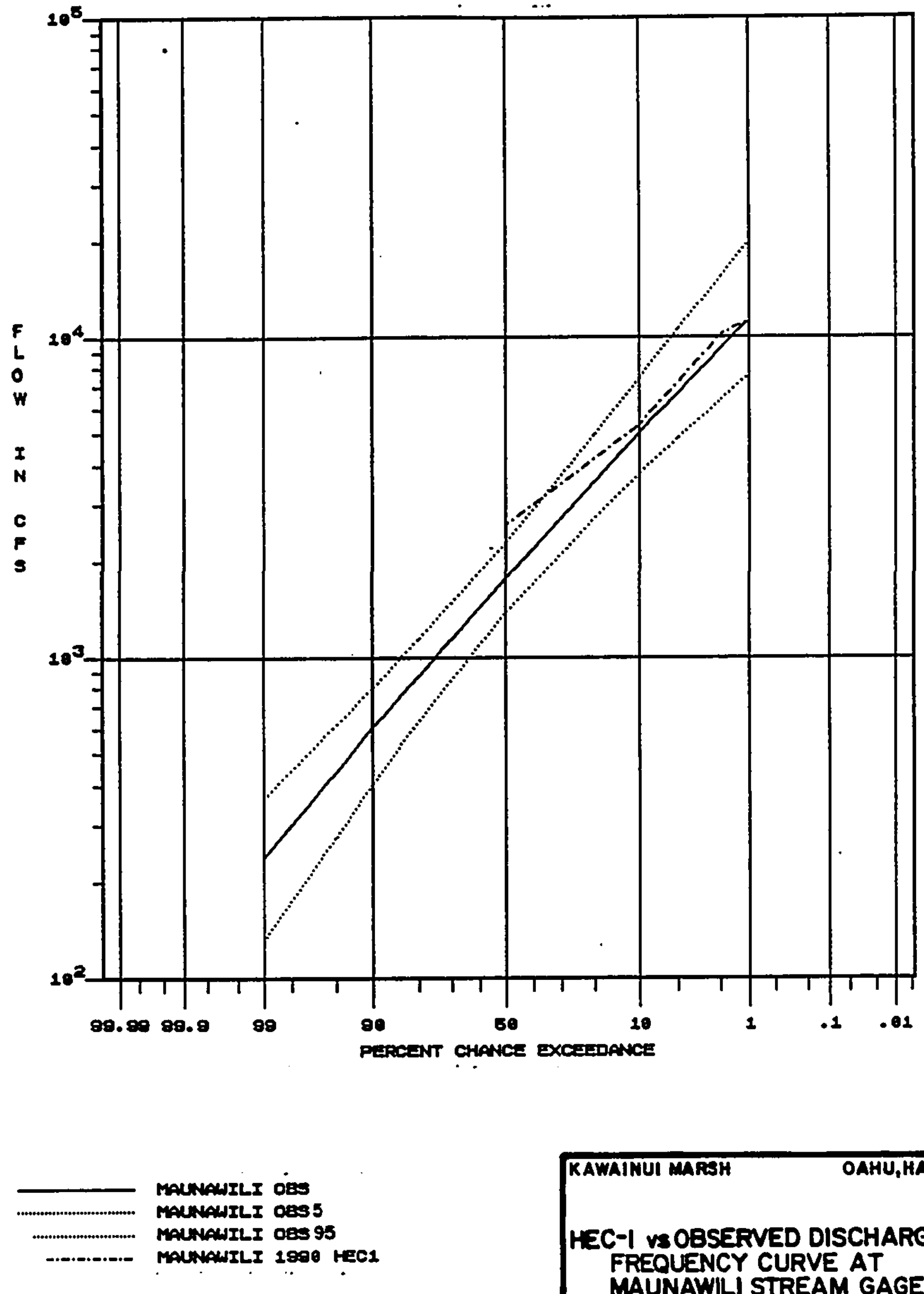


KAWAINUI MARSH OAHU, HAWAII

HEC-1 vs OBSERVED DISCHARGE-FREQUENCY CURVE AT MAKAWAO STREAM GAGE

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 13

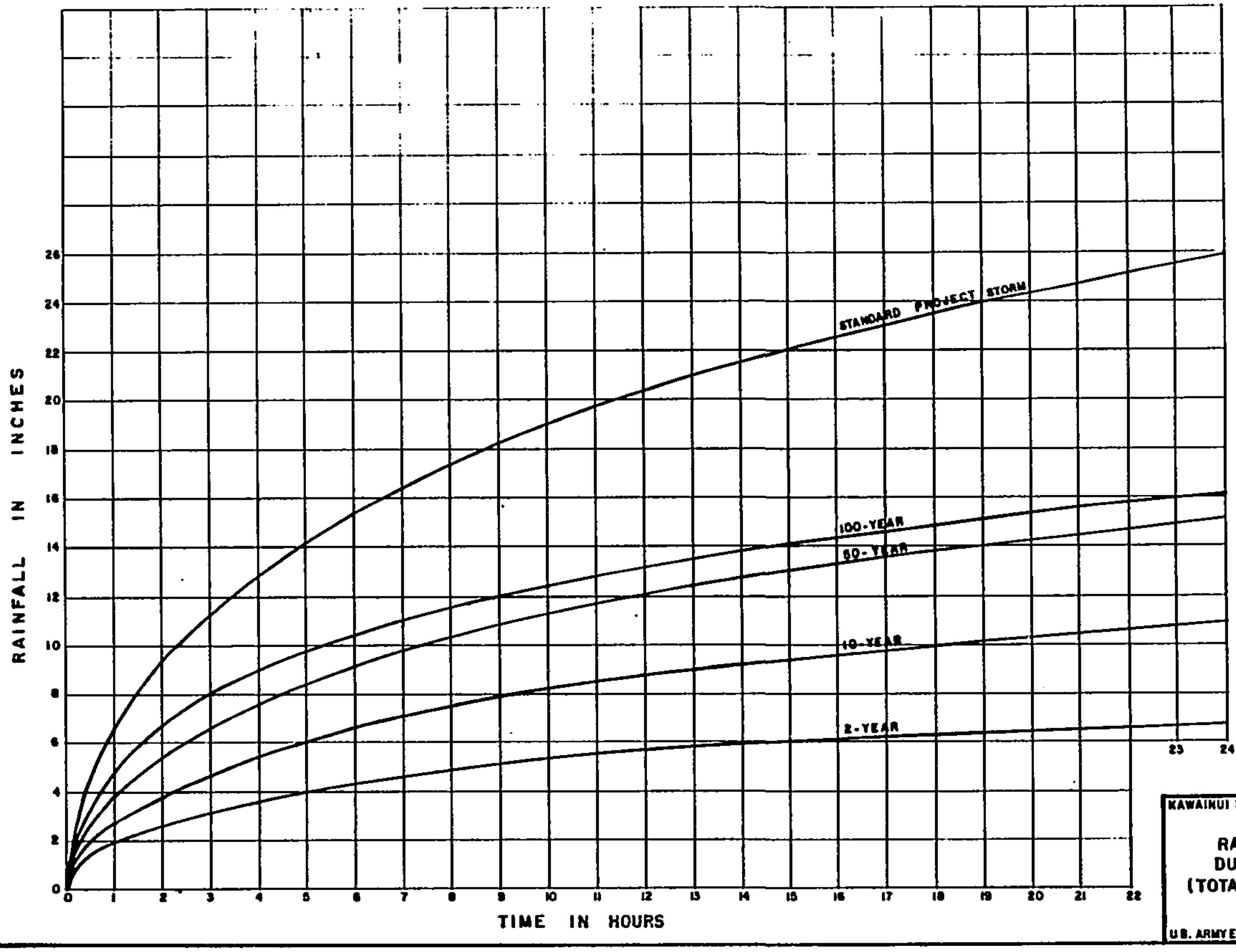


KAWAINUI MARSH OAHU, HAWAII

HEC-1 vs OBSERVED DISCHARGE-FREQUENCY CURVE AT MAUNAWILI STREAM GAGE

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 14

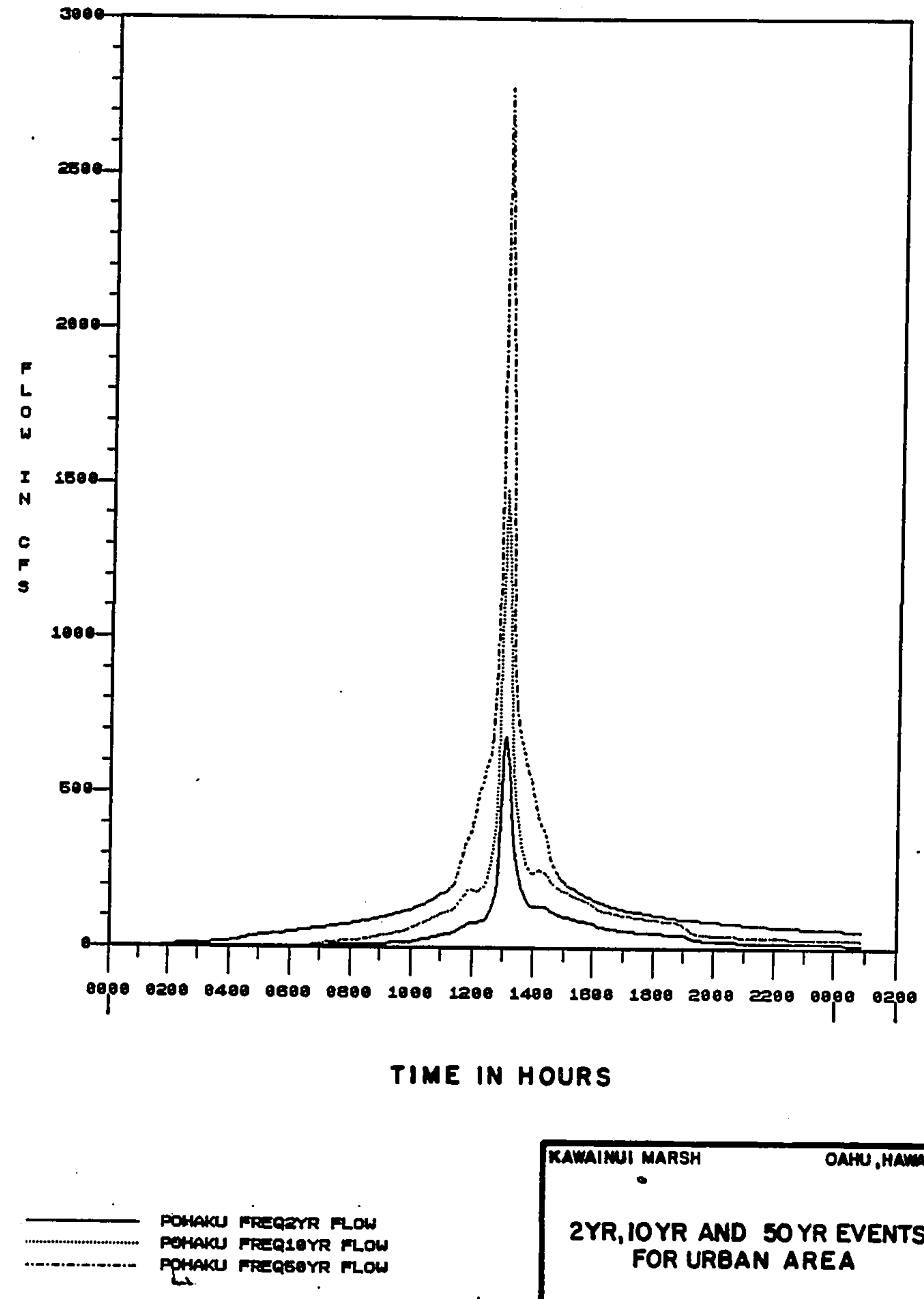


KAWAINUI MARSH OAHU, HAWAII

RAINFALL-DEPTH
DURATION CURVES
(TOTAL D.A. OF 10.62 SQ.MI.)

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 15

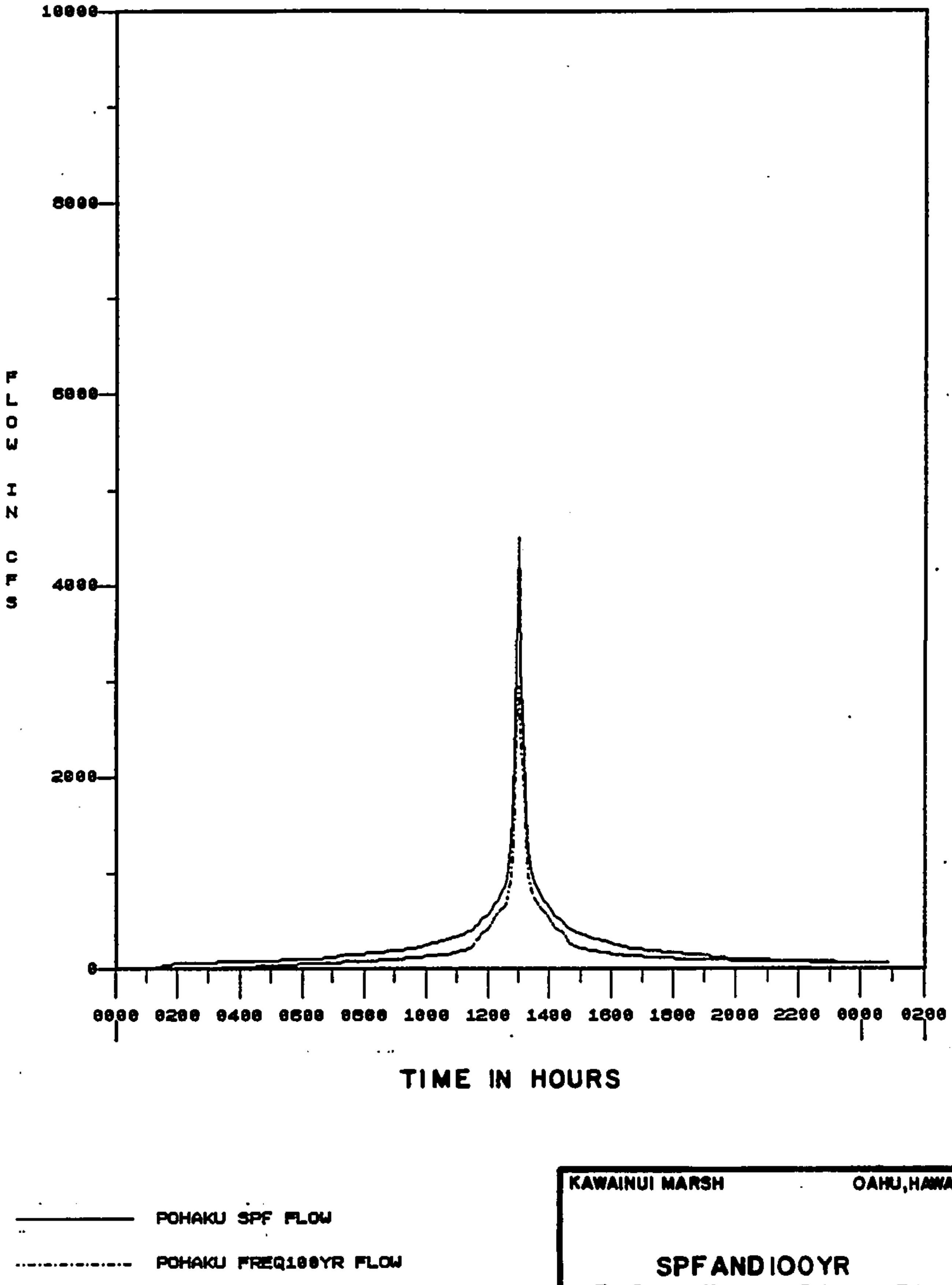


KAWAINUI MARSH OAHU, HAWAII

2YR, 10YR AND 50YR EVENTS
FOR URBAN AREA

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 16

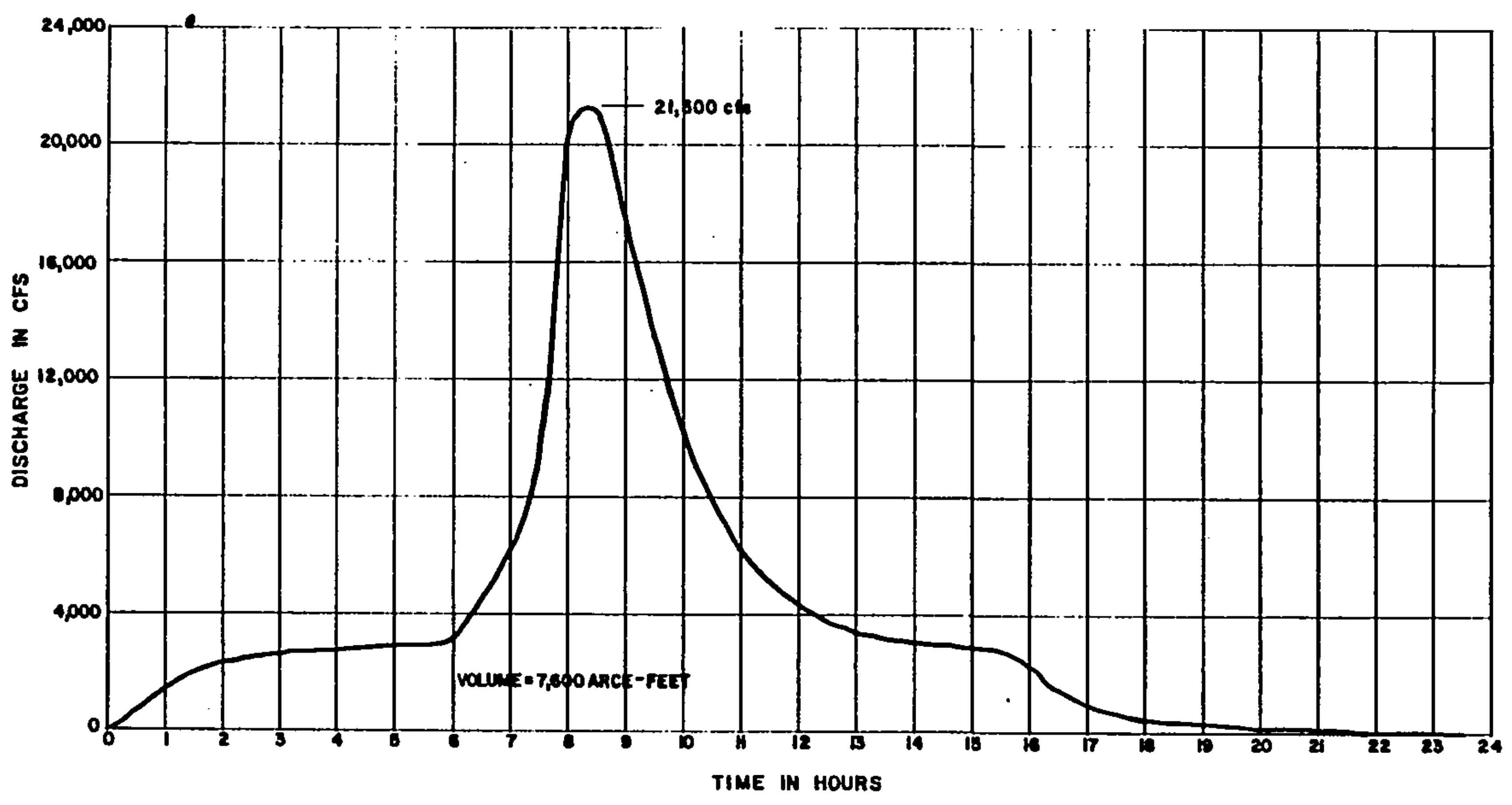


KAWAINUI MARSH OAHU, HAWAII

SPF AND 100YR
EVENTS FOR URBAN AREA

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 17

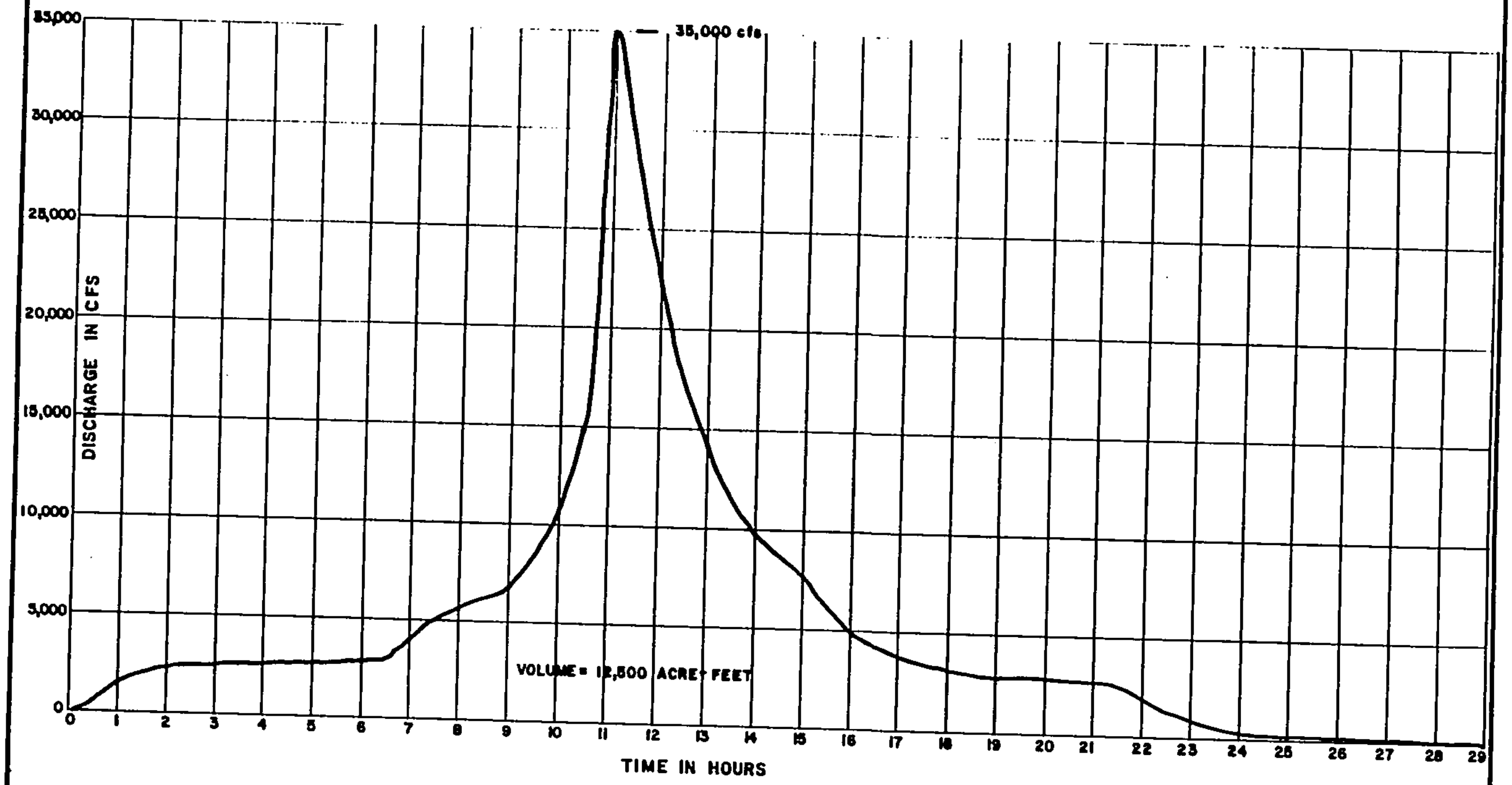


KAWAINUI MARSH OAHU, HAWAII

INFLOW HYDROGRAPH
FOR THE
100-YEAR EVENT

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 18

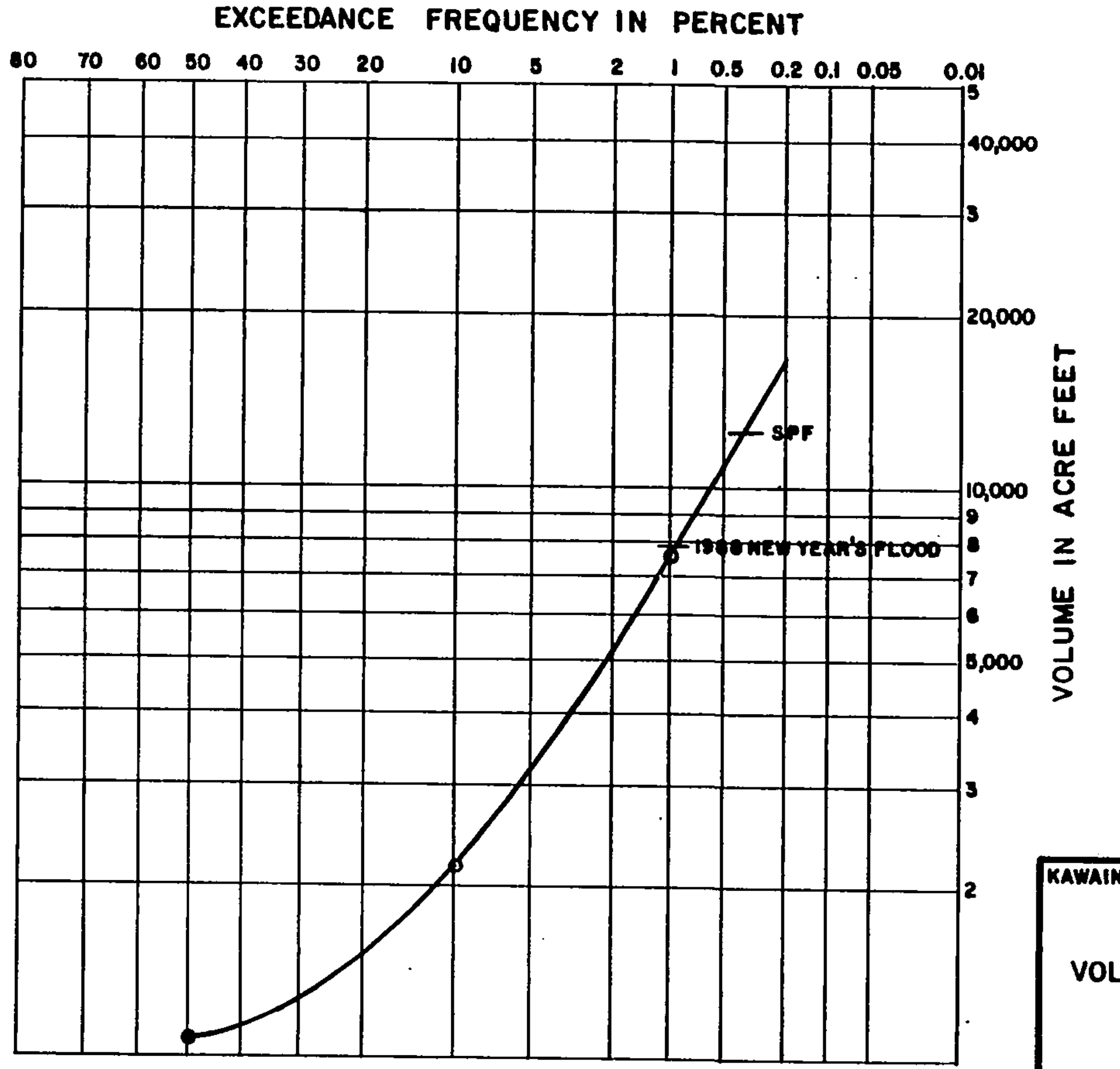


KAWAINUI MARSH OAHU, HAWAII

INFLOW HYDROGRAPH
FOR THE
STANDARD PROJECT FLOOD

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 19

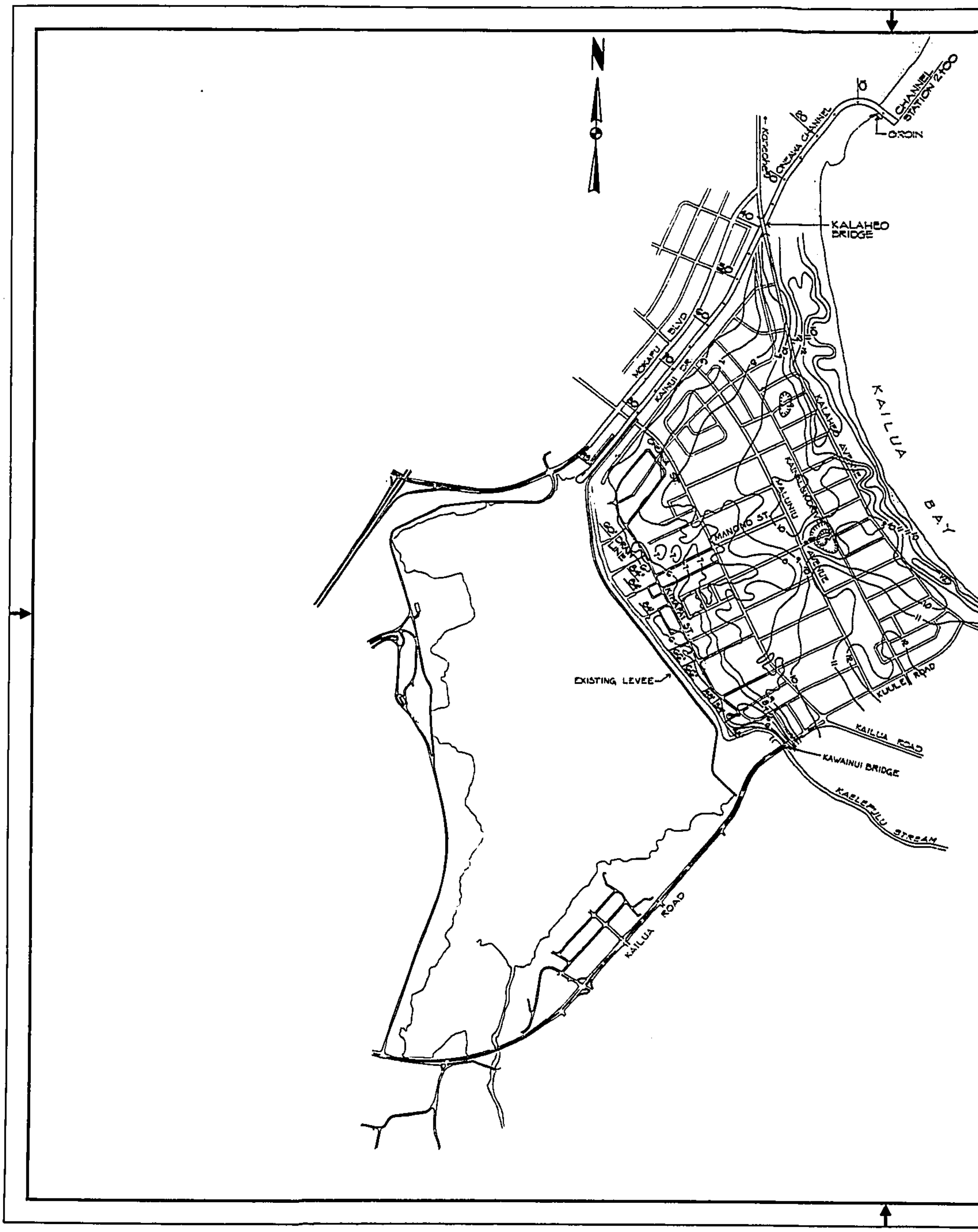


KAWAINUI MARSH OAHU, HAWAII

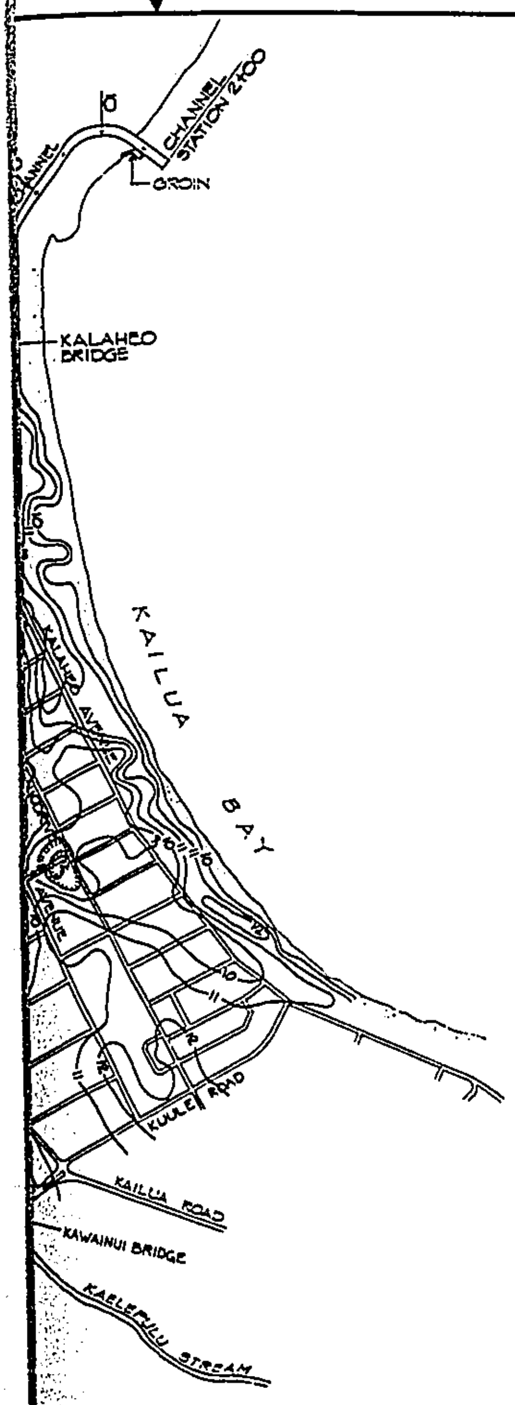
VOLUME FREQUENCY CURVE
KAWAINUI MARSH

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 20



N
CHANNEL STATION 2+00
GROIN
OKEAWA CHANNEL
KALAHEO BRIDGE
MOKAPU BLVD
KAILUA BAY
KALAHEO AVENUE
MANONO ST.
EXISTING LEVEE
KUULEI ROAD
KAILUA ROAD
KAWAINUI BRIDGE
KAELEPULU STREAM
KAILUA ROAD

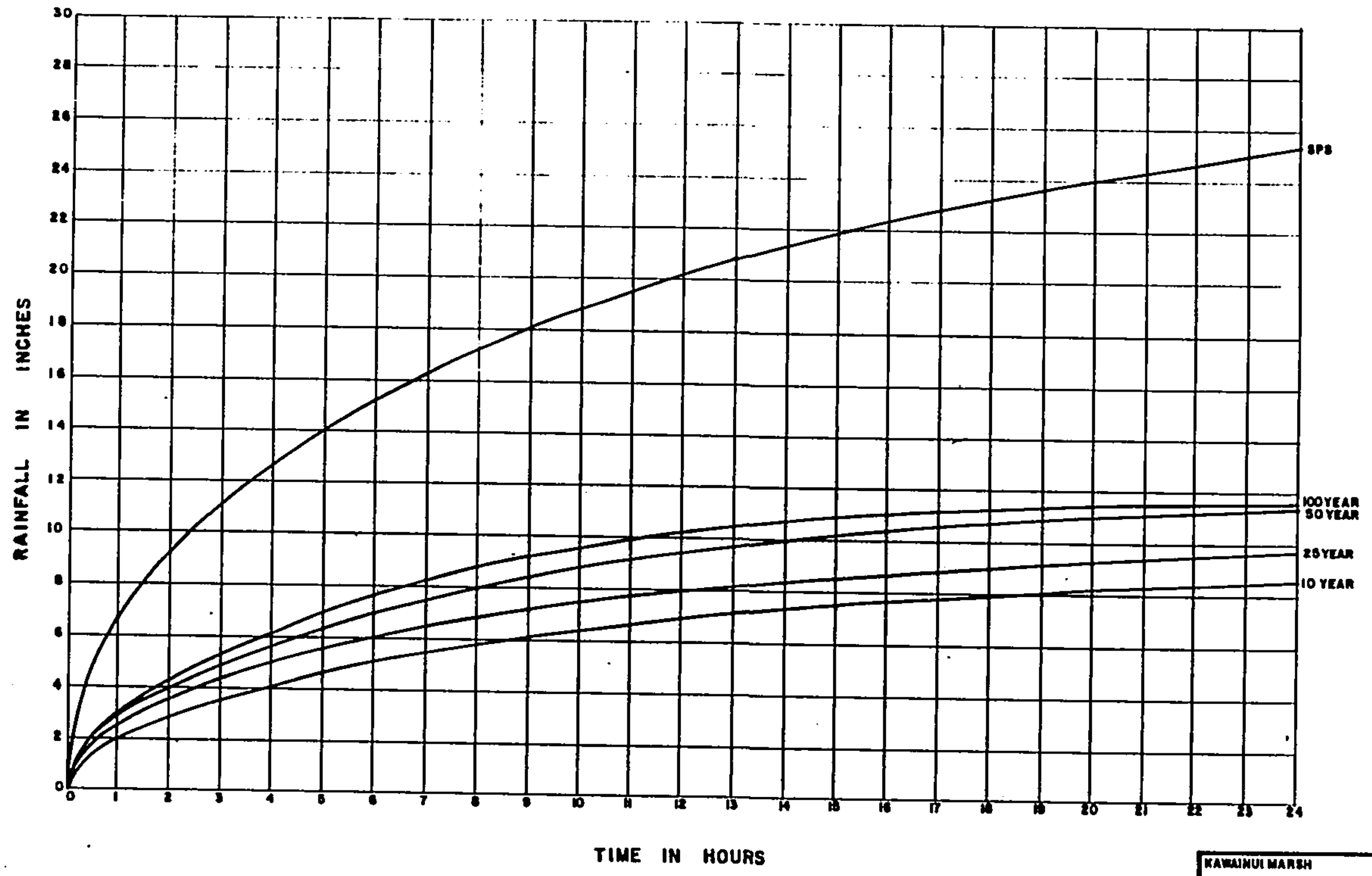


KAWAINUI MARSH OAHU, HAWAII

CONTOUR MAP OF INTERIOR DRAINAGE AREA

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 21

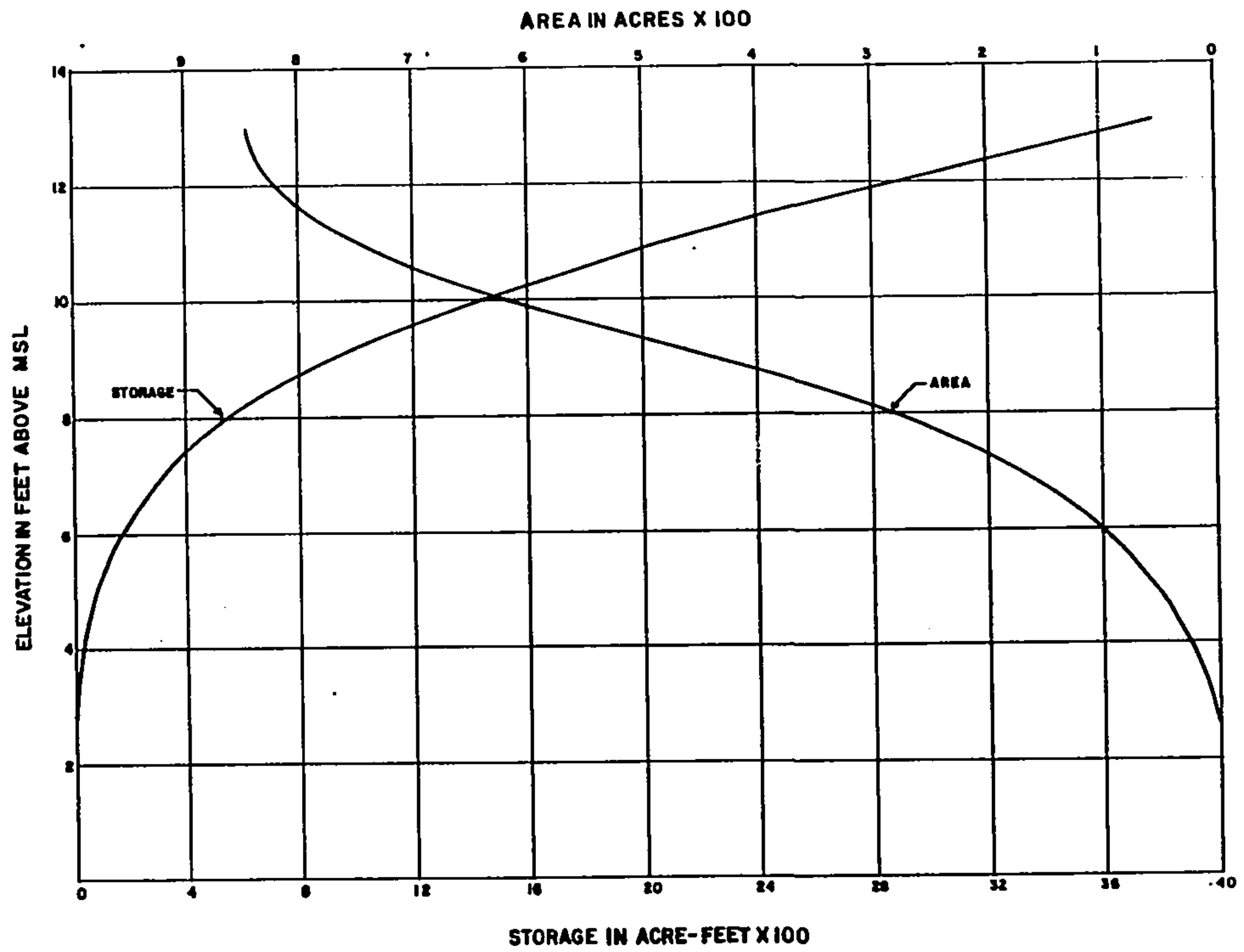


KAWAINUI MARSH OAHU, HAWAII

RAINFALL-DEPTH
DURATION CURVES
COCONUT GROVE AREA
D.A.= 0.85 SQ. MI.

U.S. ARMY ENGINEER DISTRICT, HONOLULU

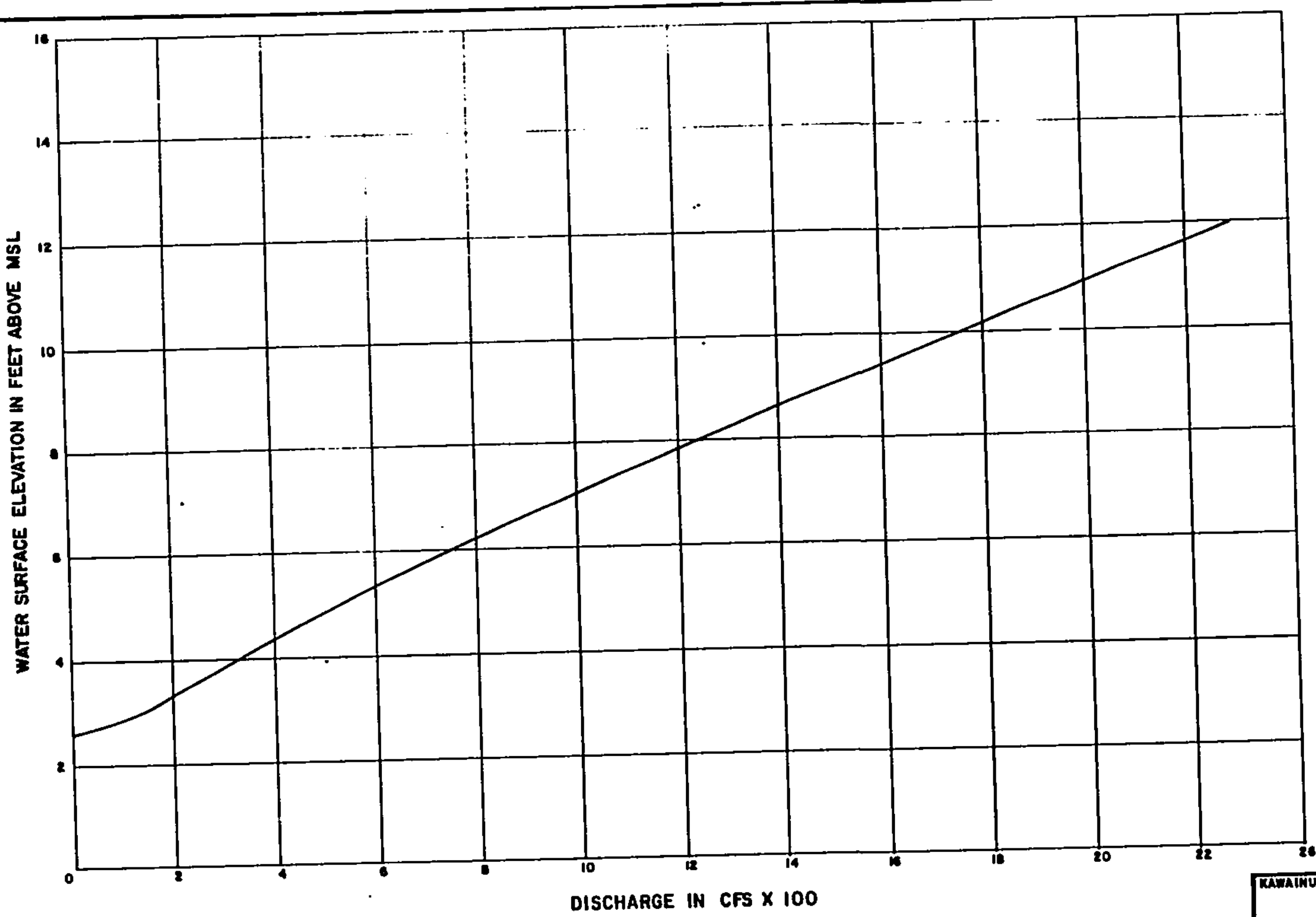
FIGURE 22



REFERENCE: CONTOUR MAP (SCALE 1"=400') FROM R.M. TOWILL REPORT "HYDROLOGIC STUDY FOR COCONUT GROVE IMPROVEMENT DISTRICT, KAILUA, OAHU, HAWAII" MARCH 1969

KAWAINUI MARSH	OAHU, HAWAII
AREA-STORAGE CURVES FOR COCONUT GROVE	
U.S. ARMY ENGINEER DISTRICT, HONOLULU	

FIGURE 23

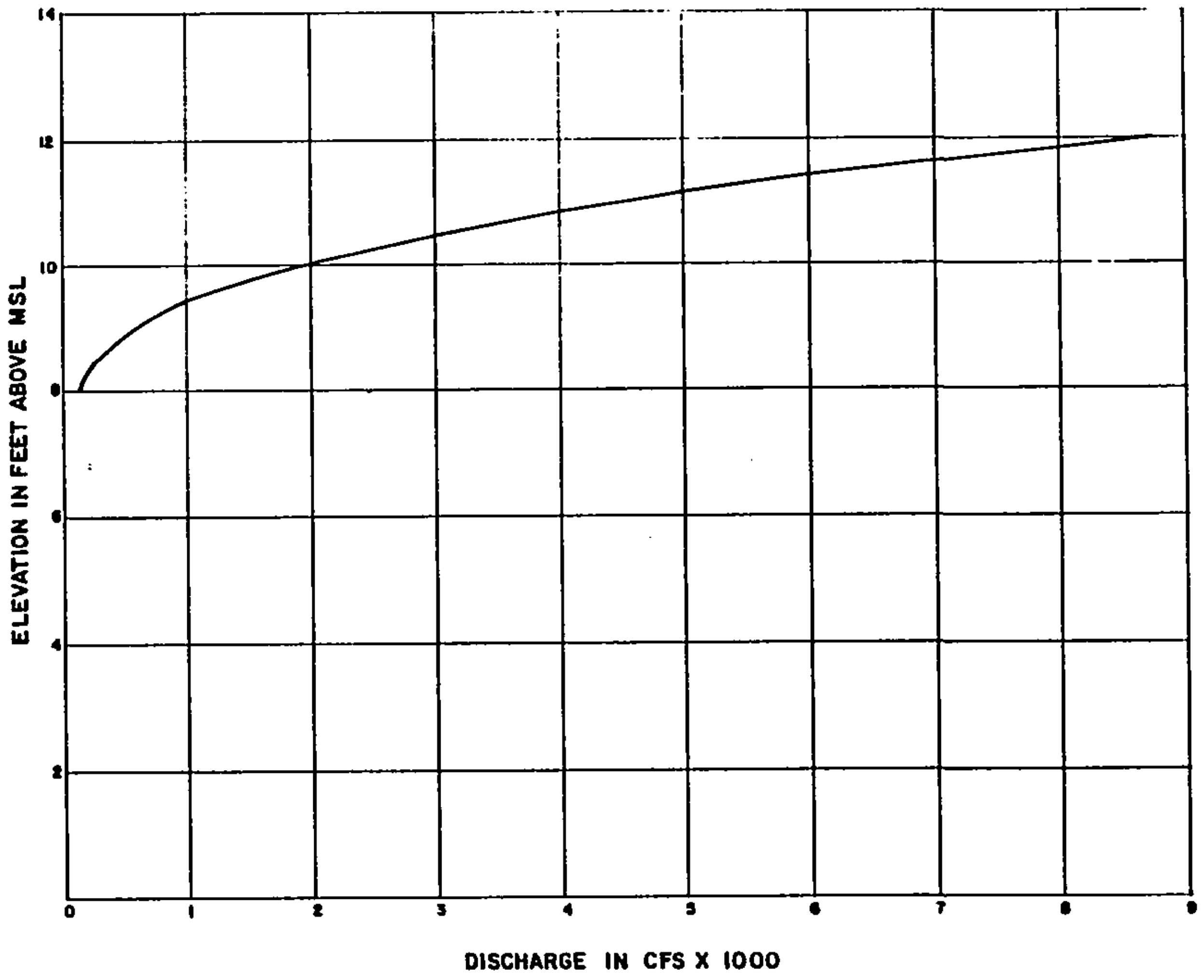


KAWAINUI MARSH OAHU, HAWAII

TAILWATER RATING CURVE
UPSTREAM OF KAWAINUI BRIDGE
ON KAELEPULU STREAM

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 24

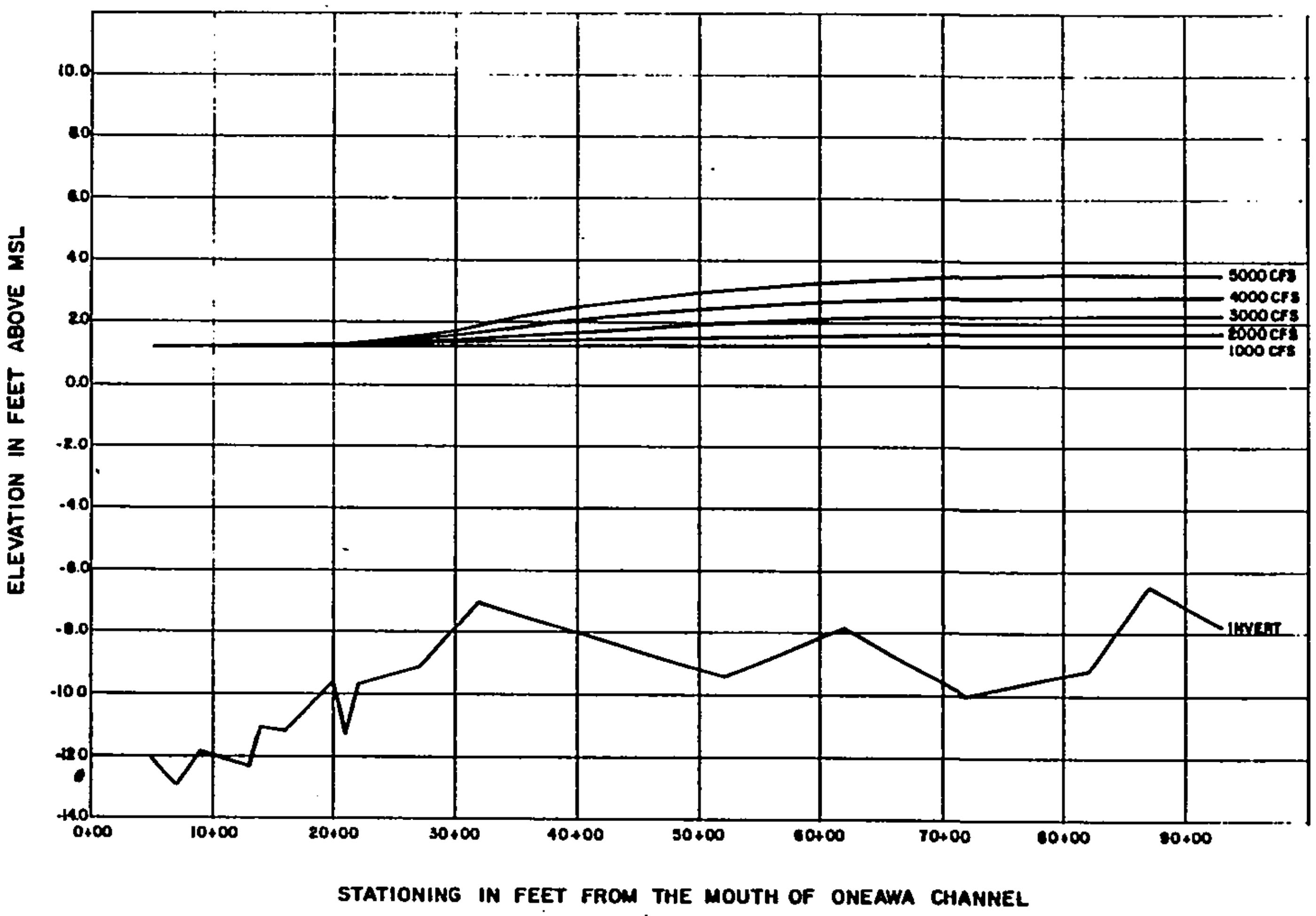


KAWAINUI MARSH — OAHU, HAWAII

TAILWATER RATING CURVE FOR DISCHARGE INTO ONEAWA CHANNEL

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 25

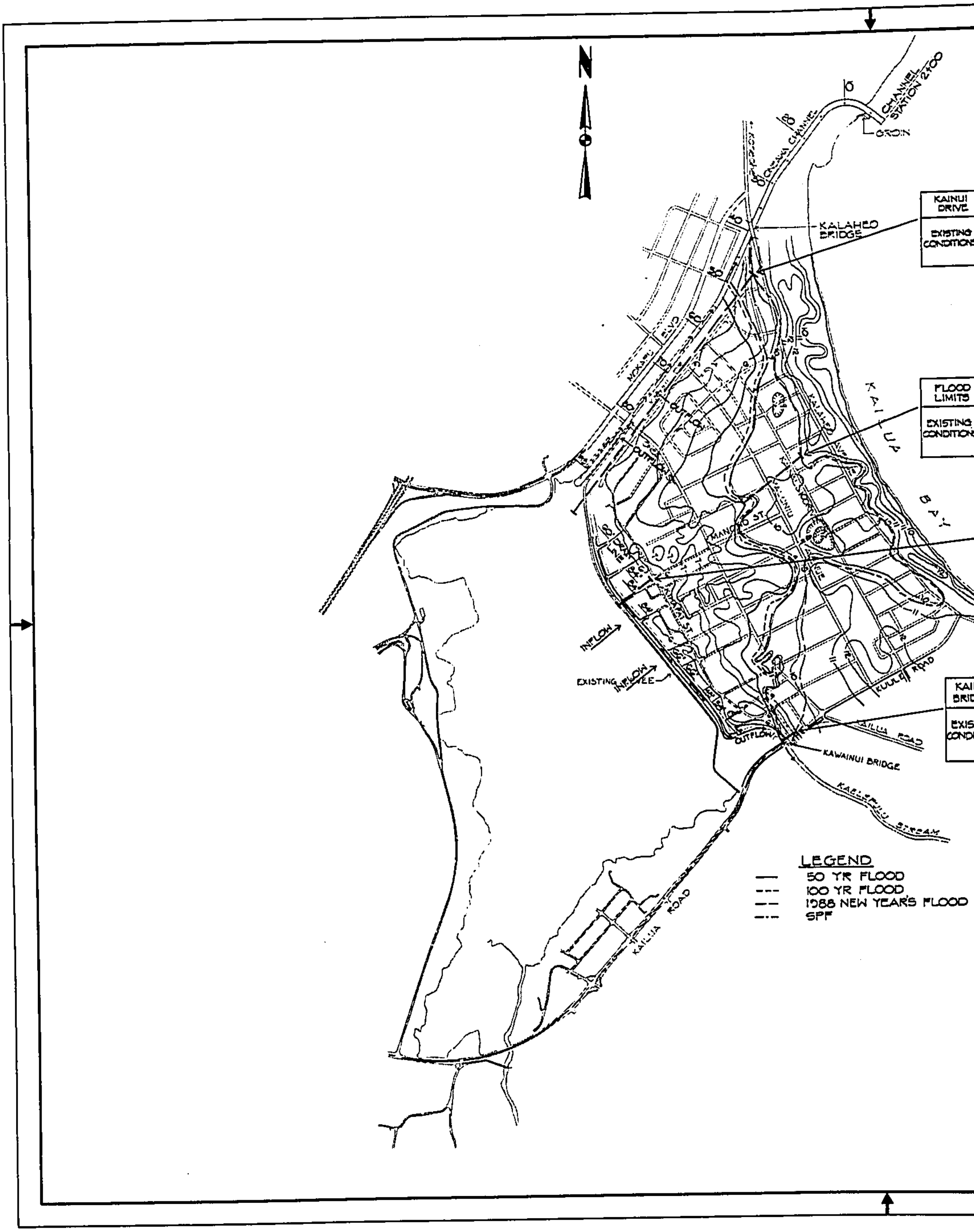


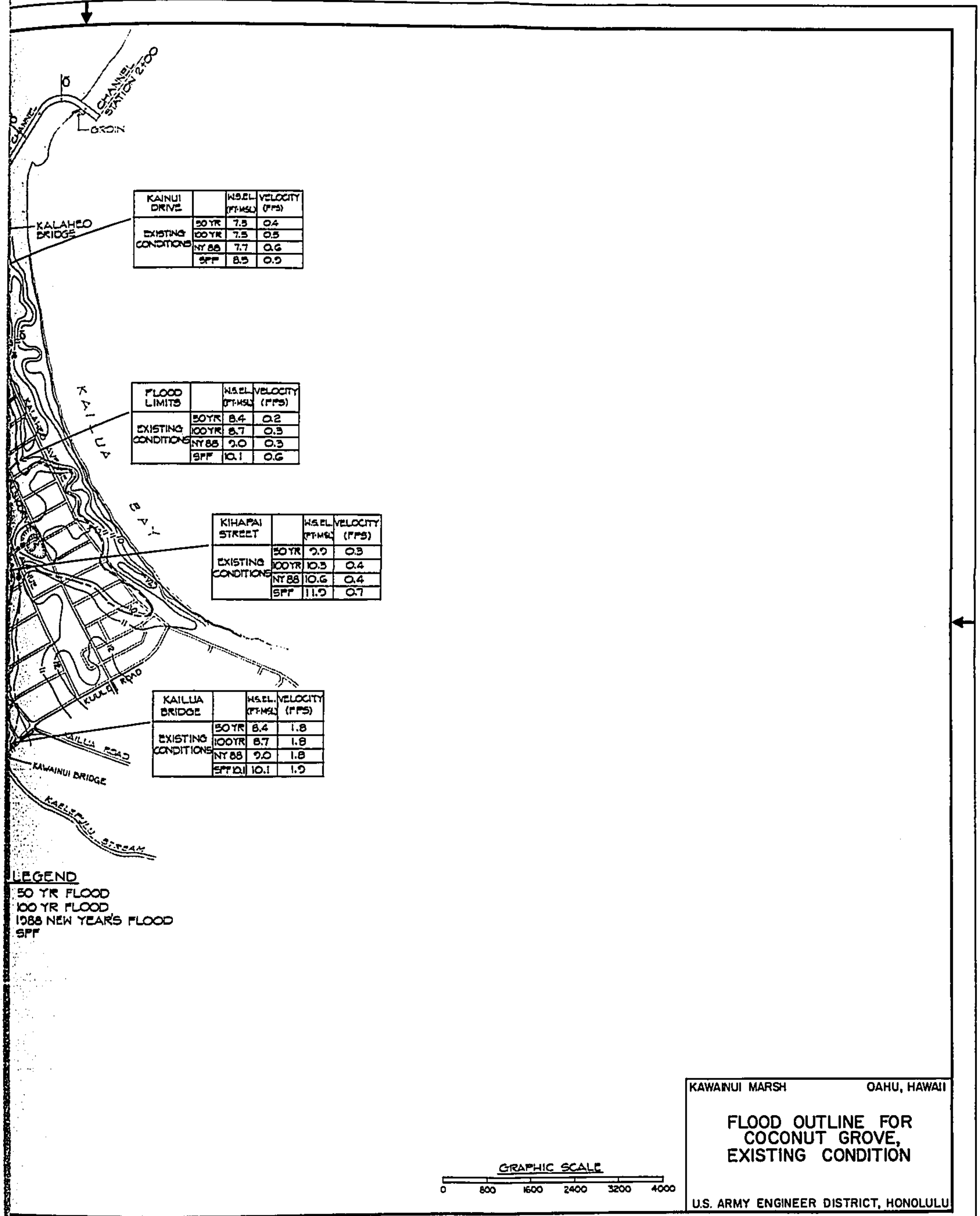
KAWAINUI MARSH OAHU, HAWAII

WATER SURFACE PROFILES
ONEAWA CHANNEL

U.S. ARMY ENGINEER DISTRICT, HONOLULU

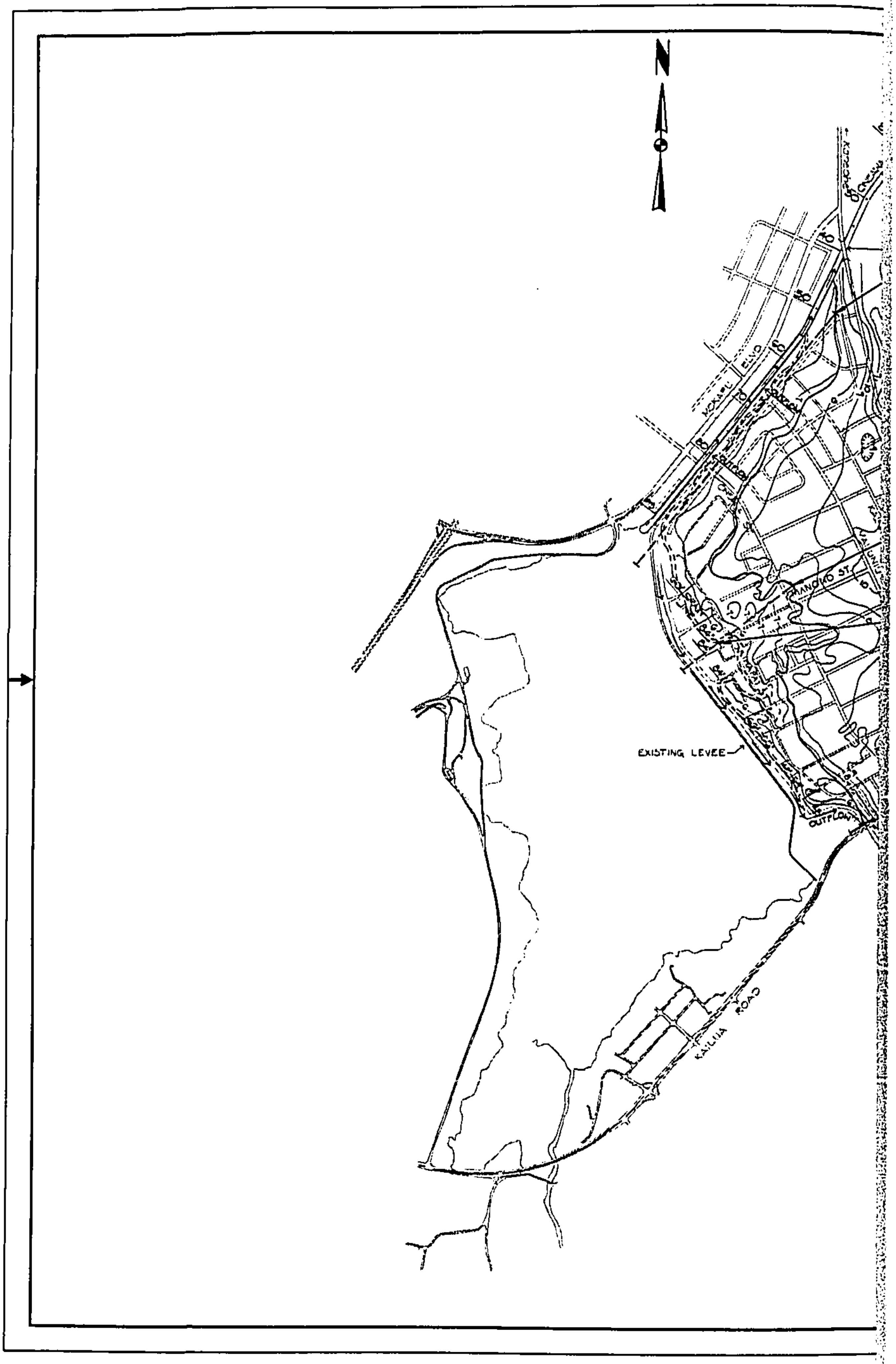
FIGURE 26

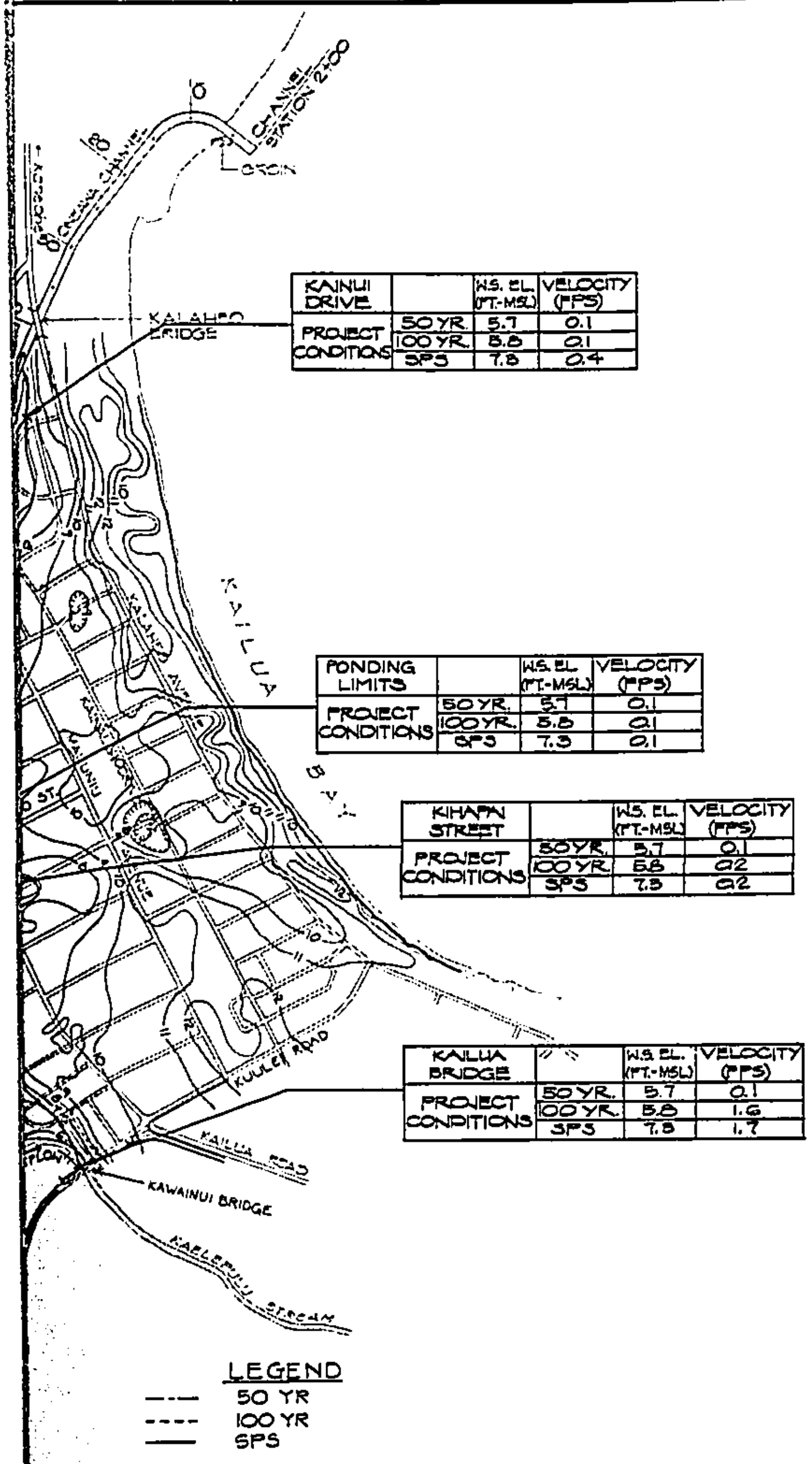

N
CHANNEL STATION 2400
GROIN
KAINUI DRIVE
EXISTING CONDITIONS
KALAHEO BRIDGE
FLOOD LIMITS
EXISTING CONDITIONS
KAILUA BAY
MANONO ST.
INFLOW
EXISTING LEVEE
INFLOW
KUULEI ROAD
OUTFLOW
KAWAINUI BRIDGE
KAILUA ROAD
KAELEPULU STREAM
LEGEND
50 YR FLOOD
100 YR FLOOD
1988 NEW YEAR'S FLOOD
SPF
KAILUA ROAD



CHANNEL STATION 2+00
GROIN
KALAHEO BRIDGE
KAILUA BAY
KUULEI ROAD
KAILUA ROAD
KAWAINUI BRIDGE
KAELEPULU STREAM
KAINUI DRIVE | W.S.EL. (FT-MSL) | VELOCITY (FPS)
EXISTING CONDITIONS 50 YR 7.5 0.4
100 YR 7.5 0.5
NY 88 7.7 0.6
SPF 8.5 0.9
FLOOD LIMITS | W.S.EL. (FT-MSL) | VELOCITY (FPS)
EXISTING CONDITIONS 50 YR 8.4 0.2
100 YR 8.7 0.3
NY 88 9.0 0.3
SPF 10.1 0.6
KIHAPAI STREET | W.S.EL. (FT-MSL) | VELOCITY (FPS)
EXISTING CONDITIONS 50 YR 9.9 0.3
100 YR 10.3 0.4
NY 88 10.6 0.4
SPF 11.9 0.7
KAILUA BRIDGE | W.S.EL. (FT-MSL) | VELOCITY (FPS)
EXISTING CONDITIONS 50 YR 8.4 1.8
100 YR 8.7 1.8
NY 88 9.0 1.8
SPF 10.1 1.9
LEGEND
50 YR FLOOD
100 YR FLOOD
1988 NEW YEAR'S FLOOD
SPF
GRAPHIC SCALE
0 800 1600 2400 3200 4000
KAWAINUI MARSH OAHU, HAWAII
FLOOD OUTLINE FOR COCONUT GROVE, EXISTING CONDITION
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 27


N
EXISTING LEVEE
OUTFLOW
MANOWO ST
KAILUA ROAD



KAINUI DRIVE		W.S. EL. (FT-MSL)	VELOCITY (FPS)
PROJECT CONDITIONS	50 YR.	5.7	0.1
	100 YR.	5.8	0.1
	SPS	7.8	0.4

PONDING LIMITS		W.S. EL. (FT-MSL)	VELOCITY (FPS)
PROJECT CONDITIONS	50 YR.	5.7	0.1
	100 YR.	5.8	0.1
	SPS	7.3	0.1

KIHAPAI STREET		W.S. EL. (FT-MSL)	VELOCITY (FPS)
PROJECT CONDITIONS	50 YR.	5.7	0.1
	100 YR.	5.8	0.2
	SPS	7.3	0.2

KAILUA BRIDGE		W.S. EL. (FT-MSL)	VELOCITY (FPS)
PROJECT CONDITIONS	50 YR.	5.7	0.1
	100 YR.	5.8	1.6
	SPS	7.8	1.7

GRAPHIC SCALE

0 800 1600 2400 3200 4000

KAWAINUI MARSH — OAHU, HAWAII

PONDING LIMITS FOR COCONUT GROVE WITH PROJECT CONDITION

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 28

KAWAINUI MARSH
FLOOD CONTROL PROJECT
OAHU, HAWAII

APPENDIX B - DESIGN AND COST ESTIMATES

APPENDIX B
KAWAINUI MARSH FLOOD CONTROL PROJECT
OAHU, HAWAII
DESIGN AND COST ESTIMATES
TABLE OF CONTENTS

APPENDIX B
KAWAINUI MARSH FLOOD CONTROL PROJECT
OAHU, HAWAII
DESIGN AND COST ESTIMATES
TABLE OF CONTENTS
(continued)

LIST OF TABLES

DETAILED COST ESTIMATES

LIST OF PLATES
(Plates Follow Page B-30)

MODEL GRIDS

WATER SURFACE ELEVATION CONTOURS

WATER SURFACE ELEVATION CONTOURS

KAWAINUI MARSH FLOOD CONTROL PROJECT
DESIGN AND COST ESTIMATES

1. GENERAL. Three alternative plans based on equivalent levels of flood protection were examined in detail. The three alternatives include an Earth Levee Raise, a Floodwall on the Existing Levee and a Combination Earth Levee Raise and Floodwall. For purposes of design and cost comparison, all alternatives are described at the one percent level of protection. A detailed description of the alternative plans is contained in the main report.

2. EXISTING HYDRAULIC CONDITIONS.

a. General. Kawainui Marsh is located in Kailua on the northeast side of Oahu. The drainage basin has an 11.2-square mile area extending from the Koolau Mountains to the ocean. Storm waters flow to the sea through two channels - Kaelepulu Stream (Kawainui Stream) which collects interior drainage from the Coconut Grove area and empties into south Kailua Bay; and the federally-constructed flood control channel (Oneawa Channel) which flows from the marsh into north Kailua Bay. The "Kawainui Swamp Flood Control" project was authorized by Section 204 of the Flood Control Act of 1950 and was completed in 1966 at a cost of $1.3 million. The project was then transferred to the local sponsor, the City and County of Honolulu (C&C), for operation and maintenance.

b. Existing Flood Control Project. The existing flood control project includes a 6,850-foot long earth levee with a design crest elevation of 9.5 feet mean sea level (msl), and a 9,470-foot long outlet channel (Oneawa Channel) flowing northeasterly from the northern end of the marsh into Kailua Bay. The project was designed to accommodate the Standard Project Flood (SPF) with a peak inflow to the marsh of 18,100 cubic feet per second (cfs) (4,700 AC-FT volume) and a peak discharge in the Oneawa Channel of 6,750 cfs. Seven hundred and fifty acres of marsh land were acquired by the C&C for temporary storage of flood flows as part of the flood control project. Annual project condition surveys have indicated that the C&C has maintained the outlet channel and levee in an acceptable manner since the project was turned over to the City and County for operation and maintenance in 1966.

c. Marsh Condition. Sewage discharges from 1970 to 1990 contributed to uncontrolled vegetation growth in the marsh. Areas of the marsh that had been open water became overgrown with wetland plants and other marsh areas became even more heavily vegetated. A mat of vegetation now prevails on the marsh surface. Parts of the mat are fastened to the bottom and other portions are free floating. This vegetation mat severely complicates the existing hydraulic conditions in the marsh making the marsh an unusual flood plain with water that may flow under, through, or over the mat. The mat can move and fold over on itself as seen in a February 1988 aerial photo of the marsh.

d. Flooding Conditions. Floods greater than the 10-year event will overtop the southern end of the existing levee due to the heavy vegetation severely restricting the flow of water from the southern end of the marsh to the Oneawa outlet channel. Flood routing through the marsh is not a reservoir routing but entails a two-dimensional flood analysis to define flood profiles throughout the marsh. Based on observations by Corps of Engineer's personnel during the New Year's flood, water elevations have varied from elevation 11 feet msl near Kailua Road to elevation 2.5 feet msl at Oneawa Channel. Water which overtops the levee eventually passes to the ocean by way of Kaelepulu Stream or through Coconut Grove and then over the right bank of the Oneawa Channel.

TABLE B-1
EXISTING CONDITION, LEVEE OVERTOPPING

Event	Peak Flow Over Levee (cfs)	Overtopping Period (hours)	Coconut Grove Maximum Water Surface Elevation (ft-msl)
10-year	0	Water reaches top of levee	
50-year	6,200	10.5	9.9
100-year	7,700	14.0	10.3
SPF	14,800	19.0	11.9
New Year's 1988 1/	8,700	12.0	10.6

1/ Estimated value

3. HYDRAULIC DESIGN.

a. General. Hydraulic design of the Kawainui Marsh Flood Control Project was accomplished at the Waterways Experiment Station, Vicksburg, Mississippi, by using the RMA-2V finite element model. RMA-2V is a finite element solution of the Navier Stokes equations for turbulent flows. Friction is calculated with Manning's equation and eddy viscosity coefficients are used to define turbulence characteristics. RMA-2V was selected to model the marsh because the program has the capability to model an entire input hydrograph, includes rainfall falling on the marsh during the design event, and can show a flood wave moving through the marsh in an unsteady flow analysis. To initiate the model, the project area was defined and a boundary was drawn completely around it as shown on Plates 11 and 12. The area within the boundary was digitized and a mesh was generated within the marsh boundaries. The connecting points on the lines are called nodes and the areas inside the lines are called elements. The elements are assigned Manning Roughness Coefficients depending upon their physical properties. Boundary conditions varied depending on the plan being modeled, but generally included two inflow points (Maunawili Stream and runoff from the quarry area) and one or two outflow points (Oneawa Channel and over the levee). Channels in the marsh created by the City and County will tend to more evenly distribute floodwaters within the marsh. The channels were not specifically modeled, but were accounted for in the starting water surface elevation level in the marsh. Prior to design, the model was calibrated by using two events; the New Year's flood of 1988 and a high water event of April 1989. When the results of the model calibration closely simulated these two events, design of alternatives proceeded using the 10-year, 50-year, 100-year, and Standard Project Flood storm events. Table B-2 illustrates differences in the original project design discharges and volumes with the currently calculated values.

TABLE B-2
DESIGN DISCHARGES AND VOLUMES

	Total Design Inflow (CFS)	Oneawa Design Outflow (CFS)	Volume (AC-FT)	Active Flood Storage (AC-FT)
Original Design (1956)				
100-Year	No Data or Calculations Made			
SPF	18,100	6,750	4,700	3,000
Current Design (1991)				
100-Year	21,300	6,750	7,600	5,400
SPF	35,000	9,200[1]	12,500	7,100

1 Modifications required to Oneawa Channel to accommodate discharge exceeding design capacity.

b. Loss Coefficients. Design roughness coefficients were selected based on calibration runs conducted by the C&C of Honolulu using the RMA-2V model. The C&C calibration runs were made to simulate the marsh water surface level that occurred during a storm in April 1989. For a sensitivity analysis, the Waterways Experiment Station applied Manning Roughness Coefficients that were lower than the C&C values as shown in Table B-. These lower values produced water surface profiles that did not correctly simulate the observed New Year's overtopping event and the lower roughness values were increased for all subsequent runs in favor of the higher C&C values.

TABLE B-3
MANNING ROUGHNESS COEFFICIENTS

TYPE AREA	C&C 2/	WES SENSITIVITY TEST
Pasture area, upstream Maunawili	0.35	0.06
Open water areas	0.06	0.04
All vegetated areas in marsh 1/	0.95	0.66
Channel area, upstream Maunawili	0.50	0.08
Sediment basin, head of Oneawa Channel	0.04	0.04
Oneawa Channel;	0.035	0.035

1/ About 80% of the area
2/ Selected values

c. Antecedent Marsh Water Levels and Water Surface Profiles. Water surface elevations for the 10-year, 50-year, 100-year and Standard Project Flood were developed by the RMA-2V model for each node of the entire grid area. A water surface profile along the levee for the Levee Raise, Floodwall, and Combination Levee Raise and Floodwall Plans showing the maximum water surface elevation level is shown on Plate 1. Maximum water surface elevations reached for the 100-year (1 percent) event for all plans are also shown on a photograph of the project area (Plate 2). Two water surface profiles are shown on Plate 1 based on using two antecedent water level conditions. The lower curve represents a level starting water elevation throughout the marsh of 6.5 ft msl and the higher profile has a starting water surface elevation of 9.0 ft msl. These different starting elevations were used to determine the sensitivity of peak water elevations to starting conditions. As shown on Plate 1, the difference in profiles for the levee raise alternative for the two antecedent conditions for the 10-year flood and Standard Project Flood is 1.4 feet and 0.7 feet, respectively. When floodwater enters the marsh, the water elevation can quickly increase and remain at a higher level for several days as evidenced by the marsh water level gaging system established by the C&C in early 1989 as well as review of records of the USGS Gage #2648 (Table B-4 and Plate 3). The C&C constructed a 30-feet wide channel on the marsh side of the flood control levee in early 1988. In addition to this 30 feet wide channel adjacent to the levee, the C&C has constructed a channel into the marsh to more evenly distribute floodwaters. The drainage effect of the 30 feet wide channel adjacent to the levee can be seen on Plate 3. The marsh water level observed after the peak of the April 1989 event shows a steeper drop than marsh water levels from November 1970 and January 1975. The new hannel constructed by the City and County should evenly distribute water within the marsh and provide a basis for selecting a level starting water elevation throughout the marsh. A marsh water surface elevation of 6.5 feet msl is an average high figure taken from Table B-4 for marsh water levels recorded at levee station 40+00 from 1967 to 1979. A higher starting water elevation of 9.0 feet msl was selected as an upper limit to approximate the existing levee crest elevation when overtopped during the New Year's flood event. This range of marsh water levels will enable sensitivity analyses to be made of peak water elevations to starting conditions. A review of Plate 3 shows how quickly marsh water levels rise and how slowly they recede for selected events.

TABLE B-4
MAXIMUM ANNUAL WATER SURFACE ELEVATIONS FOR SELECTED LOCATIONS IN KAWAINUI MARSH
USGS CREST GAGE #2648

LOCATION 1/	WATER YEAR	DATE	Gage Height (FT-MSL)	COMMENTS
Kaelepulu	1957	21 Jan 57	4.19	Marsh stage prior to levee construction
Stream Gage	1958	5 Mar 58	5.16	
Location "A"	1959	18 Jan 59	2.30	Note: Water levels
	1960	3 Aug 60	3.48	are in Kaelepulu
	1961	-	-	Stream from 1957
	1962	-	-	to 1964
	1963	15 Apr 63	4.91	
	1964	12 Dec 63	1.91	
Marsh side	1965	-	-	Levee constructed in 1965
of Levee,	1966	-	-	
Gage	1967	9 Nov 66	4.19	Gage placed on marsh side of levee 1967
Location "A"	1968	18 Dec 67	7.15	
	1969	1 Feb 69	6.80	Note: Water levels
	1970	27 Jan 70	4.54	from 1967 to 1979 are
	1971	26 Nov 70	6.20	recorded near levee
	1972	23 Jan 72	5.50	station 40+00
	1973	23 Aug 73	3.65	
	1974	2 Feb 74	4.76	
	1975	12 Jan 75	5.82	
	1976	27 Nov 75	4.02	
	1977	30 Jun 77	4.10	
	1978	23 May 78	4.60	
	1979	20 Feb 79	5.68	
Oneawa	1980	9 Dec 79	2.33	Gage moved in 1980 to Oneawa Channel
Channel	1981	7 May 81	2.32	
Gage	1982	28 Oct 81	2.32	Note: Channel water
Location "C"	1983	28 Oct 82	2.31	levels reflect high
	1984	13 Dec 83	0.88	tides from 1980 to
	1985	14 Feb 85	2.63	1988 in the Oneawa
	1986	27 Feb 86	1.93	Channel
	1987	END	<1.11	
	1988	1 Jan 88	2.49	New Year's Flood

Kawainui Canal
USGS Crest Gage #2648 "A" and "C"
Datum: 0.00 feet msl

Latitude: 21-24'-15"
Longitude: 157-45'-28"

1/ See Plate 3 for Gage Location "A" and "C"

d. Freeboard. The levee profile was set three feet above the design water surface to account for unknown hydrologic and hydraulic factors. The three feet of freeboard are a factor of safety to protect the levee and heavily urbanized area from damages due to higher than expected water surfaces. The primary unknown hydraulic factor is the future behavior of the floating mat. The design water surface profile along the Oneawa Channel is two feet below the channel banks. A minimum two feet of freeboard is maintained along the Oneawa Channel's entire length.

e. Sediment Effects on Flood Control. For the purposes of flood control, Kawainui Marsh can be divided into three zones. The zones consist of a sediment storage zone (hard bottom to 4.5 ft msl), antecedent flood storage zone (4.5 ft msl to 6.5 ft msl), and an active flood storage zone (6.5 ft msl to about 14.2 ft msl). Most sediments are accumulating below elevation 4.5 ft msl. The available sediment storage area below 4.5 ft msl is 4,100 acre-feet based on probings taken in the marsh in February 1988. This sediment storage area represents over 100 years of storage based on sediment rates calculated within the marsh between 1956 and 1988. However, the rate of marsh sedimentation is open to speculation. The rates of sedimentation are also complicated by different sedimentation rates for different areas of the marsh. Table B-5, Marsh Sedimentation Rates, illustrates different calculations from various sources (Plate 4).

TABLE B-5
MARSH SEDIMENTATION RATES

SOURCE	SEDIMENTATION RATE (AC-FT/YR)	SEDIMENTATION RATE (FT/10-YRS)
Final Report, Nutrient and Suspended Solids Budget for Kawainui Marsh, Oahu, Hawaii, AECOS, Oct 1981	0.203 (Entire Marsh)	0.0047
Kawainui Marsh Damage Mitigation Report, Page B-44, M&E Pacific, for C&C of Honolulu, Final Environmental Impact Statement, June 1990	37.86 (Entire Marsh)	0.91
Kawainui Marsh Flood Control Project Detailed Project Report and Environmental Impact Statement, U.S. Army Corps of Engineers, September 1991	17.2 (Entire Marsh)	0.3
Archaeological Excavations in Kawainui Marsh, Island of Oahu, Jane Allen-Wheeler 1981	- (Southern End)	0.25
Paleoenvironmental and Archaeological Investigations, Kawainui Marsh Flood Control Project, Oahu Island, Hawaii Athens and Ward, 1991	- (Northern End)	0.167

Two separate sedimentation rates for the entire marsh were calculated. Comparison of ground surveys taken in 1956 and 1988 indicate a sedimentation rate of 100 acre-feet/year or 0.17 ft/10 years. Biomass accumulation is assumed to be 7.5 acre-feet/year or 0.13 ft/10 years. The sedimentation rate assumed by the Corps of Engineers, 0.3 feet/10-years over a 600 acre marsh surface, is higher than the rate shown by Jane Allen-Wheeler (18 inches in 60 years) because of additional sedimentation due to plant growth. The 0.9 ft/10 years rate of sedimentation assumed by M&E Pacific is due to sedimentation by plant growth and an assumed high trap efficiency rate within a 450 acre marsh area for terrestrial sediments. The relative difference in 150 acres between the Corps study and the M&E study is accounted for by the assumed sediment storage elevations of 4.5 ft msl (600 acre area) for the Corps and 0.0 ft msl (450 acres) for M&E.

The plant growth rate for the past 22 years has been very high because the plants were covering open water areas and had unlimited nutrients during this period from four wastewater treatment plants that have since been diverted. According to the AECOS report from 1981,

"Removal of the discharges from the four WWTP's now adding their effluents to the marsh will probably have relatively small short-term effects. The amount of nitrogen and phosphorus incorporated in the sediments of Kawainui Marsh is probably sufficient to support the *present level* of vegetation for many years. One immediate effect that might be expected would be a decrease in the floating vegetation on the open water areas. This vegetation depends on dissolved nutrients for its vigorous growth, and removal of the major source of these nutrients would result in lower standing crops which could be supported."

The biological sedimentation rate would thus be expected to greatly decrease with the diversion of sewage from the marsh and the sedimentation rates assumed by M&E may be too high.

Extensive sediment studies at the Kaneohe Dam Flood Control Project, which is an adjacent drainage basin to Kawainui Marsh, were started by the Corps of Engineers, the U.S. Geological Survey, and the State Highway Department in 1983 to monitor potential sediment inflows to Kaneohe reservoir from H-3 freeway construction and subsequent golf course construction. Results of the study in 1990 showed very small quantities of sediments were trapped in the reservoir because the sediment particle sizes are too small to settle out in the reservoir. A similar case can be made for Kawainui Marsh based on the turbid waters observed exiting Kawainui Marsh during wet weather. Water leaving the marsh by Oneawa Channel is a reddish color from the dissolved clays in the upstream watersheds. If sediment particle sizes entering Kawainui Marsh are also small and the marsh detention time based on computer model studies during flood events is 8-24 hours, then the trap efficiency of Kawainui Marsh may be closer to 10 percent as opposed to the 82 percent trap efficiency value presented in the M&E report. Larger particle sizes that have been deposited in the marsh have been accounted for in the surveys taken in 1956 for the original project design and a survey taken in February 1988.

The flood control function of this project will begin to be compromised when sediments exceed an average elevation throughout the marsh of 4.5 ft msl. When sediments reach elevation 4.5 ft msl, the entire marsh would cease to be marsh and would become a bog. However, this "bog" condition would not change the flood control capability of the levee system based on roughness and porosity factors used in the RMA-2V computer model as long as the sediment level is less than elevation 4.5 ft msl.

At a sedimentation rate of 0.3 ft/10 years, the marsh will not fill to elevation 4.5 ft msl during the project life of 100 years. Therefore, sedimentation will not have any adverse impact on the proposed flood control project.

f. Hydraulic Discussion of Alternative Levee Modification Designs. The hydraulic effects will be to direct all flows entering Kawainui Marsh to the Oneawa Channel. With a starting water surface elevation of 6.5 feet and 9.0 feet msl, the water surface level in the marsh will increase by 7.7 feet and 6.2 feet, respectively during the 100-year flood event. During a 100-year flood, the Quarry Road will be temporarily flooded from Mokapu Boulevard to the Kailua landfill access road. There are no homes located within the flooded reach. However, flowage easements will be required on 107.25 acres of currently vacant land. See Table B-7 for additional information on flowage easements. Water velocities along the levee range from 2.0 to 3.0 feet per second during the 100-year flood event. No modifications are required to the Oneawa Channel (Plate 1).

4. FLOOD WARNING SYSTEM. A flood warning system with gages at 2 sites has been established by the City and County of Honolulu at a first cost of $34,000 to alert the Oahu Civil Defense Agency of rising water levels in Kawainui Marsh. Site 1 is located adjacent to the levee at Station 14+50. Site 1 has a tipping bucket rain gage and a pressure gage to sense marsh water levels. Site 2 is located on Olomana Stream about 150 yards downstream of USGS gage number 2540 "Makawao Stream near Kailua". Site 2 also has a tipping bucket rain gage and a pressure gage to sense stream water levels. Both stations transmit rainfall and water level information to the Kailua Police Station as well as the Oahu Civil Defense Agency. The gage sites were selected to provide a warning of rapidly rising stream levels and provide an indication of rainfall rates in Maunawili Valley. The gage at the levee provides an immediate indication of rising water levels. If marsh water levels are rising and levee overtopping is imminent, the Oahu Civil Defense Agency can alert the Kailua Police Station to evacuate low lying areas of Coconut Grove. This flood warning system will be made part of the flood control project. After project construction, the flood warning system will be modified to reflect a higher degree of protection to the urbanized area.

5. LEVEE OVERTOPPING ANALYSIS. A levee overtopping analysis was done to determine how the levee would function if it were overtopped by a flood greater than the design flood. Although the C&C raised the levee crest with gravel material to elevation 10.0 ft msl in February 1988, this study uses the authorized height of 9.5 feet msl for the overtopping analysis. An overtopping event would quickly erode this gravel material to the original levee profile. The existing levee was overtopped for a period of 12 hours on 1 January 1988 with no observed change in levee profile. Water which passes over the levee crest will first reach the Kaelepulu Stream and flow towards

Kailua Bay. When the capacity of the Kaelepulu Stream is exceeded, water will enter Coconut Grove and eventually spill over the right bank of the Oneawa Channel.

An overtopping analysis was made of an earth levee. The existing earth levee was overtopped on January 1, 1988 and therefore provided a real example in calibrating the model.

The overtopping flow computations were made using the weir formula:

Q=CLH**3/2 where

Q = Discharge in cfs,
C = Weir coefficient,
L = Length of levee being overtopped in feet,
H = head of water above the levee crest

Since the earth levee crest is wide in comparison to the head above the levee crest, the weir coefficient was computed indirectly by computing the water surface profile across the levee crest. The crest roughness was assumed at n=0.06 and a profile across the crest was computed using the Manning Formula. The weir coefficient was then computed at 1.33 for the earth levee. Velocities on the crest were computed from 1.5 to 2.5 feet/second at water depths up to 1.0 feet.

The earth levee is not designed for overtopping and no armoring has been incorporated into its design to prevent erosion in the event of overtopping. Inspection of the existing levee after the New Year's 1988 overtopping event showed no evidence of erosion or distress to the structure.

Plates 21 to 25 show water surface elevations under existing conditions within Kawainui Marsh for levee overtopping events of the 10-year, 50-year, 100-year, Standard Project Flood and New Year's events. Table B-1 shows peak discharges over the existing earth levee and maximum water surface elevations in Coconut Grove for the 50, 100, SPF, and New Year's floods. Additional information on water surface elevations and water velocities within Coconut Grove from a levee overtopping event is contained in the Hydrologic Analysis of Interior Area and is found in Appendix A, Hydrology.

6. STRUCTURAL DESIGN

a. Floodwalls. Flood walls will be inverted "tee" or "L" shaped walls with integral cutoffs. Wall stems and bases will be reinforced concrete and cutoffs will be steel sheet piles or reinforced concrete. Walls will be founded on the existing undisturbed original levee soil lying 1.5 feet beneath the approximate crest elevation. Properties of the existing levee soil are as follows:

$\rho_m = 90.5$ pcf

$\rho_s = 117$ pcf

$\varnothing = 30^o$

$C = 0$

Foundation material beneath the existing levee has soil properties as follows:

$\rho_s = 111$ pcf

$\varnothing = 30^o$

$C = 0$

b. Stability Design. Stability design was in accordance with the applicable requirements of EM 1110-2-2502, Retaining and Floodwalls, dated 29 September 1989. The wall will be configured to provide a travelway for maintenance vehicles on the marsh side of the wall. Wall heights investigated varied in elevation form 20.5 feet msl (Height = 12.0) to elevation 8.5 feet msl (Height = 0), represented by three typical wall sections. The design includes a freeboard allowance of 3.0 feet. The design conditions for stability will be with the water surface elevation at the wall top.

c. Concrete and Steel. All concrete will have a 28-day compression strength of 3000 psi. Steel reinforcing will be graded 40. Steel piles will conform to ASTM A690, having yield strengths of 50,000 psi. Design of the reinforced concrete items was governed by requirements of ACI 318. Detailed plans of the floodwall will be developed during the plans and specifications stage.

7. COST ESTIMATES.

a. Basis of Cost Estimates. The following assumptions were utilized in estimating construction costs. Details of the estimate are shown on Tables 8 to 22.

(1) Oahu based contractor will perform the work.

(2) Work schedule will be straight-time only at 8-hours per day and 5-days per week.

(3) Equipment and storage area will be adjacent to the work site in a small park at the northern end of the levee.

(4) Construction period estimated as follows:

Alternative	Construction Period (Months) 10-Year	50-Year	100-Year	SPF
1 - Levee Raise	16	20	23	35
2 - Concrete Floodwall	14	19	21	23
3A - Levee Raise & Concrete Floodwall	14	25	29	33
3B - Levee Raise & Concrete Floodwall with Levee Retaining Wall	14	30	32	36

(5) Estimated quantities were based on surveys and typical sections.

(6) Cost estimates are based on October 1991 price levels.

(7) Disposal site for vegetation and excess spoils will be at the Waimanalo Gulch Sanitary Landfill in Nanakuli except for interior channel material moved by the jet-spray process. Jet spray material will be deposited in a 2- to 3-inch layer on either side of the interior channels.

(8) All stones and aggregates will be from the Hawaiian Rock Products quarry approximately 5 miles from the project site.

(9) Engineering and design costs include Plans and Specifications, and Engineering During Construction.

(10) Supervision and Administration costs are based on Corps of Engineers inspection and office administration during construction.

b. Maintenance Costs.

(1) Maintenance of the project will be the responsibility of local interests. The maintenance costs shown represent the net increase in maintenance costs from the existing levee which is being maintained by the City and County of Honolulu. The average annual project maintenance costs as shown with the project cost estimates include, where applicable, levee vegetation control, vegetation control on interior channels, repair of concrete structures, and monitoring water levels within the marsh. Long term water level monitoring is required to determine if changes are occurring to the marsh over the 100-year project life. The flood warning system currently established at levee Station 14+50 would be an effective method of monitoring long term changes to marsh water levels. The estimated annual cost to monitor water levels in the marsh is $15,000. The $15,000 monitoring cost is in addition to the maintenance costs indicated below and shown in the following tables for each alternative. The average annual maintenance cost for the levee raise includes vegetation control and the average annual maintenance cost for the floodwall is for repair of concrete structures

(2) Removal of peat, silts, and vegetation is included in the annual cost of maintaining interior channels created by the City and County. The preferred method of creating and maintaining these channels is by use of a jet-spray method which cuts and grinds vegetation and sediments and then sprays the mixture by high pressure pumps into a thin layer covering surrounding marsh areas. The average annual cost of operating the jet spray equipment is estimated at $46,000 based on the amount of material estimated to be removed (1,000 cubic yards) annually. Procurement of the jet spray type equipment will be by the local sponsor and is not included in this cost estimate.

TABLE B-6
SUMMARY OF MAINTENANCE COST

ITEM	ALTERNATIVE			
	Plan 1 Levee Raise	Plan 2 Floodwall	Plan 3A Combination	Plan 3B Combination
Monitor Water Levels	$ 15,000	$ 15,000	$ 15,000	$ 15,000
Levee Vegetation Control	10,000	-	2,000	2,000
Repair Concrete Structures	-	10,000	5,000	15,000
Sub-Total	$ 25,000	$ 25,000	$ 22,000	$ 32,000
Interior Channel Maintenance 1/				
Herbicide Channel Banks (3 months)	$ 2,800	$ 2,800	$ 2,800	$ 2,800
Spray Open Water Areas (6 months)	$ 20,000	$ 10,000	$ 10,000	$ 10,000
Remove peat, silts, vegetation (24 months)	$ 92,500	$ 92,500	$ 92,500	$ 92,500
PRESENT WORTH AVG ANL COST	$ 76,300	$ 76,300	$ 76,300	$ 76,300
TOTAL	$101,300	$101,300	$ 98,300	$108,300

1/ Channel banks are 7,500 feet at $0.30/ft plus 25% contingency.
Open Water is 7.3 acres at $1,100/acre plus 25% contingency
Remove peat, silts, vegetation is 2,000 CY at $37.00/CY plus 25% contingency

8. REAL ESTATE REQUIREMENTS.

a. Required Lands. The City and County of Honolulu acquired 750.925 acres (Tax Map Key 1-4-2-16) as part of the Kawainui Swamp Flood Control project construction. Project lands that would be needed for construction of the Levee Raise, Floodwall, and combination Levee Raise and Floodwall alternatives are entirely owned by the City and County of Honolulu. Work and storage areas as well as disposal areas would be provided by the City and County of Honolulu. The cost of developing the work and storage areas is included in the mobilization and demobilization costs shown in the Detailed Cost Estimates. Flowage easements for that land not in public ownership is estimated to cost $200,000 for the 50 and 100-year designs and $250,000 for the Standard Project Flood design.

b. Flowage Easements. The State of Hawaii has acquired a buffer zone around the marsh as shown on Figure 16 of the Main Report. Figure 16 should be compared with Figure 14 (same scale) for an overview of the flowage easements required for the alternatives. As can be seen on Figure 16, the State of Hawaii has acquired lands within the required flowage easement areas except for two known parcels on the western edge of the marsh. A 19.676 acre parcel (Tax Map Key 1-4-2-15-5) is owned by private interests and would require a flowage easement over that low portion of the parcel near Quarry Road. A portion of the parcel marked "future?" (Tax Map Key 1-4-2-15-6) on Figure 16 would also require a flowage easement. A flowage easement would be required from the State of Hawaii for all areas shown on Figure 16. Table B-7 shows the required flowage easements.

TABLE B-7
REQUIRED FLOWAGE EASEMENTS
100-YEAR DESIGN

Owner	Required Area (Acres)	Status
C&C of Honolulu	644.37	Owned by C&C
State of Hawaii	67.61	Owned or leased by State
State of Hawaii	20.94	Pending State ownership
(TMK 1-4-2-15-6)	5.49	Private. State reviewing purchase.
Baldwin Estate (TMK 1-4-2-15-5)	13.21	Private.
Total	751.62 Acres	

c. Wetland Mitigation. Wetland mitigation is described for the 100-year events only. Cost estimates show the cost of wetland creation for other levels of protection.

(1) Levee Raise Plan. The Levee Raise plan would fill about 6.4 acres of wetland on the Coconut Grove side of the existing levee. This wetland fill area would be replaced by removing 35,000 cubic yards of material and creating 6.4 acres of wetland on public lands within the marsh. About 2.1 acres would be created on the marsh side of the existing levee between levee station 55+00 and station 65+67. The remaining 4.3 acres could be created on the northern edge of the model airplane field (1.0 acre) and along the Quarry Road at the far northern end of the marsh (3.3 acres). The 6.4 acres would be reduced in elevation enough to meet the definition of "wetland" as defined by the Fish and Wildlife Service and the U.S. Army Corps of Engineers.

(2) Concrete Floodwall. The concrete floodwall plan does not fill wetland areas and no mitigation is required.

(3) Combination Levee Raise and Concrete Floodwall. The combination plan fills about 1.8 acres of wetland on the Coconut Grove side of the existing levee. This wetland fill area would be replaced by removing 10,000 cubic yards of material on 1.8 acres on the marsh side of the existing levee between station 55+00 and 65+67. The subalternative with a retaining wall on the Coconut Grove side of the levee does not fill wetland areas and no mitigation is required.

LIST OF ABBREVIATIONS

ACI	American Concrete Institute
ac-ft or AF	acre feet
AISC	American Institute of Steel Construction
ASTM	American Society of Testing Materials
BCR	Benefit Cost Ratio
cfs or CFS	cubic feet per second
CY	Cubic Yards
DA	Drainage Area or Department of the Army
EC	Engineering Circular
EIS	Environmental Impact Statement
EM	Engineer Manual
ER	Engineer Regulation
ETL	Engineer Technical Letter
i	interest rate
HEC	Hydrologic Engineering Center
hr	hour
IDC	Interest During construction
msl	mean sea level
n	Manning roughness coefficient or amortization period
NED	National Economic Development
PL	Public Law
psi	pounds per square inch
SPF	Standard Project Flood
US or U.S.	United States
USGS	U.S. Geological Survey
WES	Waterways Experiment Station

TABLE B-8.
DETAILED COST ESTIMATE
ALTERNATIVE 1: LEVEE RAISE
10-YEAR LEVEL OF PROTECTION

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONT %	CONT. IN ACCT. 0.4.1.Z.-	TOTAL PROJECT COST
10-YEAR								
11.-.-.-	LEVEES & FLOODWALLS							
11.0.A.-	MOB & DEMOB	1	LS	$100,000	$100,000	10%	$10,000	$110,000
11.0.1.-	LEVEES							
11.0.1.B	Remove top 12" of levee	3,600	CY	$16	$57,600	10%	$5,760	$63,360
11.0.1.B	Remove Vegetation	21,000	CY	$38	$798,000	10%	$79,800	$877,800
11.0.1.B	Fill	45,000	CY	$37	$1,665,000	10%	$166,500	$1,831,500
11.0.1.B	Gravel Surface	3,200	TON	$41	$131,200	10%	$13,120	$144,320
11.0.1.B	SLOPE TREATMENT							
11.0.1.B	Grassing	38,600	SY	$6	$231,600	10%	$23,160	$254,760
11.0.2.B	WETLAND CREATION							
11.0.2.B	Excavate	7,800	CY	$28	$218,400	15%	$32,760	$251,160
					$3,201,800		$331,100	$3,532,900
30.-.-.-	PLANNING, ENGINEERING, AND DESIGN				$200,000			$200,000
31.-.-.-	CONSTRUCTION MANAGEMENT (S&I)				$240,000			$240,000
					$3,641,800		$331,100	$3,972,900
					TOTAL PROJECT FIRST COST (ROUNDED)			$3,970,000
					ANNUAL MAINTENANCE COST			$101,300

OCTOBER 1991 PRICE LEVEL

TABLE B-9.
DETAILED COST ESTIMATE
ALTERNATIVE 1: LEVEE RAISE
50-YEAR LEVEL OF PROTECTION

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONT. %	CONT. IN ACCT. 04.1.Z.-	PROJECT COST
50-YEAR								
11.-.-.-	LEVEES & FLOODWALLS							
11.0.A.-	MOB & DEMOB	1	LS	$100,000	$100,000	10%	$10,000	$110,000
11.0.1.-	LEVEES							
11.0.1.B	Remove Top 12" of Levee	3,700	CY	$16	$59,200	10%	$5,920	$65,120
11.0.1.B	Remove Vegetation	64,000	CY	$38	$2,432,000	10%	$243,200	$2,675,200
11.0.1.B	Fill	160,000	CY	$28	$4,800,000	10%	$448,000	$4,928,000
11.0.1.B	Gravel Surface	3,200	TON	$41	$131,200	10%	$13,120	$144,320
11.0.1.B	SLOPE TREATMENT							
11.0.1.B	Grassing	57,500	SY	$6	$345,000	10%	$34,500	$379,500
11.0.2.B	WETLAND CREATION							
11.0.2.B	Excavation	11,700	CY	$28	$327,600	15%	$49,140	$376,740
					$7,875,000		$803,880	$8,678,880
01.-.-.-	LANDS AND DAMAGES				$200,000			$200,000
30.-.-.-	PLANNING, ENGINEERING, AND DESIGN				$200,000			$200,000
31.-.-.-	CONSTRUCTION MANAGEMENT (S&I)				$491,000			$491,000
		TOTAL PROJECT COST			$8,766,000		$803,880	$9,569,880
					TOTAL PROJECT FIRST COST (ROUNDED)			$9,570,000
					ANNUAL MAINTENANCE COST			$101,300

OCTOBER 1991 PRICE LEVEL

TABLE B-10.
DETAILED COST ESTIMATE
ALTERNATIVE 1: LEVEE RAISE
100-YEAR LEVEL OF PROTECTION

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONT. %	CONT. IN ACCT 04.1.Z.-	PROJECT COST
100-YEAR								
11.-.-.-.	LEVEES & FLOODWALLS							
11.0.A.	MOB & DEMOB	1	LS	$100,000	$100,000	10%	$10,000	$110,000
11.0.1.	LEVEES							
11.0.1.B.	Remove Top 12" of Levee	3,700	CY	$16	$59,200	10%	$5,920	$65,120
11.0.1.B.	Remove Vegetation	75,000	CY	$38	$2,850,000	10%	$285,000	$3,135,000
11.0.1.B.	Fill	195,000	CY	$28	$5,460,000	10%	$546,000	$6,006,000
11.0.1.B.	Gravel Surface	3,300	TON	$41	$135,300	10%	$13,120	$148,830
11.0.1.B.	SLOPE TREAT-MENT							
11.0.1.B.	Grassing	60,900	SY	$6	$365,400	10%	$36,540	$401,940
11.0.2.B.	WETLAND CREATION							
11.0.2.B.	Excavate	35,520	CY	$28	$994,000	15%	$149,100	$1,143,100
					$9,963,900		$1,046,090	$11,009,990
01.-.-.-	LANDS ANDDAMAGES				$200,000			$200,000
30.-.-.-.	PLANNING, ENGINEERING, AND DESIGN				$200,000			$200,000
31.-.-.-.	CONSTRUCTION MANAGEMENT (S&I)				$518,000			$518,000
					$10,881,900		$1,046,090	$11,927,990
					TOTAL PROJECT FIRST COST (ROUNDED)			$11,930,000
					ANNUAL MAINTENANCE COST			$101,300

OCTOBER 1991 PRICE LEVEL

TABLE B-11.
DETAILED COST ESTIMATE
ALTERNATIVE 1: LEVEE RAISE
SPF LEVEL OF PROTECTION

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONT. %	CONT IN ACCT.. 04.1.Z.-	PROJECT COST
SPF YEAR								
11.-.-.-.	LEVEES & FLOODWALLS							
11.0.A.	MOB & DEMOB	1	LS	$100,000	$100,000	10%	$10,000	$110,000
11.0.1.	LEVEES							
11.0.1.B.	Remove Top 12" of Levee	4,000	CY	$16	$64,000	10%	$6,400	$70,400
11.0.1.B.	Remove Vegetation	111,000	CY	$38	$4,218,000	10%	$421,800	$4,639,800
11.0.1.B.	Fill	326,000	CY	$28	$9,128,000	10%	$912,800	$10,040,800
11.0.1.B.	Gravel Surface	3,500	TON	$41	$143,500	10%	$14,350	$157,850
11.0.1.B.	SLOPE TREATMENT							
11.0.1.B.	Grassing	80,800	SY	$6	$484,800	10%	$48,480	$533,280
11.0.2.B.	WETLAND CREATION							
11.0.2.B.	Excavate	47,850	CY	$28	$1,339,800	15%	$200,970	$1,540,770
12.-.-.-.	DREDGING							
12.O.A.-	MOB & DEMOB	1	LS	$175,000	$175,000	15%	$26,250	$201,250
12.O.1.-	Disposal Area							
12.O.1.B	Dike Construction	1	LS	$67,000	$67,000	15%	$10,050	$77,050
12.O.2.-	PIPELINE DREDGING							
12.O.2.B	Excavation & Disposal	15,000	CY	$33	$495,000	15%	$74,250	$569,250
					$16,215,100		$1,725,350	$17,940,450
01.-.-.-	LANDS AND DAMAGES				$250,000			$250,000
30.-.-.-.	PLANNING, ENGINEERING, AND DESIGN				$250,000			$250,000
31.-.-.-.	CONSTRUCTION MANAGEMENT (S&I)				$982,000			$982,000
					$17,722,100		$1,725,350	$19,447,450
					TOTAL PROJECT FIRST COST (ROUNDED)			$19,450,000
					ANNUAL MAINTENANCE COST			$ 101,300

OCTOBER 1991 PRICE LEVEL

TABLE B-12.
DETAILED COST ESTIMATE
ALTERNATIVE 2: CONCRETE FLOODWALL
10-YEAR LEVEL OF PROTECTION

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONT. %	CONT. IN ACCT. 04.1.Z.-	PROJECT COST
10-YEAR								
11.-.-.-.	LEVEES & FLOODWALLS							
11.0.A.	MOB & DEMOB	1	LS	$50,000	$50,000	10%	$5,000	$55,000
11.0.2.	FLOODWALLS: 6,000 FEET							
11.0.2.B.	SITEWORK							
11.0.2.B.	Remove top 12" of levee	3,600	CY	$30	$108,000	10%	$10,800	$118,800
11.0.2.B	Excavate and Backfill	6,300	CY	$45	$283,500	10%	$28,350	$311,850
11.0.2.B.	Moss Rock Veneer	17,450	SF	$17	$296,650	10%	$29,665	$326,315
11.0.2.C.	CONCRETE							
11.0.2.C.	Footings	2,600	CY	$410	$1,066,000	10%	$106,600	$1,172,600
11.0.2.C.	Walls	650	CY	$850	$552,500	10%	$55,250	$607,750
11.0.2.C.	REINFORCING STEEL	253,000	LB	$1	$253,000	10%	$25,300	$278,300
					$2,609,650		$260,965	$2,870,615
30.-.-.-.	PLANNING, ENGINEERING, AND DESIGN				$200,000			$200,000
31.-.-.-.	CONSTRUCTION MANAGEMENT (S&I)				$215,000			$215,000
					$3,024,650		$260,965	$3,285,615
					TOTAL PROJECT FIRST COST (ROUNDED)			$3,290,000
					ANNUAL MAINTENANCE COST			$ 98,300

OCTOBER 1991 PRICE LEVEL

TABLE B-13.
DETAILED COST ESTIMATE
ALTERNATIVE 2: CONCRETE FLOODWALL
50-YEAR LEVEL OF PROTECTION

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONT. %	CONT. IN ACCT. 04.1.Z.-	PROJECT COST
50-YEAR								
11.-.-.-	LEVEES & FLOODWALLS							
11.0.A.	MOB & DEMOB	1	LS	$50,000	$50,000	10%	$5,000	$55,000
11.0.2.	FLOODWALLS: 6,000 LF							
11.0.2.B.	SITEWORK							
11.0.2.B.	Remove top 12" of levee	3,600	CY	$30	$108,000	10%	$10,800	$118,800
11.0.2.B.	Excavate and Backfill	5,600	CY	$71	$397,600	10%	$39,760	$437,360
11.0.2.B.	Landscaping	6,300	LF	$15	$94,500	10%	$9,450	$103,950
11.0.2.B.	SHEETPILING							
11.0.2.B.	PZ 22	57,700	SF	$37	$2,134,900	10%	$213,490	$2,348,390
11.0.2.C.	CONCRETE							
11.0.2.C.	Footings	4,400	CY	$210	$924,000	10%	$92,400	$1,016,400
11.0.2.C.	Walls	1,530	CY	$685	$1,048,050	10%	$104,805	$1,152,855
11.0.2.C.	REINFORCING STEEL	1,065,000	LB	$1	$1,065,000	10%	$106,500	$1,171,500
					$5,822,050		$582,205	$6,404,255
01.-.-.-	LANDS AND DAMAGES				$200,000			$200,000
30.-.-.-.	PLANNING, ENGINEERING, AND DESIGN				$200,000			$200,000
31.-.-.-.	CONSTRUCTION MANAGEMENT (S&I)				$452,690			$452,690
					$6,074,740		$582,205	$7,256,945
					TOTAL PROJECT FIRST COST (ROUNDED)			$7,260,000
					ANNUAL MAINTENANCE COST			$ 101,300

OCTOBER 1991 PRICE LEVEL

TABLE B-14.
DETAILED COST ESTIMATE
ALTERNATIVE 2: CONCRETE FLOODWALL
100-YEAR LEVEL OF PROTECTION

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONT. %	CONT. IN ACCT. 04.1.Z.-	PROJECT COST
100-YEAR								
11.-.-.-.	LEVEES & FLOODWALLS							
11.0.A.	MOB & DEMOB	1	LS	$100,000	$100,000	10%	$10,000	$110,000
11.0.2.	FLOODWALLS: 6,000 LF							
11.0.2.B.	SITEWORK							
11.0.2.B.	Remove top 12" of levee	3,700	CY	$30	$111,000	10%	$11,100	$122,100
11.0.2.B.	Excavate and Backfill	6,100	CY	$71	$433,100	10%	$43,310	$476,410
11.0.2.B.	Landscaping	6,600	LF	$15	$99,000	10%	$9,900	$108,900
11.0.2.B.	SHEETPILING							
11.0.2.B.	PZ 22	72,900	SF	$37	$2,697,300	10%	$269,730	$2,967,030
11.0.2.C.	CONCRETE							
11.0.2.C.	Footings	4,890	CY	$210	$1,026,900	10%	$102,690	$1,129,590
11.0.2.C.	Walls	1,720	CY	$685	$1,178,200	10%	$117,820	$1,296,020
11.0.2.C.	REINFORCING STEEL	1,205,000	LB	$1	$1,205,000	10%	$120,500	$1,325,500
					$6,850,500		$685,050	$7,535,550
01.-.-.-	*LANDS AND DAMAGES*				$200,000			$200,000
30.-.-.-.	PLANNING, ENGINEERING, AND DESIGN				$200,000			$200,000
31.-.-.-.	CONSTRUCTION MANAGEMENT (S&I)				$542,000			$542,000
					$7,792,500		$685,050	$8,477,550

TOTAL PROJECT FIRST COST (ROUNDED) $8,480,000

ANNUAL MAINTENANCE COST $ 101,300

OCTOBER 1991 PRICE LEVEL

TABLE B-15.
DETAILED COST ESTIMATE
ALTERNATIVE 2: CONCRETE FLOODWALL
SPF LEVEL OF PROTECTION

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONT. %	CONT. IN ACCT. 04.1.Z.-	PROJECT COST
SPF								
11.-.-.-.	LEVEES & FLOODWALLS							
11.0.A.	MOB & DEMOB	1	LS	$100,000	$100,000	10%	$10,000	$110,000
11.0.2.	FLOODWALLS: 6,000 LF							
11.0.2.B.	SITEWORK							
11.0.2.B.	Remove top 12" of levee	3,900	CY	$30	$117,000	10%	$11,700	$128,700
11.0.2.B.	Excavate and Backfill	7,100	CY	$71	$504,100	10%	$50,410	$554,510
11.0.2.B.	Moss Rock Veneer	6,300	LF	$15	$94,500	10%	$9,450	$103,950
11.0.2.B.	SHEETPILING							
11.0.2.B.	PZ 22	101,300	SF	$37	$3,748,100	10%	$374,810	$4,122,910
11.0.2.C.	CONCRETE							
11.0.2.C.	Footings	5,910	CY	$210	$1,241,100	10%	$124,110	$1,365,210
11.0.2.C.	Walls	2,560	CY	$685	$1,753,600	10%	$175,360	$1,928,960
11.0.2.C.	REINFORCING STEEL	1,523,000	LB	$1	$1,523,000	10%	$152,300	$1,675,300
12.-.-.-	*DREDGING ONEAWA CANAL*		*LS*	*$175,000*	*$175,000*	*15%*	*$26,250*	*$201,250*
12.O.A.-	MOB & DEMOB	1						
12.O.1.-	DISPOSAL AREA							
12.O.1.B	SITEWORK							
12.O.A.B	Dike Construction	1	LS	$67,000	$67,000	15%	$10,050	$77,050
12.O.2.-	PIPELINE DREDGING							
12.O.2.B	SITEWORK							
12.O.2.B	Excavation and Disposal	15,000	CY	$33	$495,000	15%	$74,250	$569,250
					$9,818,400		$1,018,690	$10,837,090
01.-.-.-	LANDS AND DAMAGES				$250,000			$250,000
30.-.-.-.	PLANNING, ENGINEERING, AND DESIGN				$275,000			$275,000
31.-.-.-.	CONSTRUCTION MANAGEMENT (S&I)				$642,000			$642,000
					$11,722,400		$1,129,240	$12,851,640
					TOTAL PROJECT FIRST COST (ROUNDED)			$12,850,000
					ANNUAL MAINTENANCE COST			$ 101,300

OCTOBER 1991 PRICE LEVEL

TABLE B-16.
DETAILED COST ESTIMATE
ALTERNATIVE 3A: LEVEE RAISE AND CONCRETE FLOODWALL
10-YEAR LEVEL OF PROTECTION

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONT. %	CONT. IN ACCT. 04.1.Z.-	PROJECT COST
10-YEAR								
11.-.-.-.	LEVEES & FLOODWALLS							
11.0.A.	MOB & DEMOB	1	LS	$50,000	$50,000	10%	$5,000	$55,000
11.0.2.	FLOODWALLS: 6,000 FEET							
11.0.2.B.	SITEWORK							
11.0.2.B.	Remove top 12" of levee	3,600	CY	$30	$108,000	10%	$10,800	$118,800
11.0.2.B	Excavate and Backfill	6,300	CY	$45	$283,500	10%	$28,350	$311,850
11.0.2.B.	Moss Rock Veneer	17,450	SF	$17	$296,650	10%	$29,665	$326,315
11.0.2.C.	CONCRETE							
11.0.2.C.	Footings	2,600	CY	$410	$1,066,000	10%	$106,600	$1,172,600
11.0.2.C.	Walls	650	CY	$850	$552,500	10%	$55,250	$607,750
11.0.2.C.	REINFORCING STEEL	253,000	LB	$1	$253,000	10%	$25,300	$278,300
					$2,609,650		$260,965	$2,870,615
30.-.-.-.	PLANNING, ENGINEERING, AND DESIGN				$200,000			$200,000
31.-.-.-.	CONSTRUCTION MANAGEMENT (S&I)				$215,000			$215,000
					$3,024,650		$260,965	$3,285,615
					TOTAL PROJECT FIRST COST (ROUNDED)			$3,290,000
					ANNUAL MAINTENANCE COST			$ 98,300

OCTOBER 1991 PRICE LEVEL

TABLE B-17.
DETAILED COST ESTIMATE
COMBINATION LEVEE RAISE AND CONCRETE FLOODWALL
ALTERNATIVE 3A
50-YEAR LEVEL OF PROTECTION

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONT. %	CONT. IN ACCT. 04.1Z.	PROJECT COST
50-YEAR								
11.-.-.-.	LEVEES & FLOODWALLS							
11.0.A.	MOB & DEMOB	1	LS	$10,000	$100,000	10%	$10,000	$110,000
11.0.1.	LEVEES: 6,100 FEET							
11.0.1.B.	SITEWORK							
11.0.1.B.	Remove top 12" of levee	3,600	CY	$16	$57,600	10%	$5,760	$63,360
11.0.1.B.	Remove Vegetation	27,000	CY	$38	$1,026,000	10%	$102,600	$1,128,600
11.0.1.B.	Fill	104,000	CY	$28	$2,912,000	10%	$291,200	$3,203,200
11.0.1.B.	SLOPE TREAT-MENT							
11.0.1.B.	Grassing	38,600	SY	$6	$231,600	10%	$23,160	$254,760
11.0.2.B.	WETLAND CREATION							
11.0.2.B.	Excavate	7,800	CY	$28	$218,400	15%	$32,760	$251,160
11.O.2.-	FLOODWALLS: 6,300 LF							
11.O.2.B	SITEWORK							
11.0.2.B	Excavate and Backfill	6,300	CY	$43	$270,900	10%	$27,090	$297,990
11.O.2.B	Moss Rock Veneer	17,450	SF	$17	$296,650	10%	$29,665	$326,315
11.O.2.C	CONCRETE							
11.0.2.C	Footings	2,700	CY	$410	$1,107,000	10%	$110,700	$1,217,700
11.0.2.C	Walls	870	CY	$830	$722,100	10%	$72,210	$794,310
11.0.2.C	Reinforcing Steel	186,000	LB	$1	$186,000	10%	$18,600	$204,600
					$7,128,250		$723,745	$7,851,995
01.-.-.-					$200,000			$200,000
30.-.-.-.	PLANNING, ENGINEERING, AND DESIGN				$200,000			$200,000
31.-.-.-.	CONSTRUCTION MANAGEMENT (S&I)				$491,000			$491,000
					$8,019,250		$723,745	$8,742,995
					TOTAL PROJECT FIRST COST (ROUNDED)			$8,740,000
					ANNUAL MAINTENANCE COST			$98,300

OCTOBER 1991 PRICE LEVEL

TABLE B-18.
DETAILED COST ESTIMATE
COMBINATION LEVEE RAISE AND CONCRETE FLOODWALL
ALTERNATIVE 3A
100-YEAR LEVEL OF PROTECTION

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONT. %	CONT. IN ACCT. 04.1.Z	PROJECT COST
100-YEAR								
11.-.-.-.	LEVEES & FLOODWALLS							
11.0.A.	MOB & DEMOB	1	LS	$100,000	$100,000	10%	$10,000	$110,000
11.0.1.	LEVEES: 6,100 LF							
11.0.1.B.	SITEWORK							
11.0.1.B.	Remove top 12" of levee	3,600	CY	$16	$57,600	10%	$5,760	$63,360
11.0.1.B.	Remove Vegetation	31,000	CY	$38	$1,178,000	10%	$117,800	$1,295,800
11.0.1.B.	Fill	129,000	CY	$28	$3,612,000	10%	$361,000	$3,973,200
11.0.1.B.	SLOPE TREATMENT							
11.0.1.B.	Grassing	42,000	SY	$6	$252,000	10%	$25,200	$277,200
11.0.2.B.	WETLAND CREATION							
11.0.2.B.	Excavate	10,000	CY	$28	$280,000	15%	$42,000	$322,000
11.0.2.-	FLOODWALLS: 6,300 LF							
11.O.2.B	SITEWORK							
11.0.2.B	Excavate and Backfill	6,300	CY	$43	$270,900	10%	$27,090	$297,990
11.O.2.B	Moss Rock Veneer	17,450	SF	$17	$296,650	10%	$29,665	$326,315
11.O.2.C	CONCRETE							
11.0.2.C	Footings	2,700	CY	$410	$1,107,000	10%	$110,700	$1,217,700
11.0.2.C	Walls	870	CY	$830	$722,100	10%	$72,210	$794,310
11.0.2.C	Reinforcing Steel	186,000	LB	$1	$186,000	10%	$18,600	$204,600
					$8,062,250		$820,225	$8,882,475
01.-.-.-	LANDS AND DAMAGES				$200,000			$200,000
30.-.-.-.	PLANNING, ENGINEERING, AND DESIGN				$200,000			$200,000
31.-.-.-.	CONSTRUCTION MANAGEMENT (S&I)				$554,270			$554,270
					$9,016,520		$820,225	$9,836,745

TOTAL PROJECT FIRST COST (ROUNDED) $9,840,000

ANNUAL MAINTENANCE COST $98,300

OCTOBER 1991 PRICE LEVEL

TABLE B-19. DETAILED COST ESTIMATE
COMBINATION LEVEE RAISE AND CONCRETE FLOODWALL
ALTERNATIVE 3A
SPF LEVEL OF PROTECTION

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONT. %	CONT. IN ACCT. 04.1.Z.-.	PROJECT COST
SPF								
11.-.-.-.	LEVEES & FLOODWALLS							
11.0.A.	MOB & DEMOB	1	LS	$100,000	$100,000	10%	$10,000	$110,000
11.0.1.	LEVEES: 6,100LF							
11.0.1.B.	SITEWORK							
11.0.1.B.	Remove top 12" of levee	3,700	CY	$16	$59,200	10%	$5,920	$65,120
11.0.1.B.	Remove Vegetation	70,000	CY	$38	$2,660,000	10%	$266,000	$2,926,000
11.0.1.B.	Fill	236,000	CY	$28	$6,608,000	10%	$660,800	$7,268,800
11.0.1.B.	SLOPE TREATMENT							
11.0.1.B.	Grassing	42,000	SY	$6	$252,000	10%	$25,200	$277,200
11.0.2.B.	WETLAND CREATION							
11.0.2.B.	Excavate	25,300	CY	$28	$708,400	15%	$106,260	$814,660
11.O.2.-	FLOODWALLS: 6,300 LF							
11.O.2.B	SITEWORK							
11.0.2.B	Excavate and Backfill	6,700	CY	$43	$288,100	10%	$28,810	$310,910
11.O.2.B	Moss Rock Veneer	26,800	SF	$17	$455,600	10%	$45,560	$501,160
11.O.2.C	CONCRETE							
11.0.2.C	Footings	2,900	CY	$410	$1,189,000	10%	$118,900	$1,307,900
11.0.2.C	Walls	1000	CY	$830	$6830000	10%	$83,000	$913,000
11.0.2.C	Reinforcing Steel	206,000	LB	$1	$206,000	10%	$20,600	$226,600
12.-.-.-	DREDGING ONEAWA CANAL							
12.0.A.-	MOB AND DEMOB	1	LS	$175,000	$175,000	15%	$26,250	$201,250
12.0.1.-	DISPOSAL AREA							
12.0.1.B	SITEWORK							
12.0.1.B	Dike Construction	1	LS	$67,000	$67,000	15%	$10,050	$77,050
12.0.2.-	PIPELINE DREDGING							
12.0.2.B	SITEWORK							
12.0.2.B	Excavation and Disposal	15,000	CY	$33	$495,000	15%	$74,250	$569,250
				TOTAL	$14,093,300		$1,481,600	$15,574,900
01.-.-.-	LANDS AND DAMAGES				$250,000			$250,000
30.-.-.-.	PLANNING, ENGINEERING, AND DESIGN				$275,000			$275,000
31.-.-.-.	CONSTRUCTION MANAGEMENT (S&I)				$900,000			$900,000
					$15,518,300		$1,481,600	$16,999,900

TOTAL PROJECT FIRST COST (ROUNDED) $17,100,000

ANNUAL MAINTENANCE COST $ 98,300

OCTOBER 1991 PRICE LEVEL

TABLE B-20. DETAILED COST ESTIMATE
COMBINATION LEVEE RAISE AND CONCRETE FLOODWALL
WITH LEVEE RETAINING WALL
ALTERNATIVE 3B
50-YEAR LEVEL OF PROTECTION

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONT. %	CONT. IN ACCT. 04.1.Z.-.	PROJECT COST
50-YEAR								
11.-.-.-.	LEVEES & FLOODWALLS							
11.0.A.	MOB & DEMOB	1	LS	$100,000	$100,000	10%	$10,000	$110,000
11.0.1.	LEVEES: 6,100 LF							
11.0.1.B.	SITEWORK							
11.0.1.B.	Remove top 12" of levee	3,600	CY	$16	$57,600	10%	$5,760	$63,360
11.0.1.B.	Remove Vegetation	10,000	CY	$38	$380,000	10%	$38,000	$418,000
11.0.1.B.	Fill	29,000	CY	$44	$1,276,000	15%	$127,600	$1,403,600
11.0.1.B.	SLOPE TREAT-MENT							
11.0.1.B.	Grassing	25,000	SY	$6	$150,000	10%	$15,000	$165,000
11.O.2.-	FLOODWALLS: 6,300 LF							
11.O.2.B	SITEWORK							
11.0.2.B	Excavate and Backfill	6,300	CY	$43	$270,900	10%	$27,090	$297,980
11.O.2.B	Moss Rock Veneer	17,450	SF	$17	$296,650	10%	$29,665	$326,000
11.O.2.C	CONCRETE							
11.0.2.C	Footings	2,700	CY	$410	$1,107,000	10%	$110,700	$1,217,700
11.0.2.C	Walls	870	CY	$830	$722,100	10%	$72,210	$204,600
11.0.2.C	Reinforcing Steel	186,000	LB	$1	$186,000	10%	$18,600	$204,600
	RETAINING WALL - 5,200 LF							
11.0.2.B	SITEWORK							
11.0.2.B	Excavate and Backfill	4,500	CY	$57	$256,500	10%	$25,650	$282,150
11.0.2.B	Sheetpiles PZ27	57,200	SF	$45	$2,574,000	15%	$386,100	$2,960,100
11.0.2.C	CONCRETE							
11.0.2.C	Footings	900	CY	$345	$310,000	10%	$31,050	$341,550
11.0.2.C	Walls	1,100	CY	$760	$836,000	15%	$125,400	$961,400
11.0.2.C	Reinforcing Steel	161,000	LB	$1	$161,000		$24,150	$185,150
					$8,684,250		$1,046,975	$8,300,530
01.-.-	LANDS AND DAMAGES				$200,000			$200,000
30.-.-.-.	PLANNING, ENGINEERING, AND DESIGN				$200,000			$200,000
31.-.-.-.	CONSTRUCTION MANAGEMENT (S&I)				$554,000			$554,000
					$9,638,250		$1,046,975	$10,685,225

TOTAL PROJECT FIRST COST (ROUNDED) $10,700,000

ANNUAL MAINTENANCE COST $ 108,300

OCTOBER 1991 PRICE LEVEL

TABLE B-21. DETAILED COST ESTIMATE
COMBINATION LEVEE RAISE AND CONCRETE FLOODWALL
WITH LEVEE RETAINING WALL
ALTERNATIVE 3B
100-YEAR LEVEL OF PROTECTION

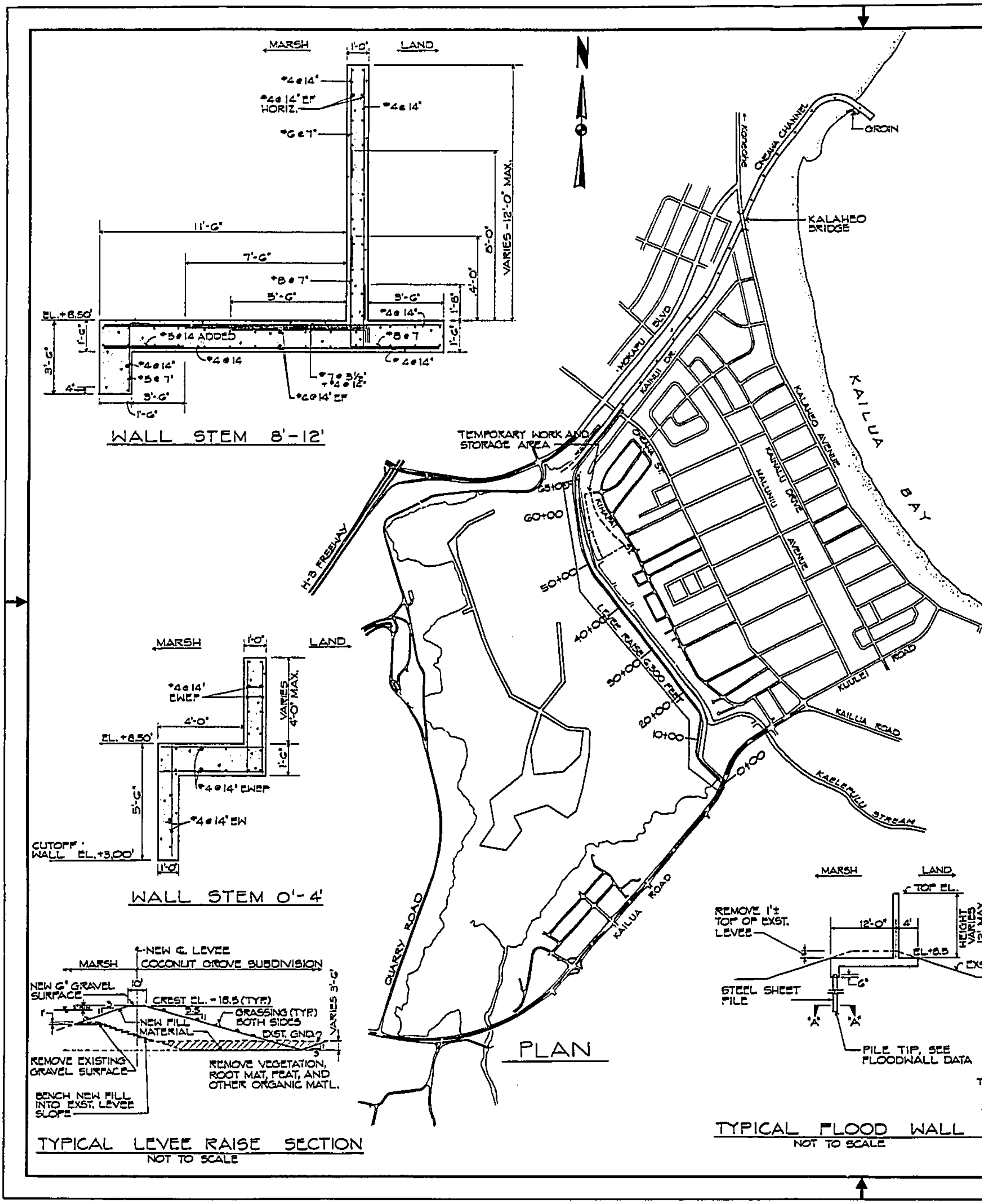
ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONT. %	CONT. IN ACCT. 04.1.Z.-.	PROJECT COST
100-YEAR								
11.-.-.-.	LEVEES & FLOODWALLS							
11.0.A.	MOB & DEMOB	1	LS	$100,000	$100,000	10%	$10,000	$110,000
11.0.1.	LEVEES: 6,100 LF							
11.0.1.B.	SITEWORK							
11.0.1.B.	Remove top 12" of levee	3,600	CY	$16	$57,600	10%	$5,760	$63,360
11.0.1.B.	Remove Vegetation	10,000	CY	$38	$380,000	10%	$38,000	$418,000
11.0.1.B.	Fill	52,000	CY	$44	$2,288,000	15%	$228,000	$2,516,800
11.0.1.B.	SLOPE TREAT-MENT							
11.0.1.B.	Grassing	25,000	SY	$6	$150,000	10%	$15,000	$165,000
11.O.2.-	FLOODWALLS: 6,300 LF							
11.O.2.B	SITEWORK							
11.0.2.B	Excavate and Backfill	6,300	CY	$43	$270,900	10%	$27,090	$297,980
11.O.2.B	Moss Rock Veneer	17,450	SF	$17	$296,650	10%	$29,665	$326,000
11.O.2.C	CONCRETE							
11.0.2.C	Footings	2,700	CY	$410	$1,107,000	10%	$110,700	$1,217,700
11.0.2.C	Walls	870	CY	$830	$722,100	10%	$72,210	$204,600
11.0.2.C	Reinforcing Steel	186,000	LB	$1	$186,000	10%	$18,600	$204,600
	RETAINING WALL - 5,200 LF							
11.0.2.B	SITEWORK							
11.0.2.B	Excavate and Backfill	4,500	CY	$57	$256,500	10%	$25,650	$282,150
11.0.2.B	Sheetpiles PZ27	62,400	SF	$45	$2,808,000	15%	$421,200	$3,229,200
11.0.2.C	CONCRETE							
11.0.2.C	Footings	900	CY	$345	$310,000	10%	$31,050	$341,550
11.0.2.C	Walls	1,200	CY	$760	$912,000	15%	$136,800	$1,048,800
11.0.2.C	Reinforcing Steel	172,000	LB	$1	$172,000		$25,800	$197,800
					$10,017,215		$1,196,325	$11,213,575
01.-.-	LANDS AND DAMAGES				$200,000			$200,000
30.-.-.-.	PLANNING, ENGINEERING, AND DESIGN				$200,000			$200,000
31.-.-.-.	CONSTRUCTION MANAGEMENT (S&I)				$591,000			$591,000
					$11,008,250		$1,196,325	$12,204,575
					TOTAL PROJECT FIRST COST (ROUNDED)			$12,200,000
					ANNUAL MAINTENANCE COST			$108,300

OCTOBER 1991 PRICE LEVEL

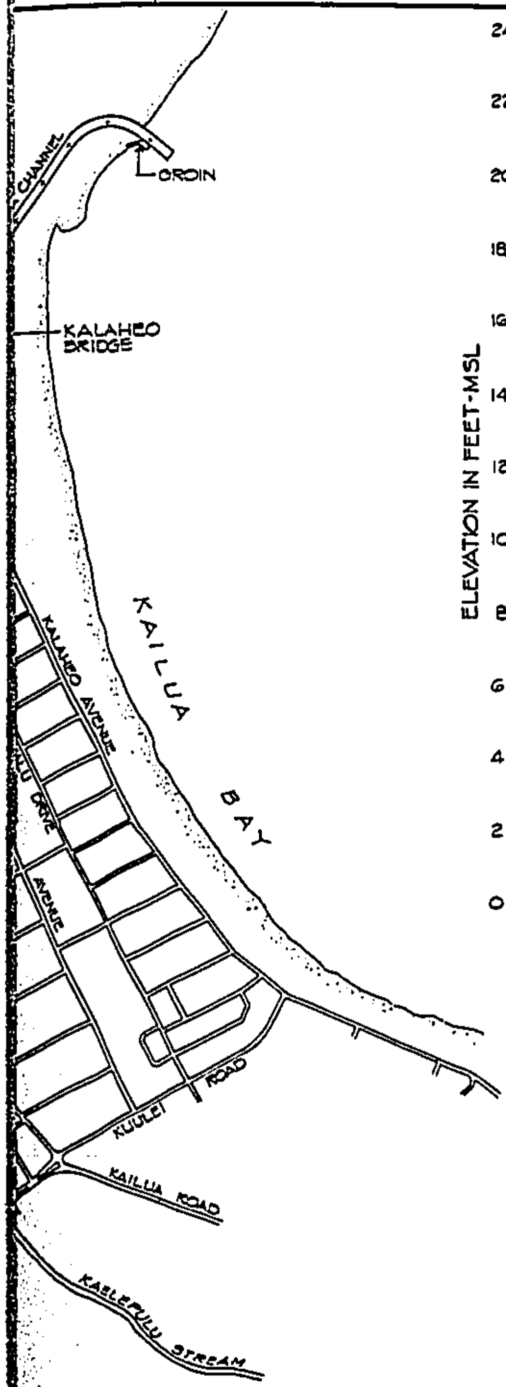
TABLE B-22. DETAILED COST ESTIMATE
COMBINATION LEVEE RAISE AND CONCRETE FLOODWALL WITH RETAINING WALL
ALTERNATIVE 3B
SPF LEVEL OF PROTECTION

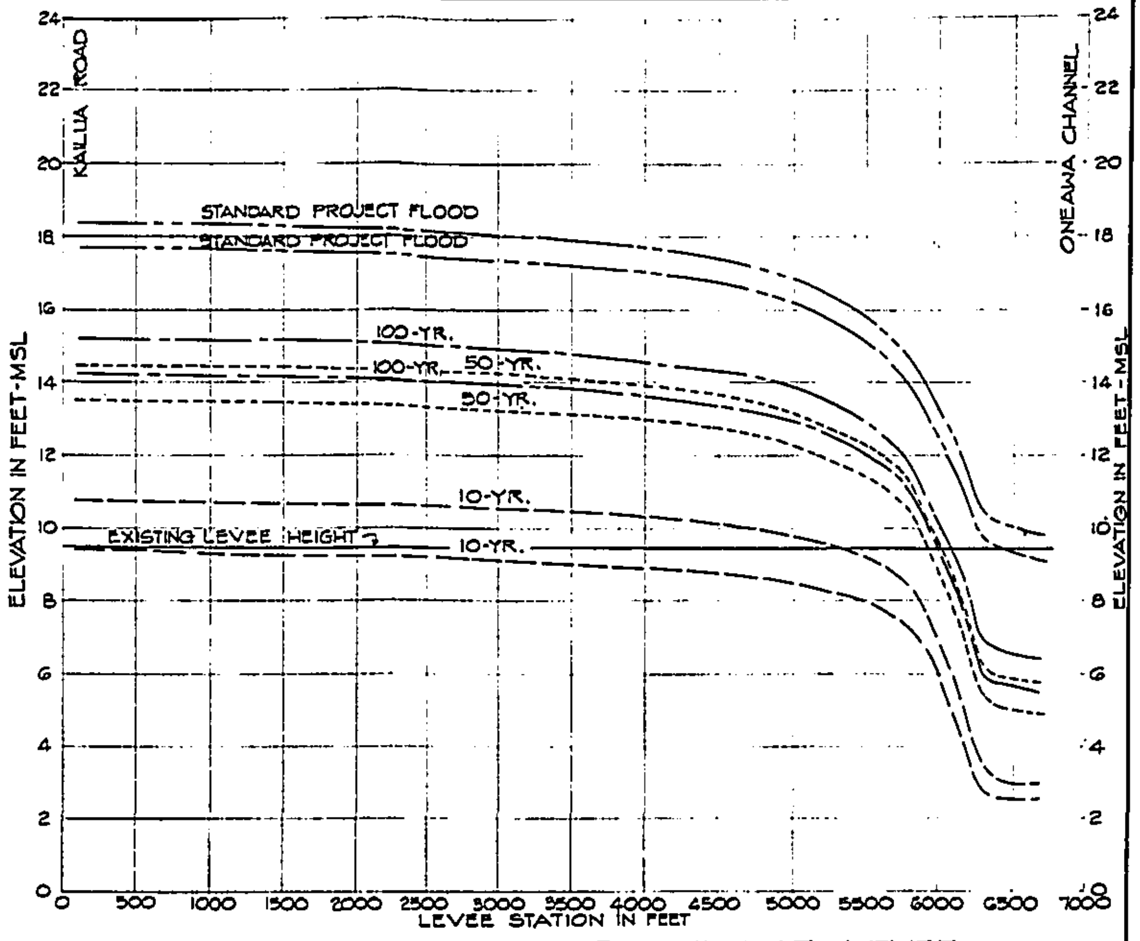
ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONT. %	CONT. IN ACCT. 04.1.Z.-	PROJECT COST
11.-.-.-.	LEVEES & FLOODWALLS							
11.0.A.	MOB & DEMOB	1	LS	$100,000	$100,000	10%	$10,000	$110,000
11.0.1.	LEVEES:							
11.0.1.B.	SITEWORK							
11.0.1.B.	Remove top 12" of levee	3,700	CY	$16	$59,200	10%	$5,920	$65,120
11.0.1.B.	Remove Vegetation	10,000	CY	$38	$380,000	10%	$38,000	$418,000
11.0.1.B.	Fill	63,000	CY	$44	$2,772,000	15%	$277,200	$3,049,200
11.0.1.B.	SLOPE TREATMENT							
11.01.B.	Grassing	25,000	SY	$6	$150,000	10%	$15,000	$165,000
11.O.2.-	FLOODWALLS: 6,700 LF							
11.O.2.B	SITEWORK							
11.0.2.B	Excavate and Backfill	6,700	CY	$43	$288,100	10%	$28,810	$316,910
11.O.2.B	Moss Rock Veneer	26,800	LF	$17	$455,600	10%	$45,560	$501,160
11.O.2.C	CONCRETE							
11.0.2.C	Footings	2,900	CY	$410	$1,189,000	10%	$118,900	$1,307,900
11.0.2.C	Walls	1000	CY	$830	$830,000	10%	$83,000	$913,000
11.0.2.C	Reinforcing Steel	206,000	LB	$1	$206,000	10%	$20,600	$226,600
	RETAINING WALL - 5,200 LF							
11.0.2.B	SITEWORK							
11.0.2.B	Excavate and Backfill	4,500	CY	$57	$256,500	10%	$25,650	$282,150
11.0.2.B	PZ 27	145,600	SF	$45	$6,552,000	15%	$982,200	$7,534,800
11.0.2.C	CONCRETE							
11.0.2.C	Footings	900	CY	$345	$310,500	10%	$31,050	$341,550
11.0.2.C	Walls	2,700	CY	$760	$2,052,000	15%	$307,800	$2,359,800
11.0.2.C	Reinforcing Steel	480,000	LB	$1	$480,000	15%	$72,000	$552,000
12.-.-.-	DREDGING ONEAWA CANAL							
12.0.A.-	MOB & DEMOB	1	LS	$175,000	$175,000	15%	$26,250	$201,250
12.0.1.-	DISPOSAL AREA							
12.0.1.B	SITEWORK							
12.0.1.B	Dike Construction	1	LS	$67,000	$67,000	15%	$10,050	$77,050
12.0.2.-	PIPELINE DREDGING							
12.0.2.B	SITEWORK							
12.0.2.B	Excavation and Disposal	15,000	CY	$33	$495,000	15%	$74,250	$569,250
					$16,817,900		$2,172,840	$18,990,740
01.-.-.-	LANDS AND DAMAGES				$250,000			$250,000
30.-.-.-.	PLANNING, ENGINEERING, AND DESIGN				$275,000			$275,000
31.-.-.-.	CONSTRUCTION MANAGEMENT (S&I)				$982,000			$982,000
					$18,324,900		$2,172,840	$20,497,740
	TOTAL PROJECT FIRST COST (ROUNDED)							$20,500,000
	ANNUAL MAINTENANCE COST							$108,300

OCTOBER 1991 PRICE LEVEL



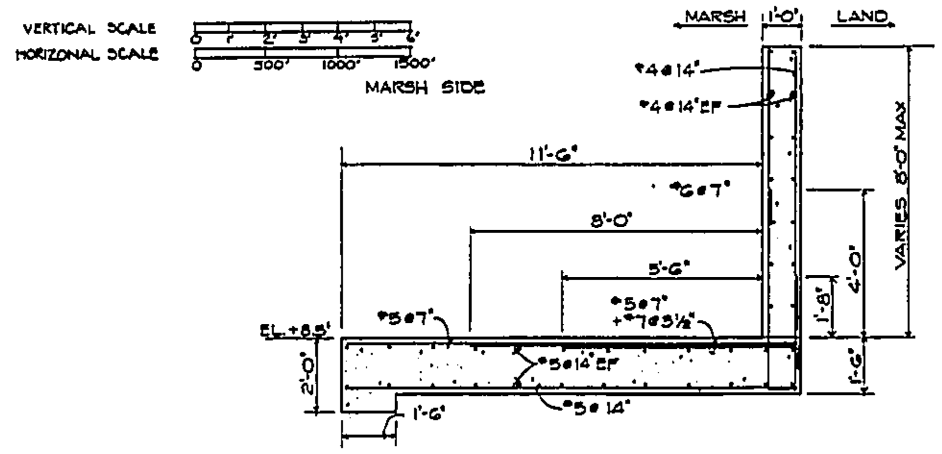
MARSH
LAND
1'-0"
#4 @ 14"
#4 @ 14" EF HORIZ.
#6 @ 7"
11'-6"
7'-6"
#8 @ 7"
5'-6"
3'-6"
#4 @ 14"
8'-0"
4'-0"
1'-8"
VARIES -12'-0" MAX.
EL. +8.50'
#5 @ 14 ADDED
#4 @ 14
#8 @ 7
#4 @ 14"
#5 @ 7"
#7 @ 3½" + #4 @ 12"
#6 @ 14" EF
3'-6"
1'-6"
WALL STEM 8'-12'
WALL STEM 0'-4'
#4 @ 14" EWEF
4'-0"
VARIES 4'-0" MAX.
EL. +8.50'
#4 @ 14" EWEF
#4 @ 14" EW
5'-6"
CUTOFF WALL EL. +3.00'
NEW ℄ LEVEE
COCONUT GROVE SUBDIVISION
NEW 6" GRAVEL SURFACE
10'
CREST EL. = 18.5 (TYP.)
GRASSING (TYP.) BOTH SIDES
NEW FILL MATERIAL
EXST. GND.
VARIES 3'-6"
REMOVE EXISTING GRAVEL SURFACE
REMOVE VEGETATION, ROOT MAT, PEAT, AND OTHER ORGANIC MATL.
BENCH NEW FILL INTO EXST. LEVEE SLOPE
TYPICAL LEVEE RAISE SECTION
NOT TO SCALE
N
GROIN
KALAHEO BRIDGE
OAEAWA CHANNEL
Kaneohe
MOKAPU BLVD
KAINUI DR.
KALAHEO AVENUE
KAILUA
BAY
TEMPORARY WORK AND STORAGE AREA
H-3 FREEWAY
65+00
60+00
50+00
40+00
30+00
20+00
10+00
0+00
LEVEE RAISE 6,300 FEET
MALUNIU AVENUE
KAINALU DRIVE
KUULEI ROAD
KAILUA ROAD
KAELEPULU STREAM
QUARRY ROAD
KAILUA ROAD
PLAN
REMOVE 1'± TOP OF EXST. LEVEE
12'-0"
4'
TOP EL.
HEIGHT VARIES
EL. +8.5
STEEL SHEET PILE
1'-6"
A
A
PILE TIP, SEE FLOODWALL DATA
TYPICAL FLOOD WALL
NOT TO SCALE



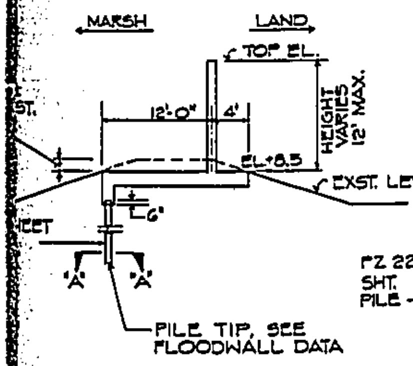


WATER SURFACE PROFILE AT LEVEE

NOTE:
LOWER PROFILE HAS STARTING MARSH WSEL @ 6.5 FT. MSL
UPPER PROFILE HAS STARTING MARSH WSEL @ 9.0 FT. MSL

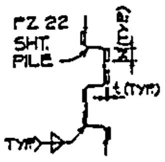


WALL STEM 4'-8'

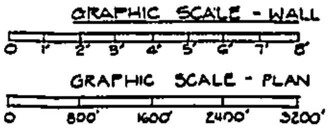


...AL FLOOD WALL
NOT TO SCALE

FLOODWALL DATA			
WALL STEM (FT-MSL)	LEVEE CREST ELEV. (FT-MSL)	PILE TIP/ CUTOFF WALL ELEV. (FT-MSL)	CUT-OFF MAT'L
+20.5	+8.5	-7.5	STEEL
+16.5	+8.5	-1.5	STEEL
+12.5	+8.5	+3.0	CONC.



SECTION "A-A"
NOT TO SCALE

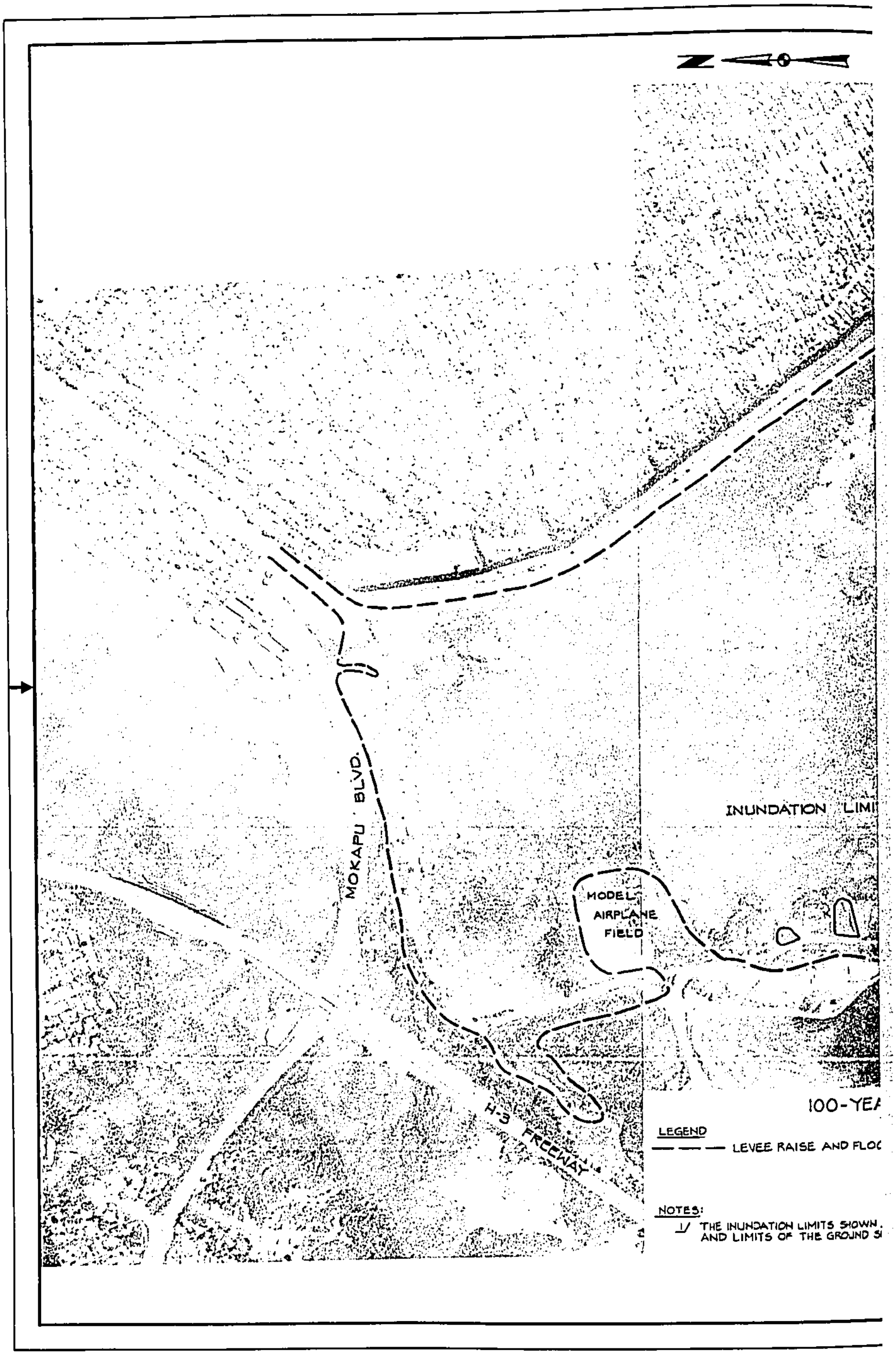


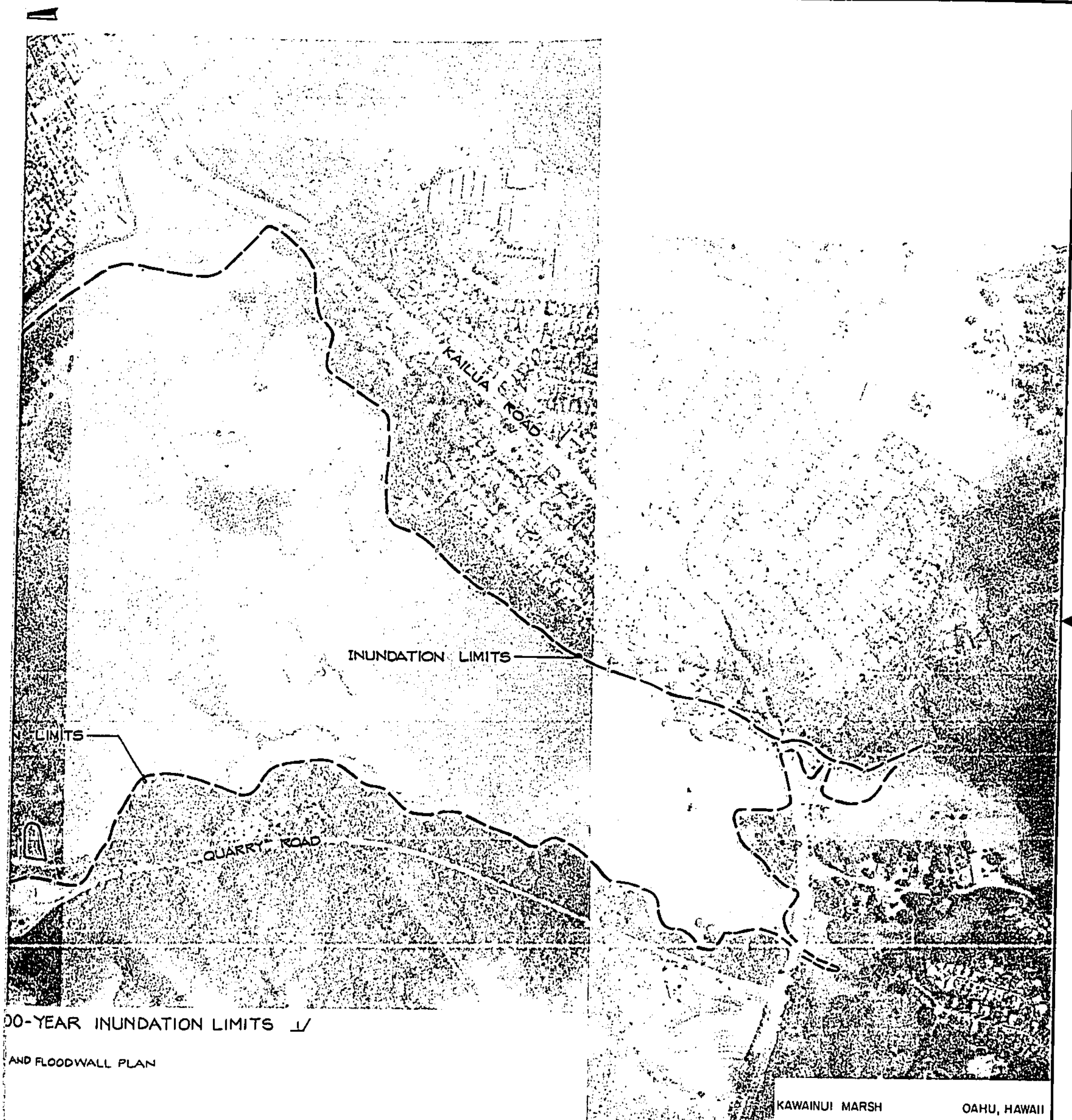
KAWAINUI MARSH — OAHU, HAWAII

LEVEE RAISE PLAN
EARTH LEVEE & CONCRETE FLOODWALL

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE 1


MOKAPU BLVD.
INUNDATION
MODEL AIRPLANE FIELD
H-3 FREEWAY
LEGEND
LEVEE RAISE AND
NOTES:
1/ THE INUNDATION LIMITS
AND LIMITS OF THE GROUND



00-YEAR INUNDATION LIMITS 1/

AND FLOODWALL PLAN

TS SHOWN ARE SUBJECT TO APPROXIMATIONS
GROUND SURVEY AND HYDRAULIC MODEL.

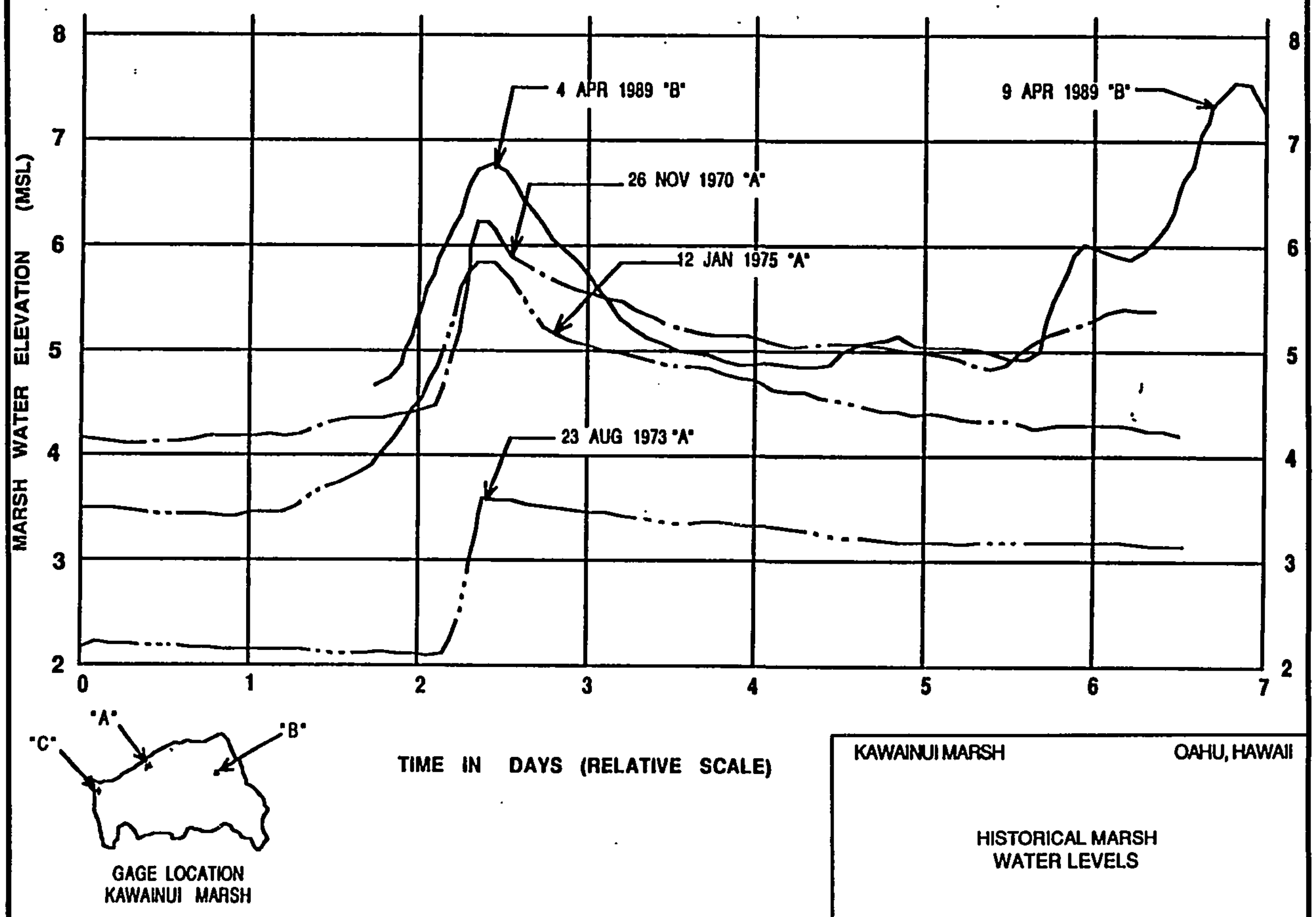
GRAPHIC SCALE
0 400' 800' 1200'

KAWAINUI MARSH OAHU, HAWAII

100-YEAR
INUNDATION LIMITS

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE 2



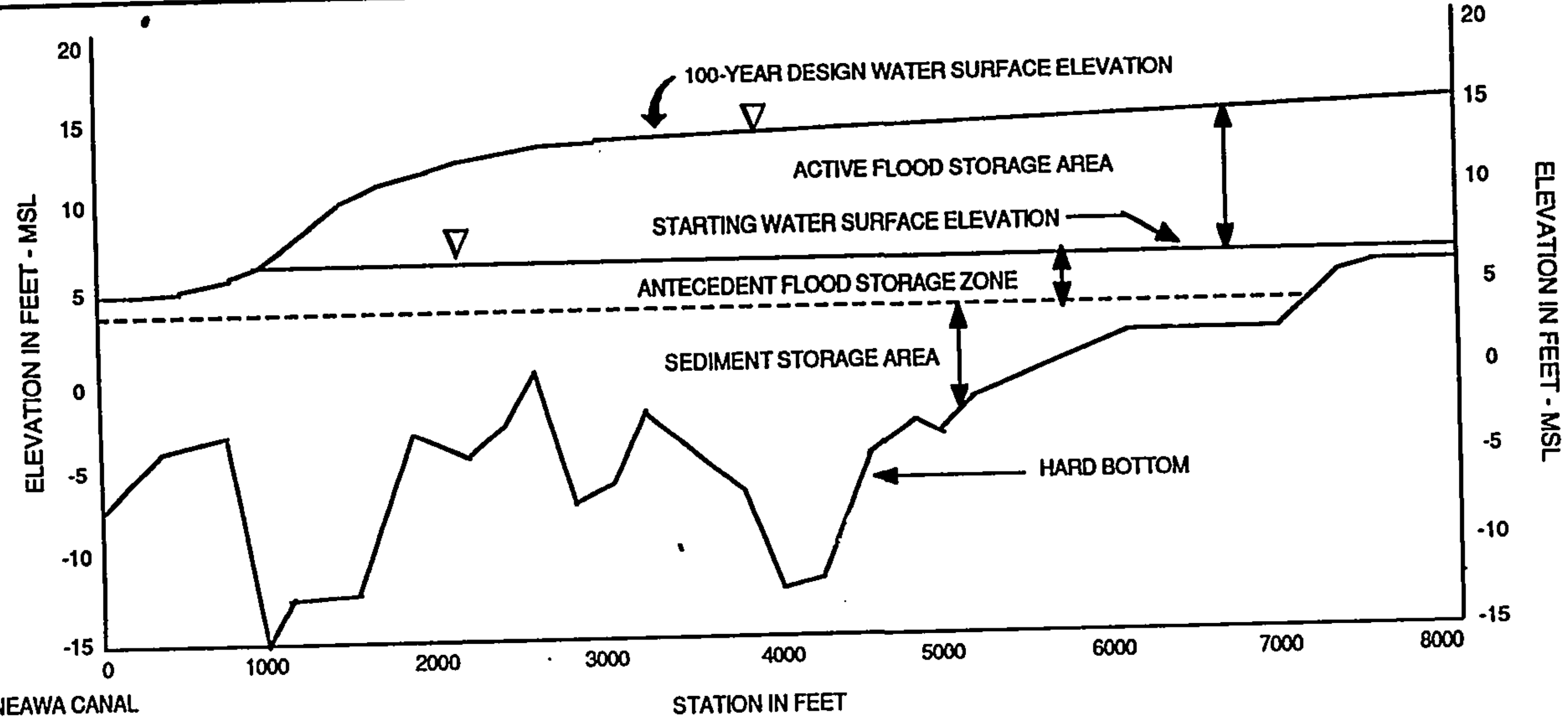
KAWAINUI MARSH — OAHU, HAWAII

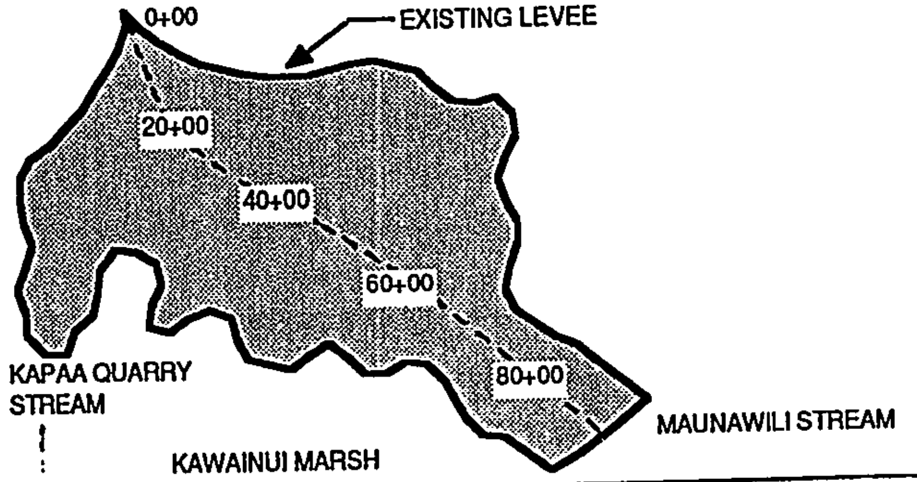
HISTORICAL MARSH
WATER LEVELS

US ARMY ENGINEER DISTRICT — HONOLULU

PLATE 3

PLATE 3





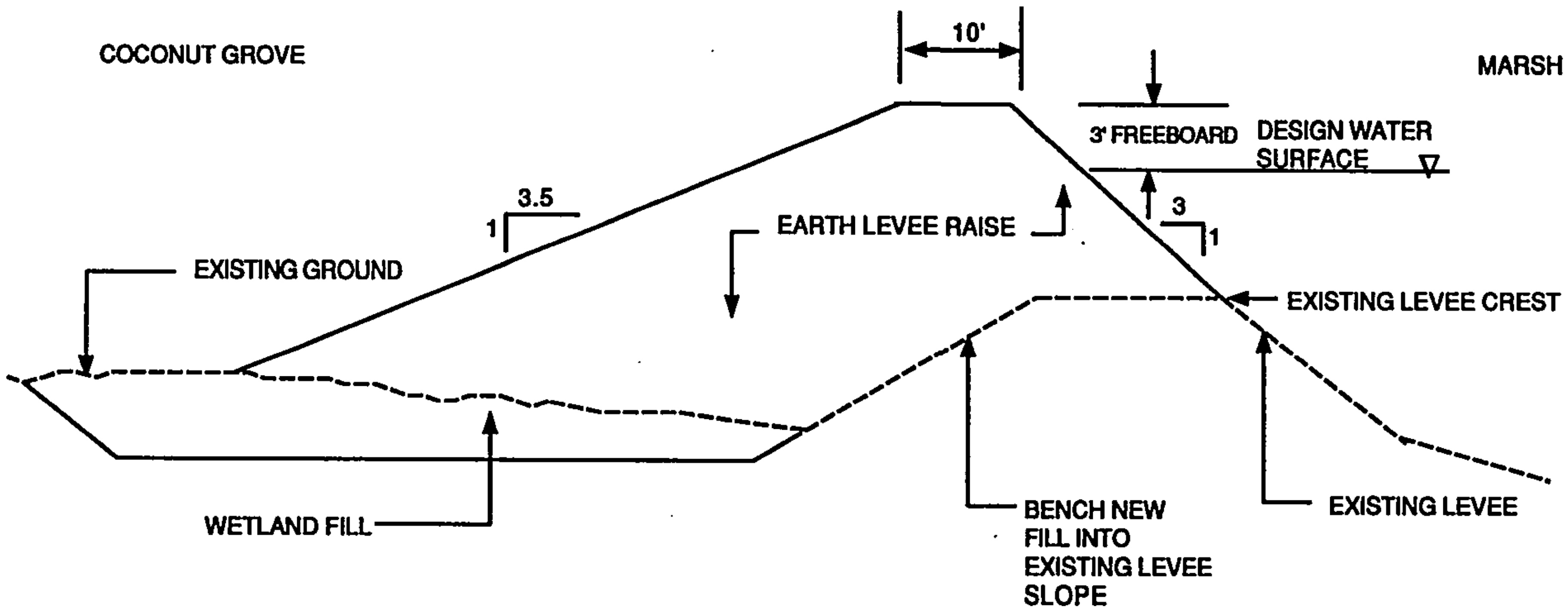
NOTE: Normal marsh water surface varies from 2.0 feet msl to 3.5 feet msl.

KAWAINUI MARSH OAHU, HAWAII

MARSH PROFILE

US ARMY ENGINEER DISTRICT HONOLULU

PLATE 4



NUMBER OF ACRES OF WETLAND FILLED = 6.4

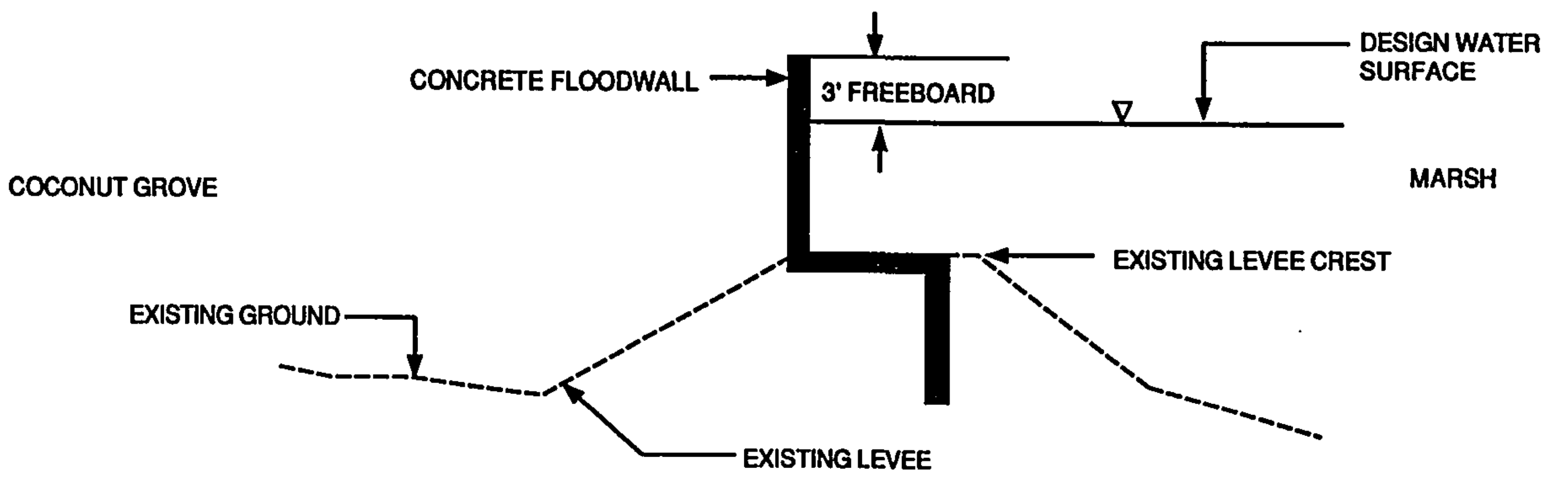
November 1991

KAWAINUI MARSH OAHU, HAWAII

PLAN 1
LEVEE RAISE

US ARMY ENGINEER DISTRICT HONOLULU

PLATE 5



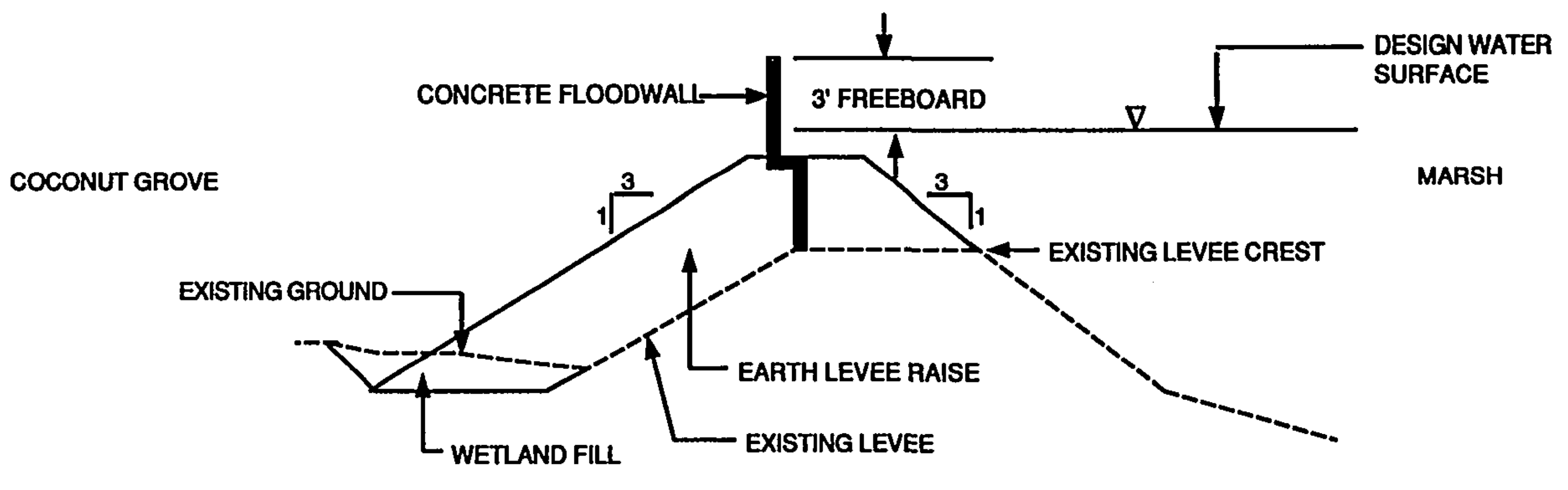
NUMBER OF ACRES OF WETLAND FILLED = 0

November 1991

KAWAINUI MARSH	OAHU, HAWAII
PLAN 2 CONCRETE FLOODWALL	
US ARMY ENGINEER DISTRICT	HONOLULU

PLATE 6

PLATE 6

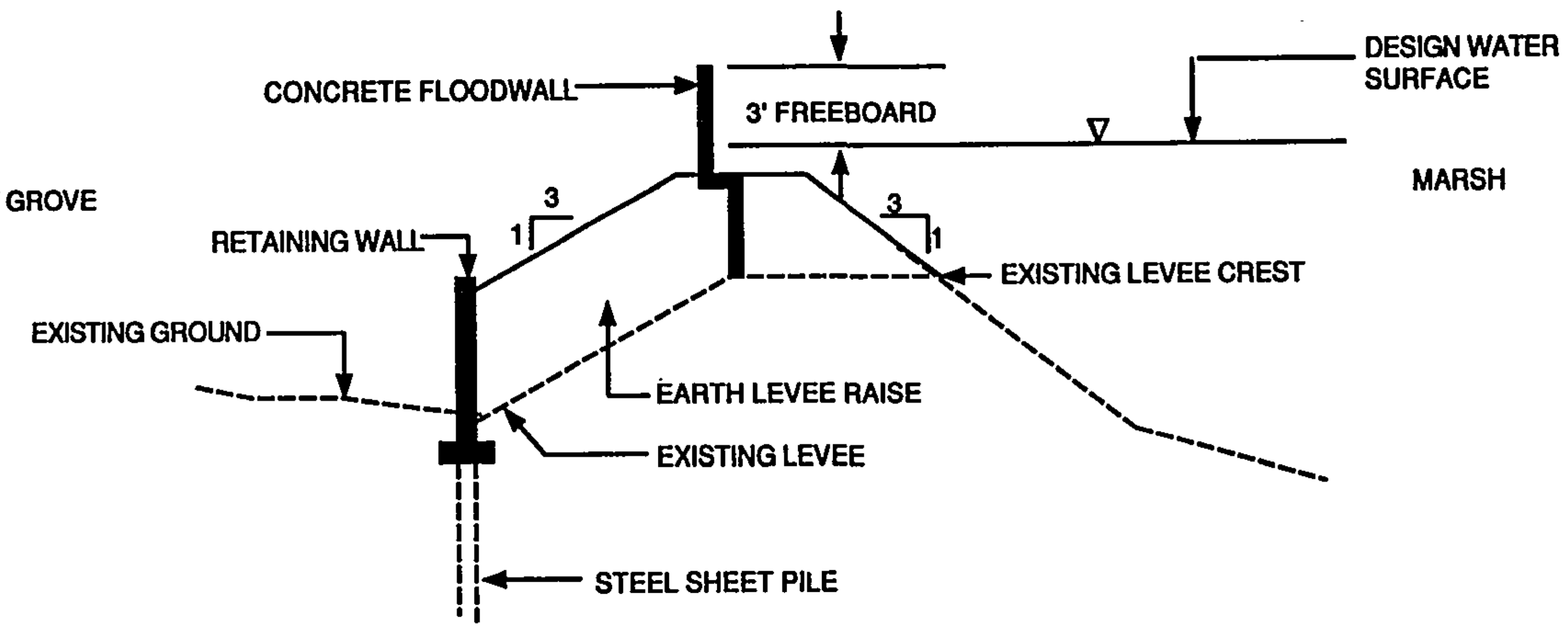


NUMBER OF ACRES OF WETLAND FILLED = 1.8

November 1991

KAWAINUI MARSH	OAHU, HAWAII
PLAN 3A COMBINATION EARTH LEVEE RAISE AND CONCRETE FLOODWALL	
US ARMY ENGINEER DISTRICT	HONOLULU

PLATE 7



NUMBER OF ACRES OF WETLAND FILLED = 0

November 1991

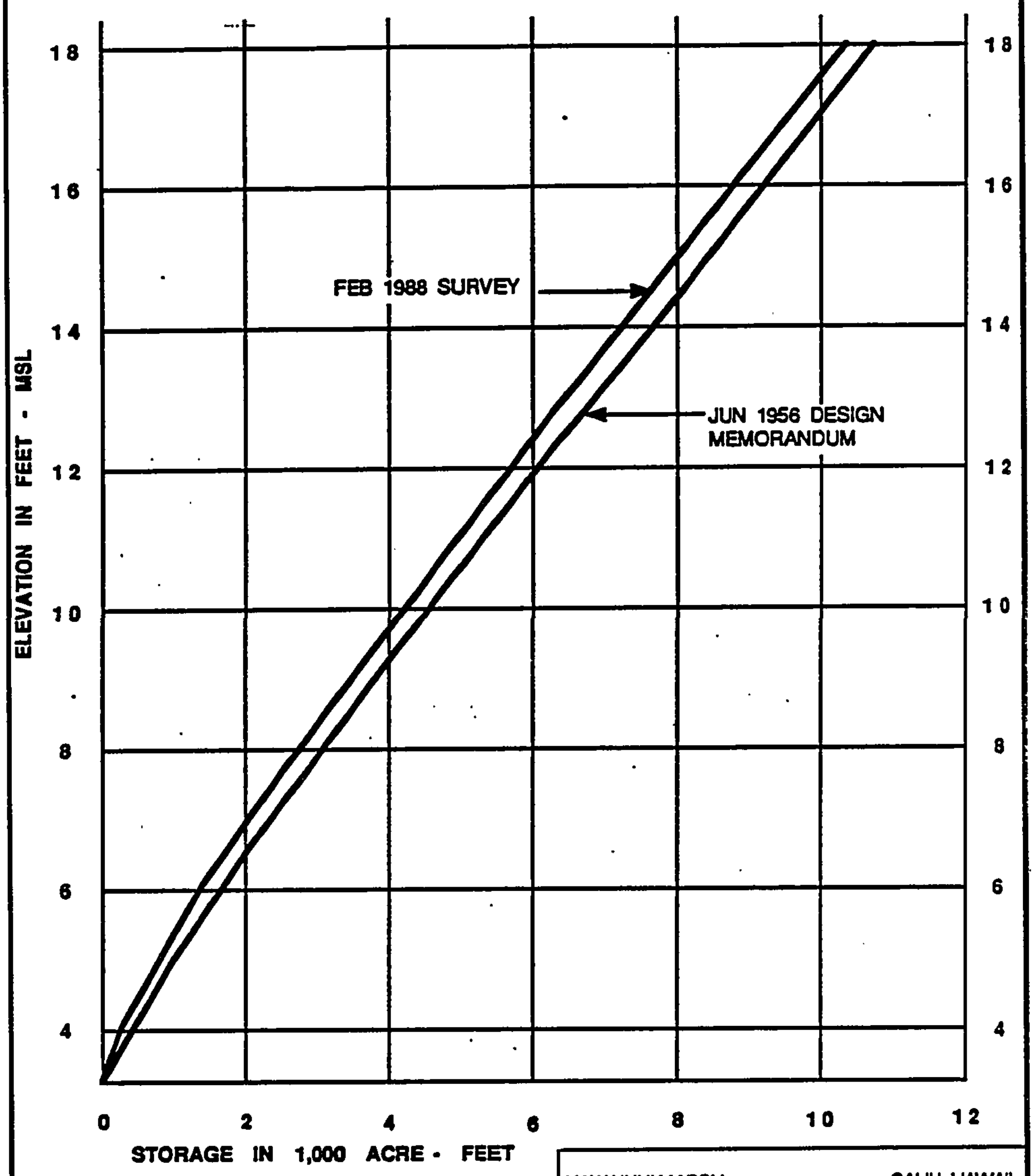
KAWAINUI MARSH — OAHU, HAWAII

PLAN 3B
COMBINATION EARTH LEVEE RAISE
AND FLOODWALL WITH RETAINING WALL

US ARMY ENGINEER DISTRICT — HONOLULU

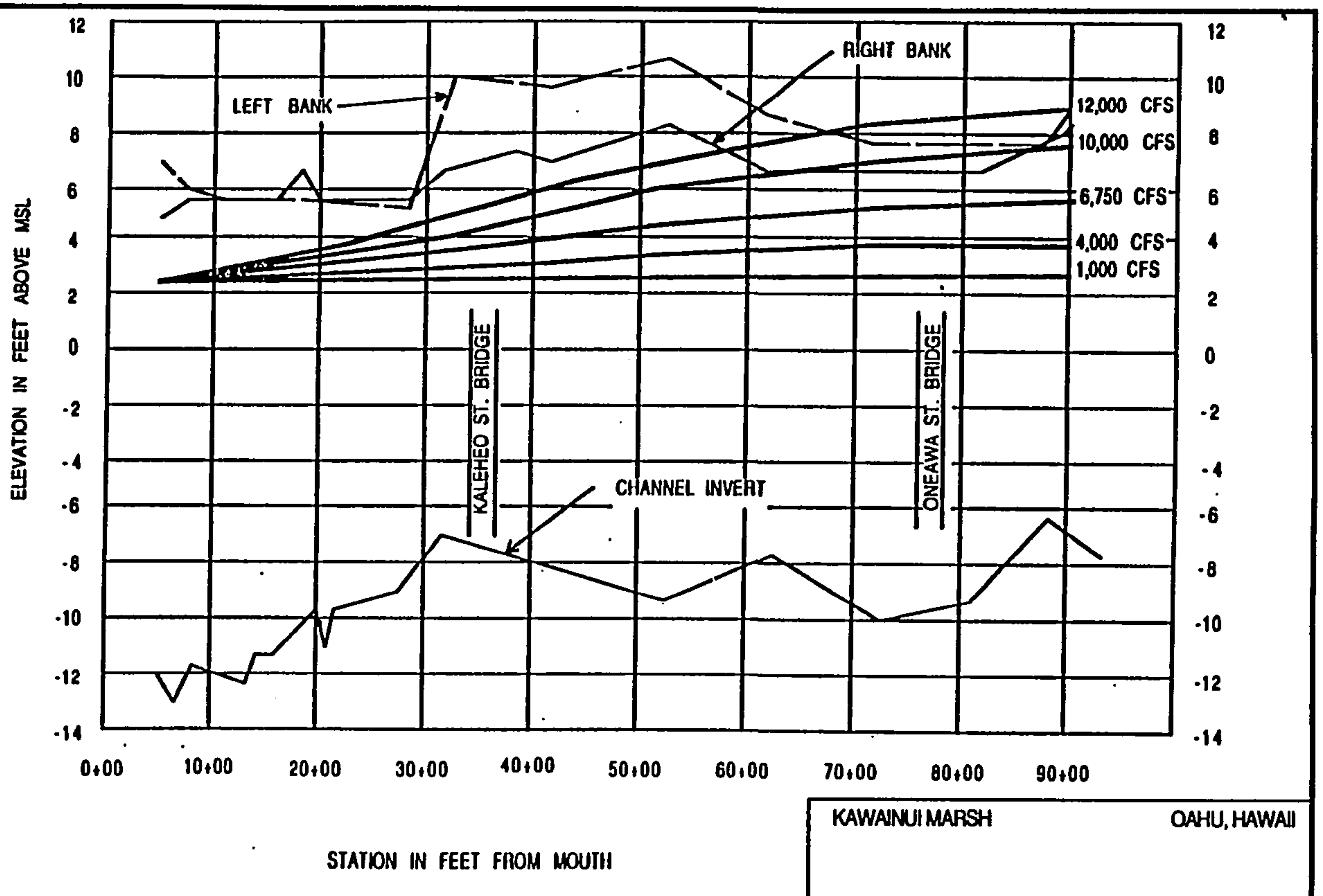
PLATE 8

PLATE 8



KAWAINUI MARSH	OAHU, HAWAII
MARSH STORAGE CURVE	
US ARMY ENGINEER DISTRICT	HONOLULU

PLATE 9

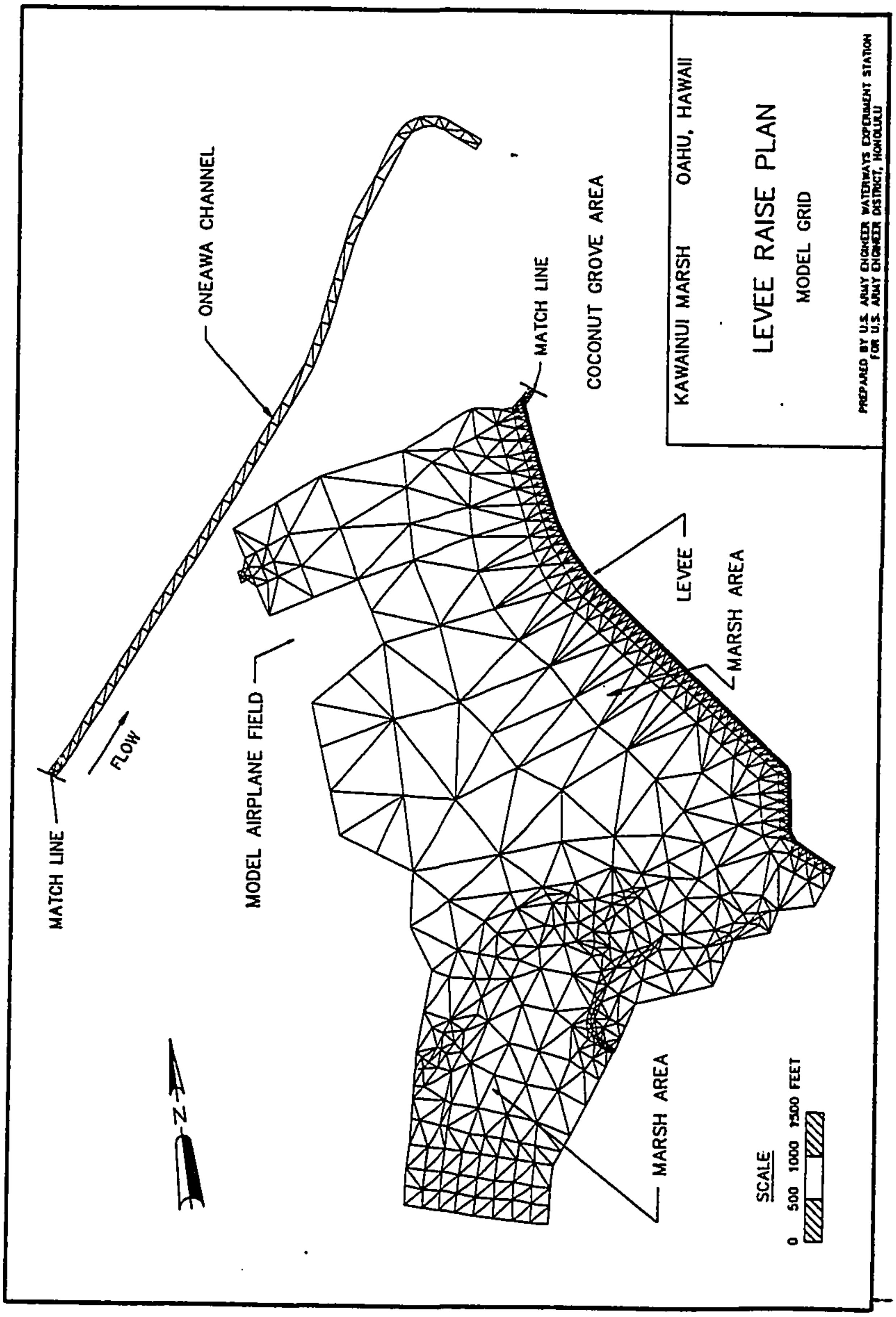


KAWAINUI MARSH — OAHU, HAWAII

WATER SURFACE PROFILES
ONEAWA CANAL

US ARMY ENGINEER DISTRICT — HONOLULU

PLATE 10



KAWAINUI MARSH OAHU, HAWAII
LEVEE RAISE PLAN
MODEL GRID
PREPARED BY U.S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION
FOR U.S. ARMY ENGINEER DISTRICT, HONOLULU
ONEAWA CHANNEL
COCONUT GROVE AREA
MATCH LINE
LEVEE
MARSH AREA
MODEL AIRPLANE FIELD
FLOW
MATCH LINE
MARSH AREA
N
SCALE
0 500 1000 1500 FEET

Plate 11

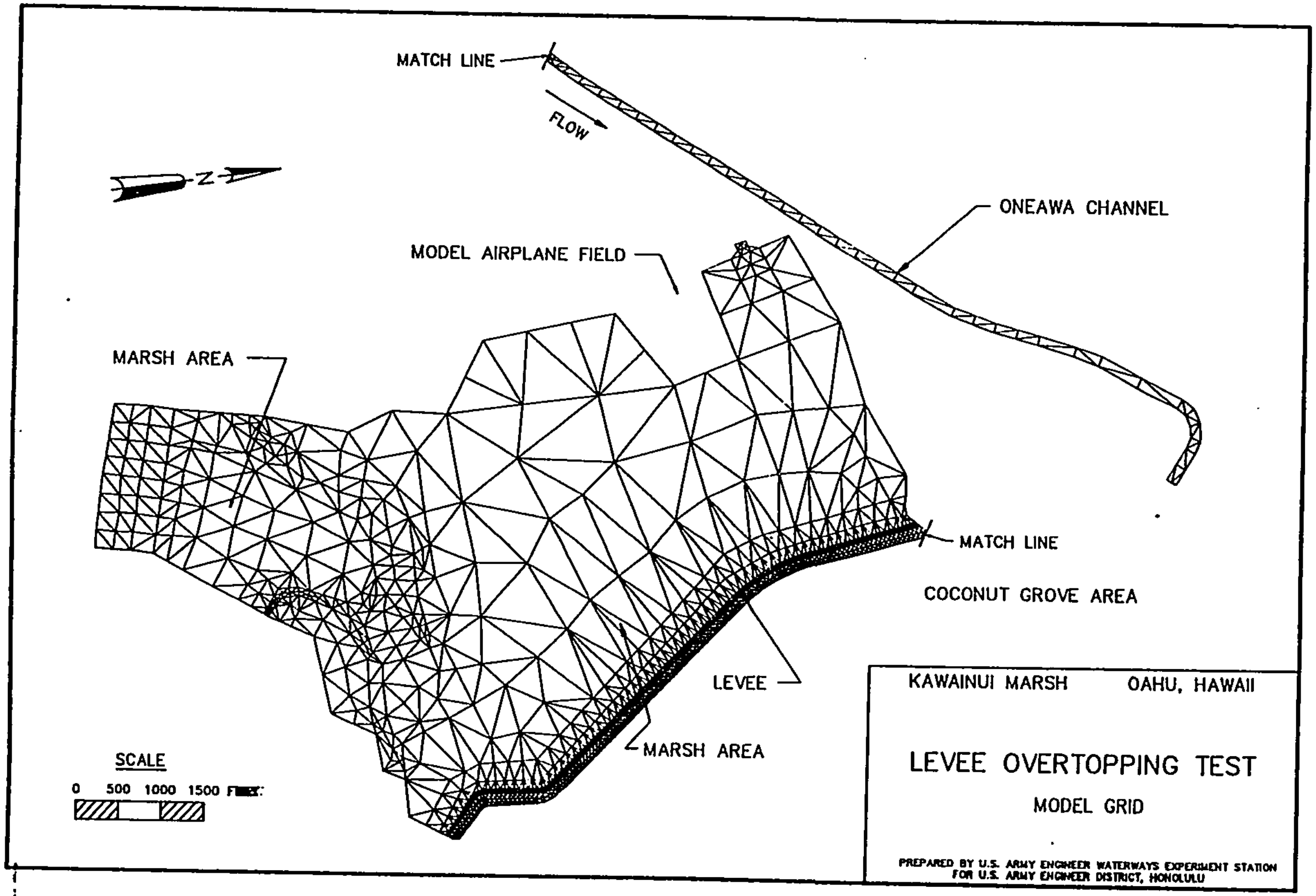
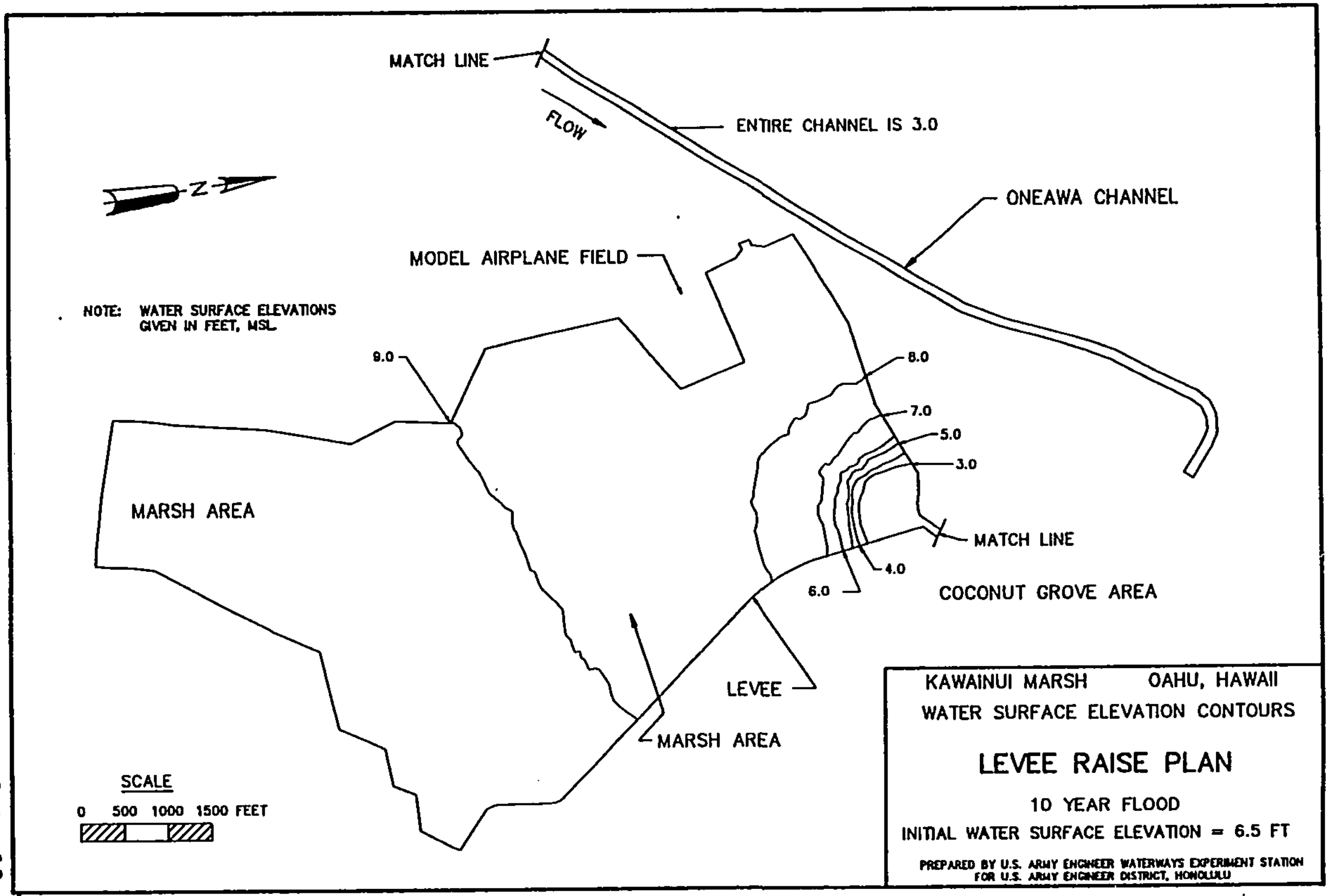


Plate 12

Plate 12



KAWAINUI MARSH OAHU, HAWAII
WATER SURFACE ELEVATION CONTOURS

LEVEE RAISE PLAN

10 YEAR FLOOD

INITIAL WATER SURFACE ELEVATION = 6.5 FT

PREPARED BY U.S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION FOR U.S. ARMY ENGINEER DISTRICT, HONOLULU

Plate 13

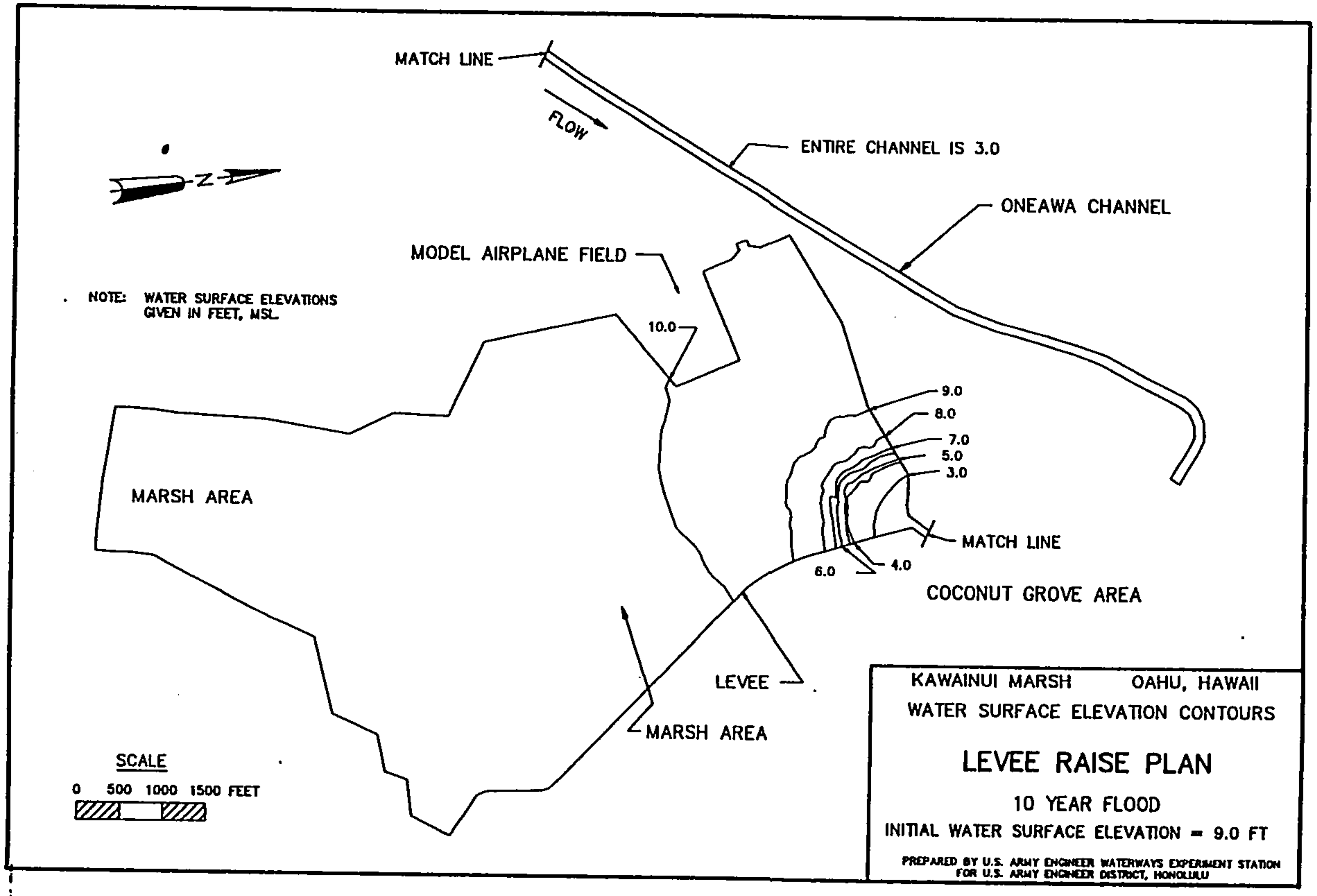
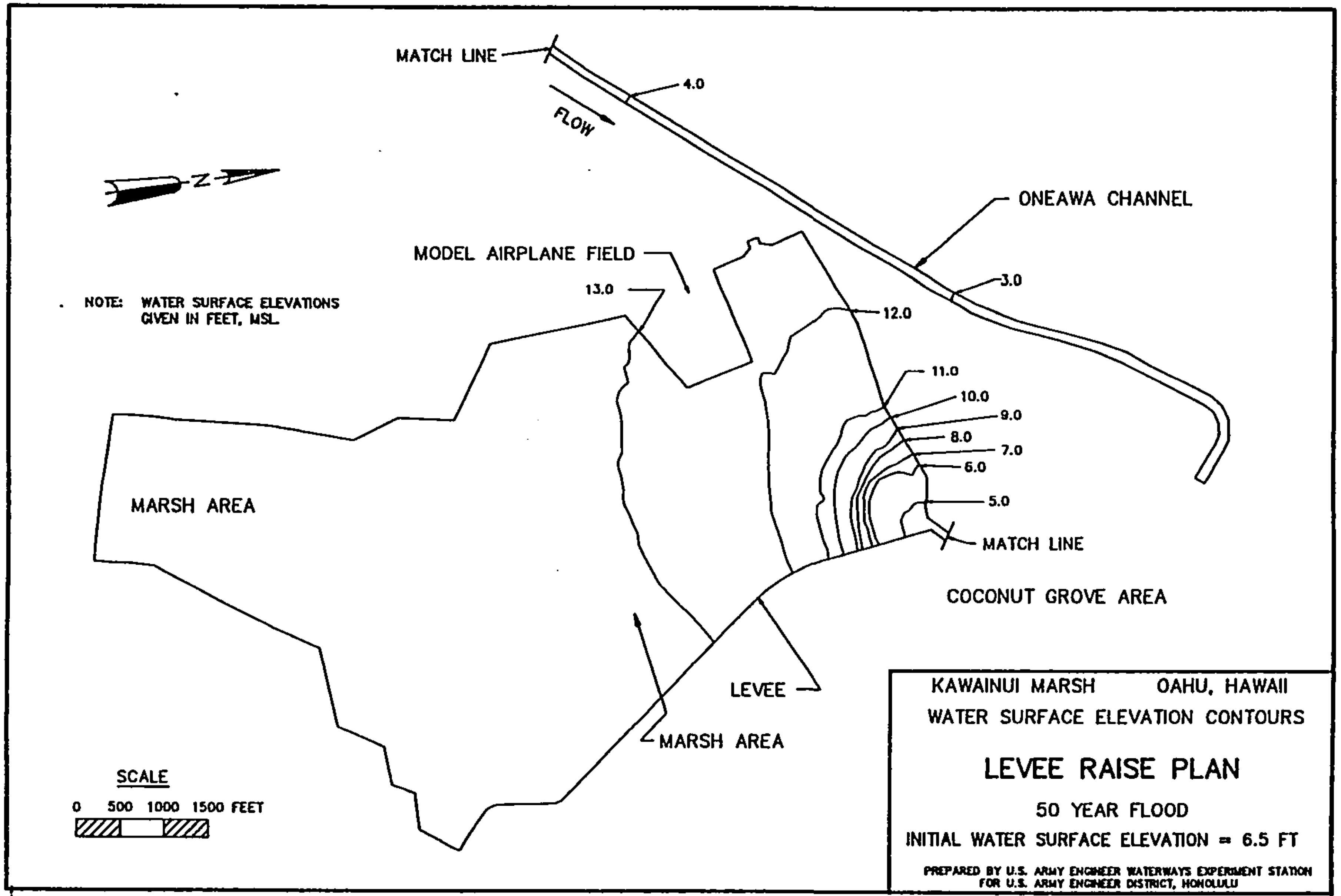

MATCH LINE
FLOW
ENTIRE CHANNEL IS 3.0
ONEAWA CHANNEL
N
MODEL AIRPLANE FIELD
NOTE: WATER SURFACE ELEVATIONS GIVEN IN FEET, MSL
10.0
9.0
8.0
7.0
5.0
3.0
MARSH AREA
MATCH LINE
6.0
4.0
COCONUT GROVE AREA
LEVEE
MARSH AREA
SCALE
0 500 1000 1500 FEET
KAWAINUI MARSH OAHU, HAWAII
WATER SURFACE ELEVATION CONTOURS
LEVEE RAISE PLAN
10 YEAR FLOOD
INITIAL WATER SURFACE ELEVATION = 9.0 FT
PREPARED BY U.S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION FOR U.S. ARMY ENGINEER DISTRICT, HONOLULU

Plate 14



KAWAINUI MARSH OAHU, HAWAII
WATER SURFACE ELEVATION CONTOURS

LEVEE RAISE PLAN

50 YEAR FLOOD

INITIAL WATER SURFACE ELEVATION = 6.5 FT

PREPARED BY U.S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION FOR U.S. ARMY ENGINEER DISTRICT, HONOLULU

Plate 15

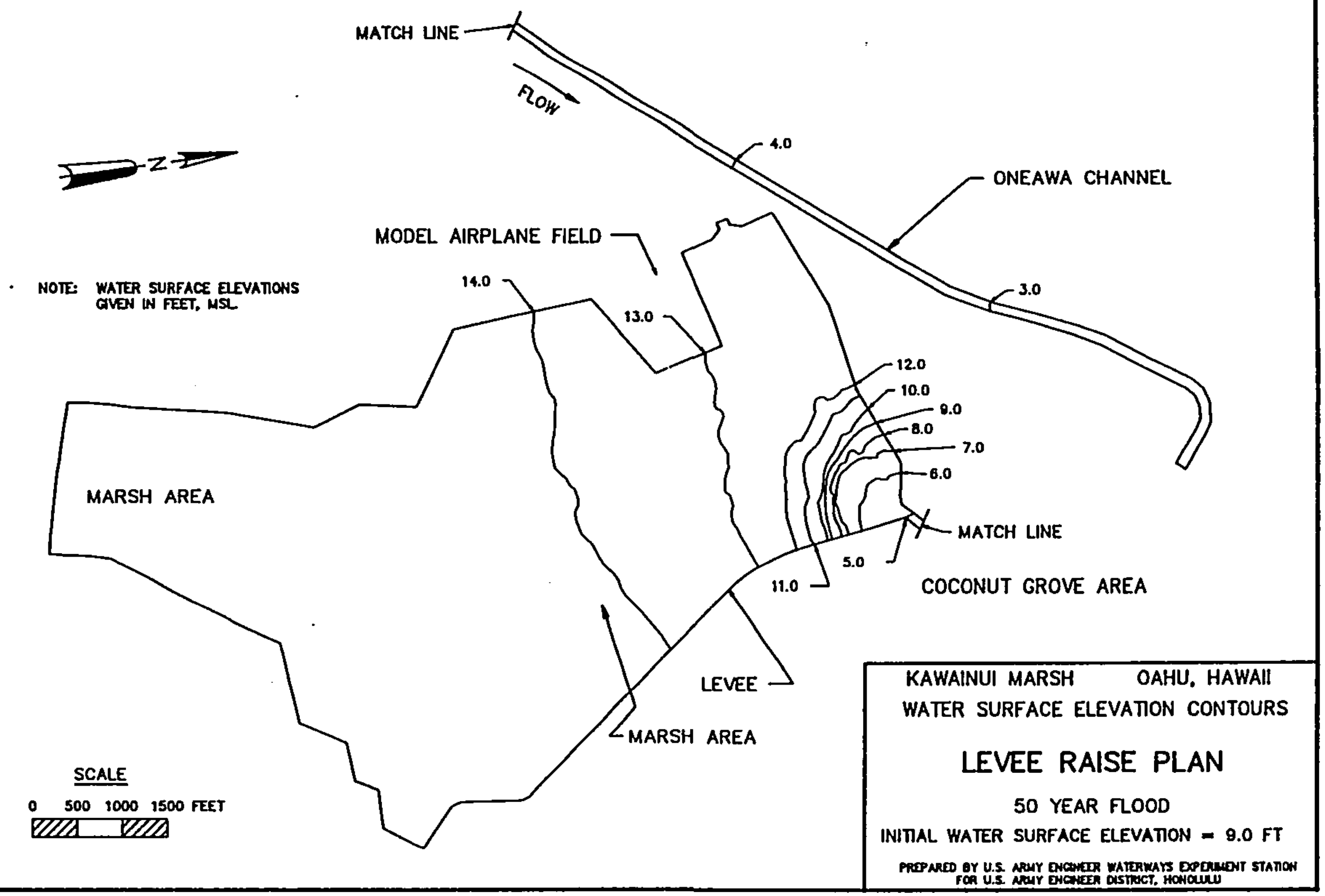

MATCH LINE
FLOW
4.0
ONEAWA CHANNEL
MODEL AIRPLANE FIELD
NOTE: WATER SURFACE ELEVATIONS GIVEN IN FEET, MSL.
14.0
13.0
3.0
12.0
10.0
9.0
8.0
7.0
6.0
MATCH LINE
5.0
11.0
COCONUT GROVE AREA
MARSH AREA
LEVEE
MARSH AREA
SCALE
0 500 1000 1500 FEET
KAWAINUI MARSH OAHU, HAWAII
WATER SURFACE ELEVATION CONTOURS
LEVEE RAISE PLAN
50 YEAR FLOOD
INITIAL WATER SURFACE ELEVATION = 9.0 FT
PREPARED BY U.S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION FOR U.S. ARMY ENGINEER DISTRICT, HONOLULU

Plate 16

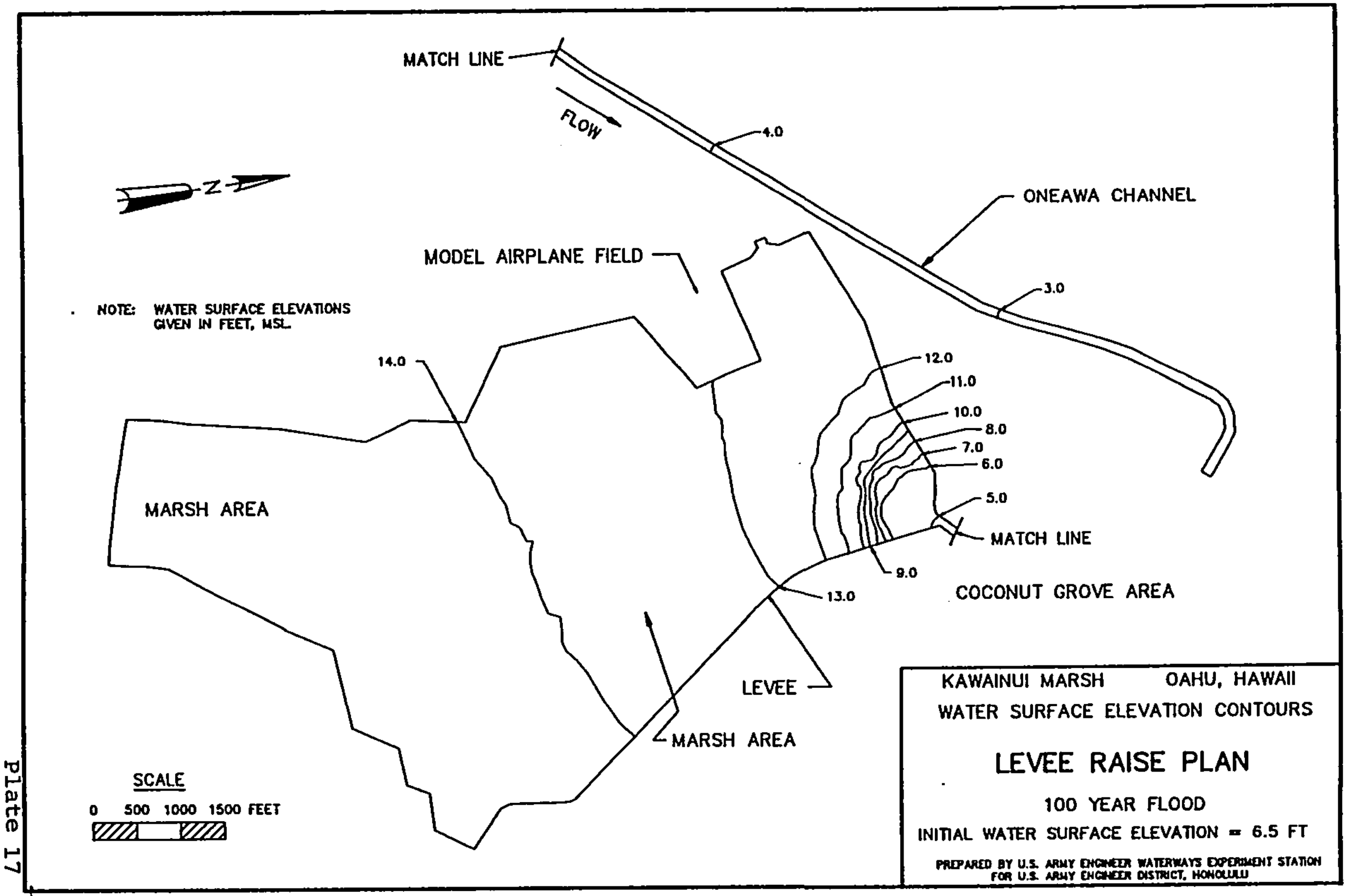


Plate 17

Plate 17

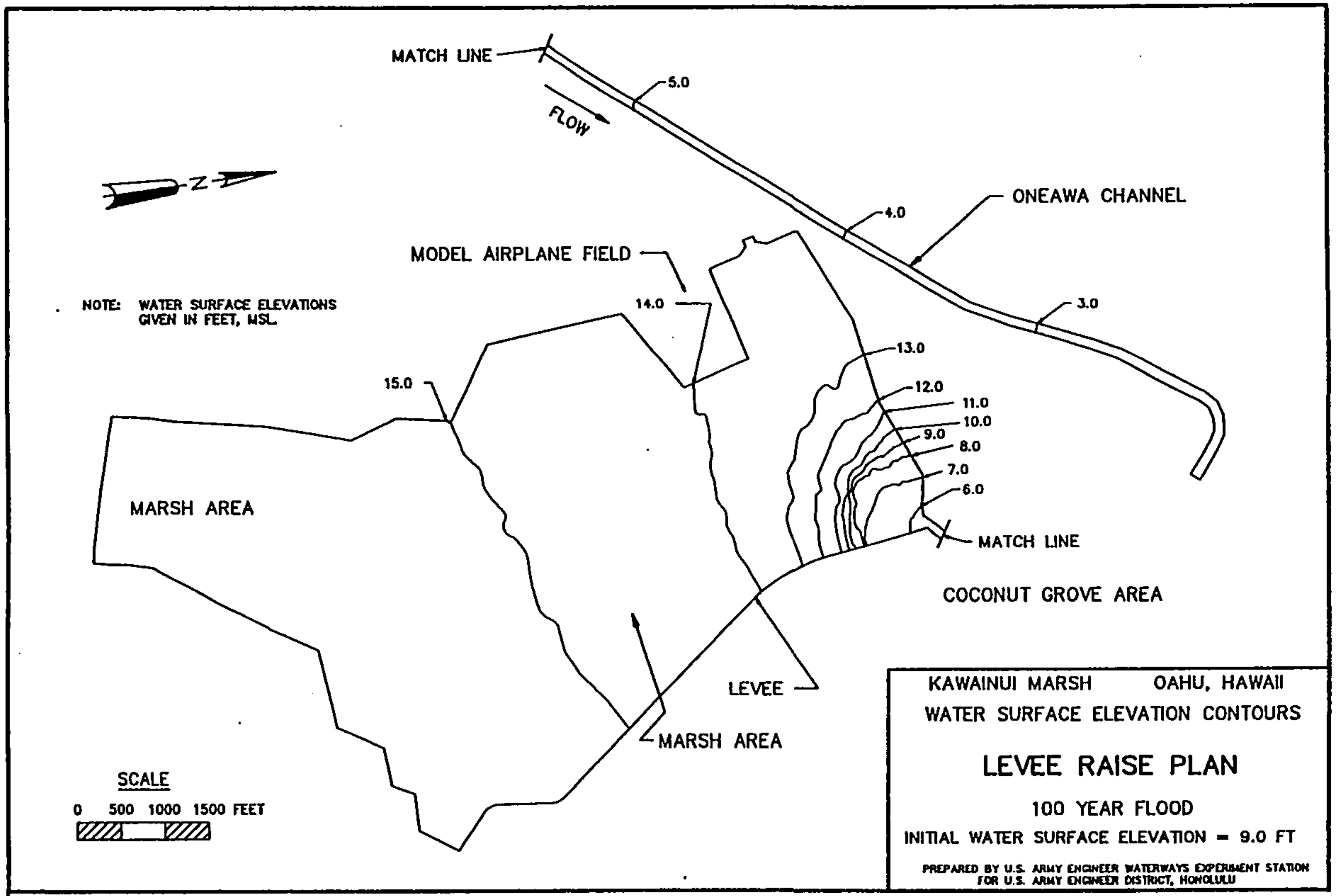
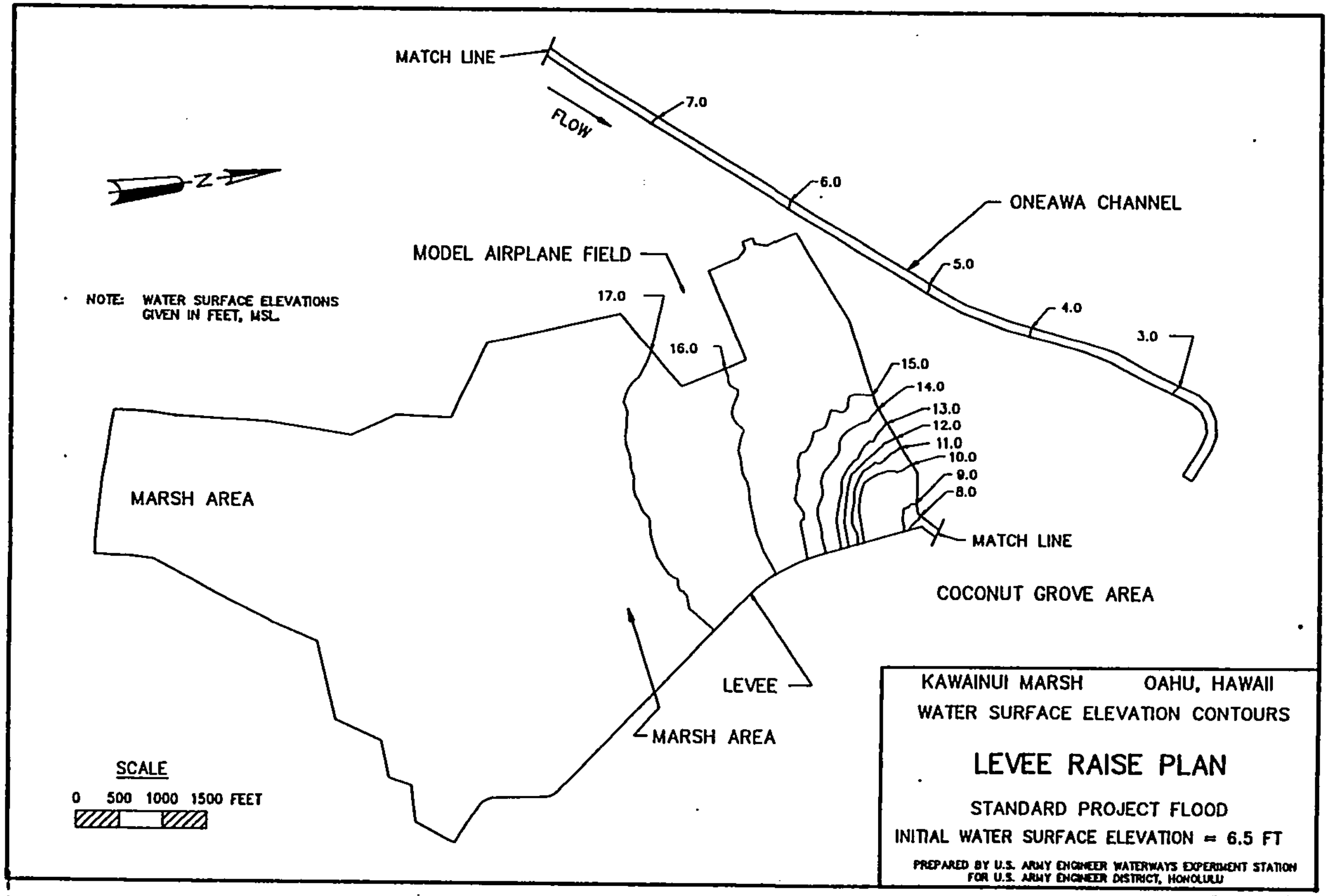

MATCH LINE
5.0
FLOW
ONEAWA CHANNEL
4.0
3.0
MODEL AIRPLANE FIELD
14.0
NOTE: WATER SURFACE ELEVATIONS GIVEN IN FEET, MSL
15.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
MATCH LINE
COCONUT GROVE AREA
MARSH AREA
LEVEE
MARSH AREA
SCALE
0 500 1000 1500 FEET
KAWAINUI MARSH OAHU, HAWAII
WATER SURFACE ELEVATION CONTOURS
LEVEE RAISE PLAN
100 YEAR FLOOD
INITIAL WATER SURFACE ELEVATION = 9.0 FT
PREPARED BY U.S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION FOR U.S. ARMY ENGINEER DISTRICT, HONOLULU

Plate 18



MATCH LINE
7.0
FLOW
6.0
ONEAWA CHANNEL
5.0
4.0
3.0
N
MODEL AIRPLANE FIELD
NOTE: WATER SURFACE ELEVATIONS GIVEN IN FEET, MSL
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
MATCH LINE
MARSH AREA
COCONUT GROVE AREA
LEVEE
MARSH AREA
SCALE
0 500 1000 1500 FEET
KAWAINUI MARSH OAHU, HAWAII
WATER SURFACE ELEVATION CONTOURS
LEVEE RAISE PLAN
STANDARD PROJECT FLOOD
INITIAL WATER SURFACE ELEVATION = 6.5 FT
PREPARED BY U.S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION FOR U.S. ARMY ENGINEER DISTRICT, HONOLULU

Plate 19

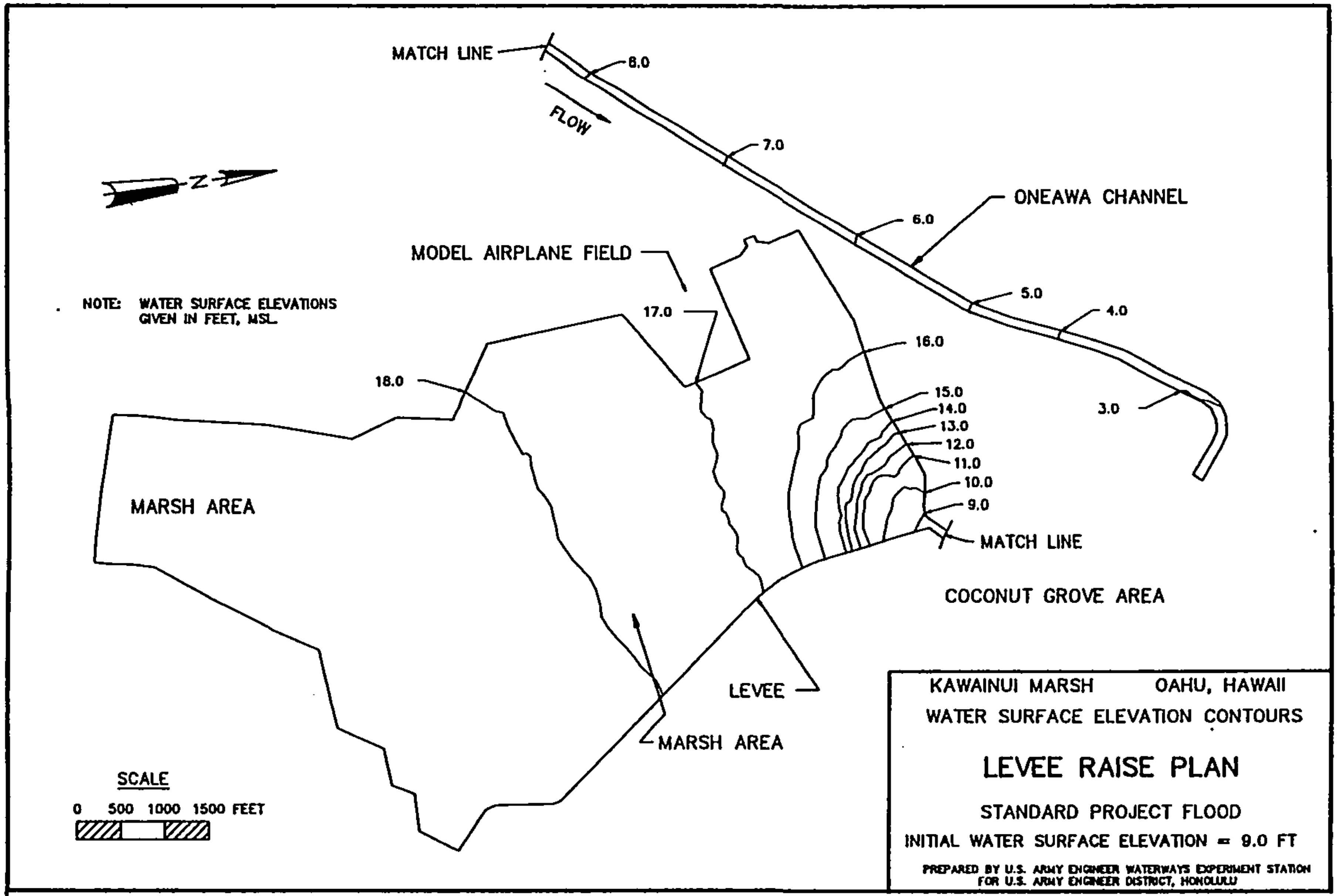
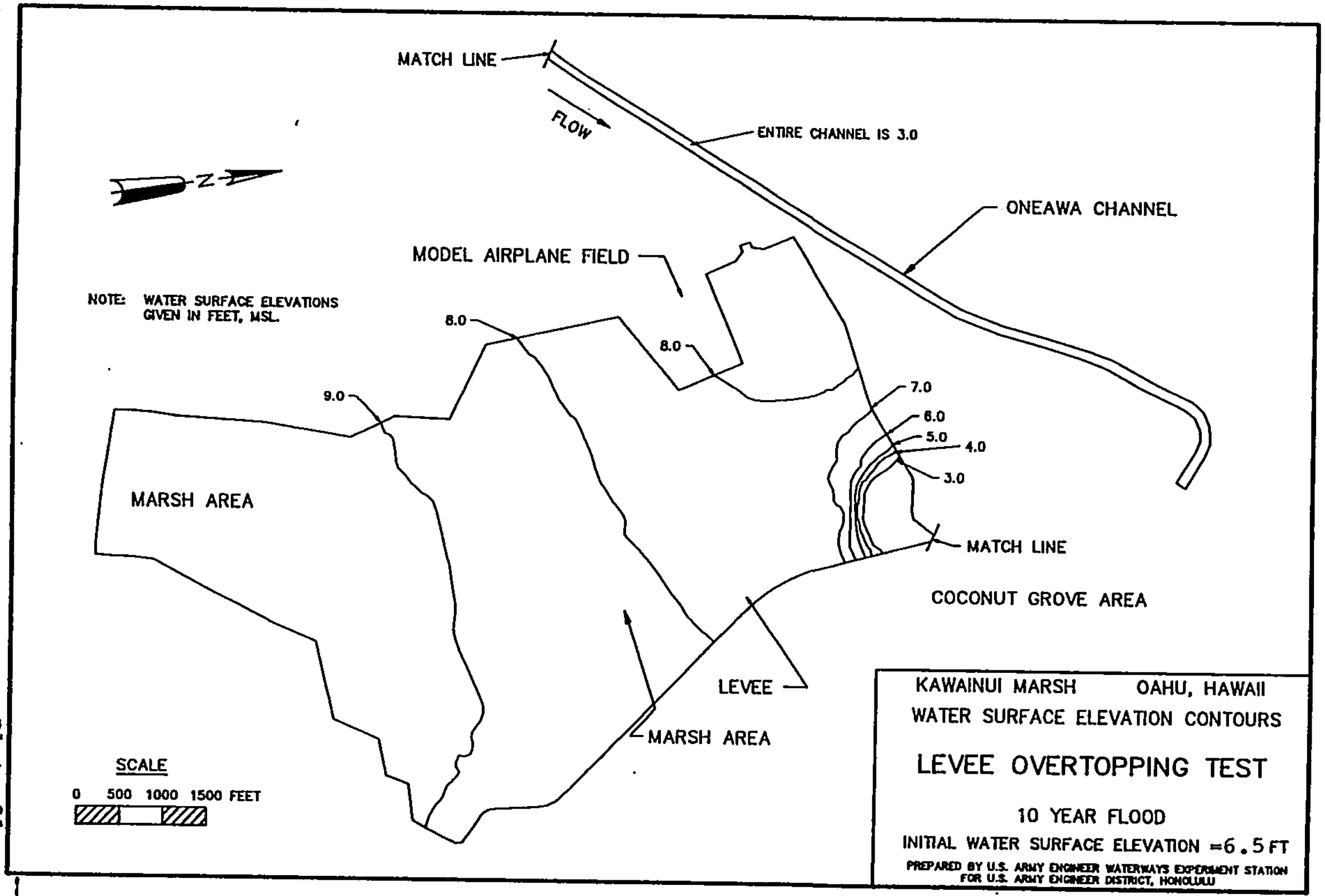

MATCH LINE
8.0
FLOW
7.0
ONEAWA CHANNEL
6.0
5.0
4.0
3.0
N
MODEL AIRPLANE FIELD
17.0
16.0
NOTE: WATER SURFACE ELEVATIONS GIVEN IN FEET, MSL
18.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
MATCH LINE
MARSH AREA
COCONUT GROVE AREA
LEVEE
MARSH AREA
SCALE
0 500 1000 1500 FEET
KAWAINUI MARSH OAHU, HAWAII
WATER SURFACE ELEVATION CONTOURS
LEVEE RAISE PLAN
STANDARD PROJECT FLOOD
INITIAL WATER SURFACE ELEVATION = 9.0 FT
PREPARED BY U.S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION
FOR U.S. ARMY ENGINEER DISTRICT, HONOLULU

Plate 20



KAWAINUI MARSH OAHU, HAWAII

WATER SURFACE ELEVATION CONTOURS

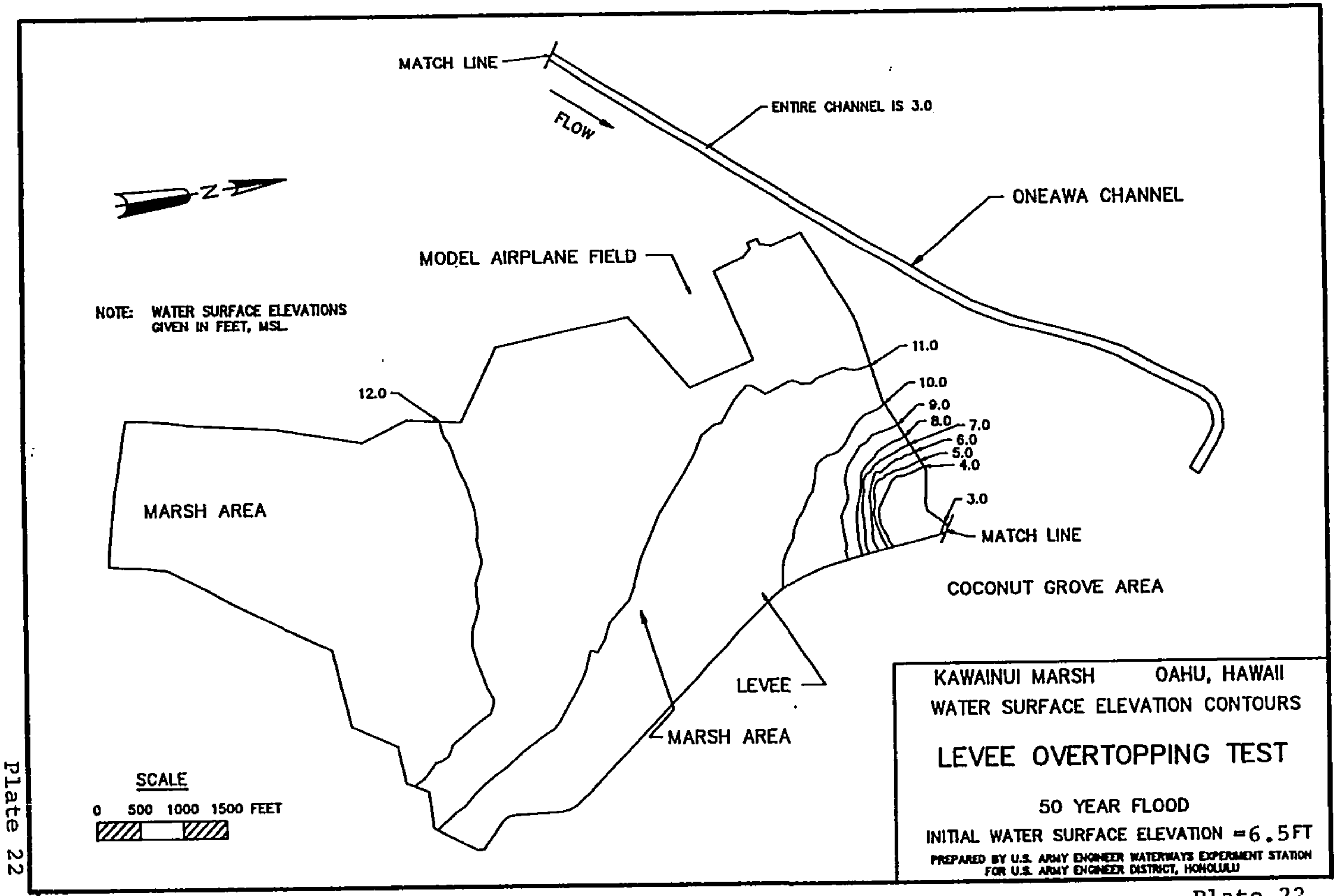
LEVEE OVERTOPPING TEST

10 YEAR FLOOD

INITIAL WATER SURFACE ELEVATION =6.5 FT

PREPARED BY U.S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION FOR U.S. ARMY ENGINEER DISTRICT, HONOLULU

Plate 21



KAWAINUI MARSH OAHU, HAWAII
WATER SURFACE ELEVATION CONTOURS

LEVEE OVERTOPPING TEST

50 YEAR FLOOD

INITIAL WATER SURFACE ELEVATION =6.5FT

PREPARED BY U.S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION FOR U.S. ARMY ENGINEER DISTRICT, HONOLULU

Plate 22

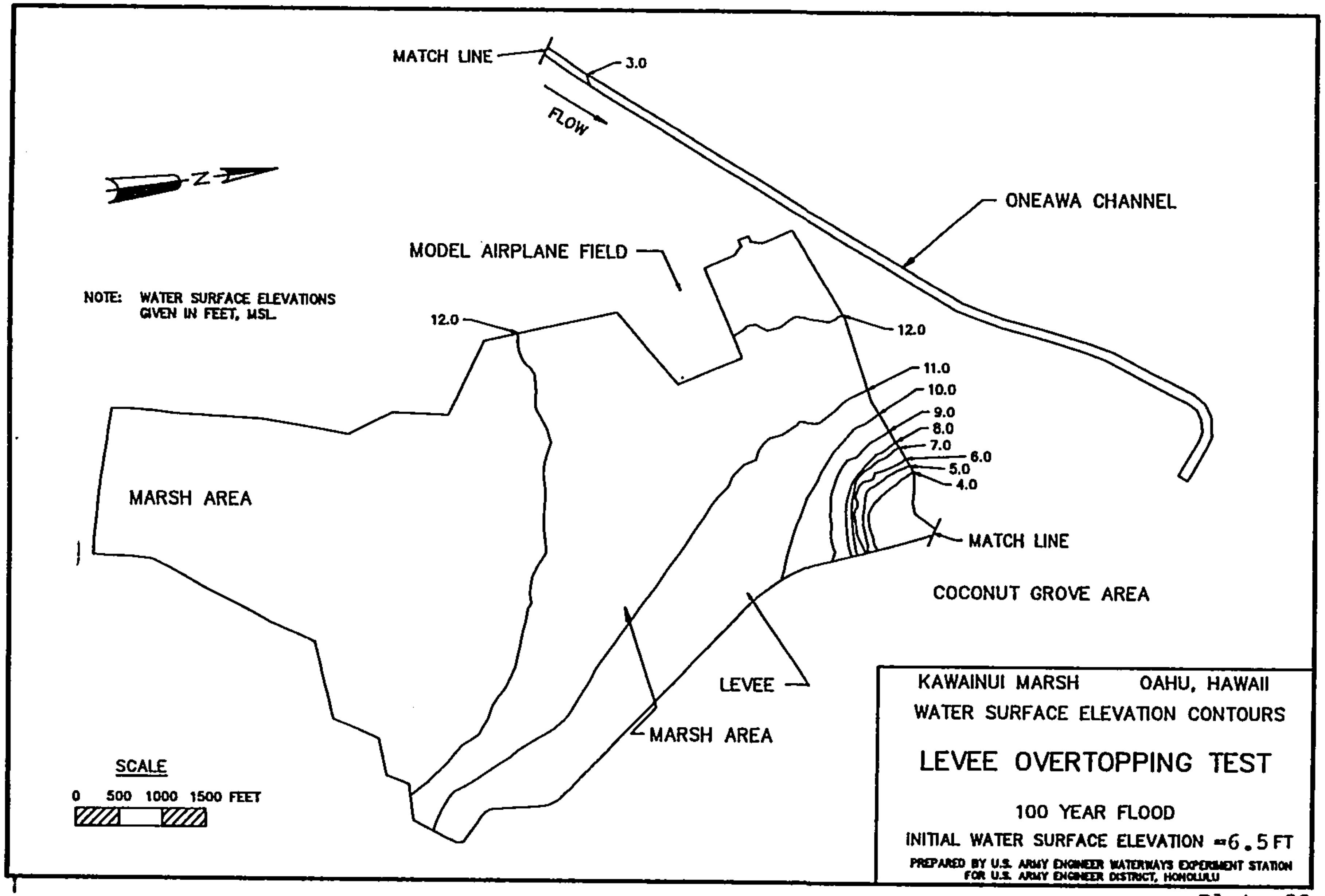


Plate 23

Plate 23

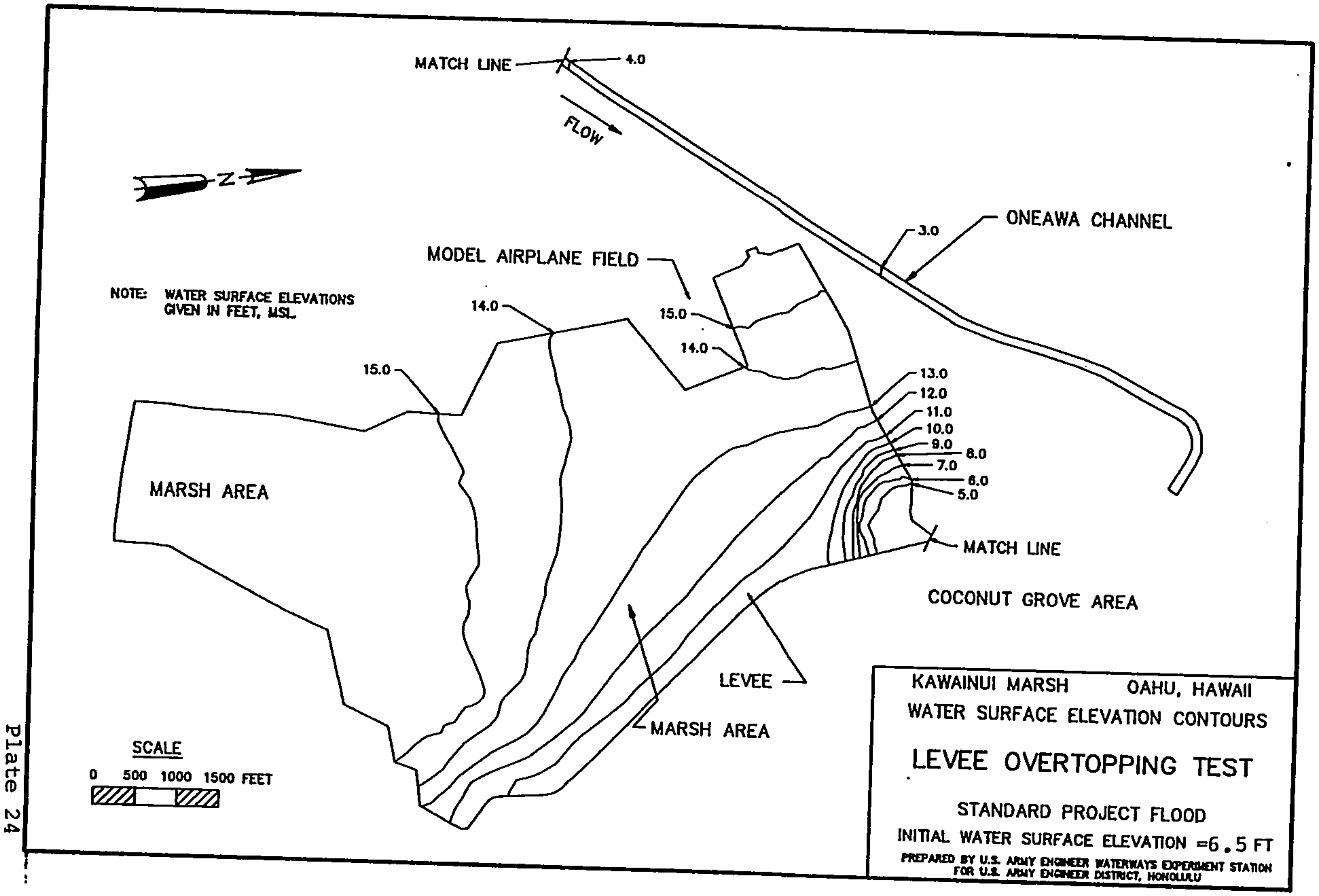
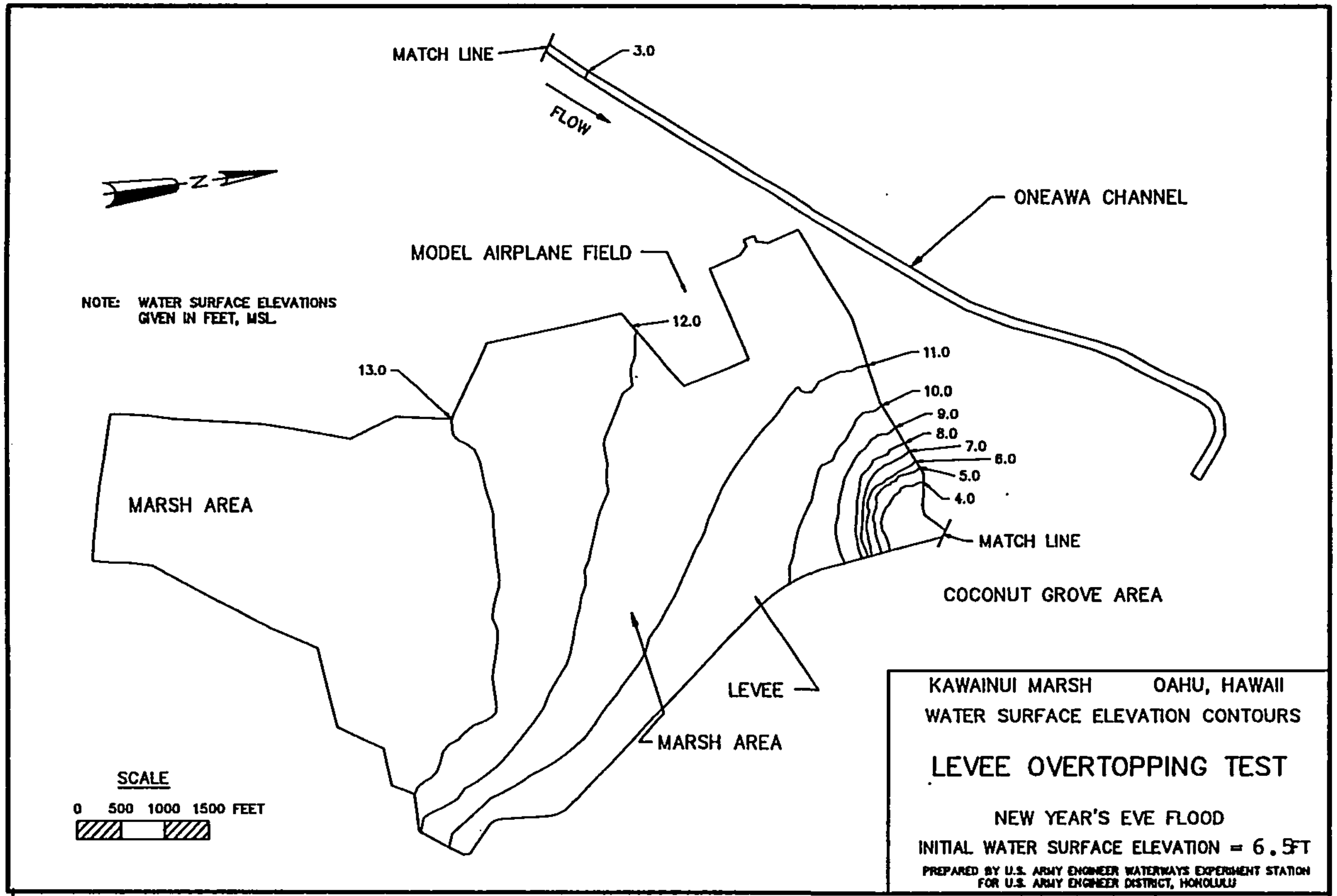

MATCH LINE
4.0
FLOW
N
ONEAWA CHANNEL
3.0
MODEL AIRPLANE FIELD
NOTE: WATER SURFACE ELEVATIONS GIVEN IN FEET, MSL
14.0
15.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
MATCH LINE
MARSH AREA
COCONUT GROVE AREA
LEVEE
MARSH AREA
SCALE
0 500 1000 1500 FEET
KAWAINUI MARSH OAHU, HAWAII
WATER SURFACE ELEVATION CONTOURS
LEVEE OVERTOPPING TEST
STANDARD PROJECT FLOOD
INITIAL WATER SURFACE ELEVATION =6.5 FT
PREPARED BY U.S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION FOR U.S. ARMY ENGINEER DISTRICT, HONOLULU

Plate 24



KAWAINUI MARSH OAHU, HAWAII
WATER SURFACE ELEVATION CONTOURS

LEVEE OVERTOPPING TEST

NEW YEAR'S EVE FLOOD
INITIAL WATER SURFACE ELEVATION = 6.5FT

PREPARED BY U.S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION FOR U.S. ARMY ENGINEER DISTRICT, HONOLULU

Plate 25

KAWAINUI MARSH
FLOOD CONTROL PROJECT
OAHU, HAWAII

APPENDIX C - GEOLOGY, FOUNDATIONS AND MATERIALS

APPENDIX C

KAWAINUI MARSH FLOOD CONTROL PROJECT

OAHU, HAWAII

TABLE OF CONTENTS

LIST OF PLATES

APPENDIX C

GEOLOGY, FOUNDATIONS AND MATERIALS

KAWAINUI MARSH FLOOD CONTROL PROJECT

1. GENERAL GEOLOGY

Oahu was formed from the coalescence of lava flows from two volcanic ranges; the Waianae and Koolau. Although the Waianae volcanic range appears to be older (the first to become extinct), both volcanoes were concurrently active from the late Tertiary Period of geologic time to the early Pleistocene Epoch (2 million to less than 1 million years before present). When volcanic activity ceased, streams carved deep, amphitheater headed canyons into the surfaces of the volcanoes' shield-shaped domes. At the same time (and over the past 600,000 years), changes in the ocean level accompanying glaciation and deglaciation of the earth during the Pleistocene Epoch were partially responsible for shifting Oahu's coastline. These ocean level changes drowned stream valleys and created wave-cut terraces and coral reef deposits at various elevations between 1,800 feet below and 1,200 feet above the present day sea level. Volcanism (The Honolulu Series) was renewed on the Koolau range between 900,000 and 100,000 years before present which created such features as Diamond Head, Salt Lake, Aliamanu, Punchbowl and the Koko craters.

2. REGIONAL GEOLOGY

Maunawili Valley is part of the remnant of the volcanic dome, the Koolau Range, which constitutes the eastern three-fourths of the island of Oahu. The precipitous cliffs, or palis, have slopes between 45 to 85 degrees; above 1,500 feet the slopes are about 60 degrees. The highest points along the crestline within the study area are in excess of 2,000 feet. The trend of the cliffs coincides with the rift zone that occurred along the flanks of the active volcano which ended during the late Pleistocene and Recent Periods.

Lava flows of the Koolau Series form the high ridges along the southwestern side and together with rock from the Kailua Volcanic Series make up the prominent volcanic ridges on the southeastern and northwestern sides of Maunawili Valley. Scattered through the valley are pyroclastic deposits and basaltic lava flows of the Honolulu Volcanic Series. The younger alluvium underlying the lower part of the stream valleys consists primarily of silt and clay soil.

The soil conditions within the marsh vary considerably with depth from the surface. Borings taken in the marsh (Dames and Moore, 1961) indicate that a thick blanket of roots and peat overlay this area. The geologic formation underlying the marsh has been identified as unconsolidated calcareous marine sediments, chiefly cream colored and light tan, which consist of very permeable beach sand of grains of worn coral, coralline algae, and shells with appreciable amounts of foraminifera and other marine organisms.

3. SEISMICITY

Although Oahu's seismic regime may appear subdued, intensities from major earthquakes on or near a neighboring island can have catastrophic effects on any or all of the Hawaiian Islands. Two such significant earthquakes occurred on the East Molokai Fracture Zone in 1871 and 1938. These events registered a Richter Magnitude 7.5 and were felt in Honolulu with a Modified Mercalli (MM) Intensity VIII. The original Modified Mercalli Intensity Scale (abridged) states for MM VIII:

> "Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; and great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls, heavy furniture overturned. Sand and mud ejected in small amounts. Changes in water wells. Persons driving motorcars disturbed."

These events have been considered the "worst of credible events" and have been used in the development of seismic probability zones as well as in seismic designs for modern structures. The Uniform Building Code lists Oahu in seismic probability Zone 1. For design consideration, Army Technical Manual TM 5-809-10 places Oahu into seismic probability Zone 2 and describes damage as "moderate".

The magnitude of Hawaiian earthquakes was not routinely determined locally until 1958. Prior to that, magnitudes of large earthquakes were measured by seismograph stations on the continental United States, usually by those at the California Institute of Technology, University of California at Berkeley, and Columbia University.

4. SUBSURFACE EXPLORATIONS AND CONDITIONS

a. Prior Borings by the Corps of Engineers.

Numerous borings were performed along the alignments of the levee and the Oneawa Canal, between May 1955 and April 1964, prior to construction of the original flood control project. The locations of 23 borings situated along the existing levee and 15 borings situated along the upper 3,000 feet of the Oneawa Canal are shown on Plate C-1. The individual logs of these borings, which were extracted from the original construction drawings, are shown on Plates C-2 and C-3. The borings along the levee alignment generally found a surficial layer of peat, 3 to 6 feet thick, underlain by sands (SM, SP, SW, SP-SM) and gravels (GP, GW) to depths of at least 25 feet, the maximum depth drilled. The borings along the Oneawa Canal generally encountered sands (SP, SP-SM, SM) and gravel (GP, GM) with the exception that silts (MH, ML) and clays (CH) were also encountered at various depths in borings situated along the southeastern bank of the canal.

b. Borings By Others.

Five borings at scattered locations within Kawainui Marsh were performed by Dames and Moore during April to May 1961 in connection with a proposed residential-commercial development. The individual locations and logs of these borings can be found in a report prepared by Dames and Moore entitled "Preliminary Site Investigation, Proposed Land Development, Kawainui Marsh, Kailua, Hawaii". According to this report the marsh is covered by a thick blanket of roots and organic matter (peat) to a maximum depth of 10 feet. The organic matter is reported to have a dry density of about 7 pounds per cubic foot and a moisture content in excess of 800 percent. A layer of organic silt (OL) up to 30 feet thick was found beneath the surficial peat material. The organic silt is reported to be very weak and compressible and possess a dry density ranging from 17 to 50 pounds per cubic foot and moisture contents ranging from 100 to 300 percent. Materials beneath the organic silt layer is reported to consist of either coral sand with shells (SP) or fairly compressible gray marine silt with shells (MH & ML) depending on the location within the swamp. The gray marine silt layer was found to be as thick as 95 feet in one of the borings.

Four borings through the crest of the existing levee were performed by Walter Lum Associates during May 1989 in connection with a study on Kawainui Marsh performed by M&E Pacific for the City and County of Honolulu. The individual locations and logs of these borings can be found in a report prepared by Walter Lum Associates entitled "Kawainui Marsh Levee, Soil Reconnaissance Report", dated July 21, 1989. In general, these borings found 1 to 2.5 feet of crushed gravel (base course) underlain by alternating layers of sands (SC, SM, SP, SP-SM, SW-SM) and gravels (GC, GM) to 40 feet, the maximum depth drilled. In one boring, a 6-foot layer of stiff brown clayey silt/silty clay (MH/CH) was found at the surface of the levee.

c. Recent Borings by the Corps of Engineers.

Twelve borings (BH-1-90 to BH-12-90) were performed by the Corps of Engineers between May to August 1990 to supplement aforementioned borings performed prior to construction of the original flood control project. Six of these borings (BH-1, BH-3, BH-4, BH-5, BH-7, and BH-8) were located on the crest of the existing levee; two borings (BH-2 and BH-6) were located along the western bank of the Kaelepulu Drainage Canal; and four borings (BH-9-90 to BH-12-90) were located near the alignment of the proposed water control structure. Individual locations of these borings are shown on Plate C-4. Logs of these borings are shown on Plates C-5 and C-6. The borings drilled through the crest of the existing levee generally encountered approximately 1-foot of gravel surfacing (crushed basalt) underlain by silts, sands and gravels to 35 feet, the maximum depth drilled. These borings generally confirm the findings of the subsurface investigations by Walter Lum Associates. The borings drilled along the western bank of the Kaelepulu Drainage Canal generally encountered sands and/or gravels to 35 feet depth, with the exception that thin layers of peat and other organic matter were found within the upper 6 feet of boring BH-2-90. The borings drilled along the alignment of the water control structure found up to 5 feet of peat and other organic matter, underlain by sands, gravels, silts, and clays.

5. LABORATORY TESTING

a. Prior Laboratory Tests:

Extensive laboratory soils tests were performed by the Corps of Engineers during the planning and design stages of the existing flood control improvements. These tests included natural moisture content, mechanical analysis, Atterberg limits, specific gravity, natural density, moisture-density relations, direct shear, consolidation, permeability and organic content. Results of these tests are shown in the original Design Memorandum, Kawainui Swamp prepared in 1957.

b. Current Laboratory Tests.

A nominal amount of laboratory tests were performed on soil samples obtained from the current subsurface investigations to supplement laboratory tests made during the planning and design stages of the original flood control project. The current laboratory tests included natural moisture content, mechanical analysis, Atterberg limits, and organic content. Results of these tests are summarized on Plates C-7 and C-8. Typical gradation curves are shown on Plates C-9 to C-14.

6. ADOPTED SOIL PARAMETERS:

Adopted soil parameters are indicated below. These soil parameters are consistent with those used in the original design of the existing levee:

a. Levee Embankment

Saturated soil unit weight = 117 pcf

Moist soil unit weight = 90.5 pcf

Submerged soil unit weight = 54.6 pcf

Angle of internal friction = 30 degrees

Cohesion	= 0 psf
Active pressure coefficient	= 0.33
Passive pressure coefficient	= 3.0
At-rest pressure coefficient	= 0.50

b. Levee Foundation:

Saturated soil unit weight	= 111 pcf
Moist soil unit weight	= N/A
Submerged soil unit weight	= 48.6 pcf
Angle of internal friction	= 30 degrees
Cohesion	= 0 psf
Active Pressure Coefficient	= 0.33
Passive Pressure Coefficient	= 3.00
At-rest Pressure Coefficient	= 0.50

7. DESIGN CONSIDERATION FOR ALTERNATE 1, EARTH LEVEE RAISE

a. General.

Under this alternative, the existing levee will be raised 0.0 to 8.2 feet to a maximum crest elevation 17.7 feet Mean Sea Level. The new earth embankment will be constructed on the Kaelepulu Canal side of the existing levee. A typical section depicting this alternative is shown on Plate C-15. Prior to embankment construction all existing vegetation, root mat, peat, organic silts, and other unsuitable materials, estimated to range from 3 to 6 feet thick, shall be removed from beneath the foot print of the new embankment to preclude problems with settlement and slope stability. The permeable gravel surfacing along the crest of the existing levee shall be removed to preclude seepage through the levee. The landward slope of the existing levee, against which the new levee embankment will be constructed, shall be benched to bond the new fill with the existing levee fill and preclude formation of a shear plane at the interface. A new gravel surface shall be provided at the crest of the new levee to provide a stabilized, "all-weather" roadway for maintenance vehicles.

b. Slope Stability Analyses.

Stability analyses, with and without seismic forces, were performed for trial levee crest elevations of 16.5 feet and 18.5 feet Mean Sea Level. The seismic analyses were performed by the pseudo-static method using a seismic coefficient of 0.10. The marsh-ward slope was analyzed for full pool and mid-pool levels. Sudden drawdown analysis was not performed in keeping with the rationale advanced during design of the original levee that the phreatic line within the embankment would recede concurrently with the water surface within the marsh. The landward slope of the levee was analyzed for the end of construction condition and for steady seepage from full pool level. Results of the slope stability analysis for trial crest elevation of 18.5 feet Mean Sea Level are summarized on Plate C-16. Critical failure surfaces (trial crest elevation 18.5 feet) for the various design conditions are shown on Plates C-17 to C-20.

On the basis of the slope stability analyses, a side slope of 1V on 3H was selected for the marsh-ward slope of the levee raise. Side slopes selected for the landward slope of the levee raise are 1V on 3H for portions of the levee having crest elevations less than 16.0 feet and 1V on 3.5H for portions of the levee raise having crest elevations higher than 16.0 feet Mean Sea Level.

c. Seepage.

In view of the relatively short duration that the levee will be subjected to the elevated water levels of the design flood, seepage is not a major concern in regard to potential piping failure of the levee.

d. Settlement.

Major settlement of the levee would be precluded by removing the existing vegetation, root mat, peat and other organic materials beneath the foot print of the new fill prior to embankment construction. The levee will be founded upon the underlying granular materials which are expected to consolidate during the construction period. As experienced with construction of the original levee, post-construction settlement is expected to be negligible.

8. DESIGN CONSIDERATIONS FOR ALTERNATE 2, FLOOD WALL

Under this alternative, the existing levee will be raised 0.0 to 8.2 feet to a maximum elevation of 17.7 feet Mean Sea Level with a reinforced concrete flood wall constructed upon the crest of the existing levee. The L-shaped flood wall would have a concrete structural key, on the marsh side to provide resistance against sliding. For walls higher than 4 feet, a continuous sheet pile curtain wall will be provided below the bottom of the concrete key for protection against seepage. Slope stability analyses were performed for the levee raise with concrete flood wall alternative to verify the stability of the existing levee with the new flood wall superimposed upon the crest. Results of the slope stability analyses, (for trial crest elevation of 20.5 feet), shown on Plate C-21, indicate that the new flood wall would not have an adverse impact upon the stability of the existing levee.

9. CONSTRUCTION MATERIALS

a. Fill Materials.

Based on borings drilled through the levee crest, the existing embankment materials consist of silts, sands and gravels having more than 10 percent passing the No. 200 sieve. The levee raise shall be constructed of materials similar to those used in the original construction. Any silt materials used in the levee raise shall have a liquid limit less than 60 and a plasticity index less than 30. To minimize turbidity and to facilitate underwater placement of fill materials without dewatering, materials to be specified for the portion of the levee below elevation. (+) 2.0 shall consist of granular sands and gravels having not more than 15 percent passing the No. 200 sieve. This initial placement of fill to elevation (+) 2.0, which shall be accomplished without rigid compaction controls, will serve as a working platform for the overlying fill materials which shall be constructed in compacted lifts.

Designers of large earthwork projects generally attempt to balance cuts and fills to avoid the expense of hauling in or disposing of large quantities of earth materials. This approach is not possible on this project since practically all of the materials to be excavated will consist of peat and organic silts, which are unsuitable for embankment construction. Accordingly, practically all embankment materials will have to be imported from outside the project limits. Since there are no large-scale commercial suppliers of earth fill materials on the Island of Oahu, contractors on most local projects are forced to "fend for themselves" to locate fill materials for their projects. Overburden materials, which are available in limited quantities from commercial rock producing quarries, are a potential source of fill materials. Other materials potentially suitable for fill include select materials and crusher waste, which are also available in limited quantities from commercial rock producing quarries. Most of the materials used in construction of the existing levee were obtained from excavation of the Oneawa Channel. Should any deepening of the Oneawa Channel be undertaken under this project, suitable fill materials would be generated from the excavation.

b. Crushed Gravel.

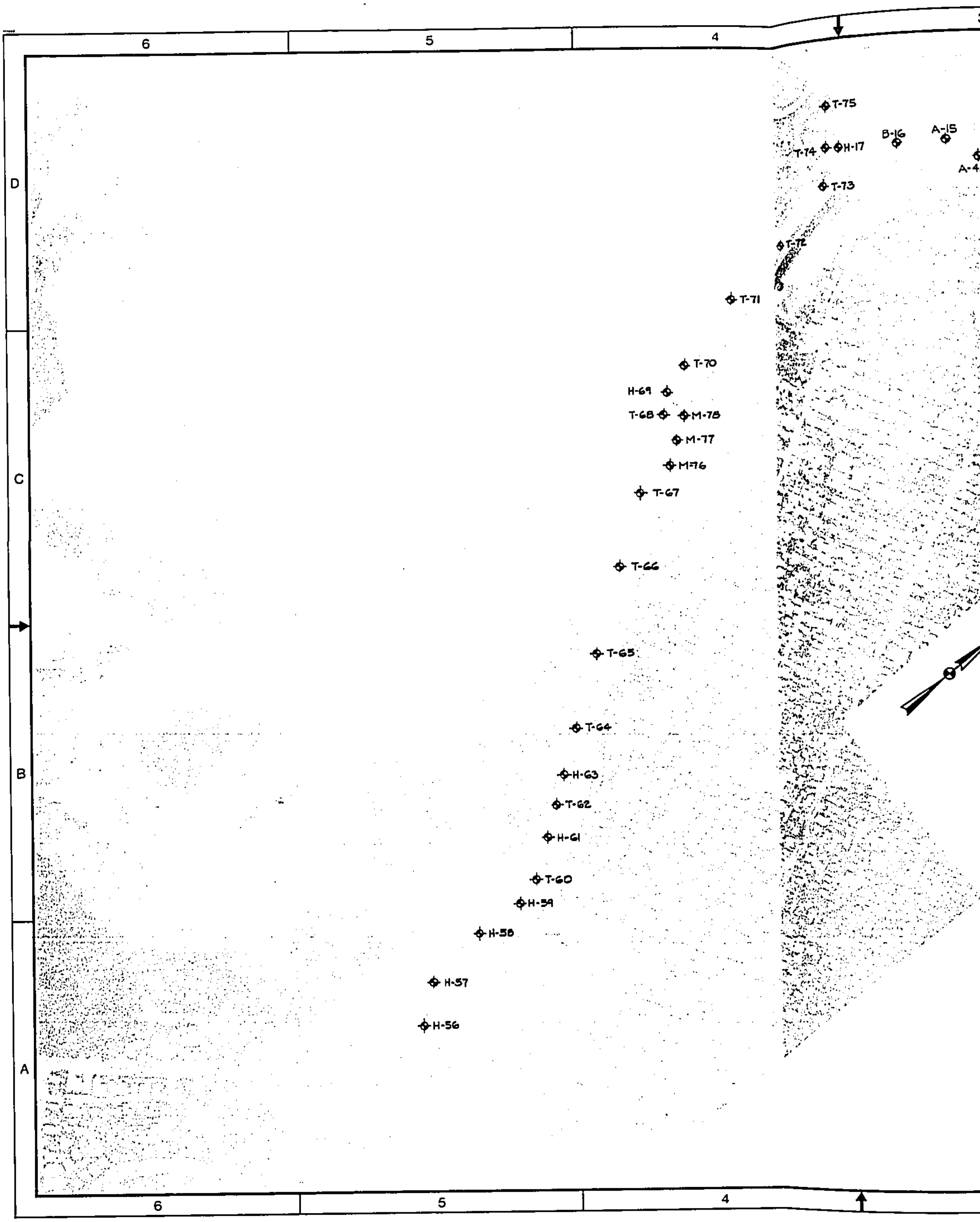
Base course material, 1-1/2 inch maximum nominal size, meeting the requirements of State of Hawaii Standard Specifications for Road and Bridge Construction, shall be specified for the new gravel surfacing to be placed upon the crest of raised levee. Since this material is a standard item at local commercial rock producing quarries, it can be obtained without any difficulty.

c. <u>Concrete Materials</u>.

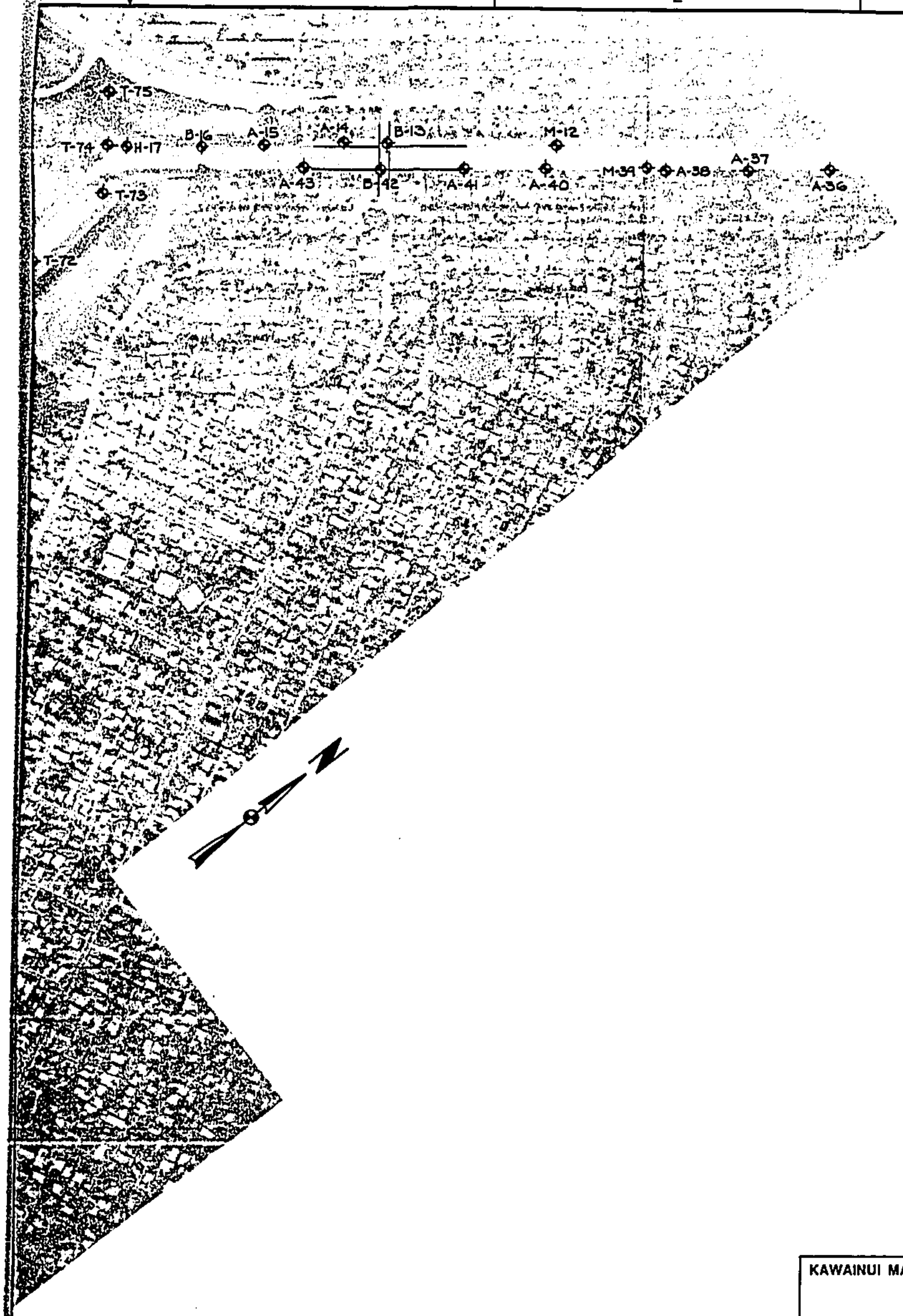
Cement for local concrete production is manufactured by Hawaiian Cement Corporation, located at Barbers Point, Oahu. This company has been producing high quality cement conforming to ATSM C150, Type 1 and Type II for more than 20 years.

Aggregates for concrete production are available at three commercial rock producing quarries located on the Island of Oahu. These quarries are the Kapaa Quarry operated by Ameron HC&D, the Halawa Quarry operated by Hawaiian Cement Corporation and the Puu Makakilo Quarry operated by Grace Pacific Corporation. All three quarries have been producing concrete aggregates for the local construction industry for many years and are currently listed as approved aggregate sources in the Special Contract Clauses of Corps of Engineer projects on the Island of Oahu.

Ready-mix concrete is available from Ameron HC&D, Hawaiian Cement Corporation and a number of smaller suppliers on Oahu. Type I cement shall be specified for all concrete structures, except those exposed to seawater, where Type II cement shall be used. A water-cement ratio not exceeding 0.55 (3,000 psi concrete) shall be specified for all structures, except those subjected to high velocity flows, where a water-cement ratio not exceeding 0.45 (4,000 psi concrete) will be used.



6
5
4
D
C
B
A
T-75
T-74
H-17
B-16
A-15
T-73
T-72
T-71
T-70
H-69
T-68
M-78
M-77
M-76
T-67
T-66
T-65
T-64
H-63
T-62
H-61
T-60
H-59
H-58
H-57
H-56

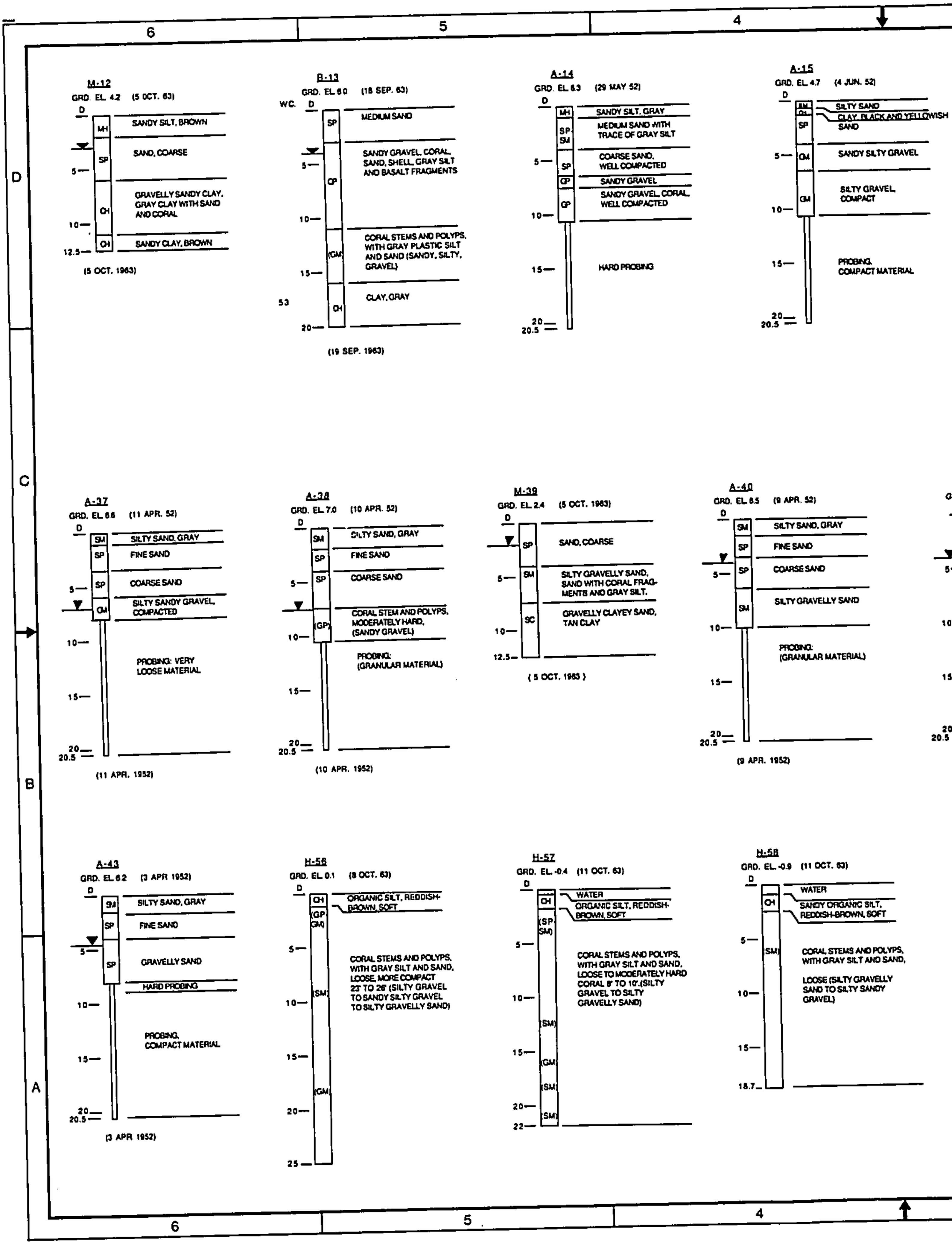


KAWAINUI MARSH OAHU, HAWAII

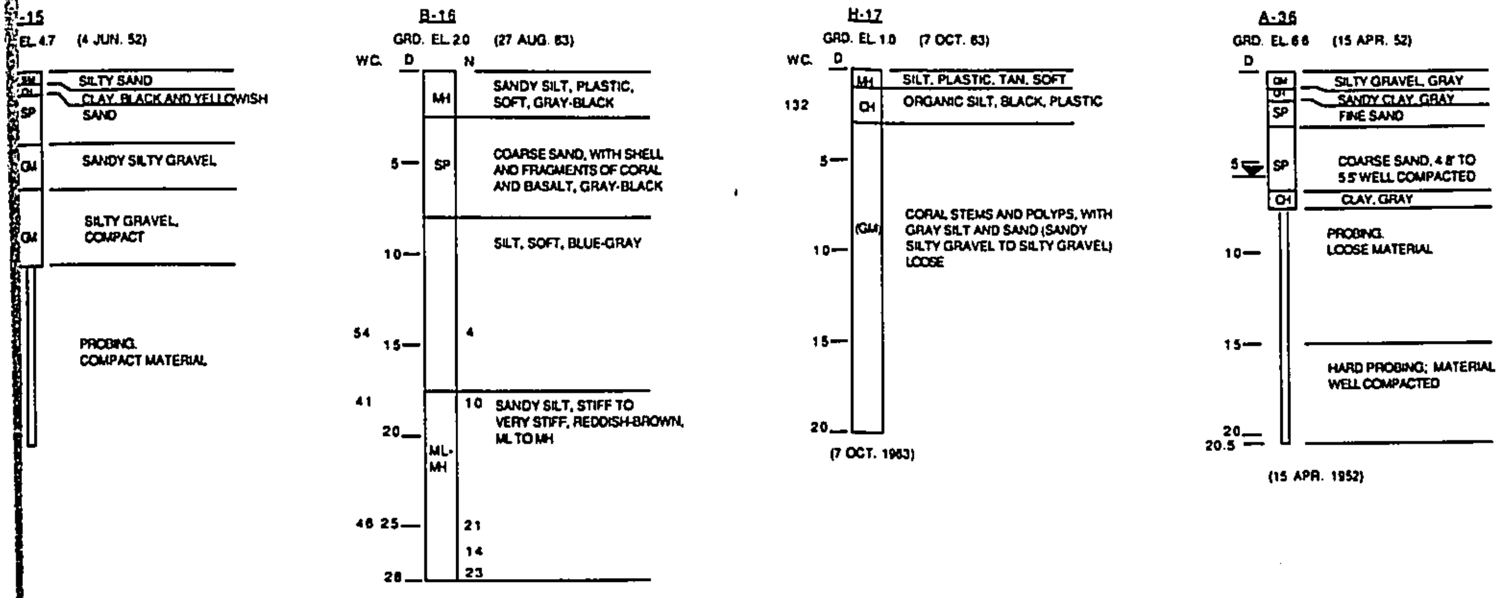
BORING LOCATION PLAN
ORIGINAL BORINGS
(1952 - 1964)

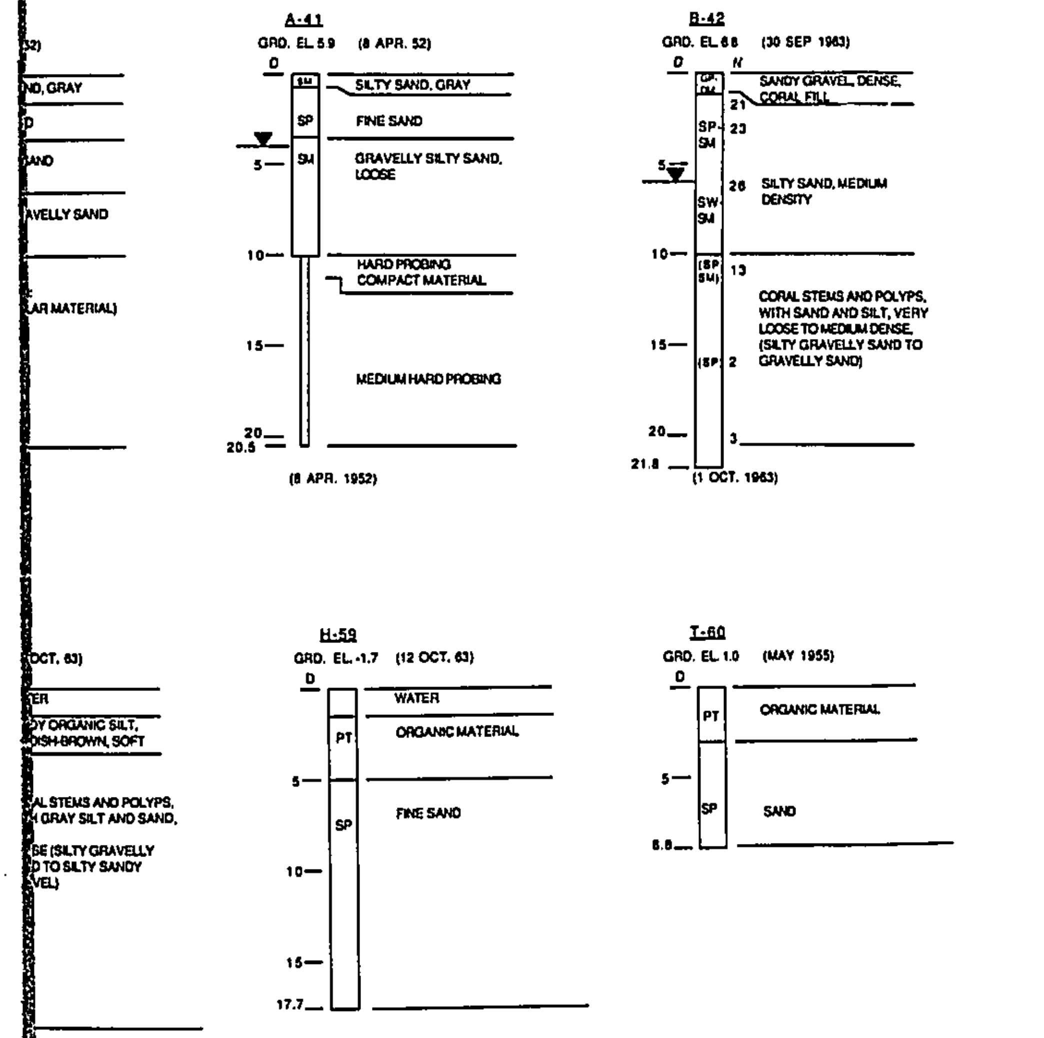
U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE C-1



6
5
4
D
C
B
A
M-12
GRD. EL. 4.2 (5 OCT. 63)
MH SANDY SILT, BROWN
SP SAND, COARSE
CH GRAVELLY SANDY CLAY, GRAY CLAY WITH SAND AND CORAL
CH SANDY CLAY, BROWN
(5 OCT. 1963)
B-13
GRD. EL 6.0 (18 SEP. 63)
WC.
SP MEDIUM SAND
GP SANDY GRAVEL, CORAL, SAND, SHELL, GRAY SILT AND BASALT FRAGMENTS
(GM) CORAL STEMS AND POLYPS, WITH GRAY PLASTIC SILT AND SAND (SANDY, SILTY, GRAVEL)
CH CLAY, GRAY
53
(19 SEP. 1963)
A-14
GRD. EL 6.3 (29 MAY 52)
MH SANDY SILT, GRAY
SP-SM MEDIUM SAND WITH TRACE OF GRAY SILT
SP COARSE SAND, WELL COMPACTED
GP SANDY GRAVEL
GP SANDY GRAVEL, CORAL, WELL COMPACTED
HARD PROBING
A-15
GRD. EL 4.7 (4 JUN. 52)
SM SILTY SAND
CLAY, BLACK AND YELLOWISH
SP SAND
GM SANDY SILTY GRAVEL
GM SILTY GRAVEL, COMPACT
PROBING, COMPACT MATERIAL
A-37
GRD. EL 6.6 (11 APR. 52)
SM SILTY SAND, GRAY
SP FINE SAND
SP COARSE SAND
GM SILTY SANDY GRAVEL, COMPACTED
PROBING: VERY LOOSE MATERIAL
(11 APR. 1952)
A-38
GRD. EL 7.0 (10 APR. 52)
SM SILTY SAND, GRAY
SP FINE SAND
SP COARSE SAND
(GP) CORAL STEM AND POLYPS, MODERATELY HARD, (SANDY GRAVEL)
PROBING: (GRANULAR MATERIAL)
(10 APR. 1952)
M-39
GRD. EL 2.4 (5 OCT. 1963)
SP SAND, COARSE
SM SILTY GRAVELLY SAND, SAND WITH CORAL FRAGMENTS AND GRAY SILT.
SC GRAVELLY CLAYEY SAND, TAN CLAY
(5 OCT. 1963)
A-40
GRD. EL 8.5 (9 APR. 52)
SM SILTY SAND, GRAY
SP FINE SAND
SP COARSE SAND
SM SILTY GRAVELLY SAND
PROBING: (GRANULAR MATERIAL)
(9 APR. 1952)
A-43
GRD. EL 6.2 (3 APR 1952)
SM SILTY SAND, GRAY
SP FINE SAND
SP GRAVELLY SAND
HARD PROBING
PROBING, COMPACT MATERIAL
(3 APR 1952)
H-56
GRD. EL 0.1 (8 OCT. 63)
CH ORGANIC SILT, REDDISH-BROWN, SOFT
(GP-GM)
(SM) CORAL STEMS AND POLYPS, WITH GRAY SILT AND SAND, LOOSE, MORE COMPACT 23' TO 26' (SILTY GRAVEL TO SANDY SILTY GRAVEL TO SILTY GRAVELLY SAND)
(GM)
H-57
GRD. EL -0.4 (11 OCT. 63)
WATER
CH ORGANIC SILT, REDDISH-BROWN, SOFT
(SP-SM) CORAL STEMS AND POLYPS, WITH GRAY SILT AND SAND, LOOSE TO MODERATELY HARD CORAL 8' TO 10'.(SILTY GRAVEL TO SILTY GRAVELLY SAND)
(SM)
(GM)
(SM)
(SM)
H-58
GRD. EL -0.9 (11 OCT. 63)
WATER
CH SANDY ORGANIC SILT, REDDISH-BROWN, SOFT
(SM) CORAL STEMS AND POLYPS, WITH GRAY SILT AND SAND, LOOSE (SILTY GRAVELLY SAND TO SILTY SANDY GRAVEL)
18.7





LEGEND

1. "A-2" ALL HOLES WITH "A" PREFIX ARE MACHINE BORING WITH 24" DISK AUGER POST HOLE DIGGER, WITH PROBING DATA BELOW THE LIMIT OF THE AUGER BORING.
2. "B" ALL HOLES WITH "B" PREFIX ARE MACHINE BORING WITH FAILING 43A DRILLING RIG WITH 4" DIAMETER HOLE. CASING REQUIRED TO HOLD HOLE.
3. "M" ALL HOLES WITH "M" PREFIX ARE MACHINE BORINGS WITH PORTABLE MCCULLOCH DRILLING MACHINE WITH 4" CONTINUOUS FLIGHT HELICAL AUGER. CASING WAS NOT USED TO HOLD HOLE.
4. "H" ALL HOLES WITH "H" PREFIX ARE MANUALLY ADVANCED BORING USING 4" POST HOLE AUGER AND 2-1/2" SHELBY TUBE SAMPLER.
5. "T" ALL HOLES WITH "T" PREFIX ARE MANUALLY ADVANCED BORINGS USING A 1" PORTER DRIVE SAMPLER.
6. "N" IS RESISTANCE TO PENETRATION OF STANDARD 2" O.D. SAMPLING SPOON DRIVEN 1 FOOT WITH A 140 POUND WEIGHT FALLING 30 INCHES, EXCEPT BORING B-16 WHERE A 207 POUND WEIGHT FALLING 20 INCHES WAS USED.
7. "W.C." WATER CONTENT IN % OF DRY WEIGHT OF SOIL.
8. "D" DEPTH OF BORING IN FEET.
9. ▼ GROUND WATER LEVEL (WATER TABLE)
10. "SP" ETC. THE LETTERS WITHIN THE BORING LOGS ARE SOIL CLASSIFICATION SYMBOLS IN ACCORDANCE WITH MILITARY STANDARD, MIL-STD-619A, UNIFIED SOIL CLASSIFICATION SYSTEM FOR ROADS, AIRFIELDS, EMBANKMENTS AND FOUNDATIONS.

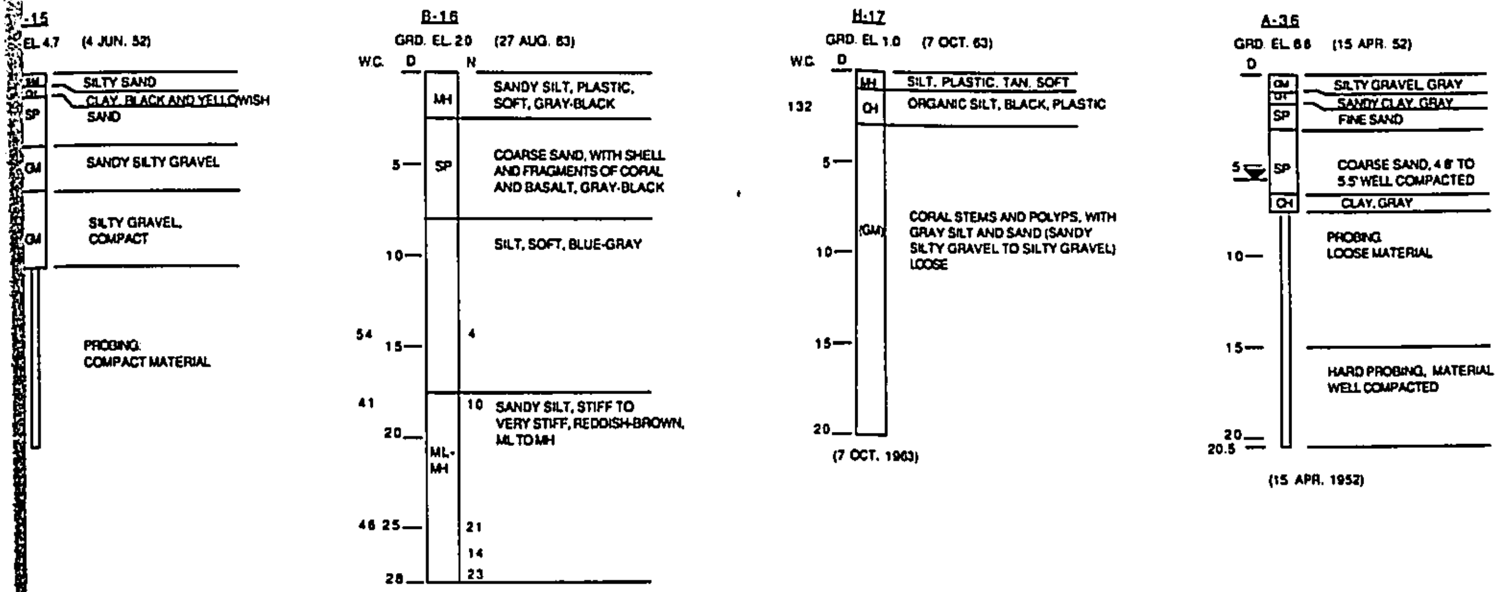
GENERAL NOTES

1. SOILS CLASSIFICATION SYMBOLS IN PARENTHESIS INDICATE LABORATORY OR VISUAL CLASSIFICATION OF CORAL STEMS AND POLYPS (TREE AND FINGER CORAL) WITH SILT AND SAND MATERIAL AS RECOVERED IN SOIL SAMPLERS DURING SUBSURFACE EXPLORATION.
2. CORAL (ROCK) IS UNSTRATIFIED LIMESTONE ROCK FORMED BY THE INTERGROWTH OF CORAL HEADS ETC. AND THE CEMENTATION OF CORAL SAND, SHELLS, AND FRAGMENTAL REEF DEBRIS.
3. DATE ABOVE BORING INDICATES DATE BORING WAS STARTED. BELOW BORING IS DATE OF WATER LEVEL READING.

KAWAINUI MARSH — OAHU, HAWAII

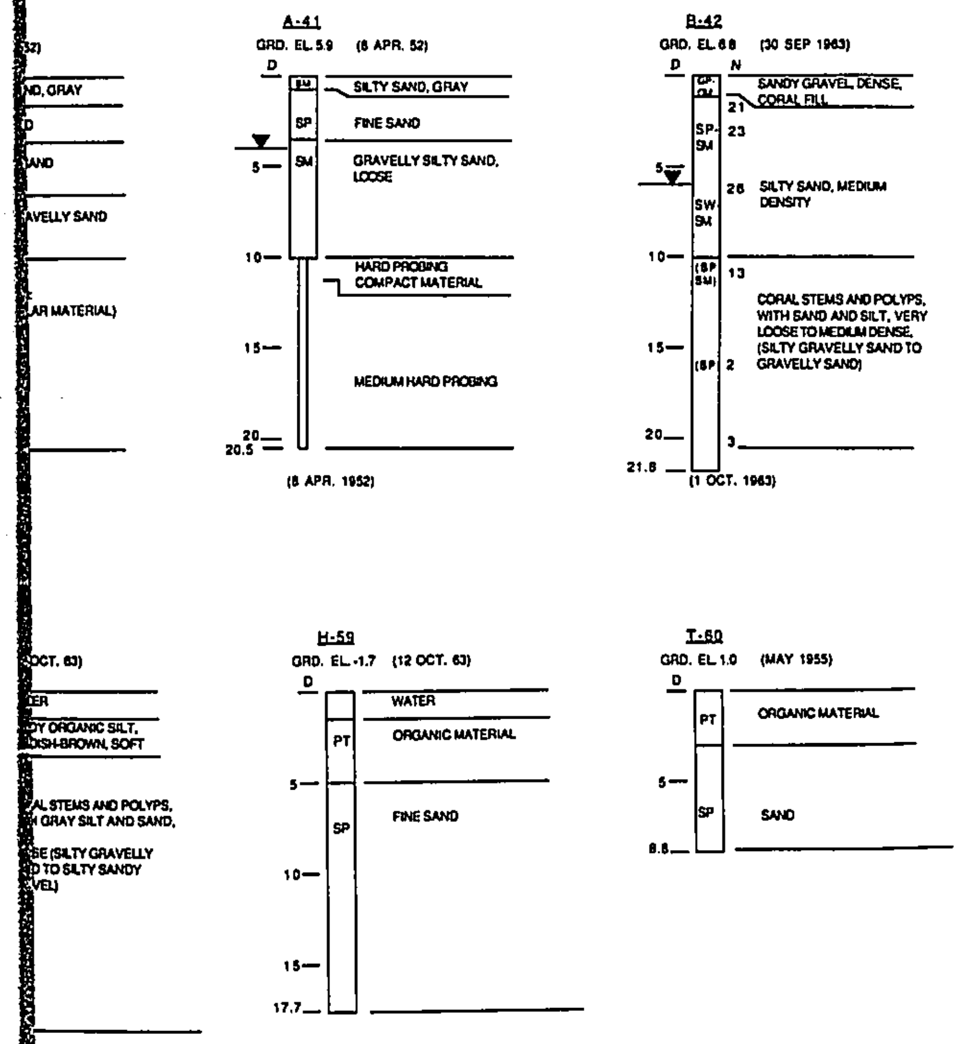
ORIGINAL BORING LOGS (1952 - 1964)

U.S. ARMY ENGINEER DISTRICT, HONOLULU



LEGEND

1. "A-2" ALL HOLES WITH "A" PREFIX ARE MACHINE BORING WITH 24" DISK AUGER POST HOLE DIGGER, WITH PROBING DATA BELOW THE LIMIT OF, THE AUGER BORING.
2. "B" ALL HOLES WITH "B" PREFIX ARE MACHINE BORING WITH FAILING 43A DRILLING RIG WITH 4" DIAMETER HOLE. CASING REQUIRED TO HOLD HOLE.
3. "M" ALL HOLES WITH "M" PREFIX ARE MACHINE BORINGS WITH PORTABLE MCCULLOCH DRILLING MACHINE WITH 4" CONTINUOUS FLIGHT HELICAL AUGER. CASING WAS NOT USED TO HOLD HOLE.
4. "H" ALL HOLES WITH "H" PREFIX ARE MANUALLY ADVANCED BORING USING 4" POST HOLE AUGER AND 2-1/2" SHELBY TUBE SAMPLER
5. "T" ALL HOLES WITH "T" PREFIX ARE MANUALLY ADVANCED BORINGS USING A 1" PORTER DRIVE SAMPLER.
6. "N" IS RESISTANCE TO PENETRATION OF STANDARD 2" O.D. SAMPLING SPOON DRIVEN 1 FOOT WITH A 140 POUND WEIGHT FALLING 30 INCHES, EXCEPT BORING B-16 WHERE A 207 POUND WEIGHT FALLING 20 INCHES WAS USED.
7. "W.C." WATER CONTENT IN % OF DRY WEIGHT OF SOIL.
8. "D" DEPTH OF BORING IN FEET.
9. GROUND WATER LEVEL (WATER TABLE)
10. "SP" ETC. THE LETTERS WITHIN THE BORING LOGS ARE SOIL CLASSIFICATION SYMBOLS IN ACCORDANCE WITH MILITARY STANDARD, MIL-STD-619A, UNIFIED SOIL CLASSIFICATION SYSTEM FOR ROADS, AIRFIELDS, EMBANKMENTS AND FOUNDATIONS.



GENERAL NOTES

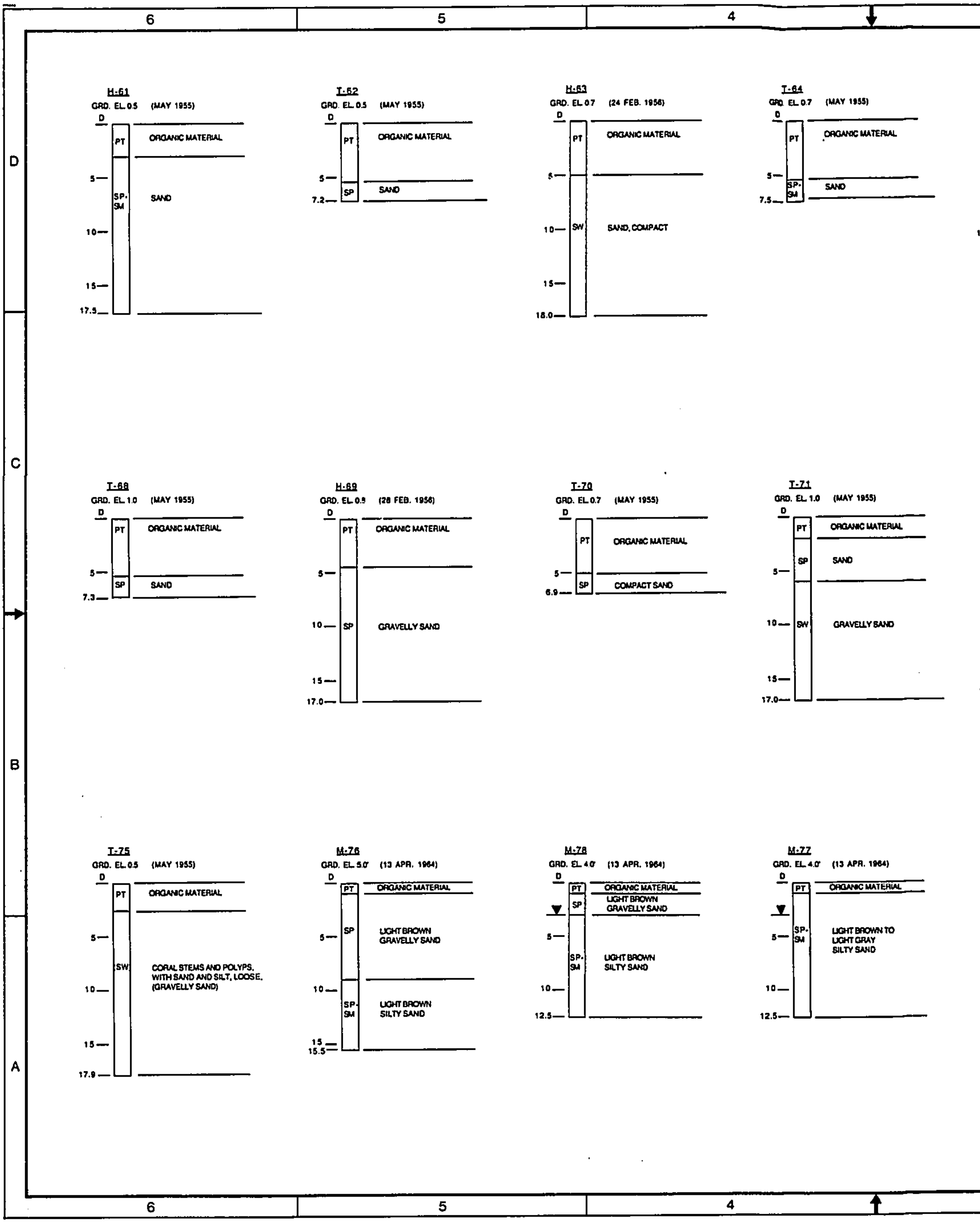
1. SOILS CLASSIFICATION SYMBOLS IN PARENTHESIS INDICATE LABORATORY OR VISUAL CLASSIFICATION OF CORAL STEMS AND POLYPS (TREE AND FINGER CORAL) WITH SILT AND SAND MATERIAL AS RECOVERED IN SOIL SAMPLERS DURING SUBSURFACE EXPLORATION.
2. CORAL (ROCK) IS UNSTRATIFIED LIMESTONE ROCK FORMED BY THE INTERGROWTH OF CORAL HEADS ETC. AND THE CEMENTATION OF CORAL SAND, SHELLS, AND FRAGMENTAL REEF DEBRIS.
3. DATE ABOVE BORING INDICATES DATE BORING WAS STARTED. BELOW BORING IS DATE OF WATER LEVEL READING.

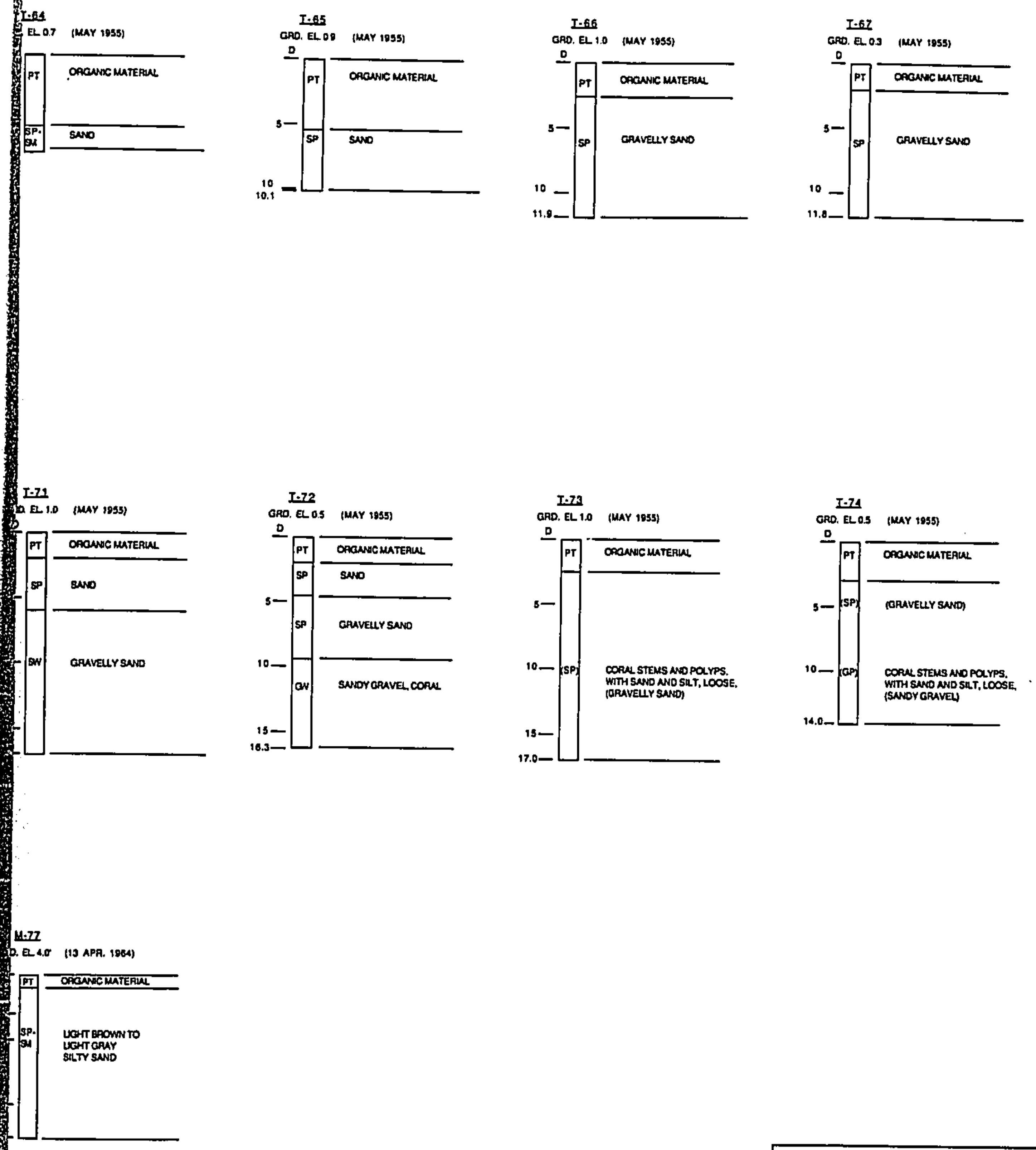
KAWAINUI MARSH | OAHU, HAWAII

ORIGINAL BORING LOGS (1952 - 1964)

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE C-2


6
5
4
D
C
B
A
H-61
GRD. EL 0.5 (MAY 1955)
D
PT
ORGANIC MATERIAL
SP-SM
SAND
5
10
15
17.5
T-62
GRD. EL 0.5 (MAY 1955)
D
PT
ORGANIC MATERIAL
SP
SAND
5
7.2
H-63
GRD. EL 0.7 (24 FEB. 1956)
D
PT
ORGANIC MATERIAL
SW
SAND, COMPACT
5
10
15
18.0
T-64
GRD. EL 0.7 (MAY 1955)
D
PT
ORGANIC MATERIAL
SP-SM
SAND
5
7.5
T-68
GRD. EL 1.0 (MAY 1955)
D
PT
ORGANIC MATERIAL
SP
SAND
5
7.3
H-69
GRD. EL 0.9 (28 FEB. 1956)
D
PT
ORGANIC MATERIAL
SP
GRAVELLY SAND
5
10
15
17.0
T-70
GRD. EL 0.7 (MAY 1955)
D
PT
ORGANIC MATERIAL
SP
COMPACT SAND
5
6.9
T-71
GRD. EL 1.0 (MAY 1955)
D
PT
ORGANIC MATERIAL
SP
SAND
SW
GRAVELLY SAND
5
10
15
17.0
T-75
GRD. EL 0.5 (MAY 1955)
D
PT
ORGANIC MATERIAL
SW
CORAL STEMS AND POLYPS, WITH SAND AND SILT, LOOSE. (GRAVELLY SAND)
5
10
15
17.9
M-76
GRD. EL 5.0' (13 APR. 1964)
D
PT
ORGANIC MATERIAL
SP
LIGHT BROWN GRAVELLY SAND
SP-SM
LIGHT BROWN SILTY SAND
5
10
15
15.5
M-78
GRD. EL 4.0' (13 APR. 1964)
D
PT
ORGANIC MATERIAL
SP
LIGHT BROWN GRAVELLY SAND
SP-SM
LIGHT BROWN SILTY SAND
5
10
12.5
M-77
GRD. EL 4.0' (13 APR. 1964)
D
PT
ORGANIC MATERIAL
SP-SM
LIGHT BROWN TO LIGHT GRAY SILTY SAND
5
10
12.5
6
5
4

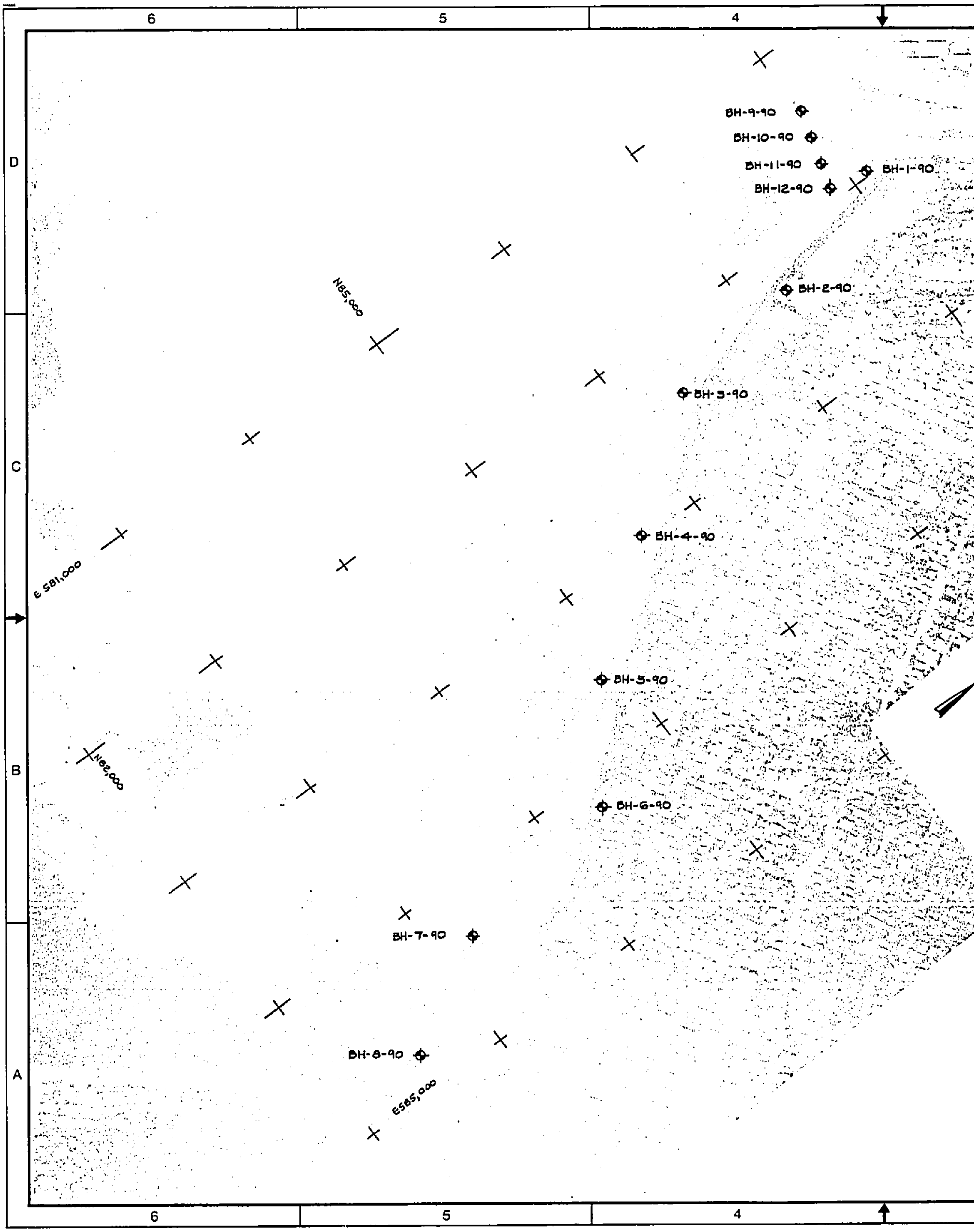


KAWAINUI MARSH — OAHU, HAWAII

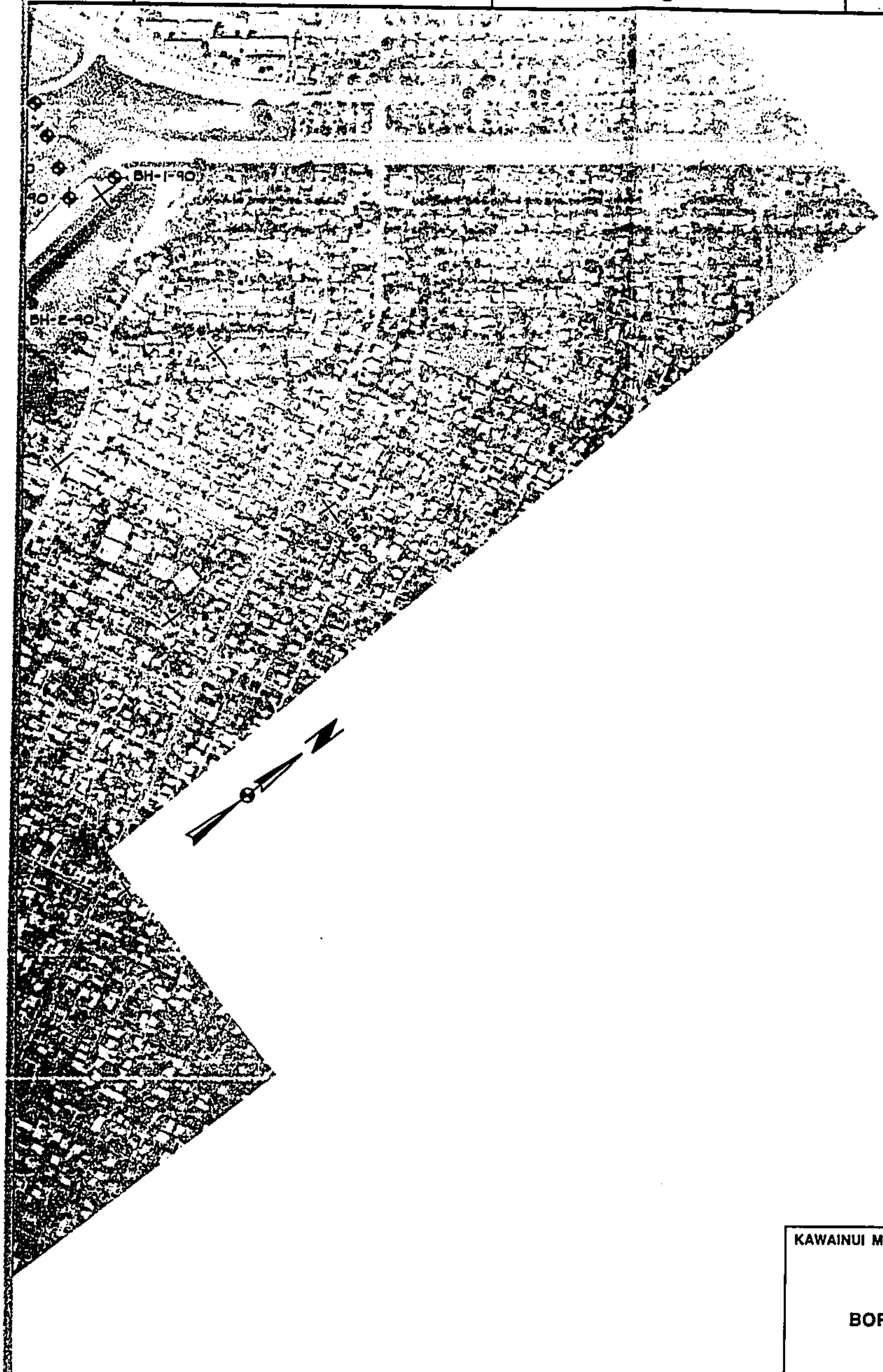
ORIGINAL BORING LOGS
(1952 - 1964)

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE C-3



6
5
4
D
C
B
A
BH-9-90
BH-10-90
BH-11-90
BH-1-90
BH-12-90
BH-2-90
BH-3-90
BH-4-90
BH-5-90
BH-6-90
BH-7-90
BH-8-90
N85,000
N82,000
E 581,000
E585,000



KAWAINUI MARSH OAHU, HAWAII

BORING LOCATION PLAN
RECENT BORINGS
(1990)

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE C-4

6	5	4

D

HOLE NUMBER BH-1-90 | PROJECT: KAWAINUI MARSH F C P., KAILUA, OAHU
LOCATION N 88,110 E 581,965
DATE STARTED 14 MAY 1990 | DATE COMPLETED 14 MAY 1990

ELEV 10.0	DEPTH	DESCRIPTION OF MATERIALS
9.0		GRAVEL SURFACE - CRUSHED BASALT, GRAY.
	2 N22 (SC) M.C.=19.1% LL=68 PL=25	CLAYEY SAND - GRAVELLY, MOIST, LOOSE TO MEDIUM DENSE, FEW COBBLES, BROWN
	4	
	6 N6 M.C.=19.5%	
1.5	8	
0.8 ▽	N11 M.C.=28.0%	CLAYEY SILT - GRAVELLY, MOIST, STIFF, WITH THIN LENSE OF FAT CLAY, GRAY.
-0.5	10	
	12 N33 (SP-SM) M.C.=32.8%	GRAVELLY SAND - SILTY, SATURATED, DENSE, CORAL, GRAY.
	14 N6	GRADING TO LOOSE.
-6.5	16	
	18 N5	SANDY GRAVEL - SATURATED, LOOSE, CORAL, GRAY.
-10.0	20	
	22 N3	SILTY CLAY - MOIST, SOFT, WITH GRAVELS.
-14.0	24	
	26 N6	SILTY GRAVEL - SATURATED, LOOSE, CORAL, GRAY.
-18.0	28	
	30 N12 (GP-GM) M.C.=24.9%	SANDY GRAVEL - SILTY, SATURATED, LOOSE TO MEDIUM DENSE, CORAL, GRAY.
	32	
	34 N9	
-25.0	35	
	36	BOTTOM OF HOLE - TOTAL DEPTH 35.0' NO CASING USED
	38	
	40	

HOLE NUMBER BH-2-90 | PROJECT: KAWAINUI MARSH F C P., KAILUA, OAHU
LOCATION N 87,270 E 582,315
DATE STARTED 31 JULY 1990 | DATE COMPLETED 31 JULY 1990

ELEV 4.4	DEPTH	DESCRIPTION OF MATERIALS
3.4		SILT - W/ GRASS, MOIST, RED.
2.7	M.C.=42.8%	PEAT - W/ ROOTS
1.0 ▽	N6 M.C.=30.5%	SANDY GRAVEL - LOOSE, DAMP, GRAY
0.4	4	
-1.1	N15	PEAT - W/ ROOTS.
	6 M.C.=26.4%	SILTY SAND - W/ GRAVEL, WET, LOOSE, GRAY.
-4.6	8 M.C.=48.4% (SM) N4 M.C.=41.0%	GRADING TO DARK BROWN
-6.6	10	SANDY GRAVEL - LOOSE, SATURATED, LIGHT GRAY.
-9.3	12 N1 M.C.=50.8%	SAND - W/ OCCASIONAL GRAVEL, VERY LOOSE, DARK BROWN, SATURATED.
	14	SILTY GRAVEL - W/ SOME CLAY, VERY LOOSE, LIGHT GRAY, SATURATED.
	16 N2 (GM)	GRADING TO INCREASED CLAY, SLIGHTLY PLASTIC.
-14.6	18	
-16.6	20	SAND - W/ OCCASIONAL GRAVEL, VERY LOOSE, DARK GRAY, SATURATED.
	N3 22	GRAVEL - W/ FAT CLAY, PLASTIC, VERY LOOSE, LIGHT GRAY, SATURATED.
	24 N4	
-22.6	26	
	28 N4 (SC) LL=36 PL=20	CLAYEY SAND - W/ GRAVEL, SLIGHTLY PLASTIC, LOOSE, GRAY, SATURATED.
-27.1	30	
	32	SANDY GRAVEL - MEDIUM DENSE TO DENSE, TAN, SATURATED.
-30.6	34 N21	
	35	
	36	BOTTOM OF HOLE - TOTAL DEPTH 35.0' NO CASING USED
	38	
	40	

HOLE NUMBER BH-3-90 | PROJECT: KAWAINUI MARSH F C P., KAILUA, OAHU
LOCATION N 86,330 E 582,420
DATE STARTED 14 MAY 1990 | DATE COMPLETED 15 MAY 1990

ELEV 9.9	DEPTH	DESCRIPTION OF MATERIALS
8.9		GRAVEL SURFACE - CRUSHED BASALT, GRAY.
	2 N11 M.C.=23.0%	CLAYEY SILT - MOIST, STIFF, TRACE CORAL SAND, BROWN
6.4		
	4 N10 M.C.=16.6% (SM)	SILTY SAND - GRAVELLY, MOIST, LOOSE TO MEDIUM DENSE, TAN
3.4	6	
2.4		SILTY CLAY - MOIST, BROWN.
1.1 ▽	8 N28 M.C.=31.1%	SANDY GRAVEL - MOIST, MEDIUM DENSE, CORAL, GRAY.
0.4	10	GRAVELLY SAND - SILTY, SATURATED, MEDIUM DENSE, CORAL GRAY.
	N22 (SM) 12	
	14 N10	2" SEAM OF GRAY CLAY AND BLACK PEAT AT 14.0'
-5.6		
	16 N24	SAND - LOOSE TO MEDIUM DENSE, OCCASIONAL GRAVEL, CORAL, GRAY.
	18	
	20	
	22 N7 (SP)	
	24	
	26 N5	
	28	
	30	
	32	
-25.1	34 N11	
	35	
	36	BOTTOM OF HOLE - TOTAL DEPTH 35.0' HOLE CASED TO 33.0'
	38	
	40	

HOLE NUMBER BH-4-90
LOCATION N 85,590
DATE STARTED 31 JULY 1990

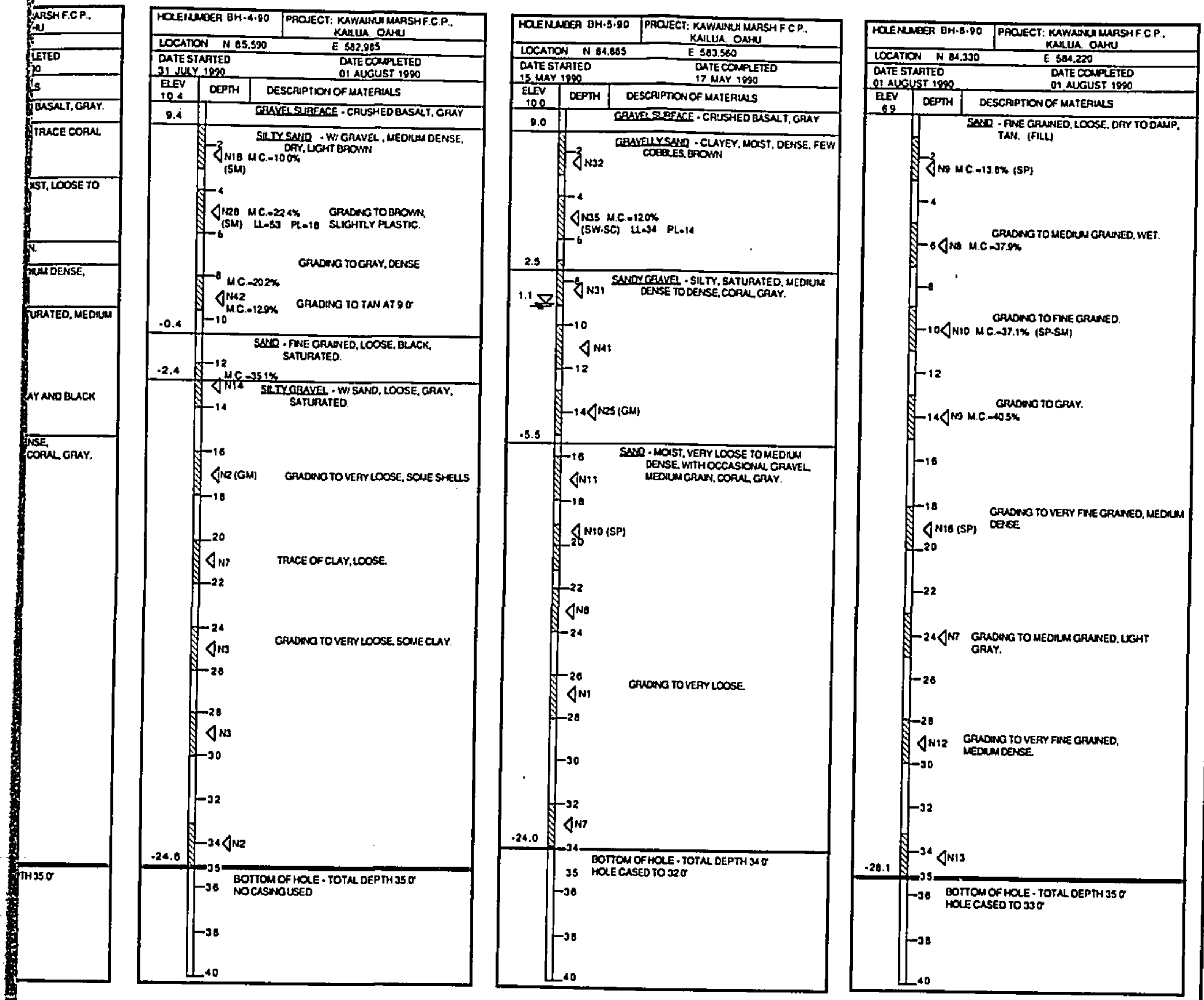
ELEV 10.4	DEPTH	
9.4		GR
	2 N18 M.C. (SM)	SI
	4	
	N28 M.C. (SM) LL 6	
	8 M.C.=20. N42 M.C.=12.	
-0.4	10	
		SA
-2.4	12 M.C.=35 N14	S
	14	
	16 N2 (GM)	
	18	
	20 N7 22	
	24 N3 26	
	28 N3 30	
	32	
-24.6	34 N2	
	35	BOTT
	36	NO CA
	38	
	40	

C

B

A

6	5	4



NOTES AND LEGEND TO BORING LOGS

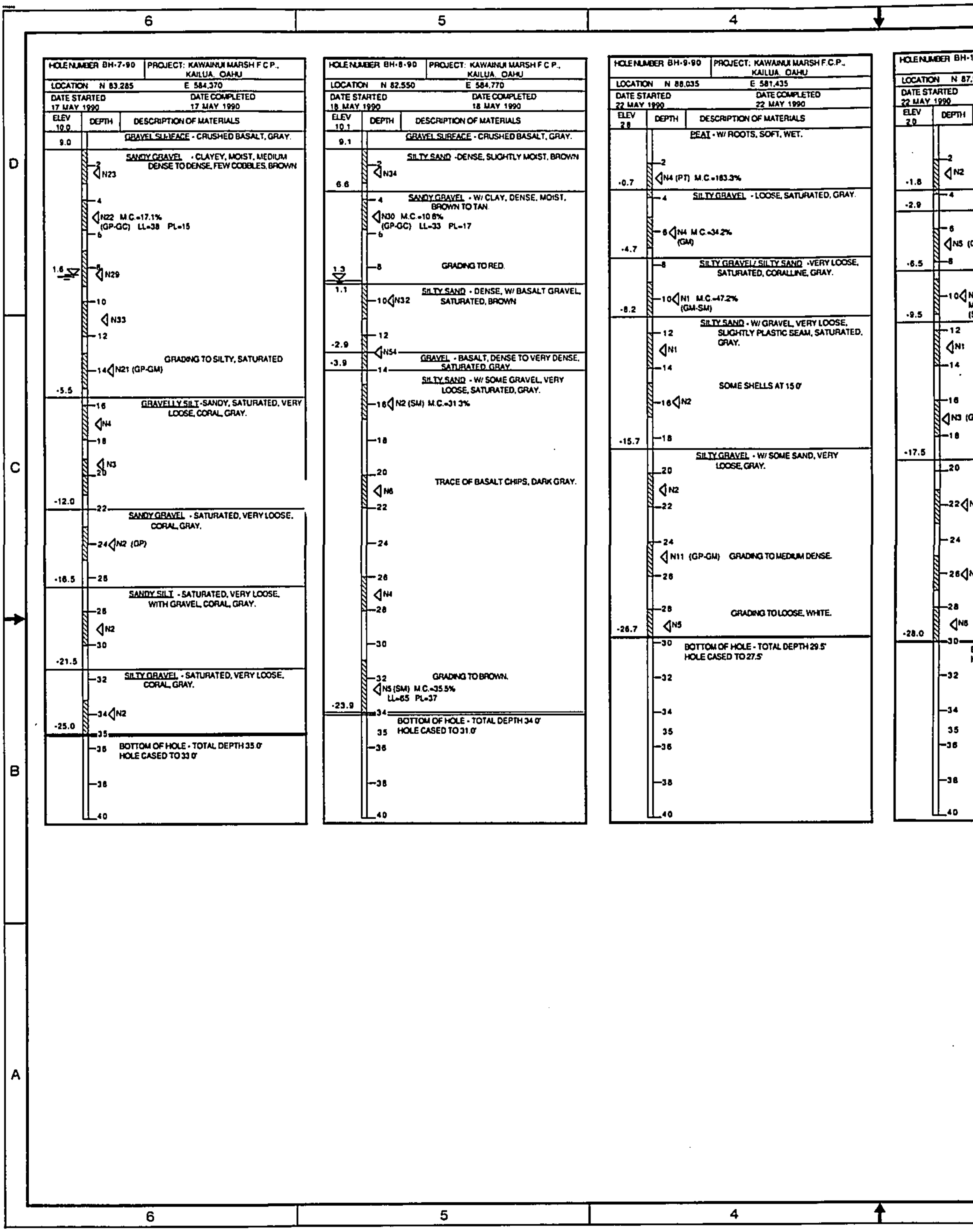
1. COORDINATES REFERRED TO HAWAIIAN PLANE COORDINATE SYSTEM.
2. ELEVATIONS REFERRED TO MEAN SEA LEVEL DATUM.
3. N27 STANDARD PENETRATION TEST INTERVAL WITH PENETRATION RESISTANCE IN BLOWS PER FOOT.
4. GROUND WATER LEVEL WHERE ENCOUNTERED.
5. (SM) LABORATORY SOILS CLASSIFICATION IN ACCORDANCE WITH THE UNIFIED SOILS CLASSIFICATION SYSTEM
6. M.C. MOISTURE CONTENT OF SOIL.
7. L.L. LIQUID LIMIT OF SOIL.
8. P.L. PLASTIC LIMIT OF SOIL.

KAWAINUI MARSH OAHU, HAWAII

RECENT BORING LOGS (1990)

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE C-5



6
5
4
D
C
B
A
HOLE NUMBER BH-7-90
PROJECT: KAWAINUI MARSH F.C.P., KAILUA, OAHU
LOCATION N 83,285 E 584,370
DATE STARTED 17 MAY 1990
DATE COMPLETED 17 MAY 1990
ELEV 10.0
DEPTH
DESCRIPTION OF MATERIALS
9.0
GRAVEL SURFACE - CRUSHED BASALT, GRAY.
SANDY GRAVEL - CLAYEY, MOIST, MEDIUM DENSE TO DENSE, FEW COBBLES, BROWN
N23
N22 M.C.=17.1% (GP-GC) LL=38 PL=15
1.6
N29
N33
GRADING TO SILTY, SATURATED
N21 (GP-GM)
-5.5
GRAVELLY SILT - SANDY, SATURATED, VERY LOOSE, CORAL, GRAY.
N4
N3
-12.0
SANDY GRAVEL - SATURATED, VERY LOOSE, CORAL, GRAY.
N2 (GP)
-16.5
SANDY SILT - SATURATED, VERY LOOSE, WITH GRAVEL, CORAL, GRAY.
N2
-21.5
SILTY GRAVEL - SATURATED, VERY LOOSE, CORAL, GRAY.
N2
-25.0
BOTTOM OF HOLE - TOTAL DEPTH 35.0'
HOLE CASED TO 33.0'
HOLE NUMBER BH-8-90
PROJECT: KAWAINUI MARSH F.C.P., KAILUA, OAHU
LOCATION N 82,550 E 584,770
DATE STARTED 18 MAY 1990
DATE COMPLETED 18 MAY 1990
ELEV 10.1
DEPTH
DESCRIPTION OF MATERIALS
9.1
GRAVEL SURFACE - CRUSHED BASALT, GRAY.
SILTY SAND - DENSE, SLIGHTLY MOIST, BROWN
N34
6.6
SANDY GRAVEL - W/ CLAY, DENSE, MOIST, BROWN TO TAN
N30 M.C.=10.8% (GP-GC) LL=33 PL=17
GRADING TO RED.
1.3
1.1
SILTY SAND - DENSE, W/ BASALT GRAVEL, SATURATED, BROWN
N32
-2.9
N54
-3.9
GRAVEL - BASALT, DENSE TO VERY DENSE, SATURATED, GRAY.
SILTY SAND - W/ SOME GRAVEL, VERY LOOSE, SATURATED, GRAY.
N2 (SM) M.C.=31.3%
N6
TRACE OF BASALT CHIPS, DARK GRAY.
N4
GRADING TO BROWN.
N5 (SM) M.C.=35.5% LL=65 PL=37
-23.9
BOTTOM OF HOLE - TOTAL DEPTH 34.0'
HOLE CASED TO 31.0'
HOLE NUMBER BH-9-90
PROJECT: KAWAINUI MARSH F.C.P., KAILUA, OAHU
LOCATION N 88,035 E 581,435
DATE STARTED 22 MAY 1990
DATE COMPLETED 22 MAY 1990
ELEV 2.8
DEPTH
DESCRIPTION OF MATERIALS
PEAT - W/ ROOTS, SOFT, WET.
N4 (PT) M.C.=183.3%
-0.7
SILTY GRAVEL - LOOSE, SATURATED, GRAY.
N4 M.C.=34.2% (GM)
-4.7
SILTY GRAVEL/ SILTY SAND - VERY LOOSE, SATURATED, CORALLINE, GRAY.
N1 M.C.=47.2% (GM-SM)
-8.2
SILTY SAND - W/ GRAVEL, VERY LOOSE, SLIGHTLY PLASTIC SEAM, SATURATED, GRAY.
N1
SOME SHELLS AT 15.0'
N2
-15.7
SILTY GRAVEL - W/ SOME SAND, VERY LOOSE, GRAY.
N2
N11 (GP-GM)
GRADING TO MEDIUM DENSE.
GRADING TO LOOSE, WHITE.
N5
-26.7
BOTTOM OF HOLE - TOTAL DEPTH 29.5'
HOLE CASED TO 27.5'
HOLE NUMBER BH-1
LOCATION N 87,
DATE STARTED 22 MAY 1990
ELEV 2.0
DEPTH
N2
-1.8
-2.9
N5
-6.5
-9.5
N1
N3
-17.5
N5
-28.0

ARSH F.C.P.
HU
LETED
90
LS
T.
TURATED, GRAY.
D - VERY LOOSE,
NE, GRAY.
VERY LOOSE,
EAM, SATURATED.
D'
AND, VERY
M DENSE.
E, WHITE.
PTH 29.5'

HOLE NUMBER BH-10-90	PROJECT: KAWAINUI MARSH F C P., KAILUA, OAHU
LOCATION N 87,990	E 581,590
DATE STARTED 22 MAY 1990	DATE COMPLETED 22 MAY 1990

ELEV 2.0	DEPTH	DESCRIPTION OF MATERIALS
		PEAT - W/ ROOTS, VERY SOFT, WET.
	2	N2
-1.8		
	4	GRAVELLY SAND - VERY LOOSE, SATURATED, GRAY.
-2.9		SANDY GRAVEL - W/ SLIGHTLY PLASTIC SILT, LOOSE, SATURATED, GRAY.
	6	N5 (GP) M.C.=53.5% LL=39 PL=24
-6.5	8	CLAYEY SAND - VERY LOOSE, SATURATED, GREENISH-GRAY.
	10	N0 M.C.=62.9% (SC) LL=59 PL=22
-9.5		SILTY GRAVEL - VERY LOOSE, SATURATED, GREENISH-GRAY.
	12	N1
	14	
	16	N3 (GM)
	18	
-17.5	20	SANDY GRAVEL - LOOSE, SATURATED, GRAY.
	22	N5
	24	W/ SOME SHELLS.
	26	N5
	28	N8 THIN SEAM OF CLAY.
-28.0	30	BOTTOM OF HOLE - TOTAL DEPTH 30.0' HOLE CASED TO 28.0'
	32	
	34	
	35	
	36	
	38	
	40	

HOLE NUMBER BH-11-90	PROJECT: KAWAINUI MARSH F C P., KAILUA, OAHU
LOCATION N 87,940	E 581,760
DATE STARTED 21 MAY 1990	DATE COMPLETED 21 MAY 1990

ELEV 2.7	DEPTH	DESCRIPTION OF MATERIALS
		PEAT - W/ ROOTS, VERY SOFT, WET.
	2	N0 (PT) M.C.=316.9%
-1.3	4	SAND - W/ TRACE CORAL GRAVEL, VERY LOOSE, SATURATED, TAN TO GRAY.
	6	N1
	8	
-7.3	10	N1 (SM) M.C.=62.8%
		SILTY SAND - VERY LOOSE, SATURATED, LIGHT GRAY.
	12	N0
	14	3" LONG CORAL PIECE
		GRADING TO MORE GRAVEL.
-13.8	16	N3
		CLAYEY SILT - W/ OCCASIONAL GRAVEL, VERY SOFT, SATURATED, GRAY.
-15.8	18	SILTY GRAVEL - W/ SAND, VERY LOOSE, CORALLINE, SATURATED, GRAY.
	20	N1
	22	
	24	GRADING TO LOOSE, TAN.
	26	N7 (GM) M.C.=37.6%
	28	N8
-27.3	30	BOTTOM OF HOLE - TOTAL DEPTH 30.0' HOLE CASED TO 27.0'
	32	
	34	
	35	
	36	
	38	
	40	

HOLE NUMBER BH-12-90	PROJECT: KAWAINUI MARSH F.C.P., KAILUA, OAHU
LOCATION N 87,900	E 581,900
DATE STARTED 25 MAY 1990	DATE COMPLETED 25 MAY 1990

ELEV 2.2	DEPTH	DESCRIPTION OF MATERIALS
		SILTY SAND - W/ GRAVEL, LOOSE, CORALLINE, MOIST, TAN TO GRAY.
	2	N6
		TRACE OF PEAT.
	4	GRADING TO VERY WET.
		N6 (SW-SM) M.C.=30.8%
	6	
-5.8		GRADING TO DARK GRAY.
	8	N4
		SILTY GRAVEL - W/ SAND, VERY LOOSE, SATURATED, LIGHT GRAY.
	10	N3 GRADING TO TAN W/ GREENISH-TAN SAND.
	12	
	14	N1
-13.3	16	CLAYEY GRAVEL - VERY LOOSE, SATURATED, GREENISH-GRAY.
		N0 (GC) M.C.=54.7% LL=72 PL=21
	18	
	20	N2
	22	
	24	
-22.8		N6 (SW-SC) M.C.=52.5% LL=74 PL=33
	26	CLAYEY SAND - LOOSE, SLIGHTLY PLASTIC, MOIST, BROWN.
-25.8	28	SANDY GRAVEL - W/ SILT, MEDIUM DENSE, SATURATED, TAN TO GRAY.
		N13
-27.8	30	BOTTOM OF HOLE - TOTAL DEPTH 30.0' HOLE CASED TO 24.5'
	32	
	34	
	35	
	36	
	38	
	40	

KAWAINUI MARSH OAHU, HAWAII

RECENT BORING LOGS
(1990)

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE C-6

KAWAINUI MARSH F[illegible]OD CONTROL PROJECT

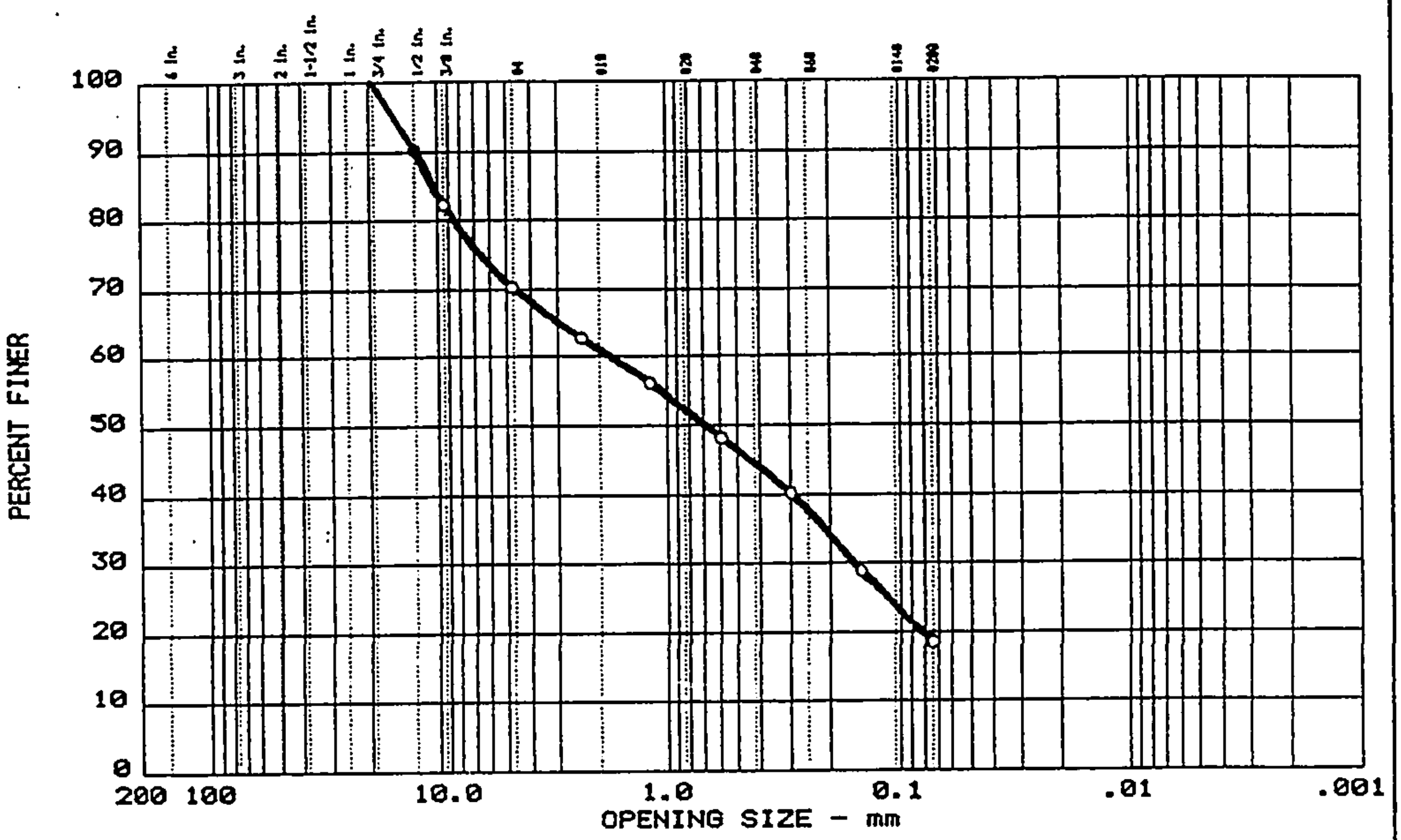
TEST DATA SUMMARY

BORING NO.	SAM. NO.	DEPTH OR ELEV. OF SAMPLE	LABORATORY CLASSIFICATION	MECHANICAL ANALYSIS GRAVEL %	SAND %	FINES %	D_{10}	ATTERBERG LIMITS LL	PL	SPECIFIC GRAVITY G	NAT. WATER CONT. %	Org.Cont. %	SHEAR DATA TEST	σ_m T/SQ FT	σ_1 T/SQ FT	REMARKS
BH-1	1	1.3-3	SC	30	52	18		68	25		19.1					
	4	11-13	SP-SM	34	58	8		—	NP		32.8					
	9	29-31	GP-GM	60	31	9		—	NP		24.9					
BH-2	4	8-9	SM	22	60	18		—	NP		48.6					
	8	16-18	GM	38	34	28		—	NP							
	12	28-30	SC	24	47	29		36	20							
BH-3	12	4-6	SM	20	60	20		—	NP		16.6					
	14	10-12	SM	32	55	13		—	NP		23.5					
	17	21-23	SP	2	96	2		—	NP		39.9					
BH-4	14	2-4	SM	31	55	14		—	NP		10.0					
	15	4-6	SM	26	47	27		53	13		22.4					
	20	16-18	GM	44	40	16		—	NP							
BH-5	21	4-6	SW-SC	32	63	5		34	14		12.0					
	24	13-15	GM	46	39	15		—	NP							
	26	19-21	SP	15	81	4		—	NP							
BH-6	26	1-3	SP	1	96	3					13.6					
	28	9-11	SP-SM	1	90	9					37.1					
	30	18-20	SP	3	93	4										
BH-7	31	4-5.8	GP-GC	47	41	12		38	15		17.1					
	34	13-15	GP-GM	53	36	11		—	NP							
	37	23-25	GP	57	42	1		—	NP							
BH-8	33	4-6	GP-GC	49	41	10		33	17		10.6					
	37	15-17	SM	37	50	13		—	NP		31.3					
	40	31-33	SM	18	43	39		65	37		35.5					
BH-9	18	2-4	PT								183.3	37.7				
	20	5-7	GM	48	39	13		—	NP		34.2					
	21	8-10	GM/SM	40	40	20		—	NP		47.2					

KAWAINUI MARSH FLOOD CONTROL PROJECT
TEST DATA SUMMARY

BORING NO.	SAM. NO.	DEPTH OR ELEV. OF SAMPLE	LABORATORY CLASSIFICATION	MECHANICAL ANALYSIS				ATTERBERG LIMITS		SPECIFIC GRAVITY G	NAT. WATER CONT. %	Org.Cont.	SHEAR DATA			REMARKS
				GRAVEL %	SAND %	FINES %	D_{10}	LL	PL			%	TEST	σ_m T/SQ FT	σ_1 T/SQ FT	
BH-9	25	24-26	GP-GM	67	22	11		—	NP							
BH-10	11	6-8	GP	81	16	3		39	24		53.5					
	12	9-11	SC	18	45	37		59	22		62.9					
	14	16-18	GM	59	28	13		—	NP							
BH-11	1	1-3	PT								316.9	21.3				
	3	9-11	SM	28	55	17		—	NP		62.8					
	8	25-27	GM	63	23	14		—	NP		37.6					
BH-12	2	4-6	SW-SM	35	53	12		—	NP		30.8					
	6	16-18	GC	64	23	13		72	21		54.7					
	8	25-26.5	SW-SC	30	59	11		74	33		52.5					

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+3"	% GRAVEL	% SAND	% SILT	% CLAY
o	0.0	29.7	51.8	18.5	

	USCS Classification	% COLLOIDS	LL	PI	D_{60}	D_{30}	D_{10}	C_c	C_u
o	SC ✓		68	43					

MATERIAL DESCRIPTION	TYPE OF TEST
o	ASTM D 422-63(72) Mechanical analysis

Project No.: 698M FY90/CIV
Project: KAWAINUI MARSH FCP
o Location: KAWAINUI MARSH

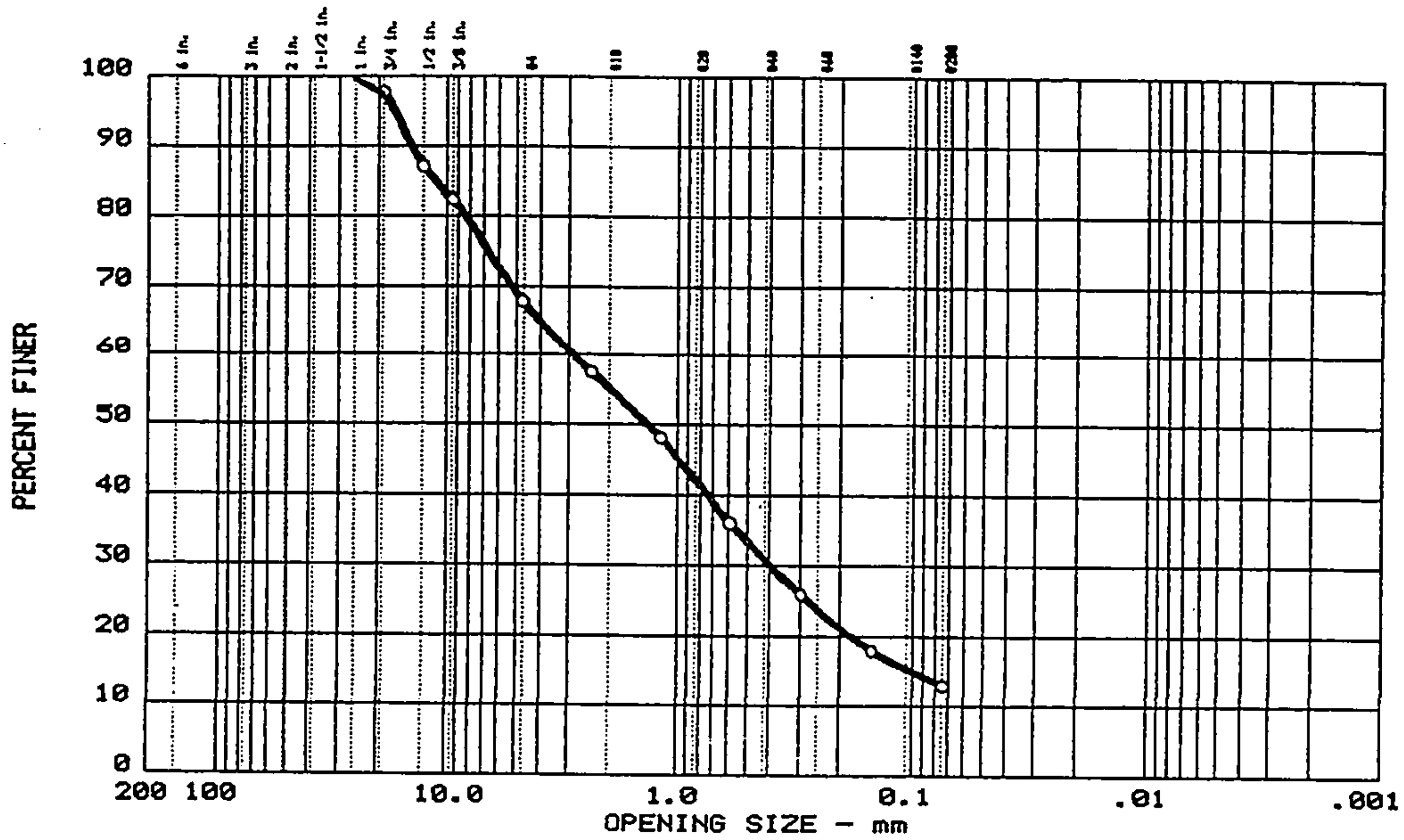
Date: 21 JUNE 1990

Remarks:
BH-1 S-1
DEPTH :1.3'-3.0'

GRAIN SIZE DISTRIBUTION TEST REPORT
US ARMY CORPS OF ENGINEERS

Plate No. C-9

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+3"	% GRAVEL	% SAND	% SILT	% CLAY
o	0.0	32.2	54.9	12.9	

	USCS Classification	% COLLOIDS	LL	PI	D_{60}	D_{30}	D_{10}	C_c	C_u
o	SM	✓							

MATERIAL DESCRIPTION	TYPE OF TEST
o	ASTM D 422-63(72) Mechanical analysis

Project No.: 698M FY90/CIV
Project: KAWAINUI MARSH FCP
o Location: KAWAINUI MARSH

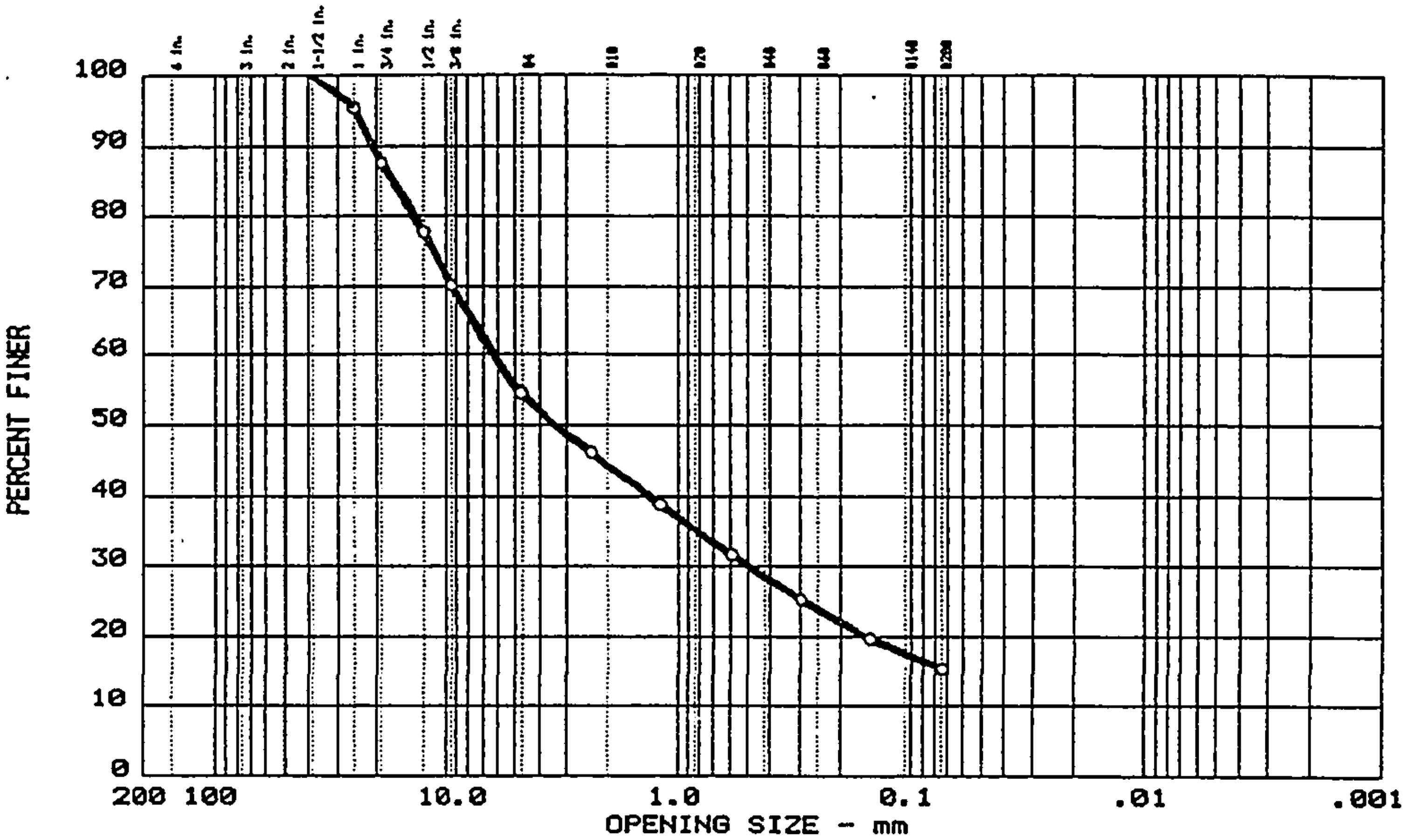
Date: 11 JUNE 1990

Remarks:
BH-3 S-14
DEPTH :10'-12'

GRAIN SIZE DISTRIBUTION TEST REPORT
US ARMY CORPS OF ENGINEERS

Plate No. C-10

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+3"	% GRAVEL	% SAND	% SILT	% CLAY
O	0.0	45.5	39.2	15.4	

	USCS Classification	% COLLOIDS	LL	PI	D_{60}	D_{30}	D_{10}	C_c	C_u
O	GM ✓								

MATERIAL DESCRIPTION	TYPE OF TEST
O	ASTM D 422-63(72) Mechanical analysis

Project No.: 698M FY90/CIV
Project: KAWAINUI MARSH FCP
o Location: KAWAINUI MARSH

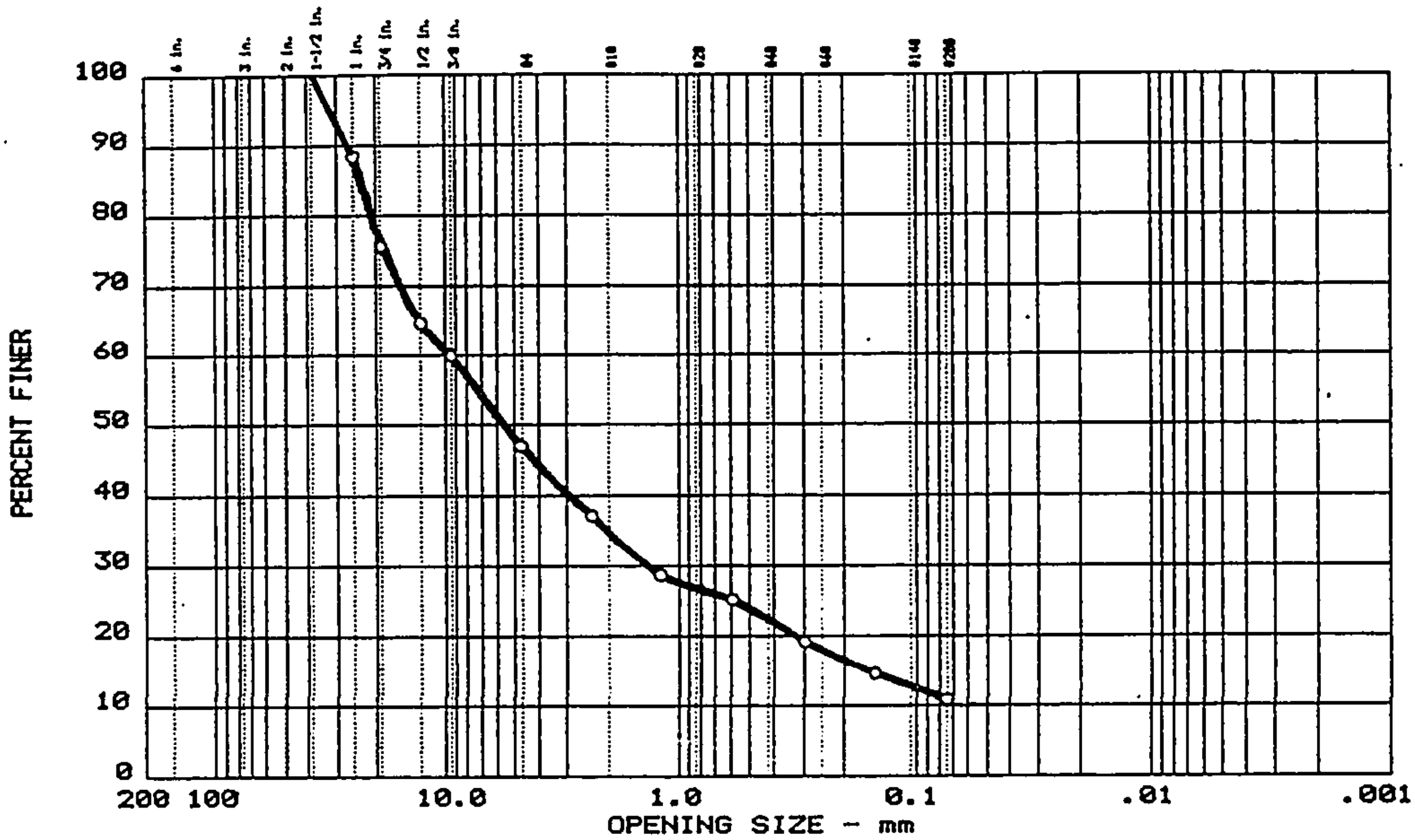
Date: 21 JUNE 1990

Remarks:
BH-5 S-24
DEPTH :13.0'-15.0'

GRAIN SIZE DISTRIBUTION TEST REPORT
US ARMY CORPS OF ENGINEERS

Plate No. C-11

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+3"	% GRAVEL	% SAND	% SILT	% CLAY
o	0.0	53.0	36.1	10.9	

	USCS Classification	% COLLOIDS	LL	PI	D_{60}	D_{30}	D_{10}	C_c	C_u
o	GP ✓								

MATERIAL DESCRIPTION	TYPE OF TEST
o	ASTM D 422-63(72) Mechanical analysis

Project No.: 698M FY90/CIV
Project: KAWAINUI KAILUA OAHU, HAWAII
o Location: KAWAINUI MARSH

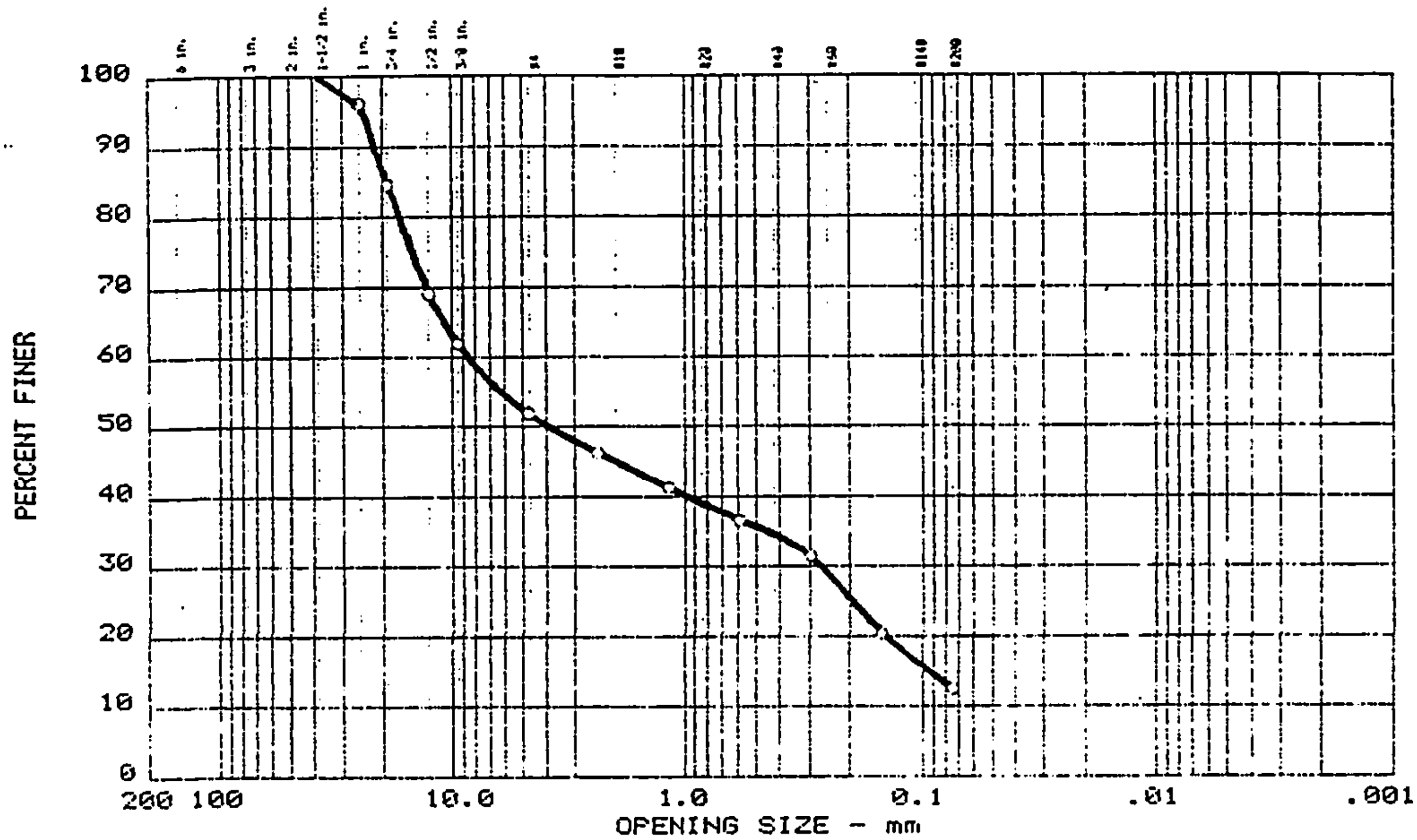
Date: 11 JUNE 1990

Remarks:
BH-7 S-34
DEPTH: 13'-15'

GRAIN SIZE DISTRIBUTION TEST REPORT
US ARMY CORPS OF ENGINEERS

Plate No. C-12

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+3"	% GRAVEL	% SAND	% SILT	% CLAY
o	0.0	48.1	39.4	12.5	

	USCS Classification	% COLLOIDS	LL	PI	D_{60}	D_{30}	D_{10}	C_c	C_u
o	GM								

MATERIAL DESCRIPTION	TYPE OF TEST
o	ASTM D 422-63(72) Mechanical analysis

Project No.: 698M FY90/CIV
Project: KAWAINUI KAILUA OAHU, HAWAII
o Location: KAWAINUI MARSH

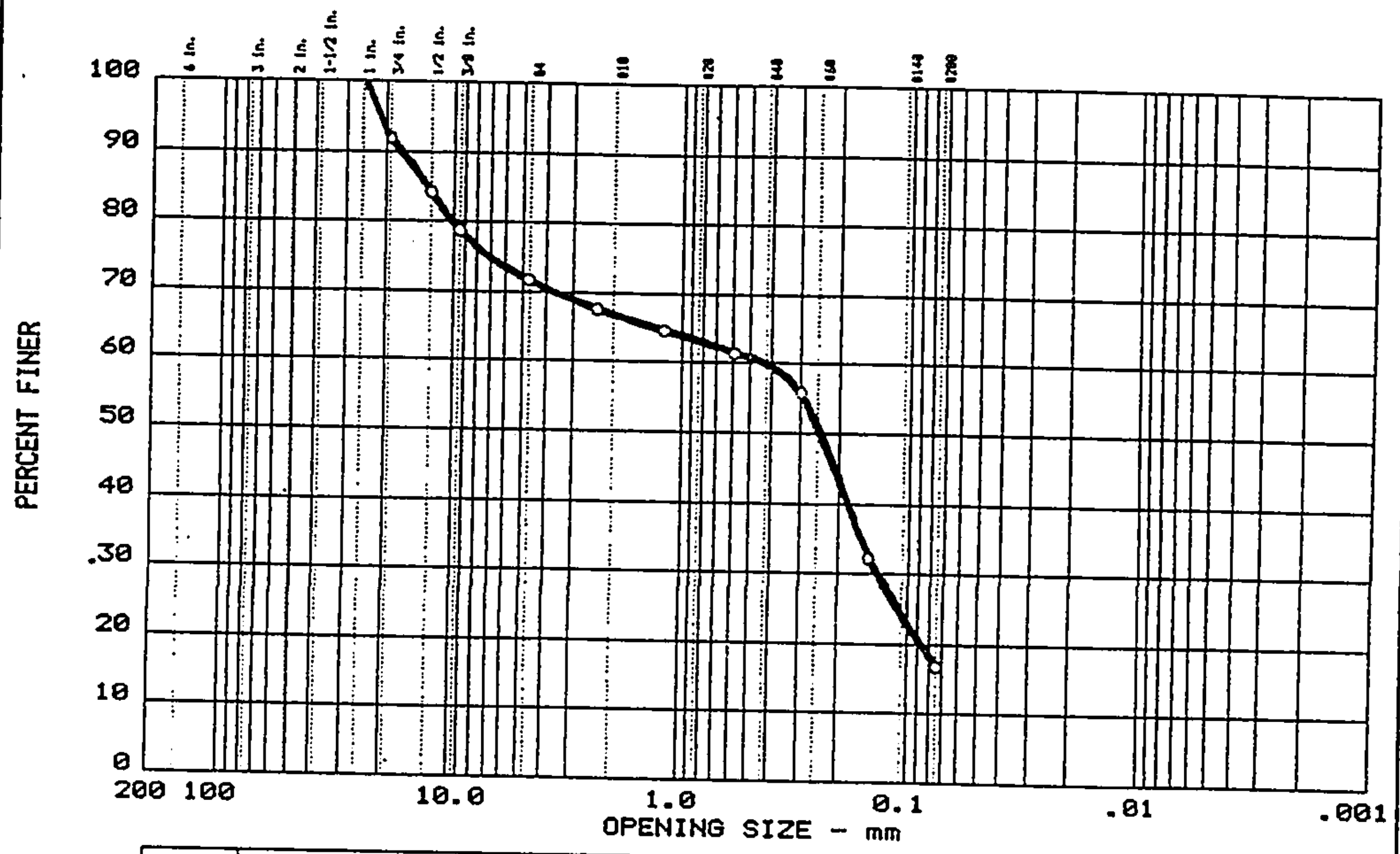
Date: 11 JUNE 1990

GRAIN SIZE DISTRIBUTION TEST REPORT
US ARMY CORPS OF ENGINEERS

Remarks:
BH-9 S-20
DEPTH :5.0'-7.0'

Plate No. C-13

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+3"	% GRAVEL	% SAND	% SILT	% CLAY
o	0.0	28.3	54.9	16.8	

	USCS Classification	% COLLOIDS	LL	PI	D_{60}	D_{30}	D_{10}	C_c	C_u
o	SM ✓								

MATERIAL DESCRIPTION	TYPE OF TEST
o	ASTM D 422-63(72) Mechanical analysis

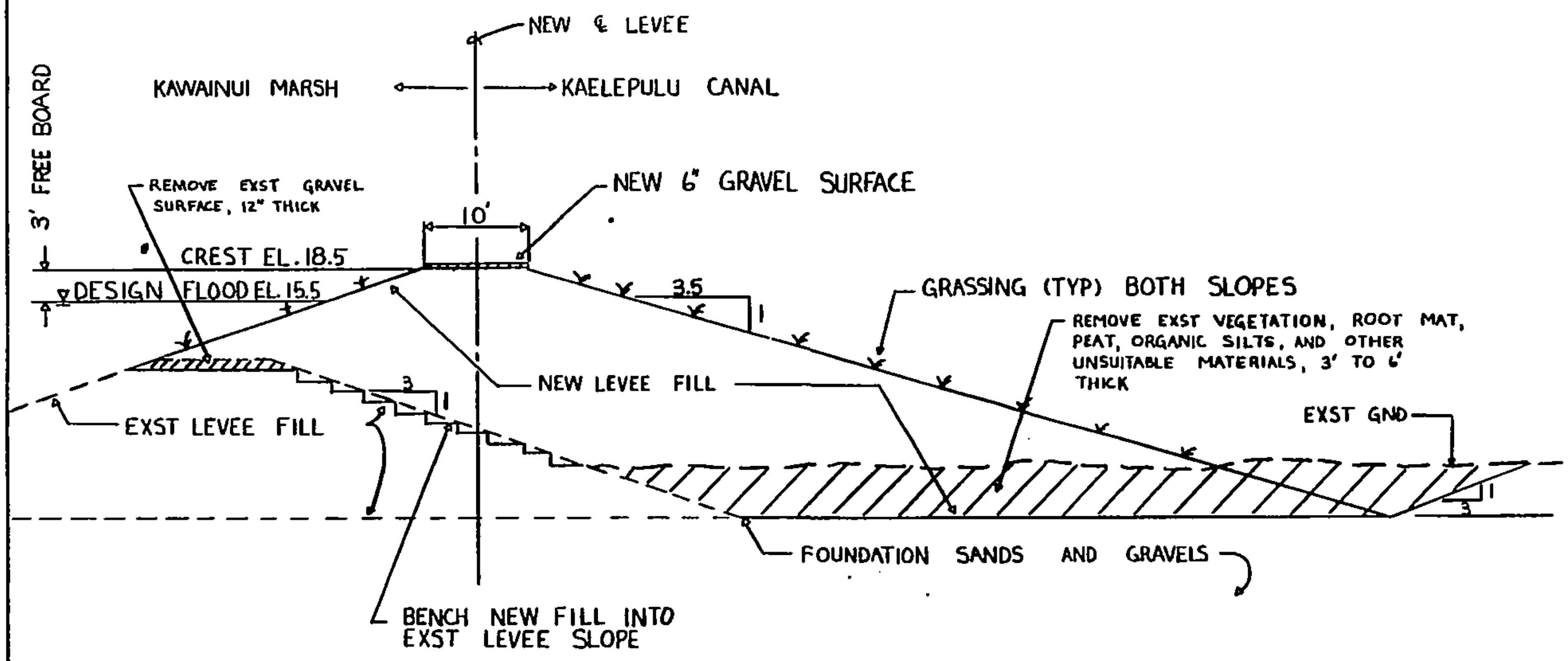
Project No.: 698M FY90/CIV
Project: KAWAINUI MARSH FCP
o Location: KAWAINUI MARSH

Date: 22 JUNE 1990

GRAIN SIZE DISTRIBUTION TEST REPORT
US ARMY CORPS OF ENGINEERS

Remarks:
BH-11 S-3
DEPTH : 9.0'-11.0'

Plate No. C-14



TYPICAL SECTION ~ EARTH FILL LEVEE RAISE

SCALE: 1" = 10'-0"

KAWAINUI MARSH OAHU, HAWAII

TYPICAL SECTION
EARTH FILL LEVEE RAISE

U.S. ARMY ENGINEER DISTRICT, HONOLULU

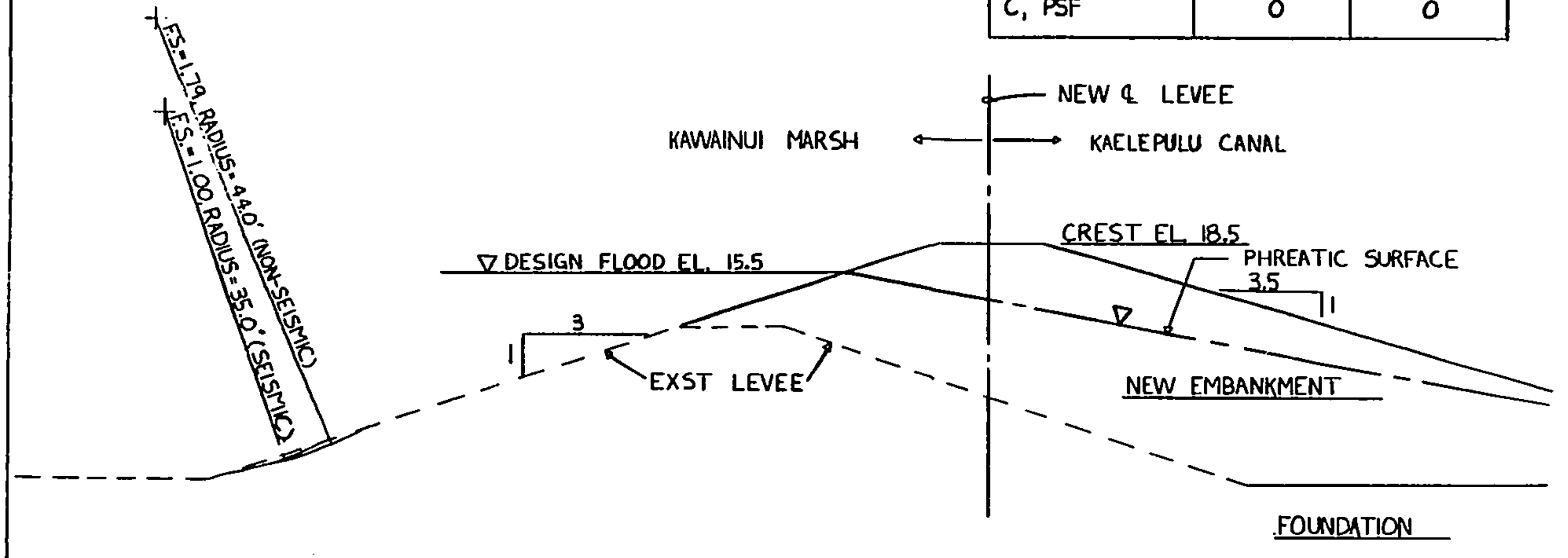
PLATE C-15

SUMMARY OF SLOPE STABILITY ANALYSES

KAWAINUI MARSH FLOOD CONTROL PROJECT

DESIGN CONDITION	COMPUTED MINIMUM FACTOR OF SAFETY	REQUIRED FACTOR OF SAFETY	REMARKS
Marsh-Ward Slope, Full Pool, Non-Seismic	1.79	1.4	O.K.
Marsh-Ward Slope, Full Pool, Seismic	1.0	1.0	O.K.
Marsh-Ward Slope, Partial Pool, Non-Seismic	1.72	1.4	O.K.
Marsh-Ward Slope, Partial Pool, Seismic	0.90	1.0	Say O.K. Shallow sliver failure at toe.
Land-Ward Slope, End of Construction, Non-Seismic	1.90	1.3	O.K.
Land-Ward Slope, End of Construction, Seismic	1.12	1.0	O.K.
Land-Ward Slope, Steady Seepage, Non-Seismic	1.45	1.4	O.K.
Land-Ward Slope, Steady Seepage, Seismic	0.99	1.0	Say O.K.

ADOPTED SOIL PARAMETERS	EXST & NEW LEVEE EMBANKMENT	LEVEE FOUNDATION
γ (SATURATED), PCF	117	111
γ (MOIST), PCF	90.5	N/A
Φ, DEGREES	30	30
C, PSF	0	0



STABILITY ANALYSIS ~ FULL POOL CONDITION

SCALE: 1" = 10'-0"

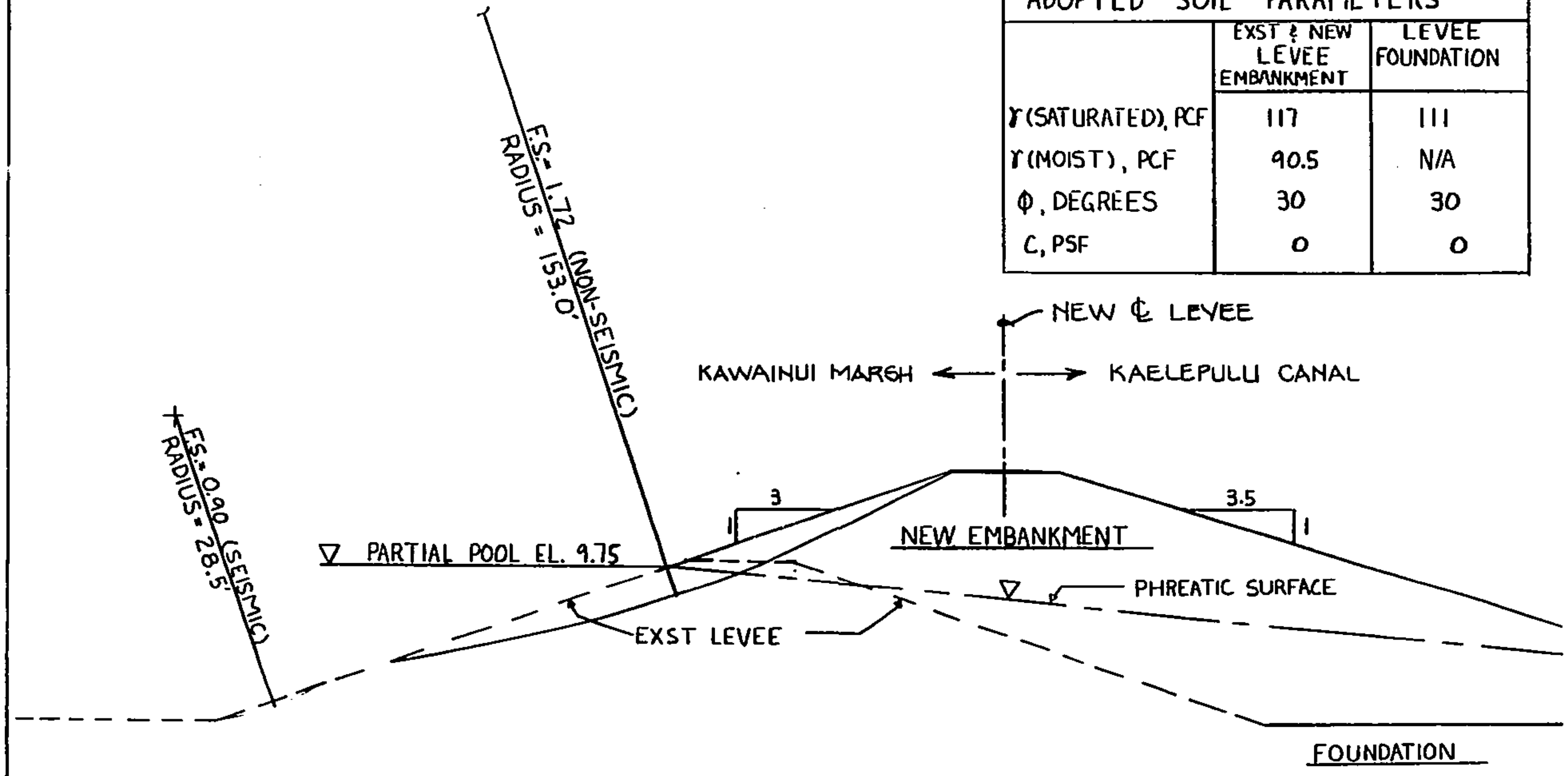
KAWAINUI MARSH OAHU, HAWAII

STABILITY ANALYSIS
FULL POOL CONDITION
UPSTREAM SLOPE

US ARMY ENGINEER DISTRICT, HONOLULU

PLATE C-17

ADOPTED SOIL PARAMETERS	EXST & NEW LEVEE EMBANKMENT	LEVEE FOUNDATION
γ (SATURATED), PCF	117	111
γ (MOIST), PCF	90.5	N/A
ϕ, DEGREES	30	30
C, PSF	0	0



STABILITY ANALYSIS ~ PARTIAL POOL CONDITION

SCALE: 1" = 10'-0"

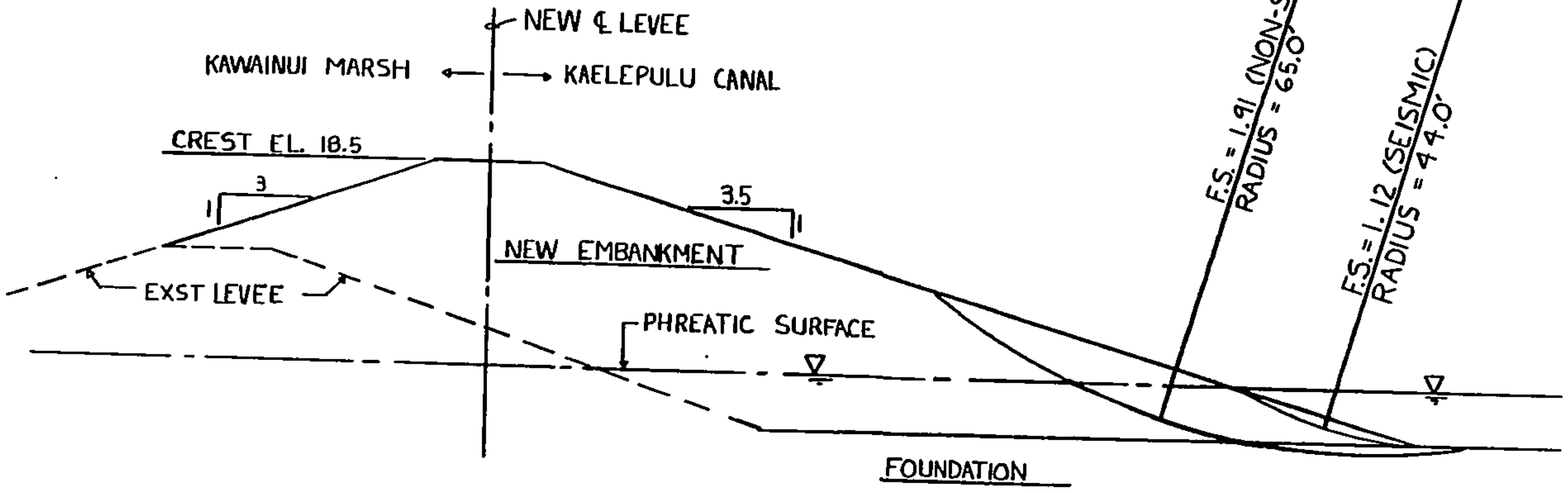
KAWAINUI MARSH OAHU, HAWAII

STABILITY ANALYSIS
PARTIAL POOL CONDITION
UPSTREAM SLOPE

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE C-18

ADOPTED SOIL PARAMETERS	EXST & NEW LEVEE EMBANKMENT	LEVEE FOUNDATION
γ (SATURATED), PCF	117	111
γ (MOIST), PCF	90.5	N/A
ϕ, DEGREES	30	30
C, PSF	0	0



STABILITY ANALYSIS ~ END OF CONST. CONDITION

SCALE: 1" = 10'-0"

KAWAINUI MARSH OAHU, HAWAII

STABILITY ANALYSIS

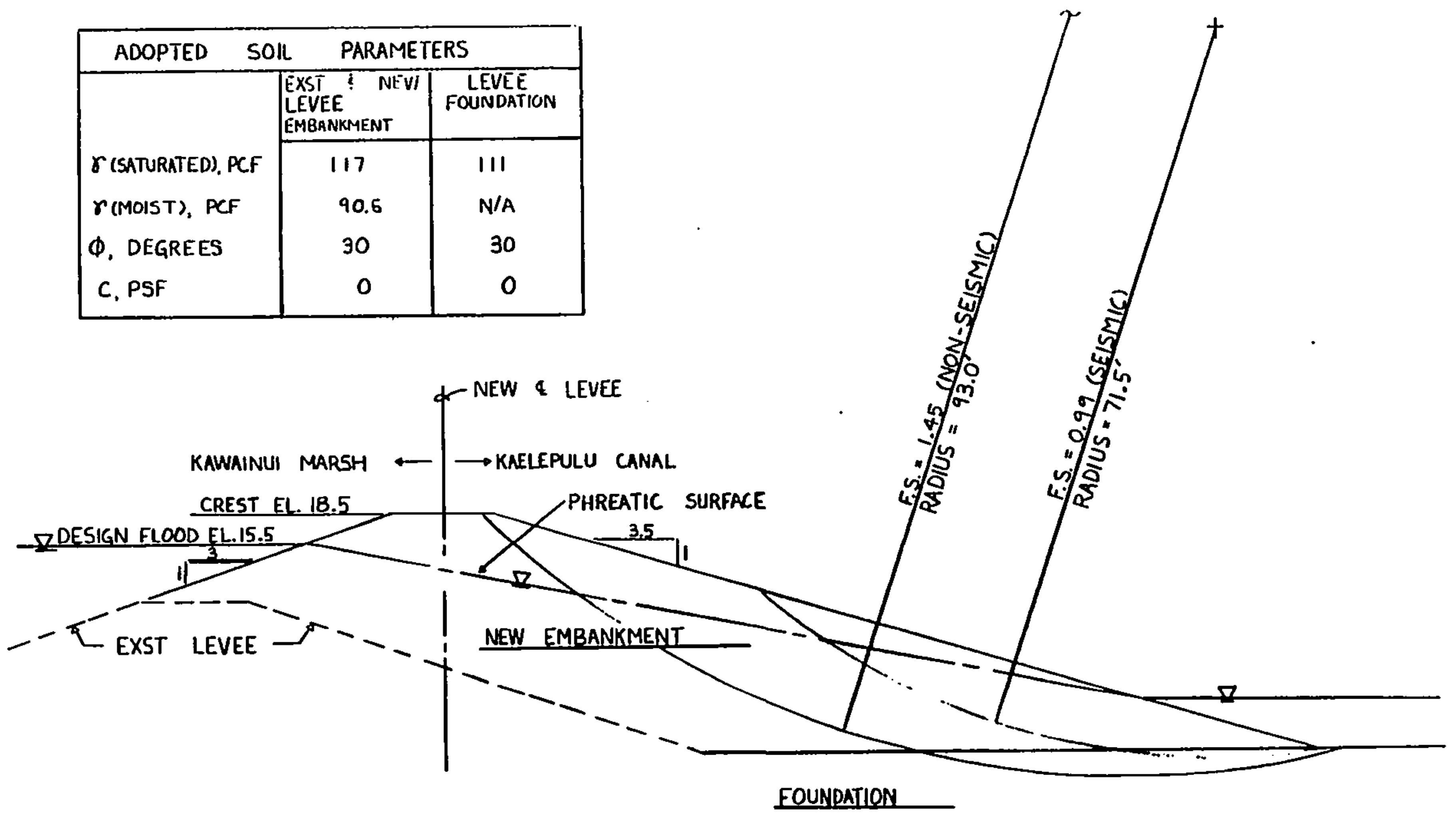
END OF CONST. CONDITION

DOWNSTREAM SLOPE

US ARMY ENGINEER DISTRICT, HONOLULU

PLATE C-19

ADOPTED SOIL PARAMETERS	EXST & NEW LEVEE EMBANKMENT	LEVEE FOUNDATION
γ (SATURATED), PCF	117	111
γ (MOIST), PCF	90.6	N/A
ϕ, DEGREES	30	30
C, PSF	0	0



STABILITY ANALYSIS ~ STEADY SEEPAGE CONDITION

SCALE : 1" = 10'-0"

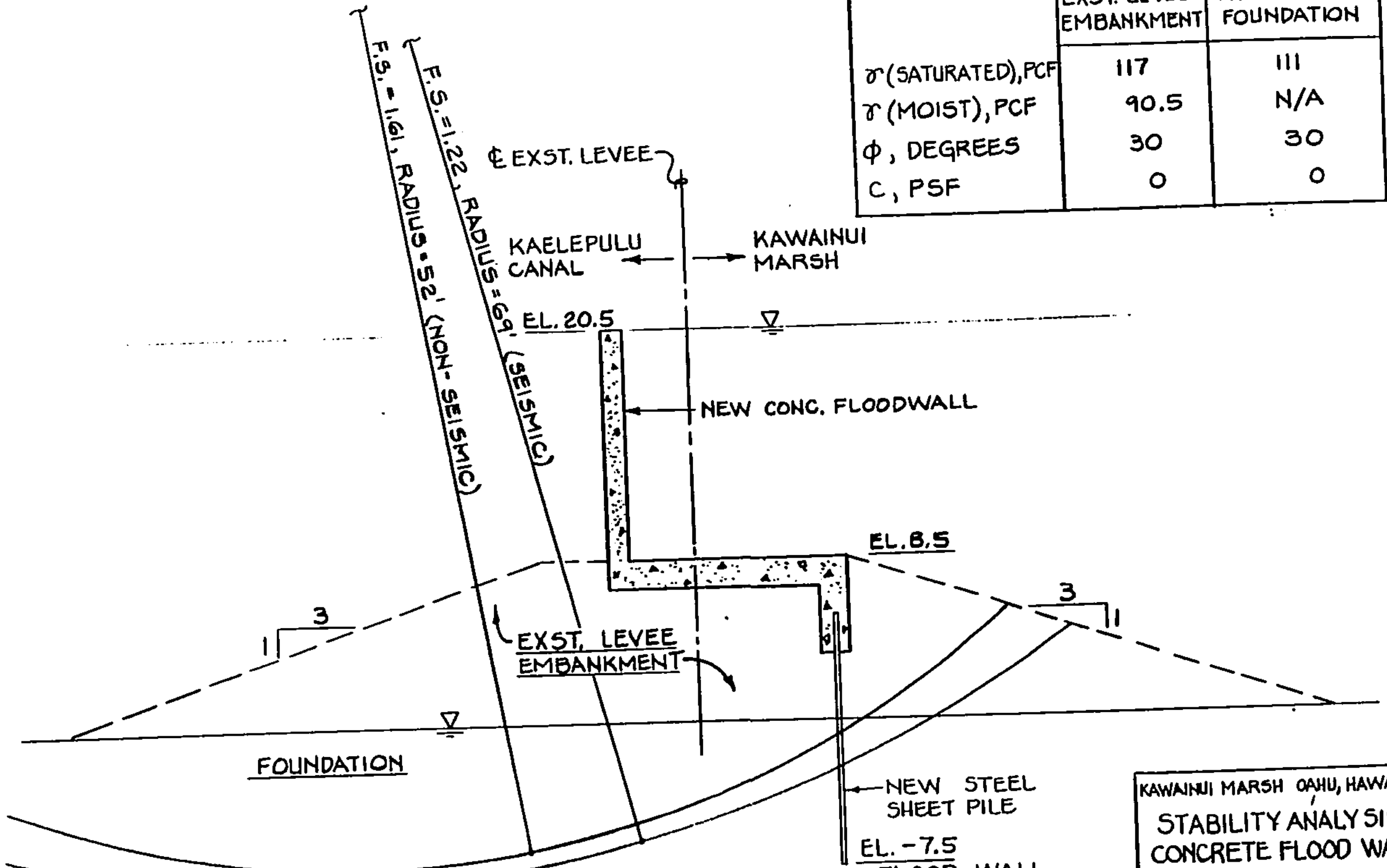
KAWAINUI MARSH, OAHU, HAWAII

STABILITY ANALYSIS
STREAM SEEPAGE CONDITION
DOWNSTREAM SLOPE

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE C-20

ADOPTED SOIL PARAMETERS	EXST. LEVEE EMBANKMENT	EXST. LEVEE FOUNDATION
γ (SATURATED), PCF	117	111
γ (MOIST), PCF	90.5	N/A
ϕ, DEGREES	30	30
C, PSF	0	0



STABILITY ANALYSIS ~ FLOOD WALL

SCALE : 1" = 5'-0"

KAWAINUI MARSH OAHU, HAWAII

STABILITY ANALYSIS CONCRETE FLOOD WALL

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE C-21

KAWAINUI MARSH
FLOOD CONTROL PROJECT
OAHU, HAWAII

APPENDIX D - DAMAGES AND BENEFITS

APPENDIX D

KAWAINUI MARSH FLOOD CONTROL PROJECT

OAHU, HAWAII

ECONOMIC EVALUATION APPENDIX

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (CONT.)

LIST OF TABLES (CONT.)

I. GENERAL

Flood plain management, including flood control and prevention, will contribute to the National Economic Development (NED) objective by improving the net productivity of flood-prone land resources. This occurs by an increase in output of goods and services and/or by reducing the cost of using the land resources (improvement in economic efficiency). The benefit standard is the willingness of users (benefiting activities) to pay for each increment of output from a plan.

The two economic principles governing the selection of the NED plan are economic justification and optimality. Project economic benefits must exceed project costs, and there should be no other alternative with greater net benefits (benefits less costs). Overriding non-economic considerations may justify deviation from these principles.

Estimated benefits result from a reduction or elimination of flood-related damages and costs that can be attributed to the installation of a Corps project. Estimated project costs are discussed in an earlier section at an October 1991 price level, and are the costs of all goods and services used in project construction and operation and maintenance. Both costs and benefits are expressed at an estimated October 1991 price level in this section. Costs and benefits occurring at different points in time are converted to an average annual equivalent basis over the 100-year period of analysis for comparison using the Federal discount rate prescribed for water resource projects. This rate is currently set at 8.50 percent.

II. BENEFITS

1. INTRODUCTION

Benefits for this study are defined as the measured difference between conditions with and without a flood control project. Benefits resulting from the four alternatives under consideration include reduction of damages to structures, their contents, and other property; reduction in emergency relief costs and in the operating cost of the National Flood Insurance Program; and restoration of real estate market performance. Intangible, but important, benefits of the project include elimination of the threat to human safety and the reduction of trauma and stress to the residents in the flood plain supposedly protected by a federally constructed flood control project.

2. DAMAGEABLE PROPERTY INVENTORY

Coconut Grove is predominantly a residential development. The flood plain is part of the area bounded by Kawainui Marsh to the west, Kailua Road to the south, Maluniu Avenue to the east, and the Oneawa Canal to the north. Out of the 2,025 units (1,961 structures) in the flood plain for which data was obtained, only 12 of the units (in 9 structures) were commercial and four were public structures (i.e. sewage pump station, schools, etc.). Most of the residential units in the flood plain were post-and-beam single family homes. The rest of the homes were slab-on-grade. A number of parcels had more than one structure on them. Ground elevations in the flood plain ranged from about four feet mean sea level (msl) at the levee to 10 feet msl between Oneawa Street and Maluniu Avenue.

For structure damage computations, the flood plain was divided into 117 blocks of approximately equal ground elevation and size. The average number of units per block came to approximately 17 units. The 1988 replacement cost less depreciation value for each structure in the flood plain was obtained from the REDI Real Estate Information Service's Real Estate Atlas of the State of Hawaii 23rd edition.

Content value for the affected units were estimated as a fraction of structure value. Percentages from a study entitled Inventory and Analysis of the Value of Damageable Property Hilo, Hawaii March 1978 conducted by Environment Capital Managers Inc. were used in computing residential content value. This study was used because it is the most recent comprehensive study available. Structure value to content ratios were estimated by value frequency to the nearest $10,000. Once determined, the corresponding percentage was applied to the structure value. Percentages used in computing content value for commercial properties were also taken from that study of flood damage reduction in downtown Hilo on the island of Hawaii done for a previous Corps project.

A Corps survey crew measured first floor elevations for a sample of homes. Each of the 117 blocks in the flood plain had at least four first floor elevations measured. These elevations were then divided evenly among the number of units in the block. Table D-1 contains a full breakdown of this information.

Damage claims information obtained by the City & County of Honolulu Corporation Counsel office for the Kawainui flood of 31 December 1987 showed structure and content damages as well as depth of water over the first floor for about 60 units. This information was analyzed and adjusted to reflect depreciated replacement value and then depth percent damage estimates were made. These were plotted by depth and compared with standard Corps curves and Federal Insurance Administration (FIA) curves. Based on this comparison, the stage-damage functions selected for use in the residential structure damage computations were a combination of the standard Corps curves and FIA curves. Another FIA curve was also used to compute residential content damages since it was the best fitting curve to the Kawainui database.

For commercial structures, standard POD depth-damage curves were used

TABLE D-1.
AN INVENTORY OF STRUCTURES IN THE COCONUT GROVE AREA
BY ELEVATION AND TYPE

1ST FLOOR ELEVATION	# ON POST	# ON SLAB
6.0	0	0
6.1	0	3 (2M, 1C)
6.2	0	0
6.3	0	2 (2M)
6.4	0	8
6.5	0	2
6.6	0	17
6.7	0	13
6.8	0	8
6.9	0	25 (1P)
7.0	0	14
7.1	0	14
7.2	0	12
7.3	0	15
7.4	0	7
7.5	10	11
7.6	0	21 (2M)
7.7	3	23
7.8	0	14
7.9	15	18 (2C)
8.0	20	6
8.1	16 (1M)	12
8.2	16 (3M)	18
8.3	23 (2M)	15
8.4	23	9
8.5	18 (2M)	14
8.6	33 (6M)	10
8.7	26	7
8.8	49 (1M)	9
8.9	23	9 (2M, 1C)
9.0	16	5
9.1	32	9
9.2	34	5
9.3	33	10
9.4	56	6 (3M, 3C)
9.5	43 (1P)	9
9.6	19	9
9.7	17 (1M)	0
9.8	24	3
9.9	34	0
10.0	34	0

1ST FLOOR ELEVATION	# ON POST	# ON SLAB
10.1	38	5
10.2	33 (2C)	0
10.3	37	0
10.4	47	5
10.5	22	0
10.6	41 (3M)	0
10.7	40 (3M)	7
10.8	42	0
10.9	29	0
11.0	40	0
11.1	46 (2P)	0
11.2	37	0
11.3	33	0
11.4	19	0
11.5	28	0
11.6	32 (1M)	7
11.7	34	0
11.8	53	0
11.9	28	0
12.0	32	0
12.1	37	0
12.2	19	0
12.3	15	0
12.4	12 (1M)	0
12.5	5	0
12.6	11	0
12.7	14	0
12.8	9	0
12.9	12	0
13.0	0	0
13.1	11	0
13.2	18	0
13.3	7	0
13.4	10	0
13.5	8	0
13.6	7	0
13.7	10	0
13.8	7	0
13.9	0	0
14.0	0	0
16.0	5	0
TOTAL:	1,545	416

M=Multi-unit structure (i.e. apartments, duplexes, etc.)
C=Commercial structure (i.e. shops, restaurants, etc.)
P=Public structure (i.e. sewage pump station, school, etc.)

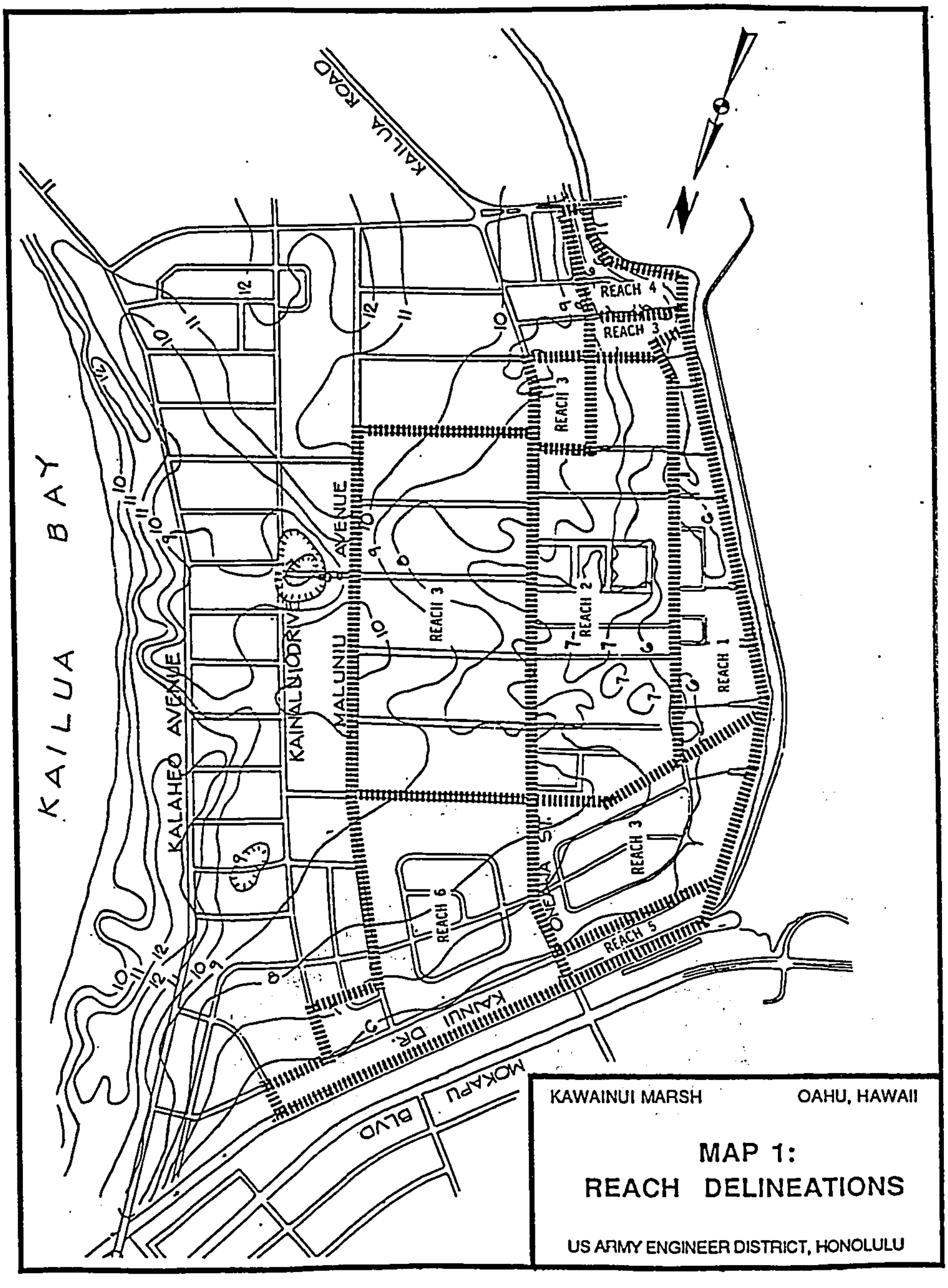
to compute inundation damages. Commercial content damages from flooding were computed using depth-damage curves taken from a 1980 Moanalua Stream flood control study done by the Corps. For the four public structures, depth-damage relationships were based on structure type, while content damages were based on residential curves. It is assumed that the flood water had minimal velocity. The analysis of damages and damage reduction benefits also assumes that no significant change in land use or development within the flood plain was likely during the period of analysis.

3. INUNDATION DAMAGE REDUCTION

Stage-damage-frequency relationships were developed based on the property inventory data base, depth-frequency water surface profile data for the alternatives with and without a freeboard as part of the project, modified residential depth-damage relationships, and standard commercial depth-damage relationships. The modified depth-damage curves were based on comparisons between standard POD and FIA curves and the actual claims of depth and damage from residents of Coconut Grove collected from the City & County's Corporation Counsel. These modified depth-damaged curves were used for residential structures, while standard POD depth-damage curves were used for commercial properties. The zero damage point was set at the 10-year event. That is the storm magnitude where overtopping of the existing levee was estimated to begin.

The calculations were done using a Hydrologic Engineering Center-developed computer program which used the aforementioned data base information as input. The program calculated for each property a depth-damage schedule and aggregated this depth-damage data to arrive at a depth-damage schedule by reach for the entire flood plain under various conditions and assumptions. See Map 1 for reach delineations.

After damages for each flood were estimated, the data for all of the structures were summed and used to arrive at an array of estimated damage-probability data. Next, having been based on 1988 structure values, these damage-probability relationships were updated to an October 1991 price level. This was accomplished in two steps. First, since inputting the original data base into the program, the 24th edition of the Real Estate Atlas of the State of Hawaii was published. It contained the 1989 replacement cost less depreciation values for the structures in the flood plain. A sample of 320 structures in the flood plain was looked at to see how the value of the homes had changed in one year. The 1989 values of these structures were compared with their 1988 values. The average percentage change for the sample was computed at 5.3 percent and used to update the price level of the damages calculated for the different events from 1988 to 1989. Second, these figures were adjusted by three percent per year which is the rate used by the City & County's Real Property Assessment Office to update the value of structures not actually assessed in a given year. Using this percentage, the 1989 damage-probability data was updated to an October 1991 price level.



KAWAINUI MARSH — OAHU, HAWAII

MAP 1: REACH DELINEATIONS

US ARMY ENGINEER DISTRICT, HONOLULU

Damage-probability data for structures and contents in the Coconut Grove flood plain are displayed in Tables D-2 through D-9 for calculation of inundation damage reduction benefits.

Integration of the data in Tables D-2 through D-9 results in average annual inundation damage estimates for each of the alternatives. Tables D-10 through D-15 show average annual inundation damages for the without project condition, those associated with the 50-year, 100-year, and SPF storm protection projects, and the inundation damage reduction benefits.

Included as part of the inundation damage reduction benefits for the 50- and 100-year protection projects are the benefits attributed to the freeboard. According to the ER 1105-2-100, one-half of the benefits of having a freeboard installed as part of a project can be claimed. To determine these benefits, the average annual damage for each alternative was calculated both with and without the freeboard. The two damage figures were then subtracted to get the amount of reduced damages achieved by putting in the freeboard. This difference was then divided by two and added to the average annual damage for the alternative including the freeboard. This total, then, was used as the average annual damages for each alternative including freeboard.

Tables D-10 through D-12 also include the effect of the increasing real value of residential contents throughout the period of analysis. Growth in the real value of contents and in the average annual damage to contents is assumed to parallel growth in real per capita income expected to occur in the future. The BEA Regional Projections to 2040 (U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Analysis Division, Projection Branch, June 1990) forecasts for per capita income growth in the state of Hawaii are equivalent to about one percent per year from 1990-2040. Water resource planning regulatory guidelines allow for the effect of increasing real value of contents to be incorporated into the damage calculation analysis subject to the constraint that the projected real value of contents does not exceed 50 percent of the real value of the structure. Presently, for this flood plain, the estimated market value of contents is about 28 percent of the average market value of the structures. At an average annual growth of one percent per year, the average real value of contents will be 50 percent of the real value of the structures in about 57 years, or about 2047. Since the estimated first year of project life is 1993, the estimated real value of contents and content damages in 1993 will be three percent higher than the content damages in 1990. Growth from 1993 to 2047 at one percent per year, with no further growth through the end of the period of analysis, results in increases in average annual damages of $5,000 in Reach 1, $11,000 in Reach 2, $5,000 in Reach 3, $1,000 in Reaches 4 and 6, and less then $1,000 in Reach 5. These figures were calculated by taking the initial average annual damage figures for each reach and escalating it by one percent a year from 1991 to 1993, and then for the first 54 years of the project. Next, the difference between the initial average annual damage amount and each year's escalated value was obtained. The values for the first 53 years of the project life were then discounted back to 1993 and summed. To that total was added the discounted content value estimated from year 54 to the end of the period of analysis. This total was then multiplied by the capital recovery factor for a 100-year project life at 8-1/2 percent interest to get the average annual amount. Adding these figures to the 1993 average annual content damage values resulted in estimated total annual damages to contents by reach for the period of analysis. Benefits for content damages prevented are calculated using these adjusted content value figures.

TABLE D-2.

ESTIMATED DAMAGE PROBABILITY DATA, ALTERNATIVES 1, 2, 3A, & 3B - 50 YEAR DESIGN WITHOUT FREEBOARD

($000)

		Exceedence Probability	Residential Damage			Nonresidential Damage		
			Structure	Contents	Total	Structure	Contents	Total
Reach 1:	Without Project	.100	0	0	0			
		.040	689	328	1,017			
		.020	1,080	606	1,686	(Residential development only in Reach 1.)		
		.010	1,189	676	1,865			
		.0035 (SPF)	1,692	962	2,654			
	With Project	.100	0	0	0			
		.040	1	0	1	(Residential development only in Reach 1.)		
		.020	1	0	1			
		.010	250	81	331			
		.0035 (SPF)	1,505	831	2,336			
Reach 2:	Without Project	.100	0	0	0	0	0	0
		.040	1,357	501	1,858	0	0	0
		.020	2,450	1,054	3,504	0	1	1
		.010	2,919	1,308	4,227	0	1	1
		.0035 (SPF)	5,549	2,831	8,380	38	14	52
	With Project	.100	0	0	0	0	0	0
		.040	6	1	7	0	0	0
		.020	11	2	13	0	0	0
		.010	492	155	647	0	0	0
		.0035 (SPF)	4,597	2,276	6,873	24	7	31
Reach 3:	Without Project	.100	0	0	0			
		.040	638	188	826			
		.020	1,216	478	1,694	(Residential development only in Reach 3.)		
		.010	1,360	551	1,911			
		.0035 (SPF)	3,460	1,463	4,923			
	With Project	.100	0	0	0			
		.040	0	0	0	(Residential development only in Reach 3.)		
		.020	1	0	1			
		.010	204	46	250			
		.0035 (SPF)	2,321	950	3,271			

TABL 3.

ESTIMATED DAMAGE PROBABILITY DATA, ALTERNATIVES 1, 2, 3A, & 3B - 50-YEAR DESIGN WITHOUT FREEBOARD

($000)

		Exceedence Probability	Residential Damage			Nonresidential Damage		
			Structure	Contents	Total	Structure	Contents	Total
Reach 4:	Without Project	.100	0	0	0	0	0	0
		.040	38	13	51	24	10	34
		.020	68	28	96	59	20	79
		.010	109	38	147	65	25	90
		.0035 (SPF)	416	149	565	101	91	192
	With Project	.100	0	0	0	0	0	0
		.040	0	0	0	0	0	0
		.020	0	0	0	0	0	0
		.010	13	2	15	0	2	2
		.0035 (SPF)	252	76	328	86	45	131
Reach 5:	Without Project	.100	0	0	0			
		.040	56	17	73			
		.020	95	35	130	(Residential development only in Reach 5.)		
		.010	113	43	156			
		.0035 (SPF)	188	77	265			
	With Project	.100	0	0	0			
		.040	0	0	0	(Residential development only in Reach 5.)		
		.020	0	0	0			
		.010	23	6	29			
		.0035 (SPF)	161	65	226			
Reach 6:	Without Project	.100	0	0	0			
		.040	215	43	258			
		.020	445	96	541	(Residential development only in Reach 6.)		
		.010	571	155	726			
		.0035 (SPF)	1,380	520	1,900			
	With Project	.100	0	0	0			
		.040	0	0	0	(Residential development only Reach 6.)		
		.020	0	0	0			
		.010	43	6	49			
		.0035 (SPF)	1,012	360	1,372			

TABLE D-4.

ESTIMATED DAMAGE PROBABILITY DATA, ALTERNATIVES 1, 2, 3A, & 3B - 50-YEAR DESIGN WITH FREEBOARD

($000)

			Residential Damage			Nonresidential Damage		
		Exceedence Probability	Structure	Contents	Total	Structure	Contents	Total
Reach 1:	Without Project	.100	0	0	0			
		.040	689	328	1,017			
		.020	1,080	606	1,686	(Residential development only in Reach 1.)		
		.010	1,189	676	1,865			
		.0035 (SPF)	1,692	962	2,654			
	With Project	.100	0	0	0			
		.040	1	0	1			
		.020	1	0	1	(Residential development only Reach 1.)		
		.010	1	0	1			
		.0035 (SPF)	646	303	949			
Reach 2:	Without Project	.100	0	0	0	0	0	0
		.040	1,357	501	1,858	0	0	0
		.020	2,450	1,054	3,504	0	1	1
		.010	2,919	1,308	4,227	0	1	1
		.0035 (SPF)	5,549	2,831	8,380	38	14	52
	With Project	.100	0	0	0	0	0	0
		.040	6	1	7	0	0	0
		.020	11	2	13	0	0	0
		.010	13	2	15	0	0	0
		.0035 (SPF)	1,253	459	1,712	0	0	0
Reach 3:	Without Project	.100	0	0	0			
		.040	638	188	826			
		.020	1,216	478	1,694	(Residential development only in Reach 3.)		
		.010	1,360	551	1,911			
		.0035 (SPF)	3,460	1,463	4,923			
	With Project	.100	0	0	0			
		.040	0	0	0			
		.020	1	0	1	(Residential development only in Reach 3.)		
		.010	3	0	3			
		.0035 (SPF)	590	172	762			

TAB[illegible]-5.

ESTIMATED DAMAGE PROBABILITY DATA, ALTERNATIVES 1, 2, 3A, & 3B - 50-YEAR DESIGN WITH FREEBOARD

($000)

	Exceedence Probability	Residential Damage			Nonresidential Damage		
		Structure	Contents	Total	Structure	Contents	Total
Reach 4: Without Project	.100	0	0	0	0	0	0
	.040	38	13	51	24	10	34
	.020	68	28	96	59	20	79
	.010	109	38	147	65	25	90
	.0035 (SPF)	416	149	565	101	91	192
With Project	.100	0	0	0	0	0	0
	.040	0	0	0	0	0	0
	.020	0	0	0	0	0	0
	.010	0	0	0	0	0	0
	.0035 (SPF)	33	11	44	18	8	26
Reach 5: Without Project	.100	0.	0	0	(Residential development only in Reach 5.)		
	.040	56	17	73			
	.020	95	35	130			
	.010	113	43	156			
	.0035 (SPF)	188	77	265			
With Project	.100	0	0	0	(Residential development only in Reach 5.)		
	.040	0	0	0			
	.020	0	0	0			
	.010	0	0	0			
	.0035 (SPF)	50	14	64			
Reach 6: Without Project	.100	0	0	0	(Residential development only in Reach 6.)		
	.040	215	43	258			
	.020	445	96	541			
	.010	571	155	726			
	.0035 (SPF)	1,380	520	1,900			
With Project	.100	0	0	0	(Residential development only in Reach 6.)		
	.040	0	0	0			
	.020	0	0	0			
	.010	0	0	0			
	.0035 (SPF)	177	35	212			

TABLE D-6.

ESTIMATED DAMAGE PROBABILITY DATA, ALTERNATIVES 1, 2, 3A, & 3B - 100-YEAR DESIGN WITHOUT FREEBOARD

($000)

		Exceedence Probability	Residential Damage			Nonresidential Damage		
			Structure	Contents	Total	Structure	Contents	Total
Reach 1:	Without Project	.100	0	0	0	(Residential development only in Reach 1.)		
		.040	689	328	1,017			
		.020	1,080	606	1,686			
		.010	1,189	676	1,865			
		.0035 (SPF)	1,692	962	2,654			
	With Project	.100	0	0	0	(Residential development only in Reach 1.)		
		.040	1	0	1			
		.020	1	0	1			
		.010	1	0	1			
		.0035 (SPF)	1,418	813	2,231			
Reach 2:	Without Project	.100	0	0	0	0	0	0
		.040	1,357	501	1,858	0	0	0
		.020	2,450	1,054	3,504	0	1	1
		.010	2,919	1,308	4,227	0	1	1
		.0035 (SPF)	5,549	2,831	8,380	38	14	52
	With Project	.100	0	0	0	0	0	0
		.040	6	1	7	0	0	0
		.020	11	2	13	0	0	0
		.010	13	2	15	0	0	0
		.0035 (SPF)	4,085	1,977	6,062	15	6	21
Reach 3:	Without Project	.100	0	0	0	(Residential development only in Reach 3.)		
		.040	638	188	826			
		.020	1,216	478	1,694			
		.010	1,360	551	1,911			
		.0035 (SPF)	3,460	1,463	4,923			
	With Project	.100	0	0	0	(Residential development only in Reach 3.)		
		.040	0	0	0			
		.020	1	0	1			
		.010	3	0	3			
		.0035 (SPF)	2,107	861	2,968			

TABL 7.

ESTIMATED DAMAGE PROBABILITY DATA, ALTERNATIVES 1, 2, 3A, & 3B - 100-YEAR DESIGN WITHOUT FREEBOARD

($000)

	Exceedence Probability	Residential Damage			Nonresidential Damage		
		Structure	Contents	Total	Structure	Contents	Total
Reach 4: Without Project	.100	0	0	0	0	0	0
	.040	38	13	51	24	10	34
	.020	68	28	96	59	20	79
	.010	109	38	147	65	25	90
	.0035 (SPF)	416	149	565	101	91	192
With Project	.100	0	0	0	0	0	0
	.040	0	0	0	0	0	0
	.020	0	0	0	0	0	0
	.010	0	0	0	0	0	0
	.0035 (SPF)	211	65	276	80	48	128
Reach 5: Without Project	.100	0	0	0	(Residential development only in Reach 5.)		
	.040	56	17	73			
	.020	95	35	130			
	.010	113	43	156			
	.0035 (SPF)	188	77	265			
With Project	.100	0	0	0	(Residential development only in Reach 5.)		
	.040	0	0	0			
	.020	0	0	0			
	.010	0	0	0			
	.0035 (SPF)	143	57	200			
Reach 6: Without Project	.100	0	0	0	(Residential development only in Reach 6.)		
	.040	215	43	258			
	.020	445	96	541			
	.010	571	155	726			
	.0035 (SPF)	1,380	520	1,900			
With Project	.100	0	0	0	(Residential development only in Reach 6.)		
	.040	0	0	0			
	.020	0	0	0			
	.010	0	0	0			
	.0035 (SPF)	886	301	1,187			

TABLE D-8.

ESTIMATED DAMAGE PROBABILITY DATA, ALTERNATIVES 1, 2, 3A, & 3B - 100-YEAR DESIGN WITH FREEBOARD & SPF DESIGN

($000)

			Residential Damage			Nonresidential Damage		
		Exceedence Probability	Structure	Contents	Total	Structure	Contents	Total
Reach 1:	Without Project	.100	0	0	0			
		.040	689	328	1,017			
		.020	1,080	606	1,686	(Residential development only in Reach 1.)		
		.010	1 189	676	1,865			
		.0035 (SPF)	1,692	962	2,654			
	With Project	.100	0	0	0			
		.040	1	0	1			
		.020	1	0	1	(Residential development only Reach 1.)		
		.010	1	0	1			
		.0035 (SPF)	96	31	127			
Reach 2:	Without Project	.100	0	0	0	0	0	0
		.040	1,357	501	1,858	0	0	0
		.020	2,450	1,054	3,504	0	1	1
		.010	2,919	1,308	4,227	0	1	1
		.0035 (SPF)	5,549	2,831	8,380	38	14	52
	With Project	.100	0	0	0	0	0	0
		.040	6	1	7	0	0	0
		.020	11	2	13	0	0	0
		.010	13	2	15	0	0	0
		.0035 (SPF)	172	41	213	0	0	0
Reach 3:	Without Project	.100	0	0	0			
		.040	638	188	826			
		.020	1,216	478	1,694	(Residential development only in Reach 3.)		
		.010	1,360	551	1,911			
		.0035 (SPF)	3,460	1,463	4,923			
	With Project	.100	0	0	0			
		.040	0	0	0			
		.020	1	0	1	(Residential development only in Reach 3.)		
		.010	3	0	3			
		.0035 (SPF)	85	16	101			

TABLE D-9.

ESTIMATED DAMAGE PROBABILITY DATA, ALTERNATIVES 1, 2, 3A, & 3B - 100-YEAR DESIGN WITH FREEBOARD & SPF DESIGN

($000)

			Residential Damage			Nonresidential Damage		
		Exceedence Probability	Structure	Contents	Total	Structure	Contents	Total
Reach 4:	Without Project	.100	0	0	0	0	0	0
		.040	38	13	51	24	10	34
		.020	68	28	96	59	20	79
		.010	109	38	147	65	25	90
		.0035 (SPF)	416	149	565	101	91	192
	With Project	.100	0	0	0	0	0	0
		.040	0	0	0	0	0	0
		.020	0	0	0	0	0	0
		.010	0	0	0	0	0	0
		.0035 (SPF)	0	0	0	0	0	0
Reach 5:	Without Project	.100	0	0	0			
		.040	56	17	73			
		.020	95	35	130	(Residential development only in Reach 5.)		
		.010	113	43	156			
		.0035 (SPF)	188	77	265			
	With Project	.100	0	0	0			
		.040	0	0	0			
		.020	0	0	0	(Residential development only in Reach 5.)		
		.010	0	0	0			
		.0035 (SPF)	8	1	9			
Reach 6:	Without Project	.100	0	0	0			
		.040	215	43	258			
		.020	445	96	541	(Residential development only in Reach 6.)		
		.010	571	155	726			
		.0035 (SPF)	1,380	520	1,900			
	With Project	.100	0	0	0			
		.040	0	0	0			
		.020	0	0	0	(Residential development only in Reach 6.)		
		.010	0	0	0			
		.0035 (SPF)	0	0	0			

TABLE D-10.
AVERAGE ANNUAL INUNDATION DAMAGES AND
INUNDATION DAMAGE REDUCTION BENEFITS FOR RESIDENTIAL
PROPERTIES, ALTERNATIVE 1, 2, 3A, & 3B - 50-YEAR DESIGN 1/
($000)

	Average Annual Damages					
		Contents				
	Structures 2/	1991 2/	1993 3/	1993-2093 4/	Total Structures and Contents 5/	Average Annual Inundation Damage Reduction Benefits 6/
50-Year Design						
Without Project						
Reach 1	63	33	34	39	102	
Reach 2	146	62	63	74	220	
Reach 3	74	27	28	33	107	
Reach 4	6	2	2	3	9	
Reach 5	6	2	2	2	8	
Reach 6	28	7	8	9	37	
TOTAL	323	133	137	160	483	
With Project						
Reach 1	8	4	4	4	12	90
Reach 2	20	9	9	11	31	189
Reach 3	10	4	4	4	14	93
Reach 4	1	0	0	0	1	8
Reach 5	1	0	0	0	1	7
Reach 6	4	1	1	1	5	32
TOTAL	44	18	18	20	64	419

1/ Oct. 1991 prices, 8-1/2% interest rate, and 100-year period of analysis, 1993-2093.

2/ From computing the trapezoidal areas under the damage-probability curves given by the damage-probability data in Tables D-2 through D-5.

3/ From multiplying 1991 figure by 1.02 to account for the effect of increasing real value of contents during period of analysis.

4/ From adding the amount attributed to affluence to the 1993 figure to account for the effect of increasing real value of contents during the period of analysis.

5/ Structure figures plus content figures for 1993-2093.

6/ Benefit equals damage without project less damage with project.

TABLE D-11.
AVERAGE ANNUAL INUNDATION DAMAGES AND
INUNDATION DAMAGE REDUCTION BENEFITS FOR RESIDENTIAL
PROPERTIES, ALTERNATIVE 1, 2, 3A, & 3B - 100-YEAR DESIGN1/
($000)

	Average Annual Damages					
		Contents			Total Structures and Contents5/	Average Annual Inundation Damage Reduction Benefits6/
	Structures2/	19912/	19933/	1993-2093 4/		
100-Year Design						
Without Project						
Reach 1	63	33	34	39	102	
Reach 2	146	62	63	74	220	
Reach 3	74	27	28	33	107	
Reach 4	6	2	2	3	9	
Reach 5	6	2	2	2	8	
Reach 6	28	7	8	9	37	
TOTAL	323	133	137	160	483	
With Project						
Reach 1	5	3	3	3	8	94
Reach 2	13	7	7	8	21	199
Reach 3	7	3	3	3	10	97
Reach 4	1	0	0	0	1	8
Reach 5	1	0	0	0	1	7
Reach 6	3	1	1	1	4	33
TOTAL	30	14	14	15	45	438

1/ Oct. 1991 prices, 8-1/2% interest rate, and 100-year period of analysis, 1993-2093.

2/ From computing the trapezoidal areas under the damage-probability curves given by the damage-probability data in Tables D-6 and D-9.

3/ From multiplying 1991 figure by 1.02 to account for the effect of increasing real value of contents during period of analysis.

4/ From adding the amount attributed to affluence to the 1993 figure to account for the effect of increasing real value of contents during the period of analysis.

5/ Structure figures plus content figures for 1993-2093.

6/ Benefit equals damage without project less damage with project.

TABLE D-12.
AVERAGE ANNUAL INUNDATION DAMAGES AND
INUNDATION DAMAGE REDUCTION BENEFITS FOR RESIDENTIAL
PROPERTIES, ALTERNATIVE 1, 2, 3A, & 3B - SPF DESIGN[1]
($000)

	Average Annual Damages					
		Contents			Total Structures and Contents[5]	Average Annual Inundation Damage Reduction Benefits[6]
	Structures[2]	1991[2]	1993[3]	1993-2093[4]		
SPF Design						
Without Project						
Reach 1	63	33	34	39	102	
Reach 2	146	62	63	74	220	
Reach 3	74	27	28	33	107	
Reach 4	6	2	2	3	9	
Reach 5	6	2	2	2	8	
Reach 6	28	7	8	9	37	
TOTAL	323	133	137	160	483	
With Project						
Reach 1	1	0	0	0	1	101
Reach 2	2	0	0	0	2	218
Reach 3	1	0	0	0	1	106
Reach 4	0	0	0	0	0	9
Reach 5	0	0	0	0	0	8
Reach 6	0	0	0	0	0	37
TOTAL	4	0	0	0	4	479

1/ Oct. 1991 prices, 8-1/2% interest rate, and 100-year period of analysis, 1993-2093.

2/ From computing the trapezoidal areas under the damage-probability curves given by the damage-probability data in Tables D-8 and D-9.

3/ From multiplying 1991 figure by 1.02 to account for the effect of increasing real value of contents during period of analysis.

4/ From adding the amount attributed to affluence to the 1993 figure to account for the effect of increasing real value of contents during the period of analysis.

5/ Structure figures plus content figures for 1993-2093.

6/ Benefit equals damage without project less damage with project.

TABLE D-13.
AVERAGE ANNUAL INUNDATION DAMAGES AND
INUNDATION DAMAGE REDUCTION BENEFITS FOR NONRESIDENTIAL
PROPERTIES, ALTERNATIVE 1, 2, 3A, & 3B - 50-YEAR DESIGN
($000)

	Average Annual Damages1/			Average Annual Benefits2/
	Structures	Contents	Total	
50-Year Design				
Without Project				
Reach 2	0	0	0	
Reach 4	3	1	4	
TOTAL	3	1	4	
With Project				
Reach 2	0	0	0	0
Reach 4	0	0	0	4
TOTAL	0	0	0	4

1/ From computing the trapezoidal areas under the damage-probability curves given by the damage-probability data in Tables D-2 and D-4.

2/ Damages without project less damages with project.

TABLE D-14.
AVERAGE ANNUAL INUNDATION DAMAGES AND
INUNDATION DAMAGE REDUCTION BENEFITS FOR NONRESIDENTIAL
PROPERTIES, ALTERNATIVE 1, 2, 3A, & 3B - 100-YEAR DESIGN
($000)

	Average Annual Damages 1/			Average Annual Benefits 2/
	Structures	Contents	Total	
100-Year Design				
Without Project				
Reach 2	0	0	0	
Reach 4	3	1	4	
TOTAL	3	1	4	
With Project				
Reach 2	0	0	0	0
Reach 4	0	0	0	0
TOTAL	0	0	0	4

1/ From computing the trapezoidal areas under the damage-probability curves given by the damage-probability data in Tables D-6 and D-8.

2/ Damages without project less damages with project.

TABLE D-15.
AVERAGE ANNUAL INUNDATION DAMAGES AND
INUNDATION DAMAGE REDUCTION BENEFITS FOR NONRESIDENTIAL
PROPERTIES, ALTERNATIVE 1, 2, 3A, & 3B - SPF DESIGN
($000)

	Average Annual Damages 1/			Average Annual Benefits 2/
	Structures	Contents	Total	
SPF Design				
Without Project				
Reach 2	0	0	0	
Reach 4	3	1	4	
TOTAL	3	1	4	
With Project				
Reach 2	0	0	0	0
Reach 4	0	0	0	0
TOTAL	0	0	0	4

1/ From computing the trapezoidal areas under the damage-probability curves given by the damage-probability data in Table D-8.

2/ Damages without project less damages with project.

4. OTHER BENEFITS

a. Automobile Damage Reduction Benefits.

In a predominantly residential area like Coconut Grove, prevention of automobile damages can also be a major source of benefits. From a sample of 196 claims to the City & County of Honolulu made by residents who suffered damages from the 1988 New Years flood, 127 of them reported damages to their automobiles as a separate item. The ratio of the dollar value of these car damages to total dollar damages claimed comes to 13 percent. Assuming this ratio holds throughout the flood plain for the average damageable property, multiplying it by the total average annual damages for the entire flood plain gives the average annual damage for automobiles.

$$.13 \times \$480,000 = \$62,400.$$

Applying the same ratio to the average annual damages of the different reaches without and with the four alternatives gives the following table of average annual automobile damage reduction benefits:

TABLE D-16.
AUTOMOBILE AVERAGE ANNUAL DAMAGE REDUCTION BENEFITS

	Automobile Damages ($000)	Average Annual Benefits ($000)
Without Project		
Reach 1	13	
Reach 2	29	
Reach 3	14	
Reach 4	1	
Reach 5	1	
Reach 6	5	
With Alt. 1, 2, 3A, or 3B 50-yr. Design		
Reach 1	2	11
Reach 2	4	25
Reach 3	2	12
Reach 4	0	1
Reach 5	0	1
Reach 6	1	4
TOTAL		54
With Alt. 1, 2, 3A, or 3B 100-yr. Design		
Reach 1	1	12
Reach 2	3	26
Reach 3	1	13
Reach 4	0	1
Reach 5	0	1
Reach 6	1	4
TOTAL		57

TABLE D-16. (CONT.)
AUTOMOBILE AVERAGE ANNUAL DAMAGE REDUCTION BENEFITS

With Alt. 1, 2, 3A, or 3B SPF Design	Automobile Damages ($000)	Average Annual Benefits ($000)
Reach 1	0	13
Reach 2	0	29
Reach 3	0	14
Reach 4	0	1
Reach 5	0	1
Reach 6	0	5
TOTAL		63

b. Yard Damage Reduction Benefits.

Besides damages to automobiles, structures, and contents, the residents of Coconut Grove also had to deal with damages to their yards after the 1988 New Years flood. The water coming over the levee not only covered the yards of those homes which were damaged, but deposited mud, grasses from the marsh, seeds, and other debris on the yards as well. Estimating it would take four man-days to rejuvenate a yard from immediate and long-term flood damage, at $10 per hour, total clean-up cost comes to approximately $300 a yard. The number of yards affected by different magnitude floods was determined using a map with contour lines and estimated flood boundaries. Damages without a project were calculated from this map and are as follows:

FREQUENCY (YEARS)	NUMBER OF YARDS DAMAGED	DAMAGES ($000)
10	0	0
25	680	204
50	1,138	341
100	1,261	378
SPF	2,280	684

Given this data the average annual damage was calculated and came to approximately $20,600. The ratio of the average annual yard damage to the total average annual damage for the 1988 New Years storm was than estimated and used to estimate the average annual benefits from yard damage reduction. This ratio equaled .0429 and was used to complete the following table:

TABLE D-17.
YARD DAMAGE REDUCTION BENEFITS

Without Project	Yard Damages ($000)
Reach 1	4
Reach 2	9
Reach 3	5
Reach 4	0
Reach 5	0
Reach 6	2
TOTAL	20

TABLE 17. (CONT.)
YARD DAMAGE REDUCTION BENEFITS

With Alt. 1, 2, 3A, or 3B 50-yr. Design	Yard Damages ($000)	Average Annual Benefits ($000)
Reach 1	1	3
Reach 2	1	8
Reach 3	1	4
Reach 4	0	0
Reach 5	0	0
Reach 6	0	2
TOTAL	3	17

With Alt. 1, 2, 3A, or 3B 100-yr. Design	Yard Damages ($000)	Average Annual Benefits ($000)
Reach 1	0	4
Reach 2	1	8
Reach 3	0	5
Reach 4	0	0
Reach 5	0	0
Reach 6	0	2
TOTAL	1	19

With Alt. 1, 2, 3A, or 3B SPF Design	Yard Damages ($000)	Average Annual Benefits ($000)
Reach 1	0	4
Reach 2	0	9
Reach 3	0	5
Reach 4	0	0
Reach 5	0	0
Reach 6	0	2
TOTAL	0	20

c. Emergency Assistance Cost Reduction Benefits.

The reduction or elimination of emergency assistance costs can also be counted as a benefit of providing flood protection near the Coconut Grove subdivision. With a new Corps project providing more protection for Coconut Grove, savings would come from the reduction in the need for a variety of services that are necessary during and after a flood. An average annual benefit for emergency cost savings can be computed based on that reduction in need. According to the Post Flood Report for the 1988 New Years flood, Waimanalo and Coconut Grove together had $1,751,000 in debris removal, emergency protection, clean up of miscellaneous utilities, and other cost. Emergency Management Division personnel estimate that the Coconut Grove area had 75 percent of the affected area in this portion of the island. Applying this ratio to the total cost for both Waimanalo and Coconut Grove allocated $1,313,000 to the Kawainui flooding.

Other costs were also incurred during the 1988 New Years flood. The total county expenditure on inmate labor ($5,000), traffic control and bus evacuation ($7,000), Fire Department ($11,000), and Police Department ($31,000) came to $54,000. Based on the ratio of total Coconut Grove evacuees to total county evacuees (42 percent), $23,000 of the total was allocated to the Kawainui flooding.

The Salvation Army also provided assistance throughout the county during and after the flood. Expenditures by the Salvation Army throughout the county came to $349,000. Of this total, 42 percent or $147,000 was allocated to the evacuees of the Coconut Grove area.

Another emergency response organization, the Red Cross, provided $725,000 in aid to 831 families in the county which included evacution and relocation. Using the 42-percent ratio of Coconut Grove evacuees to total county evacuees, the share of the total allocated to the flooding caused by Kawainui marsh came to $305,000.

After the flood, a number of federal agencies contributed to the relief effort. The Federal Emergency Management Administration provided $815,000 in temporary housing grants. Using the 42-percent share, Kawainui flood victims received $342,000. The Air Force, Marines, Navy, and National Guard helped with the clean-up effort at an estimated cost of $150,000. Coconut Grove's share of that total, based on its 42 percent share of evacuees, came to $113,000.

The total of these six emergency relief services came to $2,243,000 in 1989 dollars. To convert this figure to 1991 dollars, the Consumer Price Index-All Urban Consumers (CPI-U) was used. The increase in the CPI-U from 1989 to August 1991 (latest available data) was 10.1 percent. Increasing the 1989 emergency cost figure of $2,243,000 by 10.1 percent gave the emergency cost, in 1991 dollars, of $2,469,543.

To determine the average annual cost using this figure, it is necessary to estimate the number of houses flooded in the 1988 New Years storm. After analyzing the structure inventory data base it was determined that 730 homes had water in them above the first floor. Dividing the total cost for emergency relief services by the estimated number of homes with water over the first floor gave a per structure emergency assistance cost of $3,383. Using the estimated water surface elevations for different magnitude storms and the data base of first floor elevations for homes in the Coconut Grove area, the following frequency-emergency assistance cost table was derived:

TABLE D-18.
FREQUENCY-EMERGENCY COST DATA

FLOOD	NO. OF UNITS	COST ($)
25-YR.	371	1,255,093
50-YR.	622	2,104,226
100-YR.	709	2,398,547
SPF	1,160	3,924,280

It is assumed that none of the homes get water over the first floor during storms of less than 25-year magnitude and do not require emergency assistance.

Using this frequency-emergency assistance cost table, the average annual cost for emergency assistance came to $127,000.

To determine the average annual damages and benefits by reach, a tally was taken of the structures in the flood plain that would be affected by different flood heights. Once calculated, the number of homes in each reach were multiplied by the estimated average emergency cost per affected structure of $3,383 to come up with a frequency-cost table. From this table, the average annual emergency cost was computed for the without project condition and the with project conditions both including (WF) and excluding (NF) freeboard. Table D-19 gives the results of these computations:

TABLE D-19.
EMERGENCY AVERAGE ANNUAL COSTS
($000)

		With Project				
		50-yr.		100-yr.		SPF
Reach	Without Project	NF	WF	NF	WF	
1	35	7	3	4	2	2
2	51	12	3	9	2	2
3	27	6	2	4	1	1
4	7	1	0	1	0	0
5	2	0	0	0	0	0
6	5	2	0	1	0	0
TOTAL	127	28	8	19	5	5

From this table, total residual average annual costs were obtained and compared with the average annual costs of the without project conditions to come up with the average annual benefits from emergency cost reductions found in Table D-20.

TABLE D-20.
AVERAGE ANNUAL EMERGENCY COST REDUCTION BENEFITS

	Average Annual Cost ($000)					
	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6
Without Project	35	51	27	7	2	5
Alt. 1, 2, 3A, or 3B						
50-yr. Design	5	8	4	1	0	1
100-yr. Design	3	6	3	1	0	1
SPF Design	2	2	1	0	0	0

TABLE D-20. (CONT.)
AVERAGE ANNUAL EMERGENCY COST REDUCTION BENEFITS

	Average Annual Benefits ($000)					
	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6
Alt. 1, 2, 3A, or 3B						
50-yr. Design	30	43	23	6	2	4
100-yr. Design	32	45	24	6	2	4
SPF Design	33	49	26	7	2	5

Total average annual benefits for Alternatives 1, 2, 3A, & 3B from emergency cost reduction comes to $108,000 for the 50-year designs, $113,000 for the 100-year designs, and $122,000 for the SPF designs. As directed by the ER 1105-2-100, these calculations take one-half of the benefits from including freeboard as part of the 50- and 100-projects.

d. Flood Insurance Operating Cost Reduction Benefits.

A reduction in the operating cost of the National Flood Insurance Program can be claimed as benefits of flood control projects. By decreasing the size of the 100-year flood plain, a Corps project in Coconut Grove will reduce the number of homes that will require coverage for flood damages and, thus, the operating and administration costs to process those policies.

The present FIRM map for Coconut Grove assumes that it is protected by the levee. This is no longer true, so the present map is inaccurate. For this reason, the 100-year flood plain calculated during this study was used instead of the FIRM map's 100-year flood plain.

To measure this savings in operating cost, the number of homes in the 100-year flood plain without project and the 100-year flood plain with project was determined. A structure-to-area ratio was first computed and then applied to the flood plains under the different alternatives. Without a project, there would be 1,668 structures in the 100-year flood plain. With a 100-year project in place, the 100-year flood plain would shrink and there would be just 273 structures that must be insured. The difference in the number of structures without a project and those with a 100-year project represent a savings in operating cost to the National Flood Insurance Program. According to the Economic Guidance Memorandum Number 90-2, the savings equals $79 per policy per year. Using these numbers, the savings in operating cost can be computed.

Without Project Condition:	1,668 structures
100-Year Project Condition:	- 273 structures
	1,395 structures

1,395 X $79 = $110,205 (annual operating cost reduction)

Typically in Hawaii, only about 48 percent of the homes in the

100-year flood plain are insured. Adjusting the annual operating cost reduction by this percentage gives the total benefits claimed of $52,898. Hence, the average annual benefit for flood insurance operating cost savings for the 100-year level of protection by reach is as follows:

TABLE D-21.
FLOOD INSURANCE OPERATING COST SAVINGS BENEFIT

Reach 1:	$ 2,086
Reach 2:	$16,002
Reach 3:	$19,074
Reach 4:	$ 2,237
Reach 5:	$ 796
Reach 6:	$12,703

The 50-year project was not considered because according to the Federal Emergency Management Agency's Flood Insurance Study Guidelines and Specifications for Study Contractors, a 50-year project is considered substandard to affect the 100-year flood plain and is ignored. Only projects designed to provide a 100-year level of protection have an impact on the Flood Insurance Rate Map.

e. Restoration of Market Performance Benefits.

Major floods, or the threat of major floods, can have an adverse effect on the real estate value of properties within a flood plain. Home-owners incur losses, in addition to inundation damages, when they are not able to realize the full potential growth in the value of their property due to the threat of flooding. According to the ER 1105-2-100, the restoration of this land market value can be claimed as a benefit of a Corps flood control project.

Interviews with real estate agents show that the threat of flooding remains a dominant issue in Coconut Grove. All of the real estate agents contacted disclose the threat of flooding to their clients interested in Coconut Grove. The real estate agents also strongly suggest that buyers purchase flood insurance even if the homes are not in the 100-year flood plain as delineated in the Flood Insurance Rate Map. Due to these disclosures and suggestions, the threat of flooding is constantly being reinforced in the minds of home-owners and home-buyers.

While buyers continue to be interested in Coconut Grove, there is evidence that the threat of flooding is affecting the price performance in the area. In Oahu's robust real estate market, the threat of flooding is causing a lag in market performance for Coconut Grove in comparison with other residential neighborhoods.

There is little consensus among real estate agents as to the magnitude of the lag in market performance in Coconut Grove. The estimates of those interviewed ranged from 0 to 35 percent. That is, some of the real estate agents estimated that there has been no effect on the prices in Coconut Grove. Others estimated prices being as much as 35 percent lower than what they would be without the flood threat. Taking the median as a compromise between opposing views, the lag in market performance estimated from these interviews came to 18 percent.

A real estate researcher who tracks sales performance of different areas on Oahu has also noticed an impact on Coconut Grove since the 1988 New Years storm. While the average resale price of residential properties in Coconut Grove appreciated by 41 percent between 1987 and 1989, the average resale values in other communities in Kailua and other similarly priced neighborhoods on Oahu went up by 50 or 60 percent. After analyzing these trends, the real estate researcher believes that, without the threat of flooding, the resale price performance in Coconut Grove would have been more in line with these other neighborhoods. The owners of Coconut Grove property have suffered at least a nine percent lag in market performance.

A more detailed analysis shows that the lag in market performance varies depending on the neighborhoods compared. A comparison was done between Coconut Grove average resale prices and those from two neighborhoods geographically close to Coconut Grove, but not in the same price range. Another comparison between Coconut Grove and four similarly priced neighborhoods in other parts of Oahu was also done. In both cases, price performances before and after the flood were looked at for the different neighborhoods. From 1984 to 1987, the pre-flood time period, Coconut Grove prices increased by 24 percent. The average resale prices in the two neighborhoods near Coconut Grove increased by 7 and 24 percent. During the same time period, prices in the similarly priced neighborhoods in other parts of Oahu increased by 0, 4, 13, and 13 percent to Coconut Grove's 24 percent. Prior to the 1988 New Years flood, price increases in Coconut Grove either kept pace, or were well ahead, of those in the other neighborhoods.

The data shows this changed after the New Years flood. Between 1988 and the beginning of 1990, Coconut Grove prices rose by 53 percent. Prices in the two neighborhoods near Coconut Grove increased by 57 percent and 69 percent during that time. Prices in the four similarly priced neighborhoods in other parts of Oahu increased by 52, 62, 62, and 72 percent. A comparison of these price changes show that Coconut Grove increases have lagged behind those in other neighborhoods since the 1988 New Years flood.

Taking the averages of the changes in the prices of the different neighborhoods, during the two time periods, and comparing them with Coconut Grove price changes show the extent of the lag which has occurred. Prior to the flood, Coconut Grove's price changes outperformed those of the two neighborhoods close to Coconut Grove 24 percent to 18 percent. After the threat of flooding became apparent, the increase in Coconut Grove prices fell behind 53 percent to 63 percent. Coconut Grove's price performance had gone from six percent ahead to ten percent behind, a difference of 16 percentage points. Comparisons with the four similarly priced neighborhoods that are not geographically close to Coconut Grove show Coconut Grove's price performance had gone from outpacing the average growth of the four neighborhoods by 16 percent to falling behind by nine percent. That is a total swing of 25 percentage points.

Depending of the source of information, the data shows the lag in the Coconut Grove price performance is between 9 percent and 25 percent. Given the fact that there are other factors affecting the price performance of different neighborhoods, the estimate made by the real estate researcher of a nine percent lag was deemed a conservative one and used in the calculation of this benefit.

To calculate a measure of loss caused by this lag in market performance, the change in Coconut Grove's average resale price of $157,791 from 1987 to 1989 at 41 percent and 50 percent was compared.

$157,791 X 1.41 = $222,556
$157,791 X 1.50 = $236,687

The difference between the actual appreciation from 1987 and 1989 and what would have happened if Coconut Grove appreciated at the same rate as other similar neighborhoods is $14,131. Adjusting this amount by the national CPI-U measure of inflation from 1989 through to August 1991 of 10.1 percent gives a 1991 value of approximately $15,600.

Next, the average annual damage per structure was computed for each reach by dividing the total average annual inundation damage by the number of units in each reach that might be flooded in Coconut Grove. These results were then divided by the capital recovery factor for a 100-year project at 8-1/2 percent to bring it back to the present.

Reach	Capitalized Damage per Structure
1	63,000/147 = 428/.08502 = 5,034
2	146,000/548 = 266/.08502 = 3,129
3	74,000/296 = 250/.08502 = 2,940
4	6,000/52 = 115/.08502 = 1,353
5	6,000/15 = 400/.08502 = 4,705
6	28,000/102 = 275/.08502 = 3,235

These capitalized damages were then subtracted out of the difference in market performance to prevent double counting the actual structural damage already accounted for under inundation damages. The remaining amount is the loss due to under-performance of market value growth in Coconut Grove. Multiplying these figures by the number of homes in each reach and then applying the capital recovery factor of .08502 gives the average annual benefits from restoration of market performance displayed in Table D-22.

TABLE D-22.
RESTORATION OF MARKET PERFORMANCE BENEFITS

Reach	Value Restored
1	$132,000
2	$581,000
3	$319,000
4	$63,000
5	$14,000
6	$107,000
TOTAL	$1,216,000.

III. BENEFIT-COST SUMMARY

A summary of benefits by reach for the four alternatives is shown in Tables D-23 through D-25.

A summary of average annual benefits, costs and two measures of feasibility, the B/C ratio and net benefits, are tabulated in Table D-26 for the four alternatives.

TABLE D-23.
BENEFIT SUMMARY BY REACH ALTERNATIVES 1, 2, 3A, & 3B 50-YEAR DESIGN
($000)

	Average Annual Benefits						
	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Total
Inundation Reduction							
Residential							
Structure	55	126	64	5	5	24	279
Contents	35	63	29	3	2	8	140
Non-Residential							
Structure	--	0	--	3	--	--	3
Contents	--	0	--	1	--	--	1
Automobile	11	25	12	1	1	4	54
Yard	3	8	4	0	0	2	17
Emergency	30	43	23	6	2	4	108
TOTAL	134	265	132	19	10	42	602

TABLE D-24.
BENEFIT SUMMARY BY REACH ALTERNATIVES 1, 2, 3A, & 3B 100-YEAR DESIGN
($000)

	Average Annual Benefits						
	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Total
Inundation Reduction							
Residential							
Structure	58	133	67	5	5	25	293
Contents	36	66	30	3	2	8	145
Non-Residential							
Structure	--	0	--	3	--	--	3
Contents	--	0	--	1	--	--	1
Automobile	12	26	13	1	1	4	57
Yard	4	8	5	0	0	2	19
Emergency	32	45	24	6	2	4	113
Flood Insurance Cost	2	16	19	2	1	13	53
Market Restoration	132	581	319	63	14	107	1,216
TOTAL	276	875	477	84	25	163	1,900

TABLE D-25.
BENEFIT SUMMARY BY REACH ALTERNATIVES 1, 2, 3A, & 3B SPF DESIGN
($000)

	Average Annual Benefits						
	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Total
Inundation Reduction							
Residential							
Structure	62	144	73	6	6	28	319
Contents	39	74	33	3	2	9	160
Non-Residential							
Structure	--	0	--	3	--	--	3
Contents	--	0	--	1	--	--	1
Automobile	13	29	14	1	1	5	63
Yard	4	9	5	0	0	2	20
Emergency	33	49	26	7	2	5	122
Flood Insurance Cost	2	16	19	2	1	13	53
Market Restoration	132	581	319	63	14	107	1,216
TOTAL	285	902	489	86	26	169	1,957

TABLE D-26.1/

SUMMARY OF ANNUALIZED NED BENEFITS AND COSTS FOR ALTERNATIVES 1 & 2

Applicable Discount Rate: 8-1/2 percent.

	Alternative					
	1			2		
Flood Hazard Reduction Benefits	50-Yr.	100-Yr.	SPF	50-Yr.	100-Yr.	SPF
Inundation						
Residential						
Structure	279	293	319	279	293	319
Contents	140	145	160	140	145	160
Non-Residential						
Structure	3	3	3	3	3	3
Contents	1	1	1	1	1	1
Automobile Damages	54	57	63	54	57	63
Yard Damages	17	19	20	17	19	20
Emergency	108	113	122	108	113	122
Flood Insurance Cost	--	53	53	--	53	53
Market Restoration	--	1,216	1,216	--	1,216	1,216
Total Benefits (B)	602	1,900	1,957	602	1,900	1,957
Project Cost (C)	973	1,199	1,968	755	876	1,284
B/C Ratio	.62	1.58	0.99	.80	2.17	1.52
Net Benefits	(371)	701	(11)	(153)	1,024	673

1/ Table D-23 is required by Federal Regulations to be displayed. See ER 1105-2-100.

TABLE D-26.[1/] (CONT.)
SUMMARY OF ANNUALIZED NED BENEFITS AND COSTS
FOR ALTERNATIVES 3A & 3B

Applicable Discount Rate: 8-1/2 percent.

	Alternative					
	3A			3B		
	50-Yr.	100-Yr.	SPF	50-Yr.	100-Yr.	SPF
Flood Hazard Reduction Benefits						
Inundation						
Residential						
Structure	279	293	319	279	293	319
Contents	140	145	160	140	145	160
Non-Residential						
Structure	3	3	3	3	3	3
Contents	1	1	1	1	1	1
Automobile Damages	54	57	63	54	57	63
Yard Damages	17	19	20	17	19	20
Emergency	108	113	122	108	113	122
Flood Insurance Cost	--	53	53	--	53	53
Market Restoration	--	1,216	1,216	--	1,216	1,216
Total Benefits (B)	602	1,900	1,957	602	1,900	1,957
Project Cost (C)	908	1,028	1,718	1,124	1,267	2,083
B/C Ratio	.66	1.85	1.14	.54	1.50	0.94
Net Benefits	(306)	872	239	(522)	633	(126)

1/ Table D-23 is required by Federal Regulations to be displayed. See ER 1105-2-100.

IV. REQUIRED TABLES

U.S. Water Resources Council procedures require the display of four specific information tables in flood control study reports conducted by federal agencies. One of these displays is in Table D-26. Tables D-27 through D-29 below are the other three, and contain information on residual damages (damages with a project in place), damages without a project, and the number of structures in the flood plain without a project and with each of the four alternatives.

TABLE D-27.1/
AVERAGE ANNUAL RESIDUAL FLOOD DAMAGES BY DECADE
($000)

Applicable Discount Rate: 8-1/2 percent.

	Time Period2/						
Project	P0	P10	P20	P40	P50	P100	AAE3/
Alt. 1, 2, 3A, & 3B							
50-Yr. Design	62	64	66	71	74	75	64
100-Yr. Design	44	46	47	51	53	54	45
SPF Design	4	4	4	4	4	4	4

1/ Required by ER 1105-2-100.
2/ P10, P20, etc., denote the 10th and 20th years of project life, respectively.
3/ AAE=average annual equivalent.

TABLE D-28.1/
AVERAGE ANNUAL FLOOD DAMAGES BY DECADE WITHOUT PROJECT
($000)

Applicable Discount Rate: 8-1/2 percent.

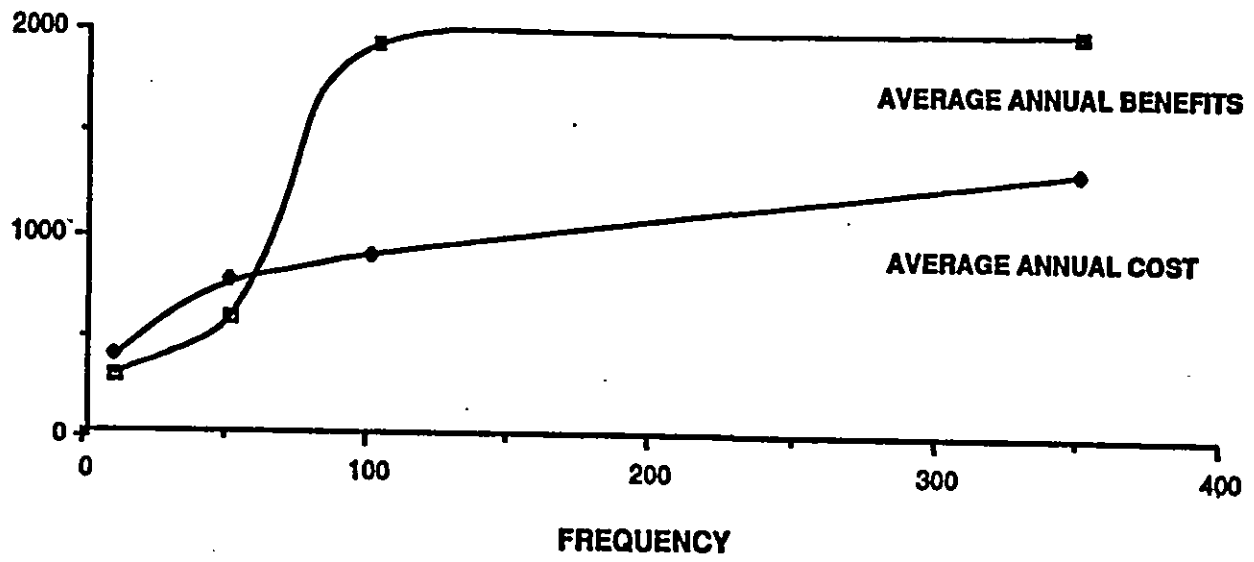
				Time Period2/					
	Existing	P0	P10	P20	P30	P40	P50	P100	AAE3/
Property Type									
Residential									
Structure	323	323	323	323	323	323	323	323	323
Contents4/	133	137	150	166	183	202	223	232	160
Non-Residential									
Structure	3	3	3	3	3	3	3	3	3
Contents	1	1	1	1	1	1	1	1	1
	460	464	477	493	510	529	550	559	487

1/ Required by ER 1105-2-100.
2/ P10, P20, denote the 10th and 20th years of project life, respectively.
3/ AAE = average annual equivalent.
4/ Increase is due to growth in contents damages through P54.

TABLE D-29.1/
NUMBER OF STRUCTURES IN THE FLOOD PLAIN

Condition	Existing	P0	P10	P20	P30	P40	P50	P100
	Structures Time Periods2/							
Without Project	1,961	1,961	1,961	1,961	1,961	1,961	1,961	1,961
Alt. 1, 2, 3A, & 3B								
50-Yr. Design	1,961	1,961	1,961	1,961	1,961	1,961	1,961	1,961
100-Yr. Design	1,961	1,961	1,961	1,961	1,961	1,961	1,961	1,961
SPF Design	1,961	1,961	1,961	1,961	1,961	1,961	1,961	1,961

1/ Required by ER 1105-2-100.
2/ P10, P20, etc., denote the 10th and 20th years of project life, respectively.



Level of Protection	Average Annuals ($000) Benefits	Costs	Net
50-Yr.	602	755	(153)
100-Yr.	1,900	876	1,024
SPF	1,957	1,284	673

Optimization occurs at the 100-year level of protection. At that level the distance between the average annual benefit and cost curves is maximized.

KAWAINUI MARSH OAHU, HAWAII

PLAN 2: OPTIMIZATION

US ARMY ENGINEER DISTRICT, HONOLULU

KAWAINUI MARSH
FLOOD CONTROL PROJECT
OAHU, HAWAII

APPENDIX E - ENVIRONMENTAL APPENDIX

KAWAINUI MARSH FLOOD CONTROL PROJECT
OAHU HAWAII
APPENDIX E
ENVIRONMENTAL APPENDIX
TABLE OF CONTENTS

KAWAINUI MARSH
FLOOD CONTROL PROJECT
OAHU, HAWAII

COMPLIANCE DOCUMENTS

TABLE E-1. STATUS OF COMPLIANCE WITH ENVIRONMENTAL STATUTES

Notes: The compliance categories used in this table were assigned based on the following definitions:

1. Full = Full compliance. All requirements of the statute or regulation have been met to the extent required by law at this stage of the project.
2. PC = Partial compliance. Some requirements of the statutue or regulation remain to be met.
3. NC = Noncompliance. None of the requirements of the statutue or regulation have been met.
4. NA = Not applicable. Statute or regulation not applicable.

Federal Environmental Laws	Compliance Status
American Folklore Preservation Act	NA
Anadromous Fish Conservation Act	NA
Antiquities Act 1906	NA
Archaeological Resources Protection Act	Full
Bald Eagle Act	NA
Clean Air Act	Full
Clean Water Act, 1977	PC
Section 401 (water qual)	PC
Section 404 (dredge fill)	PC
Coastal Zone Management Act	PC
Endangered Species Act (Section 7)	Full
Estuaries Protection Act	Full
Federal Environmental Pesticide Control Act	Full
Federal Water Project Recreation Act	Full
Fish and Wildlife Coord. Act (2b)	PC
Historic Sites Act	Full

Land and Water Conservation Fund Act	Full
Marine Mammal Protection Act	NA
Marine Protection, Research and Sanctuaries Act	Full
Migratory Bird Treaty Act	NA
National Environmental Policy Act	Full
Native American Religious Freedom Act	NA
National Historic Preservation Act: Section 106	Full
Resource Conservation and Recovery Act	Full
River & Harbor Act of 1899	NA
Submerged Lands Act	NA
Surface Mining Control and Reclamation Act	NA
Toxic Substances Control Act	NA
Watershed Protection and Flood Protection Act	Full
Wild and Scenic Rivers Act	NA

Presidential Executive Orders	**Compliance Status**
11514- Protection and Enhancement of Environmental Quality	Full
11593- Protection and Enhancement of the Cultural Environment	Full
11988-Floodplain Management	Full

11990- Protection of Wetlands	Full	
120880- Federal Compliance with Pollution Control Standards	Full	
State & County Environmental Laws	**Compliance Status**	**Agency Coord.**
Conservation District Use Application(CDUA)	PC	State Board of Land & Natural Resources
Stream Channel Authorization	PC	Concurrent with CDUA
Shoreline Management Area	PC	City & County Dept. of Land Util.
State EIS Law Full (Chapter 343 HRS)	Full	City and County Coord.
Historic Preservation (Chapter 6E HRS)	Full	State Board of Land & Natural Resources

KAWAINUI MARSH
FLOOD CONTROL PROJECT
OAHU, HAWAII

US FISH AND WILDLIFE COORDINATION

United States Department of the Interior
FISH AND WILDLIFE SERVICE
PACIFIC ISLANDS OFFICE
P.O. BOX 50167
HONOLULU, HAWAII 96850

12 JUL 1991

Lieutenant Colonel James T. Muratsuchi
U.S. Army Engineer District, Honolulu
Building 230
Fort Shafter, Hawaii 96858-5440

Re: Kawainui Marsh Flood Control Project, Kailua, Oahu

Dear Lieutenant Colonel Muratsuchi:

Enclosed is the U.S. Fish and Wildlife Services's draft Coordination Act Report for the Kawainui Marsh Flood Control Project. This report has been prepared in accordance with Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and other authorities mandating Department of the Interior concern for environmental values. This report is also consistent with the intent of the National Environmental Policy Act. The purpose of this report is to advise you and your staff of significant fish and wildlife resources within the study area and to make recommendations to avoid and mitigate adverse impacts to these resources.

This report does not fully satisfy the requirements of Section 2(b) of the Fish and Wildlife Coordination Act. Our final report shall include the recommendations from the Hawaii Department of Land and Natural Resources.

We look forward to working with your staff in completing the final report for the Kawainui Marsh Flood Control Project.

Sincerely,

Robert P. Smith

Robert P. Smith
Field Supervisor
Pacific Islands Office

Enclosure

cc: Planning Division

CEPOD-ED-P

18

PY

United States Department of the Interior

FISH AND WILDLIFE SERVICE
PACIFIC ISLANDS OFFICE
P.O. BOX 50167
HONOLULU, HAWAII 96850

12 JUL 1991

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: Kawainui Marsh Flood Control Project, Kailua, Oahu

Dear Mr. Paty:

Enclosed for your review and comment is a copy of the U.S. Fish and Wildlife Service's draft Coordination Act Report for the Kawainui Marsh Flood Control Project. This report has been prepared in accordance with Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 _et seq._) and other authorities mandating Department of the Interior concern for environmental values. U.S. Fish and Wildlife Service policy requires review and concurrence from the state natural resource agency and the inclusion of the recommended changes and concurrence in our final report to the U.S. Army Corps of Engineers.

We would appreciate receiving your comments at your earliest convenience.

Sincerely,

Robert P. Smith

Robert P. Smith
Field Supervisor
Pacific Islands Office

Enclosure

cc: U.S. Army Corps of Engineers ✓

390

JOHN WAIHEE
GOVERNOR OF HAWAII

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

DEPUTIES
KEITH W. AHUE
MANABU TAGOMORI
DAN T. KOCHI

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

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

In reply, please refer to:
REF: DOFAW

DOFAW

August 28, 1991

Dr. Robert P. Smith
Field Supervisor
Pacific Islands Office
USDI-Fish and Wildlife Service
P.O. Box 50167
Honolulu, Hawaii 96850

Dear Dr. Smith:

This responds to your letter of July 12, 1991 requesting a review of the Services' draft Coordination Act Report for the Kawainui Marsh Flood Control Project. The delay has been due to the time necessary for individual Division reviews of specific program areas.

This Department agrees that fish and wildlife conservation should receive equal consideration with the project objective of improving flood control facilities. We also concur with the position of the U.S. Fish and Wildlife Service that the project should enhance environmental values of the marsh itself. This would be consistent with the goals of the Kawainui Marsh Resource Management Plan currently being implemented by the State.

The "Marsh Clearing Alternative" would clearly be the most beneficial to improving habitat for endangered waterbirds and other water-oriented wildlife. It would also be beneficial in improving migration patterns for our native amphidromous fresh-water stream species. However, other considerations for this Department are the effectiveness of the flood control improvements and maintenance costs projected over time. Open waterways cannot be counted on for flood control as the behavior of the floating vegetation mat is unknown. The waterways could get clogged during floods. Funding for maintenance of the open waterways is not guaranteed. To this end, either the floodwall alternative or the levee-raise alternative are acceptable, for they both accomplish direct flood control with relatively low recurring maintenance costs.

Therefore, it would appear that none of the alternatives of the U.S. Army Corps of Engineers, alone, meet both objectives of environmental enhancement and effective, low maintenance flood control. An alternative that includes some combination of levee rise and marsh clearing would appear to be a reasonable solution. Our plan to develop a major wildlife sanctuary within the marsh includes the periodic clearing of vegetation, which should help mitigate future maintenance costs after the initial "marsh clearing". An increase in the height of the levee will be most effective in providing for the public safety, preventing property damage, and reducing long-term risk.

I hope the foregoing review is satisfactory for inclusion in your final report to the U.S. Army Corps of Engineers. I am also enclosing for your reference a copy of a July 8, 1991 letter to the City and County of Honolulu regarding flood control in Kawainui Marsh which expands on the above points.

Sincerely,

WILLIAM W. PATY

Enclosure

Draft

Fish and Wildlife Coordination Act Report

Kawainui Marsh Flood Control Project

prepared by

U.S. Fish and Wildlife Service
Fish and Wildlife Enhancement
Pacific Islands Office
Honolulu, Hawaii

Prepared for

U.S. Army Corps of Engineers
Pacific Ocean Division
Fort Shafter, Hawaii

June 1991

TABLE OF CONTENTS

INTRODUCTION

Authority, Purpose and Scope

In 1966, the U.S. Army Corps of Engineers completed construction of the Kawainui Marsh Flood Control Project under the authority of Section 204 of the Flood Control Act of 1950. The purpose of the project was to provide flood protection for the Coconut Grove residential subdivision located adjacent to Kawainui Marsh. The project included construction of the Oneawa Channel connecting Kawainui Marsh with Kailua Bay and construction of a 6,850-foot long earthen levee separating the marsh from Coconut Grove. In addition, 750 acres of Kawainui Marsh were acquired to provide temporary storage of flood waters. Ownership and responsibility to maintain the marsh were later transferred to the City and County of Honolulu.

The original design for the Kawainui Marsh Flood Control Project included a water control structure at the head of the Oneawa Channel. The purpose of this structure was to prevent saltwater intrusion into the marsh and to "regulate the outflow from the swamp." (U.S. Army Engineer District, Honolulu 1957). However, this water control structure was never constructed as part of the original flood control project.

On New Year's Day 1988, a major flood overtopped the existing levee, causing an estimated 10 million dollars worth of flood damage to the Coconut Grove community. As a result of this event, the City and County of Honolulu constructed an emergency ditch on the marsh side of the levee to accelerate the discharge of flood waters from the marsh. The flood also prompted the City and County of Honolulu to initiate and complete the Kawainui Marsh Flood Damage Mitigation Project report in November 1989. This report was followed by a City and County of Honolulu Final Environmental Impact Statement (EIS) in June 1990 for flood control improvements funded by the City and County of Honolulu.

A Reconnaissance Report was completed by the U.S. Army Corps of Engineers in 1989 at the request of the City and County of Honolulu who agreed to act as local sponsor for the project. The Reconnaissance Report recommended funding be provided to proceed with a feasibility report for flood damage prevention in the Kailua area as authorized under Section 205 of the Flood Control Act of 1948, as amended.

The draft Detailed Project Report (DPR) is the result of these feasibility studies. The purpose of the draft DPR is to evaluate the need to modify the Kawainui Marsh Flood Control Project due to changed conditions in the drainage basin following the project's failure to protect the Coconut Grove community from damages resulting from the New Year's Day 1988 flood. The draft report evaluates seven alternative solutions to the flood problem in order to determine the most feasible plan for implementing flood control improvements to augment the existing federally constructed flood control project.

The purpose of this report is to document the existing fish and wildlife resources in the project area and to insure that fish and wildlife conservation receives equal consideration with other project objectives as required under the Fish and Wildlife Coordination Act. The report includes an assessment of the significant fish and wildlife resources in the study area, evaluation of potential impacts associated with the project, and fish and wildlife mitigation measures.

Coordination with the State of Hawaii, Department of Land and Natural Resources

Recommendations prepared by the State of Hawaii, Department of Land and Natural Resources, Division of Forestry and Wildlife and Division of Aquatic Resources, will be incorporated into the Final 2(b) report. The report and a request for official concurrence with the Service's position and mitigation recommendations shall be forwarded to the Hawaii Department of Land and Natural Resources.

Prior U.S. Fish and Wildlife Service Studies and Reports

The Service issued a non-jeopardy Biological Opinion on July 12, 1990, following review of the Corps' Reconnaissance Report and the City and County's draft EIS. The Biological Opinion addressed the potential impacts of various Corps flood control project alternatives for Kawainui Marsh on four species of federally listed endangered waterbirds. These species included the Hawaiian Stilt, Hawaiian Duck, Hawaiian Coot, and Hawaiian Common Moorhen. Project alternatives assessed in the Biological Opinion included: 1) raising the existing levee by filling or by sheet pile wall; 2) widening the existing flow path next to the levee on the marsh side; 3) a combination of alternatives 1 and 2; 4) selective herbicide treatment and burning of marsh vegetation; 5) and flood proofing homes. Reasonable and Prudent Measures and Conservation Recommendations were included in the Biological Opinion to minimize take (as defined under the Endangered Species Act of 1973, as amended) of the four species of endangered waterbirds. Detailed project plans and other information necessary to assess impacts to endangered species for other alternatives were not available during the consultation period and therefore, these alternatives were not evaluated. Alternatives not considered in the Biological Opinion, but evaluated by the Corps in the draft DPR, include alternatives which would require excavation of sediment and vegetation to clear channels and direct flows into the interior of the marsh and the construction of a training dike in the marsh.

DESCRIPTION OF THE PLANNING AREA

Kawainui Marsh is a 1,000-acre freshwater wetland located on the northeast windward coast of Oahu between Kailua Bay and the base of the Koolau Mountains. Kawainui Marsh drains an 11-square mile area within the Maunawili Valley drainage basin. The marsh is fed by two major streams entering from the south, Maunawili Stream and Kahanaiki Stream, and several smaller, intermittent streams which enter the marsh at various points along its border. Kawainui Marsh discharges through the federally constructed Oneawa Channel into Kailua Bay. Kailua Bay and the Oneawa Channel are tidal systems; however, tidal influence into Kawainui Marsh is apparently obstructed due to existing elevations of the marsh and the presence of dense vegetation mats at the head of the channel.

Kawainui Marsh is nearly encircled by development. Coconut Grove subdivision is located along Kawainui's eastern boundary. Sanitary landfills, a rock quarry, an abandoned vehicle yard, and a movie theatre are located to the north and west. Kalanianaole Highway, Kailua Road, and additional residential areas are found to the south and southeast. The 6,850-foot long earthen levee and the Kaelepulu drainage canal separate Kawainui Marsh from the adjacent Coconut Grove subdivision. The excavated Kaelepulu drainage canal collects stormwater runoff from Coconut Grove and Kailua Town. The canal connects to Kaelepulu stream and ultimately discharges into Kailua Bay at the Kailua Beach Park.

Vegetation composition and patterns within Kawainui Marsh have been significantly influenced by human activities. Portions of the marsh were historically used by native Hawaiians for cultivating taro and raising fish. The marsh was later used for rice cultivation and as pasture land. Higher elevations of the marsh were drained to grow vegetable and fruit crops (Kelly 1979). Over the last two decades and until recently, treated sewage effluent discharged into the marsh which significantly increased nutrient loads into Kawainui. Likewise, increased stormwater runoff and erosion from surrounding urban developments have accelerated sediment loading and caused the insidious infilling of Kawainui Marsh. Higher ground elevations in combination with increased nutrient loading, withdrawal of water from the Maunawili Stream system, and introduction of aquatic weed species have resulted in accelerated growth of emergent vegetation and diminished areas of open water habitat.

The effects of these perturbations are evidenced in the present species composition of vegetation communities within the marsh. In wetter portions of the marsh, dominant vegetation includes a bulrush/sawgrass community interspersed with areas of open water and floating aquatic weeds. The bulrush/sawgrass community is found on floating islands of thick, matted vegetation with peat-based soils. Dominant species of this community include California bulrush (Schoenoplectus californicus = Scirpus californicus), sawgrass (Cladium jamaicense), taro patch fern (Thelypteris interrupta), common cattail (Typha latifolia), California grass (Brachiaria mutica), and arrowhead (Sagittaria latifolia). Interspersed within this community are limited areas of open water and other shallow water habitats supporting aquatic plants such as water hyacinth (Eichhornia crassipes) and water lettuce (Pistia stratiotes).

The drier portion of the marsh, which includes primarily the southern and western portions of the marsh, is dominated by a wet California grass meadow community which has developed on mineral-based soils. Species diversity is low in this community and consists primarily of California grass interspersed with Honohono grass (Commelina diffusa) and common cattail.

DESCRIPTION OF FISH AND WILDLIFE RESOURCES

Existing Conditions

Open water areas within Kawainui Marsh are limited in number and are characterized as openings in the dense emergent vegetation and floating mat or as small ponds in the wet pasture. The aquatic community within the marsh is relatively low in species diversity and is generally dominated by introduced species. Tilapia (Tilapia mossambica), mosquitofish (Gambusia affinis), guppies (Poecilia spp.), carp (Cyprinus carpio), and crayfish (Procambarus clarkii) have been reported from Kawainui Marsh (Ford 1975). The rice eel (Monopterus albus) was observed within the dredge spoils from the excavation of the emergency ditch along the levee. Smallmouth bass (Micropterus dolomieui), swordtail (Xiphophorus helleri), Chinese catfish (Clarias fuscus), and loach (Misgurnus anguillicaudatus) are likely present in the larger open water ponds that are continuous with Maunawili Stream. No fishes were observed within the experimental potholes that were blasted in the floating mat by the City and County of Honolulu. Post-larval and juvenile forms of the endemic gobies and invertebrates may migrate through Kawainui Marsh to reach suitable habitats in Maunawili Stream and tributaries.

The streams in the Maunawili Valley drainage are characterized by introduced species. Chinese catfish, carp, smallmouth bass, guppies, tilapia, swordtail, crayfish, and Tahitian prawn (Macrobrachium lar) are distributed throughout these streams (Ford 1975, Timbol and Maciolek 1978, and Archer 1984). Native species are relatively rare in these streams and include the native shrimp (Atyoida bisulcata) and pond snail (Melanoides spp.) (Archer 1984).

The Oneawa Channel estuary supports a higher diversity of aquatic resources. Native fishes including the endemic goby Awaous stamineus, indigenous goby Stenogobius genivittatus, endemic eleotrid Eleotris sandwicensis, endemic flagtail (Kuhlia sandvicensis), and indigenous mullet (Mugil cephalus) have been reported from Oneawa Channel (Ford 1975). Tilapia are abundant throughout the estuary.

Kawainui Marsh provides valuable habitat for migratory waterfowl, wintering shorebirds, and resident species of wading birds. Migratory waterfowl are found within the small ponds in the wet pasture and the larger open water areas during winter months (Shallenberger 1977). Migratory geese and ducks reported from Kawainui Marsh include Northern Pintail (Anas acuta), Northern Shoveler (Anas clypeata), Mallard (Anas platyrhynchos), Canada Goose (Branta canadensis), Emperor Goose (Chen canagica), Ring-necked Duck (Aythya collaris), Lesser Scaup (Aythya affinis), Green-winged Teal (Anas crecca), American Widgeon (Anas americana), and Redhead (Aythya americana) (Shallenberger 1977, Conant 1981, and Engilis 1988). Feral mallards are abundant along the banks of Kaelepulu Canal and Oneawa Channel. Migratory shorebirds reported from Kawainui Marsh include the Lesser Golden Plover (Pluvialis dominica), Ruddy Turnstone (Arenaria interpres), Sanderling (Calidris alba), and Wandering Tattler (Heteroscelus incanus) (Shallenberger, 1977, Conant 1981, and Engilis 1988). The Black-crowned Night Heron (Nycticorax nycticorax hoactli) is commonly seen within the open water areas and potholes within the wet pasture.

Kawainui provides essential nesting, breeding, and resting habitat for four federally listed endangered waterbirds. These species, which are all resident, non-migratory species endemic to the Hawaiian Islands, include the Hawaiian Coot or Alae keokeo (Fulica americana alai), the Hawaiian Stilt or Aeo (Himantopus mexicanus knudseni), Hawaiian Common Moorhen or Alae ula (Gallinula chloropus sandvicensis), and the Hawaiian Duck or Koloa (Anas wyvilliana).

Nesting within Kawainui has been documented for all four species. These four species are considered permanent residents of the marsh. The Hawaiian duck nests on the ground near water and feeds on snails, earthworms, rice, algae, and seeds and leaf parts of wetland plants (Swedberg 1967 and Weller 1980). In Kawainui Marsh, Koloa are most commonly observed around open waterways and channels.

The Hawaiian Common Moorhen prefers dense stands of marsh vegetation interspersed with areas of open water for nesting (USFWS 1985b). Similar areas of cover are used as feeding and resting sites (Nagata 1983). The secretive nature of the Alae ula in Kawainui Marsh make sightings more difficult.

The preferred habitat of the Hawaiian Coot is similar to that of the Hawaiian Common Moorhen, although the Hawaiian Coot prefers more open water particularly for feeding. Nesting sites are usually in or adjacent to vegetation within areas with stable water levels (USFWS 1985b). Hawaiian Coots feed near the surface of the water, diving and foraging in sand or mud for seed and leaves of aquatic plants, snails, crustaceans, and aquatic and terrestrial insects (Schwartz and Schwartz 1949).

The Hawaiian Stilt uses a variety of aquatic habitats. Frequently, nest sites are separated from feeding sites and stilts move between these areas daily. Nesting sites are usually on or adjacent to islands within fresh, brackish or salt water ponds, mudflats, or marshes. Stilts feed on a wide variety of invertebrate and other aquatic organisms found in shallow water and mudflat habitats (USFWS 1985b). Stilts are observed in relatively low numbers within Kawainui, possibly due to the limited areas of mudflat habitat.

Terrestrial species using marsh habitats within Kawainui Marsh include mongoose, feral cats and dogs, mice and rats. In addition, cattle and horses are sometimes grazed in drier, upper portions of the marsh.

Future Without the Project

The habitat for migratory waterfowl, wintering shorebirds, and endangered Hawaiian waterbirds will improve after completion of the City and County of Honolulu's clearing of approximately 30 acres of open water channels and removal of water hyacinths within Kawainui Marsh. These open water channels will provide edge and open water habitats within areas that are currently overgrown with emergent vegetation. However, these channels are relatively deep and will not likely be used by the Hawaiian Stilt. The long-term benefit to wildlife of the vegetation clearing depends upon the maintenance of the open water and edge habitats by the City and County of Honolulu as part of the flood control project. The construction of these channels will proceed regardless of any federal action.

The open water areas currently overgrown with water hyacinth are to be treated with an herbicide approved for aquatic uses. The water hyacinth forms dense mats that have overgrown the open water areas, thereby excluding migratory waterfowl and endangered waterbirds. Migratory waterfowl have responded positively to the clearing of water hyacinths in Kawainui Marsh (Shallenberger 1977). However, the Hawaiian Common Moorhen can be seen in areas overgrown with water hyacinth. These habitat improvements are only temporary and must be maintained routinely to keep the water hyacinth density low.

Insidious changes to Kawainui Marsh may occur from the construction of the emergency ditch. Prior to the construction of the emergency ditch, the marsh drained only through the 600-foot wide outlet at the head of the Oneawa Channel. However, with the construction of the approximately 6,800-foot long emergency ditch, the marsh now drains along the entire length of the emergency ditch into Oneawa Channel. By providing a more efficient conveyance to transport water from Kawainui Marsh to Oneawa Channel, the hydrology of the wetland may be altered by decreasing storage and retention capacity (Brown 1988). The emergency ditch may further worsen the negative water balance in Kawainui Marsh during dry weather periods. These hydrological changes may secondarily alter the vegetation composition and waterbird habitats within Kawainui Marsh (Josselyn, Faulkner, and Patrick 1990). The changes to the vegetation community and waterbird habitat from altering the hydrology would be gradual and would further accelerate the conversion of Kawainui Marsh into upland habitat.

DESCRIPTION OF ALTERNATIVES EVALUATED

Alternative actions identified by the U.S. Army Corps of Engineers to accomplish the goal of increased flood protection for the Coconut Grove subdivision within the Kawainui Marsh project area include the following: raising the elevation of the existing levee, constructing a floodwall, clearing marsh vegetation in combination with channel excavation, constructing a channel and associated dike structure parallelling Quarry Road, constructing a back levee and channel, floodproofing homes, and taking no federal action.

Alternative 1 - Levee Raise. This alternative would raise the existing levee by placing approximately 195,000 cubic yards of earthfill for a distance of 6,300 feet on the Coconut Grove side of the existing levee. This alternative would add an additional eight feet of height to the levee at the Kailua Road end for most of the 6,300 feet of levee. The levee would taper to its existing height at Oneawa Channel. Approximately three acres of wetlands would be filled.

Alternative 2 - Floodwall. Under this alternative a concrete floodwall on top of the existing levee would be built. The height of the floodwall would be identical to the height of the earthfill levee described in alternative 1. This alternative does not require any wetland fill.

Alternative 3 - Marsh Clearing. This alternative would clear portions of the marsh to allow floodwaters to pass more easily through the heavily vegetated marsh. Clearing of vegetation and sediment by mechanical means (cookie cutter or spray disposal pumps) would create approximately 76 acres of open water habitat by widening and connecting the channels cleared by the City and County of Honolulu's mitigation project. The levee would be raised an additional 2-4 feet between Oneawa Channel and Kailua Road. Approximately 15,000 cubic yards of material would be dredged from the Oneawa Channel deepening portions of the channel by about 1.5 feet. A water control structure would be placed just upstream of the channel to stabilize water levels in the marsh during low flow periods and to allow management of water levels for fish and wildlife. Construction of the Quarry Road channel (Alternative 4, exclusive of the dike structure) is incorporated into this alternative.

Alternative 4 - Quarry Road Channel. This alternative includes raising portions of the levee by 1 to 5 feet between the Oneawa Channel and Kailua Road, dredging 15,000 cubic yards of material from the Oneawa Channel, excavating a new 7,300-foot long channel to connect Oneawa Channel with the existing open water area at the southern end of the marsh, and constructing a dike to guide flows into the newly created channel. The new channel would have a 40-foot bottom width, 200-foot top width, 10 horizontal to 1 vertical side slopes, and would create 33.5 acres of open water. The dike would extend 2,500 feet into the marsh from the marsh's southern boundary to the Quarry Road channel entrance. Approximately 56,700 cubic yards of fill material would be required to construct the dike, and approximately 3 acres of wetlands would be filled.

Alternative 5 - Back Levee and Channel. This alternative includes construction of a new levee parallel to the existing levee located adjacent to Coconut Grove, extension of the Oneawa Channel, raising portions of the existing levee, and realigning Kaelepulu Stream. This alternative would extend the Oneawa Channel along the Coconut Grove side of the levee. The existing levee would be used as a block to the floating mats of vegetation. Water would pass through constructed culverts to the channel. The extension would increase the total length of the channel to 5,300 feet. The right bank of the channel would form a new levee preventing marsh flood flows from entering Coconut Grove. Construction of this new back levee would fill approximately 5 acres of wetlands. Kaelepulu Stream would be aligned so that interior stormwater runoff from Coconut Grove would pass to the Enchanted Lakes area and into Kailua Bay. The existing levee would be raised approximately 6.5 feet in height by constructing a floodwall. The floodwall would extend 1,400 feet from Kailua Road to the upper end of the extended Oneawa Channel.

Alternative 6 - Floodproofing. This alternative includes floodproofing homes in the Coconut Grove subdivision.

Alternative 7 - No Corps Action. This alternative would dictate no further federal action for the project.

FISH AND WILDLIFE RESOURCE CONCERNS AND PLANNING OBJECTIVES

The Service's primary concerns with the proposed flood control project are impacts caused by dredge and fill activities within the marsh and the potential drainage of the marsh caused by channelization. Specific Service planning objectives are to maintain and enhance the existing significant habitat values of the marsh for federally endangered waterbirds, migratory waterfowl, wintering shorebirds, resident wading birds, and fishery resources and to provide mitigation for project related habitat losses consistent with the Service's Mitigation Policy and Regional Wetlands Protection Policy.

The Service's Mitigation Policy (USFWS 1981) outlines internal guidance for evaluating project impacts affecting fish and wildlife resources. The Mitigation Policy complements the Service's participation under the National Environmental Policy Act and Fish and Wildlife Coordination Act. The Service's Mitigation Policy was formulated with the intent to protect and conserve the most important fish and wildlife resources, while facilitating balanced development of this nation's natural resources. The policy primarily focuses on habitat values and identifies four resource categories and mitigation guidelines. The resource categories are the following:

a. Resource Category 1: Habitat to be impacted is of high value for the evaluation species and is unique and irreplaceable on a national basis or in the ecoregion section.

b. Resource Category 2: Habitat to be impacted is of high value for the evaluation species and is relatively scarce or becoming scarce on a national basis or in the ecoregion section.

c. Resource Category 3: Habitat to be impacted is of high to medium value for the evaluation species and is relatively abundant on a national basis.

d. Resource Category 4: Habitat to be impacted is of medium to low value for the evaluation species.

Migratory waterfowl (Mallard, Northern Pintail, and Northern Shoveler) and shorebirds (Lesser Golden Plover, Ruddy Turnstone, Sanderling, and Wandering Tattler) and the resident Black-crowned Night Heron were selected as evaluation species for wetland habitats that may be affected by the proposed project. These species are also protected under the Migratory Bird Treaty Act.

The emergent wetlands of Kawainui Marsh provide high value habitat for the evaluation species. These habitats are relatively scarce in Hawaii. The mitigation goal for this habitat type is no net loss of in-kind habitat value. Under this designation, the Service will recommend ways to avoid or minimize the losses. If losses are unavoidable, mitigation measures to immediately rectify, reduce, or eliminate these losses over time will be recommended. As necessary, compensation by replacement of the in-kind habitat values may be incorporated as integral project features. The habitat valuation is also consistent with the Regional Wetlands Protection Policy which has the stated goal of "no net loss in acreage or value of wetland habitats."

PROJECT IMPACTS

With the exception of the no federal action alternative, all alternatives may cause the temporary displacement of trustee wildlife species in the general project area due to increased levels of noise and other disturbances related to construction activities. Construction of the concrete floodwall and floodproofing homes will not require filling of wetlands and altering the hydrology of Kawainui Marsh or cause other long-term adverse impacts to fish and wildlife habitats. Therefore, no significant adverse impacts to trustee fish and wildlife resources from construction of the concrete floodwall, floodproofing, or the no action alternative are anticipated.

Construction of the earthen levee, Quarry Road channel, and back levee and channel alternatives would require filling emergent wetland habitat. The construction of these alternatives would result in the direct loss of wetland habitats, functions, and values. The earthen levee alternative requires three acres of fill for levee construction, the Quarry Road channel places three acres of fill for the dike, and the back levee alternative involves five acres of fill for back levee construction. Because of the direct impacts to wetlands, these alternatives are not consistent with the mitigation goals for this resource category. While opportunities for compensatory mitigation may exist within Kawainui Marsh, project alternatives that have the least environmental impact exclusive of mitigation should be foremost considered.

The marsh clearing alternative does not require filling of wetlands. The material cut by the cutterhead dredge would be removed from Kawainui Marsh and would not be stockpiled or stored within the wetland. This alternative, by clearing emergent vegetation and creating open water and edge habitats, would result in an improvement in migratory waterfowl habitat in Kawainui Marsh. A water control structure would also be constructed at the head of Oneawa Channel to prevent drainage of the marsh during low flow conditions and to manage water levels within the marsh for waterbirds. The water control structure would also mitigate the drainage impacts from the emergency ditch. Adverse impacts to waterbirds may occur from resuspension of heavy metals that are apparently contained with sediments and vegetation in the marsh during the clearing of the channels. Invertebrates and fishes may accumulate heavy metals and pass these contaminants to migratory waterfowl and shorebirds and to endangered waterbirds.

Hawaii water quality standards may be exceeded within Oneawa Channel, Kaelepulu Canal, and Kailua Bay from the dredging in Oneawa Channel and Kawainui Marsh. Habitats for estuarine fishes and invertebrates would be temporarily degraded in Oneawa Channel from dredging by increased suspended sediment loads, turbidity, and nutrient levels. Habitats for reef fishes and invertebrates in Kailua Bay may also be temporarily impacted by the increased turbidity and suspended sediments generated by the dredging in Oneawa Channel. The construction of interior waterways that connect directly to Oneawa Channel may alter nutrient and freshwater inputs into Kailua Bay by reducing the residence time of flood waters in Kawainui Marsh.

SERVICE RECOMMENDATIONS

According to the 1983 Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies,

> "The Federal objective of water and related land resources project planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements."

Furthermore, Lieutenant General H.J. Hatch, Commander, U.S. Army Corps of Engineers, in his 14 February 1990 Memorandum, emphasized a new "strategic direction for environmental planning" for the U.S. Army Corps of Engineers. Colonel Hatch stated:

> "We must plan wisely at the outset and integrate environmental concepts with engineering creativity in all phases of our [Corps] projects and activities. We will not only mitigate environmental impacts of development, but, when authorized to do so, we will expand our work that directly addresses environmental problems as a central purpose of the engineering effort."

We believe the Kawainui Flood Control Project represents an excellent opportunity to support the new environmental goals and initiatives of the U.S. Army Corps of Engineers. Simple compliance with environmental laws and standards has given way to the enhancement of the environment. Therefore, we encourage the Corps to select a final alternative that considers not only the Net Economic Development (NED) benefits but enhances the environmental values of Kawainui Marsh as well. In addition, final design features, plans, and specifications for protection of fish and wildlife resources shall be developed in consultation with the Service and the State of Hawaii, Department of Land and Natural Resources as required by the Fish and Wildlife Coordination Act.

Of the seven alternatives identified, marsh clearing will provide increased flood protection while enhancing and restoring essential habitat for Hawaii's endangered waterbirds, migratory waterfowl, shorebirds, and wading birds. While this alternative does not meet the federal NED standards, we recommend the Corps give serious consideration to the marsh clearing alternative. The following mitigation measures should be incorporated into the design and construction of the selected alternative:

a. The emergency ditch shall be abandoned as an active flood control feature. As necessary, the emergency ditch shall be blocked by check dams upon completion of the flood control improvements. We note that the baseline condition for planning this flood control project does not incorporate the emergency ditch.

b. Construction, operation, and maintenance of the flood control project shall not decrease water levels or water quality in the marsh below pre-project levels. Monitoring programs shall be implemented to insure water levels and quality are being maintained. Final design of the water control structure at the outlet of Kawainui Marsh shall be coordinated with the Service and the Hawaii Department of Land and Natural Resources.

c. To reduce the potential for increased turbidity and sediment loading into Kailua Bay, the project shall use silt curtains and other erosion control measures in Oneawa Channel during dredging operations. In addition, post-project sediment loads within the Oneawa Channel shall be monitored for an appropriate period following construction. The monitoring plan shall include a contingency plan to resolve any water quality concerns identified under the monitoring program. Marsh clearing shall be planned to limit sediment transport to Oneawa Channel.

d. Concentrations of heavy metals in the benthic fauna, sediment, vegetation, and water column shall be monitored before, during, and after dredging operations in Kawainui Marsh and Oneawa Channel. State water quality standards for heavy metals and other water quality parameters shall not be exceeded during the dredging operations.

e. Sediment and vegetation dredge spoils shall not be stored in wetland habitats.

f. A trained biologist shall be present at the site during the mobilization and construction of the project to insure compliance with the mitigation recommendations and to provide assistance to the contractor in meeting environmental standards.

g. The marsh clearing alternative was not evaluated in the 12 July 1990 Biological Opinion. Therefore, the Corps should consider re-initiating consultation pursuant to Section 7 of the Endangered Species Act of 1973, as amended. The Service will append the Biological Opinion to include this alternative. An incidental take statement with revised Reasonable and Prudent Measures will be included to satisfy the legal requirements of the Act and to minimize impacts to the four endangered species of waterbirds.

LITERATURE CITED

Archer, K.A. 1984. Biological survey of Maunawili, Ainoni and Makawao Streams, Windward Oahu. Prepared for Fukunaga and Associates, Inc.

Brown, R. G. 1988. Effects of wetland channelization on runoff and loading. Wetlands. 8:123-133.

Coleman, R.A. 1981. The reproductive biology of the Hawaiian subspecies of the Black-necked Stilt, *Himantopus mexicanus knudseni*. Ph.D. Thesis. 106 pp.

Conant, S. 1981. A survey of the waterbirds of Kawainui Marsh. Prepared for Hawaii Department of Land and Natural Resources. 63 pp.

Engilis, A. 1988. Waterbird status in Kawainui Marsh. State of Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife. #1771I(21). Unpublished. 3 pp.

Ford, J. I. 1975. Preliminary biological survey of Kawainui Marsh and the Maunawili-Kahanaiki stream system. Water Resources Research Center. Univ. of Hawaii, Honolulu.

Josselyn, M.N., S.P. Faulkner, and W.H. Patrick, Jr. 1990. Relationships between seasonally wet soils and occurrence of wetland plants in California. Wetlands. 10(1):7-26.

Kelly, Marion. 1979. Brief history of Kawainui fishpond and associated sites. Department of Anthropology, Bishop Museum. Honolulu, Hawaii. Unpublished. 32 pp.

M&E Pacific, Inc. 1989. Draft Environmental Impact Statement. Kawainui Marsh Flood Damage Mitigation Project. Prepared for the City and County of Honolulu, Division of Engineering, Department of Public Works. Honolulu, Hawaii. 83 pp.

Nagata, S. E. 1983. Status of the Hawaiian Gallinule on lotus farms and a marsh on Oahu, Hawaii. Master of Science Thesis. Colorado State University. 87 pp.

Pratt, HD., Bruner, P.L., and Berrett, D.G. 1987. *The Birds of Hawaii and the Tropical Pacific*. Princeton University Press. Princeton, New Jersey. 409 pp.

Schedberg, G. E. 1967. The Koloa. Federal Aid to Wildlife Restoration Act (W-5-R). Department of Land and Natural Resources. Honolulu, Hawaii. 56 pp.

LITERATURE CITED (CONTINUED)

Schwartz, C.W. and E.R. Schwartz. 1949. The Game Birds in Hawaii. Div. Fish and Game and Board Comm. Agric. & For. Honolulu, Hawaii. 168 pp.

Shallenberger, R.J. 1977. An ornithological survey of Hawaiian wetlands. Volume II. Prepared by Ahuimanu Productions.

Timbol, A.S. and Maciolek, J.A. 1978. Stream channel modification in Hawaii. Part A: Statewide inventory of streams; habitat factors and associated biota. FWS/OBS-78/16. 171 pp.

U.S. Army Engineer District, Honolulu. 1957. Kawainui Swamp Flood Control Design Memoranda.

U.S. Army Engineer District, Honolulu. 1991. Draft Environmental Impact Statement. Kawainui Marsh Flood Control Project. Honolulu, Hawaii. 82 pp.

U.S. Fish and Wildlife Service. 1981. U.S. Fish and Wildlife Service Mitigation Policy. Federal Register. Vol. 46, No. 15. pp. 7644-7663.

U.S. Fish and Wildlife Service. 1985a. Regional Wetlands Policy. Region 1 Policy Book. Habitat Resources Policy No. 11. pp. HR11-1 - HR11-2.

U.S. Fish and Wildlife Service. 1985b. Recovery plan for the Hawaiian waterbirds. Portland, Oregon. 99 pp.

U.S. Fish and Wildlife Service. 1990. Biological Opinion issued for the Kawainui Marsh Flood Control Project. 8 pp.

Wagner, W. L., Herbst, D. R., and Sohmer, S. H. 1990. Manual of the Flowering Plants of Hawaii, Vol. I and II. University of Hawaii Press. Bishop Museum Press. Honolulu, Hawaii. 1853 pp.

Weller, M.W. 1980. The Island Waterfowl. The Iowa State University Press. Ames, Iowa. 121 pp.

KAWAINUI MARSH
FLOOD CONTROL PROJECT
OAHU, HAWAII

US FISH AND WILDLIFE SERVICE
SECTION 7 CONSULTATION

United States Department of the Interior
FISH AND WILDLIFE SERVICE
PACIFIC ISLANDS OFFICE
P.O. BOX 50167
HONOLULU, HAWAII 96850

PLNG
1. PV
2. PH

JUL 12 1990

Mr. Kisuk Cheung 07/17/90
Director, Engineering
U. S. Army Engineer District, Honolulu
Building 230
Fort Shafter, Hawaii 96858-5440

Dear Mr. Cheung:

This responds to your March 6, 1990 request for consultation under Section 7 of the Endangered Species Act of 1973 (Section 7). At issue are the possible impacts of the U. S. Army Corps of Engineers (Corps) funding and permitting various alternative flood control measures in Kawainui Marsh, Kailua, Oahu, Hawaii on the four species of endangered Hawaiian waterbirds that may be found there. These are the Hawaiian stilt, Hawaiian duck, Hawaiian coot, and Hawaiian common moorhen.

Our log number for this consultation is 1-2-90-F-008.

Copies of pertinent materials and documentation are maintained in an administrative record in this Service's office in Honolulu, Hawaii.

Biological Opinion

It is our biological opinion that your pursuing any of the alternatives described in your November 20, 1989 memorandum (on the subject: Reconnaissance Report for Kawainui Marsh Flood Control Project - Kailua, Oahu, Hawaii) is not likely to jeopardize the continued existence of any listed species. These alternatives are:

1. Raising the existing levee by filling or by sheet pile wall.

2. Widening the existing flow path next to the levee on the marsh side.

3. Combination of the above options.

Likewise, the selective herbicide treatment and burning of marsh vegetation as proposed in your August 31, 1988 Notice of Intent to prepare a draft environmental impact statement and subsequent correspondence and discussions are not likely to jeopardize the continued existence of any listed species.

Flood proofing homes (raising the floor elevations of houses in flood prone areas) will not affect listed species.

Background Information and Description of the Proposed Action

Kawainui Marsh (Kawainui) is located on the northeast, windward coast of Oahu and is situated between the Koolau Mountain Range and the town of Kailua (Enclosure 1). It is fed by an 11 square mile watershed. Although it was historically a 450-acre fishpond maintained by the local Hawaiian population, regular clearing of encroaching vegetation ceased many decades ago. Vegetation has since moved into the fishpond, choking off much of the open water area. The accumulation of sediments in the marsh has also decreased both the depth and open-water area of the marsh. It remains the largest freshwater wetland in Hawaii.

Sedimentation and the dense growth of vegetation (cattails, rushes, California grass, water hyacinth, and other species) contributed to the decrease in the water-holding capacity of the wetland. In 1966, the Kawainui Flood Control Project was completed to protect the Coconut Grove community, adjacent to Kawainui. This project included the construction of a 6,850-foot long earth levee with a design crest elevation of 9.5 feet above mean sea level and a 9,470-foot long outlet channel (Oneawa Channel) which flows into Kailua Bay. These features were not sufficient, however, to protect Coconut Grove from flooding on January 1, 1988 after a record 23-inch rainfall in 24 hours. The levee was topped, and it has been determined that water was backed up into the marsh because the thick vegetation did not allow water to flow freely into the outlet channel.

As a result of the New Year's flood, the Corps has been involved with the City and County of Honolulu in developing additional flood control measures to protect the community and surrounding areas. The Corps has already enhanced the flood control function of Kawainui by clearing a 30-foot wide strip of vegetation along the marsh side of the levee to provide a pathway for floodwaters to reach the Oneawa Channel. Your March 6, 1990 letter included two enclosures (Corps Reconnaissance Report for Kawainui Marsh Flood Control Project of November 20, 1989 and the Notice of Intent to Prepare a Federal Environmental Impact Statement, February 1988). These pose various additional measures for increasing flood control and property protection.

In determining the scope of this formal Section 7 consultation, the following alternatives were reviewed:

1. The November 1989 Reconnaissance Report provides three options for flood control:

   a. Raising the existing levee by filling or by sheet pile wall.

   b. Widening the existing water flow path adjacent to the levee on the marsh side.

   c. A combination of the above two actions.

2. The February 1988 environmental impact statement notice lists the following alternatives:

   a. Selective herbicide treatment and burning of marsh vegetation.

   b. Excavating sediment or vegetation, or combinations of both from the marsh to clear a channel through the marsh or increase flood storage.

   c. Raising the existing levee.

d. Widening Oneawa Canal.

e. Widening the existing ditch next to the levee on the marsh side.

f. Flood-proof homes (raise floor elevations of houses in flood prone zones).

g. Construction of a training dike in the marsh to direct water flows into a channel.

h. Combinations of two or more of the above alternatives.

3. The City and County of Honolulu published the Kawainui Marsh Preliminary Draft Environmental Impact Statement (Draft EIS) on June 19, 1989. This document considered four alternatives:

a. No action.

b. Channelization through the marsh.

c. Diverting flood water above the marsh.

d. Increasing the ability of the marsh to distribute and store flood water.

The first three of the Draft EIS alternatives were eliminated from further consideration primarily because of significant environmental and technical concerns (Draft EIS, page 1-2).

Proposals for (1) excavating sediment and/or vegetation from the marsh to clear a channel to increase flow and flood storage and (2) constructing a training dike in the marsh to direct water flows into a channel have been considered. However, there is insufficient information on which to make a determination on jeopardy to listed species. As discussed with Ms. Margo Stahl of your staff, additional detailed information on the location, dimensions, alignment, and hydrology of such channels and dikes will be required before their potential to decrease water levels in the marsh can be determined. Generally, however, if the maintenance of a conservation water level within the marsh and wetland acreage can be guaranteed, channels and dikes will not be likely to jeopardize any listed species.

Subsequent conversations with members of your staff narrowed our Section 7 review of options and alternatives to those currently under serious consideration. These are discussed below. This does not infer that other alternatives may lack validity or may not be given more serious consideration in the future. In addition, we were advised to focus our consultation on the more general aspects of the alternatives for flood control rather than on a detailed analysis of specific, quantifiable plans and engineering specifications. As this more detailed information becomes available and as the exact methods for flood control are chosen, further consultation may be required to address impacts to listed species.

1. Raising the existing levee by filling or by sheet pile wall:

As described in your Reconnaissance Report, the existing flood control levee needs to be modified to restore its intended flood control function. Such modification would involve either building a flood wall on top of the levee or increasing the levee cross-section and height with fill material (Enclosure 2). (Note: The proposal to widen the channel on the marsh side of the levee is no longer under serious consideration. The Corps believes floating vegetation in the marsh would quickly float into any channel along the levee during flood periods, choking the channel, and exacerbating the flooding problem.)

2. Increasing the open water area of the marsh to better accommodate and store flood waters:

Various alternative methods for removing and excluding vegetation from the marsh have been discussed since the 1988 flood. Herbicide treatment, burning, increased grazing, mechanical harvesting, blasting, and dredging have all been considered. The creation of different configurations and locations of open water areas have also been considered.

Effects of the Proposed Action on Listed Species

Three major sources of information on the presence and abundance of listed species in Kawainui Marsh (A Survey of Waterbirds of Kawainui Marsh by S. Conant, 1981; An Ornithological Survey of Hawaiian Wetlands by Shallenberger, 1977; and the State Division of Forestry and Wildlife's Waterbird Status in Kawainui Marsh, 1988) indicate that all four species of Hawaii's endangered waterbirds can be found in Kawainui Marsh. A map noting the distribution of four listed waterbirds within the marsh was provided in the Draft EIS (Enclosure 3).

1. Hawaiian common moorhen: This bird is a permanent resident in the marsh, inhabiting open waterways, channels, and densely vegetated areas. Young have been observed, indicating that they nest there. The State's survey reported 35 moorhens from the area. In that the State-wide population may be in the low hundreds, the marsh represents a significant habitat for the maintenance and recovery of the species.

2. Hawaiian duck: The koloa is a permanent resident restricted to the open water areas of the marsh; it is known to nest there. According to the State's 1988 report, the "10 to 12 birds that can be regularly seen in Kawainui represent the largest known concentration on windward Oahu." The total population of the duck State-wide is estimated to number in the low hundreds.

3. Hawaiian stilt: The low counts of approximately 12 stilt residing at Kawainui represent a very small percentage of the over 1,000 that are estimated to make up their State-wide population. The marsh does offer some nesting and feeding habitat on its mud flats and adjacent vegetated areas.

4. Hawaiian coot: The 1988 summer State-wide population of coots was estimated to be around 900. As long as open water is present, the birds use Kawainui; up to 20 have been counted there during floods, when open water is most abundant. Adults with young have been seen there indicating that the area is used for nesting.

In general, all four listed waterbirds in Kawainui would benefit from increases in the area of open water, mud flats, and edge where open water and grasses meet. Open water act as a physical barrier to such predators as rats, cats, dogs, and mongooses, protecting both birds and their nests. It also supports the growth of the plant, invertebrate, and vertebrate foods used by the birds. Mud flats serve as important stilt feeding and nesting areas. Over the years, the gradual diminution of open water by encroaching vegetation has decreased the area of these important habitats in Kawainui, decreasing their usefulness for waterbird feeding, breeding, and nesting. Almost any action which opens or creates waterways, channels, or ponds within the marsh will be beneficial if (1) the methods employed in accomplishing the task are compatible with the birds' needs, (2) the water quality is maintained or improved, and (3) the actions do not decrease water levels within the Marsh to such an extent as to dry the wetland or allow the proliferation of grasses and other emergent vegetation.

Raising the levee by constructing a five-foot high sheet pile or concrete flood-wall on the crest of the levee (Enclosure 4, Alternative 1) will cause localized and temporary increases in noise and local water turbidity due to the construction. This would not significantly harm the birds, their habitat, or food sources. Long-term adverse impacts on any of the listed waterbirds would not be expected. Once completed, the wall may be beneficial in that it may help to keep predators from entering the wetland.

Proposals to raise the levee by adding to the earthworks and widening its base would require the filling of a portion of the wetland on the marsh side of the levee (Enclosure 4, Alternative 2). The existing levee is 6,850 feet long, and the proposal calls for adding 35 to 40 feet to its width. This would fill approximately six acres of wetland. While this is a very small fraction (about 1%) of the total Kawainui Marsh area of 600 to 700 acres, the area to be filled represents a portion of the marsh identified in the State's Waterbird Status of Kawainui Marsh (Enclosure 1) as providing habitat for the birds. The other concentration of endangered birds within Kawainui is in the more central open water "pond" of the marsh. The birds probably congregate near the existing levee because open water can be found there.

The creation of open water channels to allow for more efficient movement of water through the wetland to the outlet canal could be beneficial for waterbirds once construction is completed. Such channels would create open water and vegetation edge that affords excellent feeding and nesting habitat for some species. The open water would also pose a physical barrier to predators. Our major concern with channels is that should they be designed solely for flood control purposes, they may function too well in their capacity to transport water from the upper marsh to the outlet channel. This could lower the average depth of the water in the marsh. Any reduction in water levels in the marsh below current average depths would decrease the amount and quality of waterbird habitat there as previously described. In addition to the immediate decreases in open water and other wetland habitats that would result from such drainage, reductions in water levels would encourage the growth of the choking vegetation which already hinders waterbirds attempting to use Kawainui. Dryer conditions would also accelerate the transition of the wetland into a woody, upland vegetation habitat of limited use to waterbirds.

Adverse impacts which would be expected during the construction phase would include increased noise, increased water turbidity, and loss of any existing habitat afforded by the existing area to be dredged.

<u>Cumulative Effects</u>

As defined in Section 402.02 of 50 Code of Federal Regulations, cumulative effects are those effects of future local government or private activities, not involving Federal activities, that are reasonably certain to occur within the area of the Federal action subject to consultation. Such actions are "reasonably certain" to occur if they require the approval of a local resource or land use control agency, and such agencies have essentially approved the action.

There are no such cumulative effects anticipated concerning any of the four listed waterbirds.

<u>Incidental Take</u>

Section 9 of the Act prohibits any taking (harm, harassment, mortality, etc.) of listed species without specific exemption. Under the terms of Section 7(b)(4) and Section 7(o)(2), taking that is incidental to and not intended as part of your action is not considered taking within the bounds of the Act provided that such taking is in compliance with this incidental take statement.

1. Birds in the immediate vicinity of dredging or construction would be expected to temporarily leave the area for elsewhere in Kawainui or the wetlands across from Hamakua Drive, the Nuupia Ponds at the Marine Corps Air Station, or other local area wetlands. Such disturbances are considered harassment, and allowance for such harassment of listed waterbirds at Kawainui is provided in this incidental take statement.

2. No taking of any listed species through injury or nest destruction is allowed under this incidental take statement.

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize the taking of Hawaiian stilt, Hawaiian common moorhen, Hawaiian coot, and Hawaiian duck:

1. You must ensure that no injury of a listed waterbird or destruction of their nests occurs as a result of the construction of a flood control structure or its operation.

2. You must ensure that both the quantity and quality of listed waterbirds' wetland habitat is maintained at Kawainui Marsh.

In order to be exempt from the prohibitions of Section 9 of the Act (Prohibited Acts), the following terms and conditions, which implement the reasonable and prudent measures described above, must be complied with:

1. Prior to any construction at Kawainui, you must survey the area to be disturbed to determine if any active nests of listed waterbirds are present which would be destroyed. If a nest is identified, work within 100 feet of the nest is to be suspended pending either desertion of the nest by the adult(s) or fledging of young.

2. Any open water or mud flat area of Kawainui which would be filled as a result of your selection of a flood control plan must be replaced two for one by the creation of similar habitat areas within the marsh. For example, if the levee is to be made wider by extending its base into the marsh, filling five acres of what is now open water, then ten acres of marsh is to be cleared of vegetation elsewhere in Kawainui, creating ten acres of open water habitat. The area to be cleared is to be excavated to a depth which will exclude emergent grass or reed-like vegetation. Such areas will be maintained to both prevent the encroachment of aquatic vegetation and allow for the removal of sediments which may collect there. Any proposal to create such open water habitat will require the approval of this Service prior to implementation, and additional features, such as a sculpted shoreline and nesting islets, may be required.

3. You must ensure that any construction or operation which alters the water retention, direction of flow, or amount of flow in Kawainui does not reduce water levels in the marsh below present levels. This requirement makes it imperative that any engineering design considers water retention, as well as water expulsion, as part of the flood control plan.

4. Any proposal to divert or re-direct the flow of water into Kawainui Marsh (such as through a training dike) must first determine if that action will adversely affect water levels in the marsh. If it is found that such a structure, vegetation clearing or dredging plan may decrease water levels below what is "normally" found in the marsh, consultation with this office must be reinitiated. Similarly, should it be determined that water quality will decrease anywhere in the marsh because inflows are being re-directed or decreased in volume, consultation must be reinitiated.

Conservation Recommendations

Section 402.02 (Definitions) of Section 7 of the Act states that discretionary measures which would serve to minimize or avoid adverse effects of a proposed action on listed species or critical habitat may be recommended. Further, the Act charges federal agencies with using their authorities in the conservation of listed species. We believe you have the opportunity to assist in this effort by accepting the following recommendations.

1. Precautions must be taken to insure that any springs which feed Kawainui Marsh are not covered or damaged so as to decrease their present level of flow. The maintenance of water quality and water levels in the marsh must be maintained to insure the welfare of waterbirds.

2. Any plan to create open water areas must consider the creation of favorable waterbird habitat. The shoreline edge, bottom contours and nesting islets should be designed and constructed to encourage waterbird nesting and feeding. We are available to assist you with these considerations.

3. To improve waterbird habitat while increasing the marsh's flood control capabilities, encourage the periodic removal of vegetation which encroaches on open water areas. Regularly dredge open water areas to prevent a buildup of sediments.

4. Encourage more stringent enforcement of existing erosion and sediment control requirements at points upstream from the marsh.

This letter addresses only the effect of generalized flood control alternatives on listed species. As emphasized earlier in this letter, we do not yet have specific and detailed plans or other information required to analyze possible impacts more thoroughly. As you more clearly define the scope and method of a chosen flood control plan and as more information becomes available, reinitiation of consultation as directed by Section 7 may be required.

We will be continuing to work with you in assessing the project's impacts on other biological resources as directed by other legislation, and may recommend additional mitigation or project modifications to decrease the impact of wetland fills on these resources.

Sincerely yours,

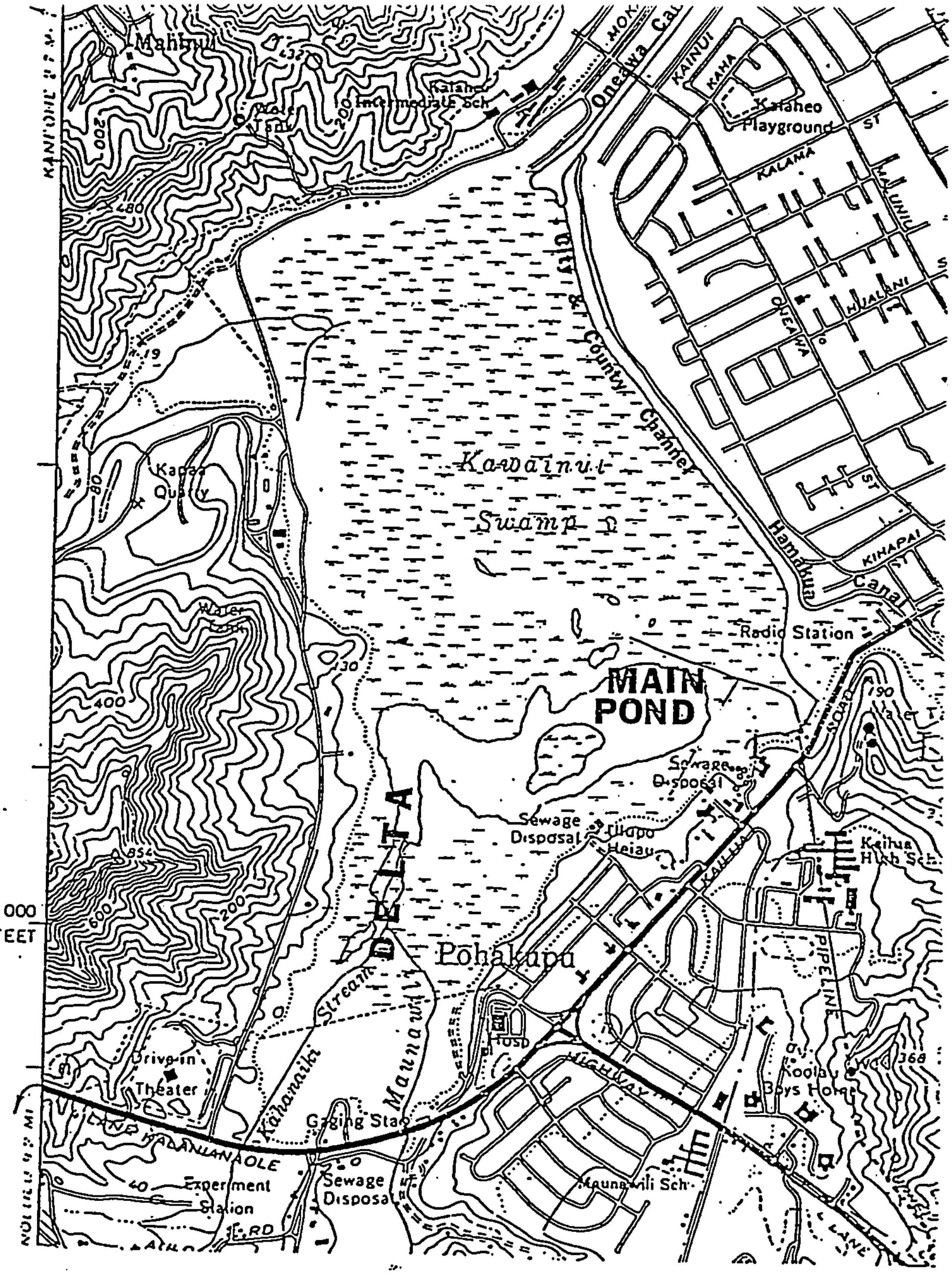
William R. Farnell

for Ernest Kosaka
Field Office Supervisor
Office of Environmental Services

Enclosures

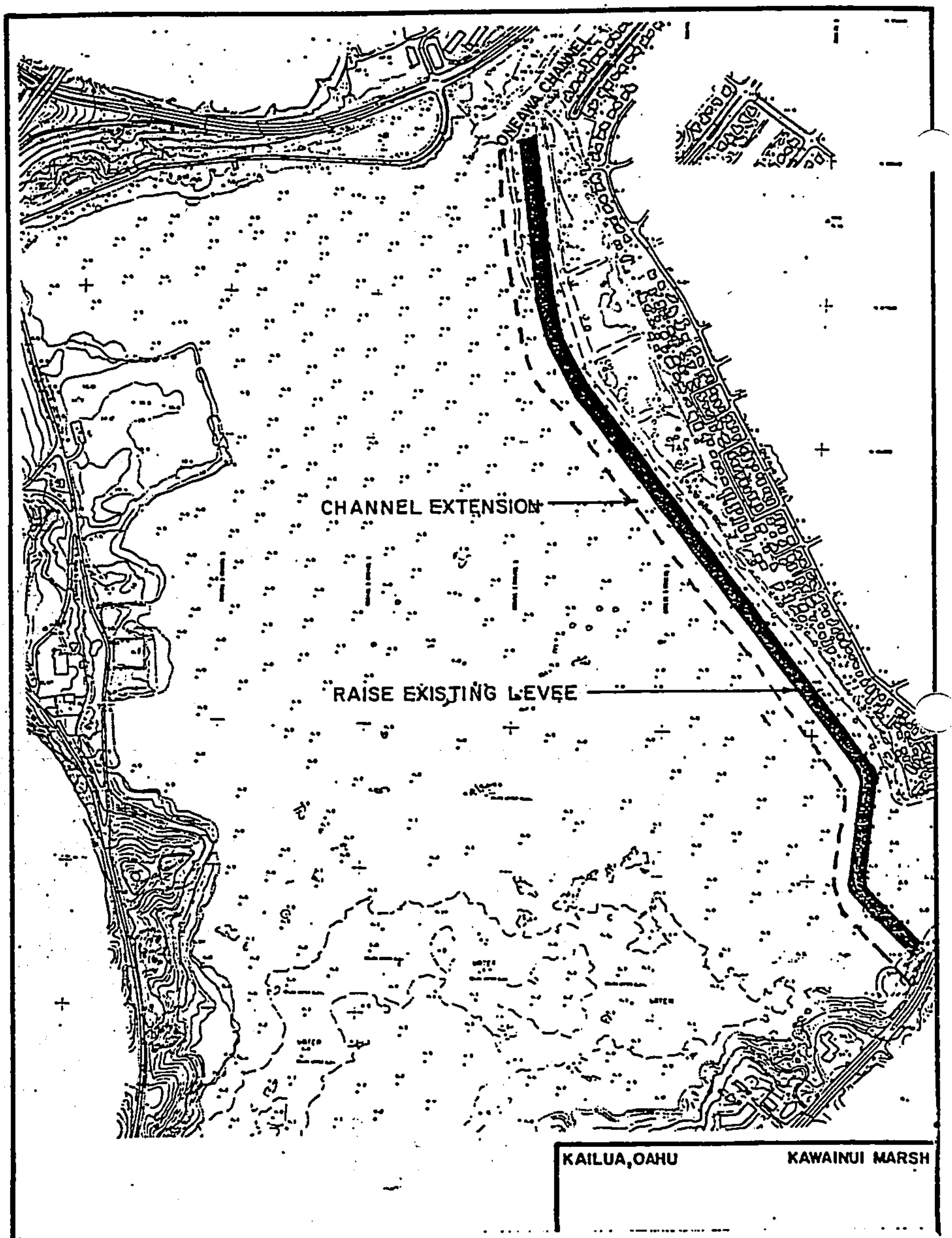
cc: Regional Director, Fish and Wildlife Service, Region 1, Portland, Oregon
(Attn: Section 7 Coordinator)

RECEIVED AS FOLLOWS



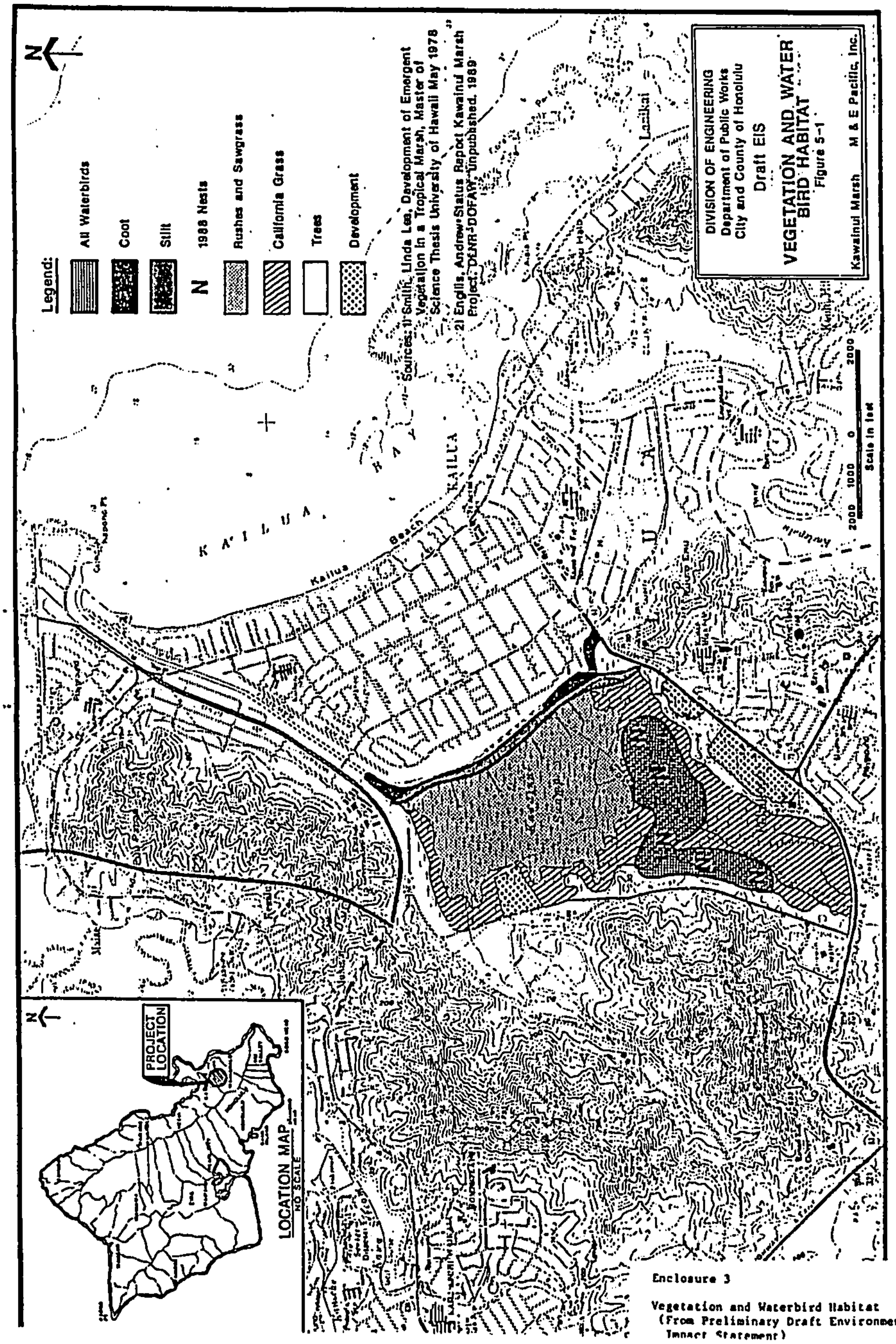
Enclosure 1

Map of Kawainui Marsh
from "Waterbird Status in Kawainui
Marsh" (State of Hawaii)



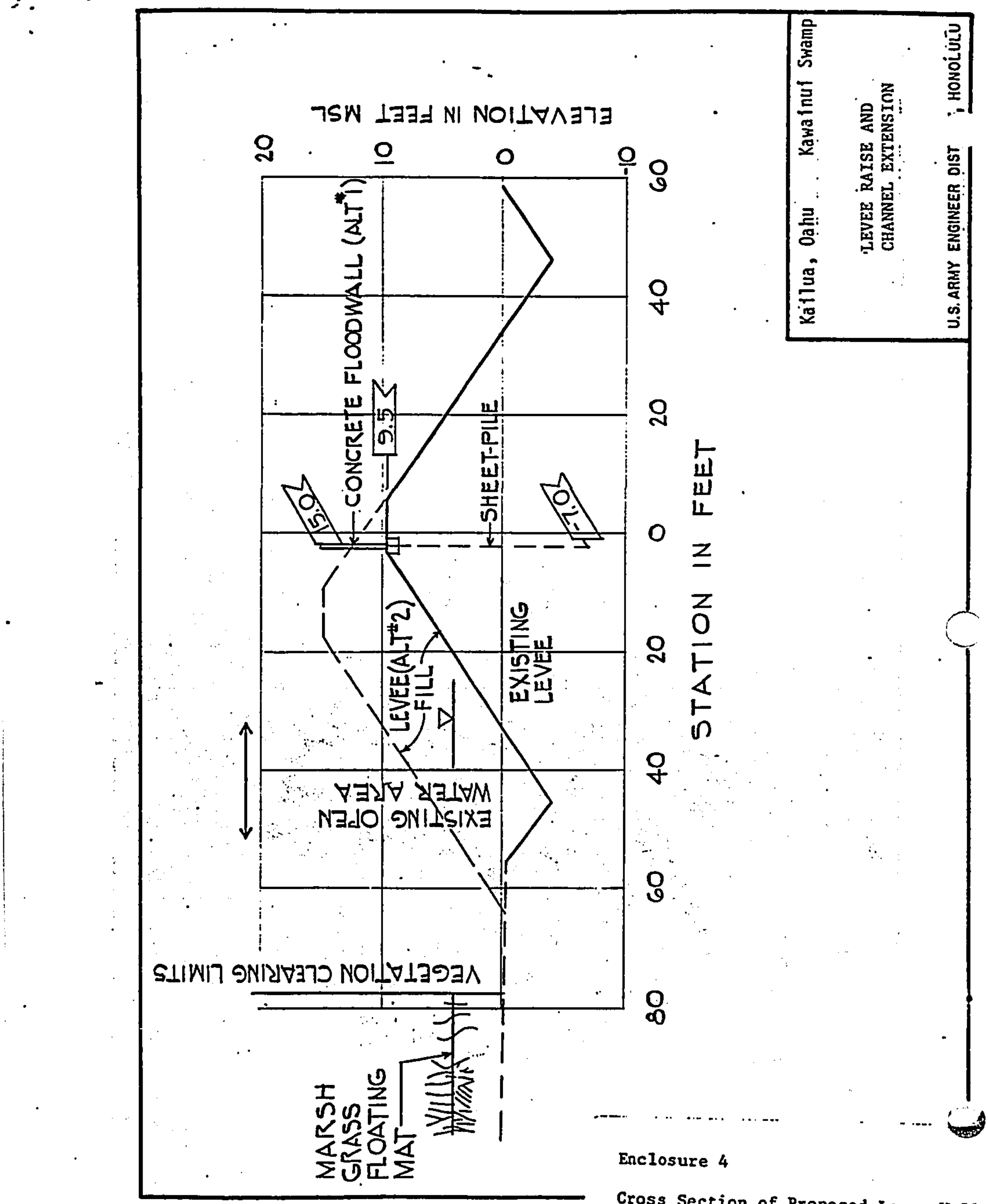
Enclosure 2

Proposed Channel Extension and Levee Construction (from Corps 1989 Reconnaissance Report)



Enclosure 3

Vegetation and Waterbird Habitat
(From Preliminary Draft Environmental Impact Statement)



Enclosure 4

Cross Section of Proposed Levee Wall
(From 1989 Reconnaissance Report)

KAWAINUI MARSH
FLOOD CONTROL PROJECT
OAHU, HAWAII

COASTAL ZONE MANAGEMENT PROGRAM
FEDERAL CONSISTENCY DETERMINATION

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, HONOLULU
FORT SHAFTER, HAWAII 96858-5440

DETERMINATION

OF

FEDERAL CONSISTENCY:

FY 1992

KAWAINUI MARSH FLOOD CONTROL PROJECT

AT

KAILUA, OAHU, HAWAII

December, 1991
HAWAII CZM PROGRAM

ASSESSMENT FORMAT

RECREATIONAL RESOURCES

Objective: Provide coastal recreational opportunities accessible to the public.

Policies:

1) Improve coordination and funding of coastal recreation planning and management.

2) Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area by:

a) Protecting coastal resources uniquely suited for recreational activities that cannot be provided in other areas;

b) Requiring replacement of coastal resources having significant recreational value, including but not limited to surfing sites and sandy beaches, when such resources will be unavoidably damaged by development; or requiring reasonable monetary compensation to the State for recreation when replacment is not feasible or desirable;

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

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

e) Encouraging expanded public recreational use of County, State, and Federally owned or controlled shoreline lands and waters having recreational value;

f) Adopting water quality standards and regulating point and non-point sources of pollution to protect and where feasible, restore the recreational value of coastal waters;

g) Developing new shoreline recreational opportunities, where appropriate, such as artificial reefs for surfing and fishing; and

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

Check either "Yes" or "No" for each of the following questions.

	Yes	No	
1.		X	Will the proposed action involve or be near a dedicated public right-of-way?
2.		X	Does the project site abut the shoreline?
3.	X		Is the project site near a State or County park?
4.	X		Is the project near a perennial stream?
5.		X	Will the proposed action occur in or affect a surf site?
6.		X	Will the proposed action occur in or affect a popular fishing area?
7.	X		Will the proposed action occur in or affect a recreational or boating area?
8.		X	Is the project site near a sandy beach?
9.	X		Are there other recreational uses in the area?

Discussion

Kawainui Marsh is a City and County Regional Park. The project is believed consistent with the State's Kawainui Marsh Resource Management Plan. Although the levee is used for passive activities such as walking, bird watching, etc., recreational opportunities in Kawainui Marsh are restricted by lack of permitted access to the levee and marsh interior. Tours of the levee are granted by the City and County of Honolulu with advanced notice.

HISTORIC RESOURCES

Objective: Protect, preserve, and where desirable, restore those natural and man-made historic and pre-historic resources in the coastal zone management area that are significant in Hawaiian and American history and culture.

Policies:

1) Identify and analyze significant archaeological resources;

2) Maximize information retention through preservation of remains and artifacts or salvage operations; and

3) Support State goals for protection, restoration, interpretation, and display of historic resources.

Check either "Yes" or "No" for each of the following questions.

	Yes	No	
1.	X		Is the project site within a historic/cultural district?
2.		X*	Is the project site listed on or nominated to the Hawaii or National register of historic places.
3.		X	Does the project site include undeveloped land which has not been surveyed by an archaeologist?
4.	X		Has a site survey revealed any information on historic or archaeological resources?
5.	X		Is the project site within or near a Hawaiian fishpond or historic settlement area?

Discussion

* The State Historic Preservation Officer and the Keeper of the National Register have determined that the entire Kawainui Marsh is eligible to be listed on the National Register of Historic Places. Two large Hawaiian heiau (Ulu po and Pahukini) are in the vicinity of the marsh. Extensive wetland agricultural systems, terraced hillslope dryland agricultural systems, habitation sites, and submerged walls within and in the proximity of the marsh have been identified. No cultural material has been found on the levee or its immediate vicinity. The marsh's significance to the Hawaiian culture has been documented in oral tradition, chanting and hula. The highly productive area of the Kailua ahupua'a (land division) became the central government of Oahu and was associated with a number of prominent ali'i or Hawaiian royalty. Coordination with the State Historic Preservation Officer in accordance with Section 106 of the National Historic Preservation Act is ongoing.

SCENIC AND OPEN SPACE RESOURCES

Objective: Protect, preserve and, where desirable, restore or improve the quality of coastal scenic and open space resources.

Policies:

1) Identify valued scenic resources in the coastal zone management area;

2) Insure that new developments are compatible with their visual environment by designing and locating such developments to minimize the alteration of natural landforms and existing public views to and along the shoreline;

3) Preserve, maintain and, where desirable, improve and restore shoreline open space and scenic resources; and

4) Encourage those developments which are not coastal dependent to locate in inland areas.

Check either "Yes" or "No" for each of the following questions.

	Yes	No	
1.	X		Does the project site abut a scenic landmark?
2.		X	Does the proposed action involve the construction of a multi-story structure or structures?
3.	X		Is the project site adjacent to undeveloped parcels?
4.		X	Does the proposed action involve the construction of structures visible between the nearest coastal roadway and the shoreline?
5.		X	Will the proposed action involve construction in or on waters seaward of the shoreline? On or near a beach?

Discussion

Kawainui Marsh is a scenic landmark. The entire project area is undeveloped, but the residential subdivision of Coconut Grove (Kailua, Oahu) lies to the east of the project. No significant adverse visual impacts are anticipated from the project alternatives. Landscaping is a component of all levee modifications.

COASTAL ECOSYSTEMS

Objective: Protect valuable coastal ecosystems from disruption and minimize adverse impacts on all coastal ecosystems.

Policies:

1) Improve the technical basis for natural resource management;

2) Preserve valuable coastal ecosystems of significiant biological or economic importance;

3) Minimize disruption or degradation of coastal water ecosystems by effective regulation of stream diversions, channelization, and similar land water uses, recognizing competing water needs; and

4) Promote water quantity and quality planning and management practices which reflect the tolerance of fresh water and marine ecosystems and prohibit land and water uses which violate State water quality standards.

Check either "Yes" or "No" for each of the following questions.

	Yes	No	
1.	X		Does the proposed action involve dredge or fill activities?
2.		X	Is the project site within the Shoreline Setback Area (20 to 40 feet inland of the shoreline)?
3.		X	Will the proposed action require some form of effluent discharge into a body of water?
4.	X		Will the proposed action require earthwork beyond clearing and grubbing?
5.		X	Will the proposed action include the construction of special waste treatment facilities, such as injection wells, discharge pipes, or cesspools?
6.	X		Is an intermittent or perennial stream located on or near the project site?
7.	X		Does the project site provide habitat for endangered species of plants, birds, or mammals?
8.	X		Is any such habitat located nearby?
9.	X		Is there a wetland on the project site?
10.		X	Is the project site situated in or abutting a Natural Area Reserve?

11. X Is the project site situated in or abutting a Marine Life Conservation District?

12. X Is the project site situated in or abutting an estuary?

Discussion

Kawainui Marsh is the State's largest remaining wetland. No impact to coastal water quality is anticipated as a result of any levee modification. Some levee alternatives will have an impact on wetland features. Compensatory wetland mitigation for these alternatives will include the restoration of previously filled wetland in the marsh near the Oneawa Channel.

ECONOMIC USES

Objective: Provide public or private facilities and improvements important to the State's economy in suitable locations.

Policies:

1) Concentrate in appropriate areas the location of coastal dependent development necessary to the State's economy;

2) Insure that coastal dependent development such as harbors and ports, visitor industry facilities, and energy generating facilities are located, designed, and constructed to minimize adverse social, visual, and environmental impacts in the coastal zone management area; and

3) Direct the location and expansion of coastal dependent developments to areas presently designated and used for such development and permit reasonable long-term growth at such areas, and permit coastal dependent development ouside of presently designated areas when:

a) Utilization of presently designated locations is not feasible;

b) Adverse environnmental effects are minimized; and

c) Important to the State's economy.

Check either "Yes" or "No" for each of the following questions.

	Yes	No	
1.		X	Does the project involve a harbor or port
2.	X		Is the project site within a designated tourist destination area?
3.		X	Does the project site include agricultural lands or lands designated for such use?
4.		X	Does the proposed activity relate to commercial fishing or seafood production?
5.		X	Does the proposed activity relate to energy production?
6.		X	Does the proposed activity relate to seabed mining?

Discussion

Flood control improvements will have positive economic impacts to the community of Coconut Grove.

COASTAL HAZARDS

Objective: Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, and subsidence.

Policies:

1) Develop and communicate adequate information on storm wave, tsunami, flood, erosion, and subsidence hazard;

2) Control development in areas subject to storm wave, tsunami, flood erosion, and subsidence hazard;

3) Ensure that developments comply with requirement of the Federal Flood Insurance Program; and

4) Prevent coastal flooding from inland projects.

Check either "Yes" or "No" for each of the following questions.

	Yes	No	
1.		X	Is the project site on or abutting a sandy beach?
2.		X	Is the project site within a potential tsunami inundation area as depicted on the National Flood Insurance Program flood hazard map?
3.	X		Is the project site within a potential flood inundation area according to a flood hazard map?
4.		X	Is the project site within a potential subsidence hazard area according to a subsidence hazard map?
5.		X	Has the project site or nearby shoreline areas experienced shoreline erosion?

Discussion

The project site is in Zone A of the FEMA Flood Insurance Rate Map (Panel 60 and 90, Rev., 4 Sept.1987), which means that it lies within a Special Flood Hazard Area. The marsh is protected from development as a result of its use as a flood storage basin. Flood waters were not passed quickly enough to the Oneawa outlet channel during the 1988 New Year's Flood resulting in the overtopping of the levee and severe economic damages to the people of Coconut Grove.

MANAGING DEVELOPMENT

Objective: Improve the development review process, communication, and public participation in the management of coastal resources and hazards.

Policies:

1) Effectively utilize and implement existing law to the maximum extent possible in managing present and future coastal zone development;

2) Facilitate timely processing of application for development permits and resolve overlapping or conflicting permit requirements; and

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

Check either "Yes" or "No" for each of the following questions.

	Yes	No	
1.	X		Will the proposed activity require more than two (2) permits or approvals?
2.	X		Does the proposed activity conform with the State and County land use designations for the site?
3.	X		Has or will the public be notified of the proposed activity?
4.	X		Has a draft or final environmental impact statement or an environmental assessment been prepared?

Discussion

In addition to this CZM coordination, this action is being coordinated with the U.S. Fish and Wildlife Service under the Endangered Species Act, the State Historic Preservation Office under Section 106 (NHPA), and other State and County agencies for approvals or exemptions therefrom. The project is located in a Conservation District and is necessary to prevent further economic losses in the event of flooding. The integrity of the marsh as a flood control basin, water levels in the basin, and its status as a wildlife sanctuary will be maintained. Two public workshops were held on February 21,1990 and April 19, 1990. A formal public meeting was held on May 29, 1991 to receive public comment on the DEIS. Several other informational meetings have been held since the New Year's Flood of 1988. This FEIS is a coordinated effort by the City and County of Honolulu and the U.S. Army Corps of Engineers, Honolulu District.

FEDERAL CONSISTENCY
SUPPLEMENTAL INFORMATION FORM

Project/Activity Title or Description: KAWAINUI MARSH FLOOD CONTROL PROJECT

Island: OAHU Tax Map Key No.: 4-2-13,16 Pors Est. Start Date: 1993

APPLICANT OR AGENT

Name & Title: James T. Muratsuchi
Lieutenant Colonel, U.S. Army
District Engineer

Agency/Organization: U.S. Army Engineer District, Honolulu
Address: Building 230
Fort Shafter, Hawaii 96858-5440

TYPE OF APPLICATION

[X] I. Federal Activity

"The proposed activity is consistent with and will be conducted in a manner consistent to the maximum extent practicable with the Hawaii Coastal Zone Management Program."

Signature: 6 MAR 92
JAMES T. MURATSUCHI
Lieutenant Colonel, U.S. Army
District Engineer
Date

KAWAINUI MARSH
FLOOD CONTROL PROJECT
OAHU, HAWAII

STATE OF HAWAII HISTORIC PRESERVATION OFFICE
SECTION 106 COORDINAITON

(P) 28

PV

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

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

DEPUTIES
KEITH W. AHUE
MANABU TAGOMORI
DAN T. KOCHI

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

FEB 27 1991

REF:HP-TK

Kisuk Cheung
Director of Engineering
Planning Division
Department of the Army
U.S. Army Engineer District, Honolulu
Building 230
Fort Shafter, HI 96858-5440

Dear Mr. Cheung:

SUBJECT: U.S. Army Corps of Engineers, Review of draft final report entitled Paleo-environmental and Archaeological Investigations, Kawainui Marsh Flood Control Project, O'ahu Island, Hawai'i
Kailua, Ko'olaupoko, O'ahu
TMK: 4-2-3:10, 18

This project was designed to evaluate the presence or absence of historic sites in the vicinity of the levee on the eastern side of Kawainui Marsh. Field methods included surface survey, examination of previously recorded surface features, test excavations, and extensive coring within the marsh. These methods were carried out competently. No archaeological remains were found within the project area; previously recorded surface features were determined to be remnants of dredged sediment. We believe that the project area has been adequately surveyed and that no historic sites are located within the project area. We believe that the flood control project will have "no effect" on significant historic sites.

It is possible that construction activities during the flood control project will unearth historic sites; possibilities include remains preserved in the anaerobic marsh conditions and subsurface structural remains associated with an historically noted fishpond. Periodic archaeological monitoring of disturbance to intact marsh sediments is recommended. As usual, inadvertent finds during the course of construction should be reported to the State Historic Preservation Division and construction activities halted until the context of the finds can be investigated.

Last, we would like to state, that in our view, this report makes an important substantive contribution to the study of Hawaiian prehistory. In particular, data from the marsh cores have been marshalled to test several interesting hypotheses. These include hypotheses on 1) the evolution of Kawainui Marsh and the Kailua berm, 2) the nature of the lowland forest on Windward O'ahu prior to the arrival of Polynesian peoples, 3) vegetation changes after Polynesian settlement, and 4) ancient Hawaiian agricultural practices, in particular the use of fire to clear forest and agronomic techniques associated with soil conservation. We believe that the detailed information provided by this report will aid us in our mission of promoting the use and conservation of historic sites for the education, inspiration, pleasure and enrichment of Hawaii's citizens.

Very truly yours,

WILLIAM W. PATY
Chairperson and State
Historic Preservation Officer

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

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

DEPUTIES
KEITH W. AHUE
MANABU TAGOMORI
DAN T. KOCHI

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

Copy DPW

REF: HP-JLE

MAY 30 1991

Kisuk Cheung
Director of Engineering
Department of the Army
U.S. Army Engineer District, Honolulu
Building 230
Fort Shafter, Hawaii 96858-5440

Dear Mr. Cheung:

SUBJECT: Department of the Army, U.S. Army Engineer District -- Detailed Project Report and Draft Environmental Impact Statement for the Kawainui Marsh Flood Control Project Kailua, Koolaupoko, O'ahu
TMK: 4-2

The draft environmental impact statement considers the impacts of six alternate plans. The first two of these, raising the levee and building a floodwall atop the levee, were the subject of an archaeological inventory survey draft report completed in February 1991. A final report of this work is not yet complete. We concurred with the draft findings of this survey that there were no historic sites within the levee project area and agree with the assessment in the draft environmental impact statement that these alternatives will have "no effect" on historic sites in the levee area.

The remaining four alternate plans, which include marsh clearing, a Quarry Road Channel connecting with Oneawa Channel, an extension to Oneawa Channel with a new "back levee," and flood-proofing of approximately 2,030 homes in Coconut Grove, have not been the subject of archaeological inventory surveys and thus we are unable to offer detailed comments. However, the draft environmental impact statement notes that these alternate plans may have adverse effects on historic sites, an opinion with which we concur. In our opinion, the "back levee" and flood-proofing alternates would likely entail extensive archaeological excavations in order to mitigate their probable adverse effects outside of Kawainui Marsh. If any of these four alternate plans were chosen then we would require an archaeological inventory survey as the first step in the historic preservation process.

Should you have any questions, please have your staff contact Dr. Tom Dye at 587-0014.

Sincerely,

WILLIAM W. PATY, Chairperson and
State Historic Preservation Officer

KAWAINUI MARSH
FLOOD CONTROL PROJECT
OAHU, HAWAII

SECTION 404 (b)(1)
FACTUAL DETERMINATION

Section 404 (b)(1) Practicable Alternatives Analysis
Discharge of Fill Material
Kawainui Marsh Flood Control Project Project

The 404(b)(1) Guidelines are the substantive criteria used in specifying discharge allocation of dredged or fill material under Section 404 of the Clean Water Act (40 CFR Part 230). The purpose of the Guidelines is to restore and maintain the chemical, physical, and biological integrity of waters of the United States through the control of discharges of dredged or fill material. The Guidelines apply to all Department of the Army (DA) permit decisions under Section 404 of the Clean Water Act as well as to civil works projects of the Corps involving the discharge of dredged or fill material for which there is no DA permit (see 33 CFR 209.145 and section 150 of Pub.L.94-587, Water Resources Development Act of 1976).

Water Dependency:

Levee fill is required to improve the existing flood control function of the levee. The basic project purpose of the levee is to divert water. Hence, the basic project purpose is water dependent and the legal presumption, that a least environmentally damaging alternative is available, does not apply.

Disposal of marsh vegetation and sediment:

Disposal site for vegetation and excess spoils associated with the levee raise and new wetland creation will be at the Waimanalo Gulch Sanitary Landfill in Nanakuli or at the Kapa`a Landfill site near the marsh. Maintenance of interior channels created by the City and County may occur through a jet-spray process which would broadcast spray vegetation and sediment on either side of the interior channels. The material would be deposited in a 2-3 inch layer in the marsh.

Avoidance and Minimization:

Alternative Project Location: The project involves the improvement of an existing flood control levee. Thus, an analysis of alternative locations is not reasonable.

Practicable Alternatives Analysis: The practicable alternatives considered are shown in the following table. Detailed project costs are provided in Appendix B.

Alternatives (100 yr Protection)	Amount of Fill Cubic Yards	Wetland Filled (acres)
Alternative 1: Raise Levee	40,000	6.4
Alternative 2: Floodwall	0	0
Alternative 3A: Combination of raised levee and flood wall	20,300	1.8
Alternative 3B: Combination of raised top of levee and flood wall	0	0

Levee Raise: Requires the most fill: Approximately 195,000 cubic yards of material would be required for levee fill. The levee would be constructed by first removing the gravel surface on the existing levee, benching the Coconut Grove side of the levee, and removing the vegetation, root mat, peat, and other organic material estimated to range from 3 to 6 feet thick, from a strip of low lying land between the existing levee and Kaelepulu Stream to prevent problems with settlement and slope stability. The fill material would then be placed to construct a levee with a crest width of 10 feet and having dimensions specified in this final document. All slopes would be grassed and a gravel road would be constructed on the levee crest to provide a stabilized, "all-weather" roadway for maintenance vehicles. Approximately 6.4 acres of wetland would be filled by the new levee.

Floodwall: No fill required: An L-shaped concrete floodwall would be constructed upon the crest of the existing levee. No wetland areas will filled.

Floodwall atop Levee Raise 3A: Minimal fill required

This compromise alternative fills less wetland than the earthen levee raise (1.8 acres) and utilizes a floodwall of lesser height (max. 4 feet).

Floodwall atop Levee Raise with Retaining Wall 3B: No fill required:

This alternative was designed to include a levee retaining wall to eliminate the need to fill wetland.

Selection of Alternative:

Alternative 3A has been selected because it is more aesthetically pleasing than the eight foot floodwall and consequently more acceptable to the community. It appears to accomodate the concerns of residents and resource agencies on both issues (i.e., wetland fill and aesthetics). Compensatory wetland mitigation may ultimately be of greater value than avoiding the impact to the wetland by building a floodwall alone. There are areas that would benefit from restoration efforts and provide better habitat than the strip of wetland that would be filled. The earthen levee raise alone would be most compatible with the wilderness character of the marsh and existing maintenance and recreational usage but fills four times more wetland habitat than alternative 3A.

Factual Determinations for Selected Alternative:

Physical Substrate determination: Wetland fill will create dry upland environment.

Water Circulation, fluctuation and salinty determinations: Fill does not alter the water circulation, fluctuation or salinity patterns in Kaelepulu Stream or Kawainui Marsh, which are already altered by the presence of the existing levee.

Suspended particulate/turbidity determination: Temporary turbidity and sedimentation may occur during the period of construction. Erosion control measures are required as part of the construction contract to minimize turbidity and sedimentation.

Contaminant Determination: Fill material for the levee modifications shall be brought in by truck from a clean upland site which is removed from sources of contamination within approximately five miles of the project site. All stones and aggregates will be from the Hawaiian Rock Projects quarry approximately five miles from the project site. Any silt materials used in the levee raise shall have a liquid limit less than 60 and a plasticity index less than 30. This material is similar to the material at the base of the existing levee and does not require chemical or biological testing.

Aquatic ecosystem and organisms determination: No significant aquatic organisms are present in the wetland.

Other Wildlife: Endangered and threatened species are found in the marsh and Kaelepulu Stream. The marsh is identified as important endangered waterbird habitat. No birds or nests are known to exist in the specific wetlands impacted by the project. Section 7 consultation with the USFWS was completed on 12 July 1990 and a no jeopardy opinion was received for levee modifications.

Potential Impacts on Special Aquatic Sites: 1.8 acres of wetland would be filled by Alternative 3A.

Potential effects on Human Use Characteristics:

Municipal and private water supply: None

Recreational and Commerical fishing: None

Water recreation: None

Aesthetics: Some viewplane loss from Coconut Grove.

Parks, national and historical monuments, seashores, wilderness areas, research sites and similar preserves: Kawainui Marsh is an educational and cultural resource as well as eligible for listing on the National Register of Historic Places. The fill will not impact the historic significance of the marsh.

Actions to Minimize Adverse Effects:

The fill materials to be placed in the portion of the levee below elevation (+) 2.0 feet MSL shall consist of granular sands and gravels having not more than 15 percent passing the No. 200 sieve, in order to minimize turbidity and to facilitate underwater placement of fill materials without dewatering. The initial placement of fill for the levee will be to elevation (+) 2.0 feet MSL, and will be accomplished without rigid compaction controls. The initial fill will serve as a working platform for the overlying fill materials which shall be placed in lifts and compacted. Runoff and other discharges from the fill areas will be minimized. Efforts shall be made to minimize the attraction of endangered waterbirds. Vegetation will be removed from the project site and disposed of at the Waimanalo Gulch Sanitary Landfill in Nanakuli or at the Kapa'a Landfill near the marsh.

Construction of wetland areas in the marsh will be timed to avoid the active breeding and nesting season of waterbirds within the marsh or other biologically critical time periods for other species.

Mitigation for Selected Alternative:

Compensatory wetland mitigation for the 1.8 acre wetland fill will include restoration of equivalent wetland acreage from fastland bordering the levee on the marsh side at the estuary end.

Finding:

The discharge of fill material for improvement of the Kawainui Marsh Flood Control Project is specified as complying with the requirements of these guidelines with the inclusion of appropriate and practicable discharge conditions to minimize pollution or adverse effects to the affected aquatic ecosystems.

KAWAINUI MARSH
FLOOD CONTROL PROJECT
OAHU, HAWAII

HEAVY METALS DATA

Heavy Metals Data

Excerpted from the City and County of Honolulu Kawainui Marsh Flood Damage Mitigation Project Final Environmental Impact Statement

June 1990

Chlorides and Conductivity

Measurement of chlorides and conductivity relate, in this instance, to what can be termed brackishness of the water. That is, both measurements provide a conservative measure of mixing of fresh water from streams and sea water (or brackish ground water) in which the chloride content (>18,000 mg/L in seawater) and conductivity would both be high.

The samples shown in Table B-8 all show low chlorides content (<30 mg/L) and low conductivity (<260 µmhos/cm at 25°C) indicative of fresh water. The results are consistent from place to place, with the exception of the sample from Station 8 where both chloride and conductivity are slightly elevated. The increase is not great (chloride content remains less than 0.4% that of sea water), but appears real. The next highest chloride (and conductivity) was recorded at Station 7, ostensibly downstream from Station 8, although the sample was collected one month earlier.

Table B-9. Results of May 25, 1989 field measurements for temperature, pH, and dissolved oxygen at selected locations in Kawainui Marsh and tributary streams.

STATION		Time	pH	Temp. °C	DO mg/L
1	Maunawili Str.	1141	7.93	23.2	7.5
2	Kahanaiki Str.	1154	7.71	24.0	7.9
3	southwest (A)	1125	7.60	25.0	6.6
5	flow off marsh	0945	6.69	24.2	3.6
-	head end of drainage channel	0927	6.83	24.2	2.2
-	drainage channel above 1st riffle zone	1015	6.89	26.1	3.6
-	drainage channel 20 m below start of riffles	1020	6.90	25.5	3.1
7	upper end Oneawa canal at mouth of drainage channel	1035	7.05	25.8	3.2
8	northwest (2 ft below WL)	1212	7.28	24.9	1.2

Sediment Metals

Sediment samples (Table B-10) were collected at Stations 3, 5, and 8 on April 15, 1989. All samples were vertical cores of the upper sediment layer to a depth not exceeding 30 cm. A duplicate sample was taken at Station 3. The Station 8 sample was actually collected within a few meters of the old landfill (whereas the water quality station was some 30 meters away from the landfill). The Station 5 sample represents the silty mud at the bottom of the city emergency ditch.

The results of total metals analysis for selected heavy metals are given in Table B-10. In addition to analysis of a duplicate sample, an aliquot of the Station 3 sample was spiked with a known amount of each of the metals analyzed. Spikes were generally at the same order of magnitude concentrations as the initial results. Recoveries varied between 118.5% (Zn) and 87.8% (Cu) and averaged 97.4%.

Table B-10. Sediment heavy metals in Kawainui Marsh (mg/kg dry wt.)

STATION SQ	As	Cd	Cu	Cr	Hg	Ni	Pb	Ag	Zn
3	1.44	0.34	35.9	56.7	0.08	53.0	12.4	0.28	35.2
3	1.42	0.35	34.8	53.3	0.06	48.0	12.0	0.34	30.8
2	0.50	0.35	9.2	9.8	0.03	17.0	6.0	0.36	6.8
8	0.40	0.38	41.4	48.5	0.03	86.6	6.8	0.45	33.2

With the exception of cadmium, and perhaps mercury, both of which occur much the same concentration in all three areas sampled, the heavy metal burden of the upper marsh (Station 3) sediment is seen to be substantially greater than that of the lower marsh sediments. However, nickel in particular, was found in greatest concentration at Station 8.

The sediment samples were also analyzed for a variety of other chemical properties shown on Table B-11, for pesticides and PCBs by Gas Chromatography, and for polynuclear aromatic hydrocarbons (PAH) and phenols by EPA Method 8270 (GC/MS scan for semi-volatile organics). All of latter results are included at the end of Appendix B. However, for reporting purposes, the results of the pesticides and PCB analyses on three samples plus one duplicate, as well as the results of the GC/MS scan on three sediment samples, were all less than reporting limits. That is, none of these potentially hazardous organic compound was detected in the sediment samples.

Table B-11. Miscellaneous analyses of sediments from Kawainui Marsh (mg/kg dry wt.)

STATION SQ	TOC	Total CN-	Total S-	Oil & Grease	Pet.HydroC
3	86,000	< 1	33	<100	<100
3	38,000	< 1	32	180	<100
2	96,000	< 1	17	<100	<100
8	11,000	1.4	81	320	<100

Vegetation Mat Samples

Three samples of the vegetation mat, consisting of stems, leaves, and roots of marsh vegetation and a mixture of living plant tissue and debris in various stages of decomposition, were analyzed. These results are presented in Tables B-12 through B-16. The samples were subjected to an EPTox extraction and the extract analyzed for heavy metals. The extraction procedure provides an indication of the concentration of heavy metals that are mobilized at pH 4. That is, unlike the metals concentrations given in Table B-14 which are the total concentration of each heavy metal element in each sample, the EP Toxicity metals are concentrations that might be found in moderately acidic water percolating through the dried sample. These concentrations are given in Table B-15.

Table B-12. Some properties of vegetation mat samples from three areas in Kawainui Marsh.

Sample BQ	Total solids % wet wt	TOC mg/Kg	Ash % dry wt	Alkalinity mg/L $CaCO_3$	Density wet kg/m³	Density dry kg/m³
1	8.82	16,069	10.66	1110	1076	90
2	11.31	217,730	13.47	3000	900	121
3	8.95	306,000	25.69	1900	894	230

Table B-13. Chemical properties of vegetation mat samples from Kawainui Marsh (mg/kg[1]).

Sample BQ	TKN	Si[2]	P	K	Na	SO4[3]	SO4[4]	SO4[5]
1	5250	2.76	612	938	718	141	1600	1598
2	4250	4.55	1184	4936	1533	575	5100	5083
3	14000	20.17	618	637	1002	107	1200	1195

1 As the element on a dry weight basis unless otherwise indicated.
2 Insoluble silica.
3 Sulfate concentration in fresh sample (wet wt basis).
4 Sulfate concentration after drying sample (dry wt basis).
5 Sulfate in fresh sample corrected to dry weight basis.

Table B-14. Heavy metals in vegetation mat samples from Kawainui Marsh (mg/kg dry wt.)

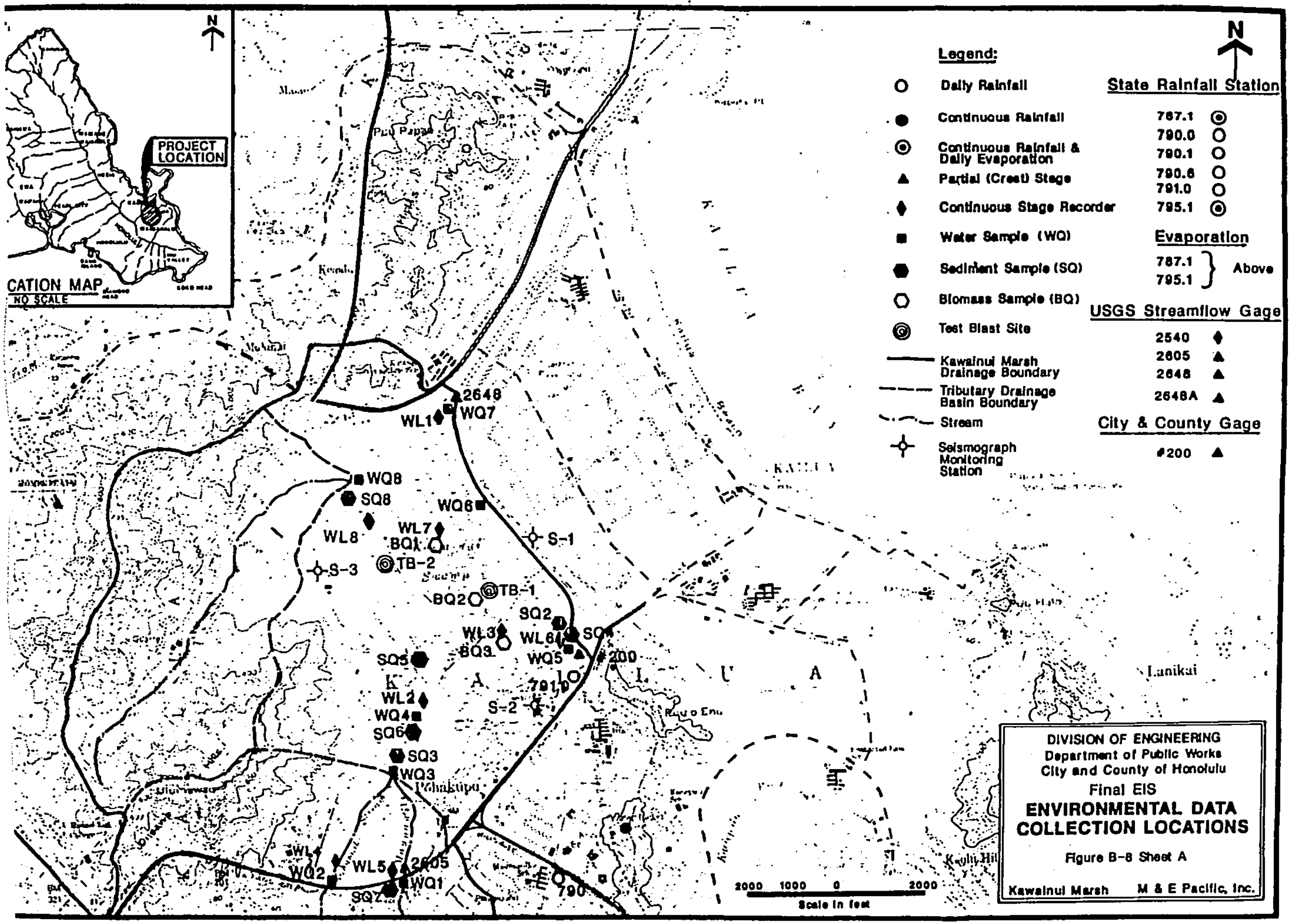
Sample BQ	As	Ba	Cd	Cr	Fe	Pb	Hg	Se	Ag
1	0.13	8.0	0.20	10.2	13720	13.9	0.032	0.046	0.20
2	0.016	19.9	0.20	14.9	20390	7.5	0.016	0.058	0.49
3	0.063	5.05	0.30	34.4	12450	8.0	0.024	0.023	0.23

Table B-15. EP Toxicity metals in vegetation mat samples from Kawainui Marsh (mg/L).

Sample SQ	As	Ba	Cd	Cr	Pb	Hg	Se	Ag
1	<0.01	0.5	<0.01	<0.1	<0.1	<0.0001	<0.002	<0.01
2	<0.01	0.7	<0.01	0.4	0.1	0.003	<0.002	<0.01
3	<0.01	0.6	<0.01	<0.1	<0.1	0.0006	<0.002	<0.01

Table B-16. Additional elements measured in the EP Toxicity extracts of vegetation mat samples from Kawainui Marsh (mg/kg dry wt.)

Sample BQ	P	K	Na	Fe
1	1.1	19.9	38.4	18.0
2	6.1	29.5	40.2	102.5
3	<0.1	0.6	35.0	<0.5



DIVISION OF ENGINEERING
Department of Public Works
City and County of Honolulu
Final EIS

ENVIRONMENTAL DATA COLLECTION LOCATIONS

Figure B-8 Sheet A

Kawainui Marsh M & E Pacific, Inc.

Burmah Technical Services, Inc.
Analytical Laboratories Division
15199 Community Road
P O Drawer 2609
Gulfport, MS 39505
601-863-3036

ANALYTICAL REPORT

AECOS
970 N. Kalaheo, Suite A300
Kailua, Hawaii 96734

ATTENTION: Ms. Kay Town

DATE SAMPLE RECEIVED: 4/19/89
MONTH COVERED: April, 1989
CLIENT NUMBER: AEC200
SAMPLED BY: Client
FREQUENCY: As Requested
DATE: April 26, 1989

IDENTIFICATION: Sediment Samples

SAMPLE NUMBER:	CLIENT I.D.	TOC	UNITS
14655	3520 Sta 3	86,185	mg/kg
14656	3520 Sta 3 Dup.	38,000	mg/kg
14657	3520 Sta 5	96,050	mg/kg
14658	3520 Sta 8	11,300	mg/kg
	*3520 Spike	N/A	mg/kg

*Note: Spiking procedure calls for sample spike prior to prep. Prep procedure calls for multiple rinses with dilute acid and D.I. water. The prep procedure would rinse off spike.

2000 Standard - 1998
Date Analyzed - 4/24/89
Analyst - DD

RECEIVED MAY 0 1 1989

APPROVED BY:

RONALD MCAFEE
LABORATORY MANAGER

CHEMWEST ANALYTICAL LABORATORIES
SEMIVOLATILE ORGANICS

Client I.D.: Sta.3
Date Extracted : 04/24/89
Date(s) Analyzed: 05/03/89

CHEMWEST I.D.: 3683-1
Matrix : Soil

Compound	Amount Detected (ug/Kg)	RL (ug/Kg)
Phenol	BRL	200
2-Chlorophenol	BRL	200
bis(2-Chloroethyl) ether	BRL	200
1,3-Dichlorobenzene	BRL	200
1,4-Dichlorobenzene	BRL	200
1,2-Dichlorobenzene	BRL	200
Benzyl alcohol	BRL	200
2-Methylphenol	BRL	200
bis(2-Chloroisopropyl) ether	BRL	200
Hexachloroethane	BRL	200
N-Nitroso-di-n-propylamine	BRL	200
4-Methylphenol	BRL	200
Nitrobenzene	BRL	200
Isophorone	BRL	200
2-Nitrophenol	BRL	200
2,4-Dimethylphenol	BRL	200
bis(2-Chloroethoxy) methane	BRL	200
2,4-Dichlorophenol	BRL	200
1,2,4-Trichlorobenzene	BRL	200
Benzoic acid	BRL	400
Naphthalene	BRL	200
4-Chloroaniline	BRL	200
Hexachlorobutadiene	BRL	200
4-Chloro-3-methylphenol	BRL	200
2-Methylnaphthalene	BRL	200
Hexachlorocyclopentadiene	BRL	200
2,4,6-Trichlorophenol	BRL	200
2,4,5-Trichlorophenol	BRL	400
2-Chloronaphthalene	BRL	200
2-Nitroaniline	BRL	400
Acenaphthylene	BRL	200
Dimethylphthalate	BRL	200
2,6-Dinitrotoluene	BRL	200
3-Nitroaniline	BRL	400
Acenaphthene	BRL	200
2,4-Dinitrophenol	BRL	400
Dibenzofuran	BRL	200
4-Nitrophenol	BRL	400
2,4-Dinitrotoluene	BRL	200
Fluorene	BRL	200
4-Chlorophenyl-phenylether	BRL	200
Diethylphthalate	BRL	200
4-Nitroaniline	BRL	400
4,6-Dinitro-2-methylphenol	BRL	400

CHEMWEST ANALYTICAL LABORATORIES
SEMIVOLATILE ORGANICS

Client I.D.: Sta.3

CHEMWEST I.D.: 3683-1
Matrix : Soil

Compound	Amount Detected (ug/Kg)	RL (ug/Kg)
N-Nitrosodiphenylamine	BRL	200
4-Bromophenyl-phenylether	BRL	200
Hexachlorobenzene	BRL	200
Pentachlorophenol	BRL	400
Phenanthrene	BRL	200
Anthracene	BRL	200
Di-n-butylphthalate	BRL	200
Fluoranthene	BRL	200
Pyrene	BRL	200
Butylbenzylphthalate	BRL	200
Benzo(a)anthracene	BRL	200
3,3'-Dichlorobenzidine	BRL	400
Chrysene	BRL	200
bis(2-Ethylhexyl)phthalate	BRL	200
Di-n-octylphthalate	BRL	200
Benzo(b)fluoranthene	BRL	200
Benzo(k)fluoranthene	BRL	200
Benzo(a)pyrene	BRL	200
Indeno(1,2,3-cd)pyrene	BRL	200
Dibenz(a,h)anthracene	BRL	200
Benzo(g,h,i)perylene	BRL	200

Surrogates	% Recovery	Acceptance Window
2-Fluorophenol	71%	25-121%
Phenol-d5	85%	24-113%
Nitrobenzene-d5	76%	23-120%
2-Fluorobiphenyl	98%	30-115%
2,4,6-Tribromophenol	76%	19-122%
Terphenyl-d14	81%	18-137%

BRL: Below Reporting Limit.
RL: Reporting Limit.

Approved by: ____

REV4:1.89

CHEMWEST ANALYTICAL LABORATORIES
SEMIVOLATILE ORGANICS

Client I.D.: Sta.5
Date Extracted : 04/24/89
Date(s) Analyzed: 05/03/89

CHEMWEST I.D.: 3683-2
Matrix : Soil

Compound	Amount Detected (ug/Kg)	RL (ug/Kg)
Phenol	BRL	200
2-Chlorophenol	BRL	200
bis(2-Chloroethyl) ether	BRL	200
1,3-Dichlorobenzene	BRL	200
1,4-Dichlorobenzene	BRL	200
1,2-Dichlorobenzene	BRL	200
Benzyl alcohol	BRL	200
2-Methylphenol	BRL	200
bis(2-Chloroisopropyl) ether	BRL	200
Hexachloroethane	BRL	200
N-Nitroso-di-n-propylamine	BRL	200
4-Methylphenol	BRL	200
Nitrobenzene	BRL	200
Isophorone	BRL	200
2-Nitrophenol	BRL	200
2,4-Dimethylphenol	BRL	200
bis(2-Chloroethoxy) methane	BRL	200
2,4-Dichlorophenol	BRL	200
1,2,4-Trichlorobenzene	BRL	200
Benzoic acid	BRL	400
Naphthalene	BRL	200
4-Chloroaniline	BRL	200
Hexachlorobutadiene	BRL	200
4-Chloro-3-methylphenol	BRL	200
2-Methylnaphthalene	BRL	200
Hexachlorocyclopentadiene	BRL	200
2,4,6-Trichlorophenol	BRL	200
2,4,5-Trichlorophenol	BRL	400
2-Chloronaphthalene	BRL	200
2-Nitroaniline	BRL	400
Acenaphthylene	BRL	200
Dimethylphthalate	BRL	200
2,6-Dinitrotoluene	BRL	200
3-Nitroaniline	BRL	400
Acenaphthene	BRL	200
2,4-Dinitrophenol	BRL	400
Dibenzofuran	BRL	200
4-Nitrophenol	BRL	400
2,4-Dinitrotoluene	BRL	200
Fluorene	BRL	200
4-Chlorophenyl-phenylether	BRL	200
Diethylphthalate	BRL	200
4-Nitroaniline	BRL	400
4,6-Dinitro-2-methylphenol	BRL	400

CHEMWEST ANALYTICAL LABORATORIES
SEMIVOLATILE ORGANICS

Client I.D.: Sta.5

CHEMWEST I.D.: 3683-2
Matrix : Soil

Compound	Amount Detected (ug/Kg)	RL (ug/Kg)
N-Nitrosodiphenylamine	BRL	200
4-Bromophenyl-phenylether	BRL	200
Hexachlorobenzene	BRL	200
Pentachlorophenol	BRL	400
Phenanthrene	BRL	200
Anthracene	BRL	200
Di-n-butylphthalate	BRL	200
Fluoranthene	BRL	200
Pyrene	BRL	200
Butylbenzylphthalate	BRL	200
Benzo(a)anthracene	BRL	200
3,3'-Dichlorobenzidine	BRL	400
Chrysene	BRL	200
bis(2-Ethylhexyl)phthalate	BRL	200
Di-n-octylphthalate	BRL	200
Benzo(b)fluoranthene	BRL	200
Benzo(k)fluoranthene	BRL	200
Benzo(a)pyrene	BRL	200
Indeno(1,2,3-cd)pyrene	BRL	200
Dibenz(a,h)anthracene	BRL	200
Benzo(g,h,i)perylene	BRL	200

Surrogates	% Recovery	Acceptance Window
2-Fluorophenol	77%	25-121%
Phenol-d5	90%	24-113%
Nitrobenzene-d5	79%	23-120%
2-Fluorobiphenyl	93%	30-115%
2,4,6-Tribromophenol	72%	19-122%
Terphenyl-d14	76%	18-137%

BRL: Below Reporting Limit.
RL: Reporting Limit.

Approved by: [illegible]

REV4:1.89

CHEMWEST ANALYTICAL LABORATORIES
SEMIVOLATILE ORGANICS

Client I.D.: Sta.8
Date Extracted : 04/24/89
Date(s) Analyzed: 05/03/89

CHEMWEST I.D.: 3683-3
Matrix : Soil

Compound	Amount Detected (ug/Kg)	RL (ug/Kg)
Phenol	BRL	200
2-Chlorophenol	BRL	200
bis(2-Chloroethyl) ether	BRL	200
1,3-Dichlorobenzene	BRL	200
1,4-Dichlorobenzene	BRL	200
1,2-Dichlorobenzene	BRL	200
Benzyl alcohol	BRL	200
2-Methylphenol	BRL	200
bis(2-Chloroisopropyl) ether	BRL	200
Hexachloroethane	BRL	200
N-Nitroso-di-n-propylamine	BRL	200
4-Methylphenol	BRL	200
Nitrobenzene	BRL	200
Isophorone	BRL	200
2-Nitrophenol	BRL	200
2,4-Dimethylphenol	BRL	200
bis(2-Chloroethoxy) methane	BRL	200
2,4-Dichlorophenol	BRL	200
1,2,4-Trichlorobenzene	BRL	200
Benzoic acid	BRL	400
Naphthalene	BRL	200
4-Chloroaniline	BRL	200
Hexachlorobutadiene	BRL	200
4-Chloro-3-methylphenol	BRL	200
2-Methylnaphthalene	BRL	200
Hexachlorocyclopentadiene	BRL	200
2,4,6-Trichlorophenol	BRL	200
2,4,5-Trichlorophenol	BRL	400
2-Chloronaphthalene	BRL	200
2-Nitroaniline	BRL	400
Acenaphthylene	BRL	200
Dimethylphthalate	BRL	200
2,6-Dinitrotoluene	BRL	200
3-Nitroaniline	BRL	400
Acenaphthene	BRL	200
2,4-Dinitrophenol	BRL	400
Dibenzofuran	BRL	200
4-Nitrophenol	BRL	400
2,4-Dinitrotoluene	BRL	200
Fluorene	BRL	200
4-Chlorophenyl-phenylether	BRL	200
Diethylphthalate	BRL	200
4-Nitroaniline	BRL	400
4,6-Dinitro-2-methylphenol	BRL	400

CHEMWEST ANALYTICAL LABORATORIES
SEMIVOLATILE ORGANICS

Client I.D.: Sta.8

CHEMWEST I.D.: 3683-3
Matrix : Soil

Compound	Amount Detected (ug/Kg)	RL (ug/Kg)
N-Nitrosodiphenylamine	BRL	200
4-Bromophenyl-phenylether	BRL	200
Hexachlorobenzene	BRL	200
Pentachlorophenol	BRL	400
Phenanthrene	BRL	200
Anthracene	BRL	200
Di-n-butylphthalate	BRL	200
Fluoranthene	BRL	200
Pyrene	BRL	200
Butylbenzylphthalate	BRL	200
Benzo(a)anthracene	BRL	200
3,3'-Dichlorobenzidine	BRL	400
Chrysene	BRL	200
bis(2-Ethylhexyl)phthalate	BRL	200
Di-n-octylphthalate	BRL	200
Benzo(b)fluoranthene	BRL	200
Benzo(k)fluoranthene	BRL	200
Benzo(a)pyrene	BRL	200
Indeno(1,2,3-cd)pyrene	BRL	200
Dibenz(a,h)anthracene	BRL	200
Benzo(g,h,i)perylene	BRL	200

Surrogates	% Recovery	Acceptance Window
2-Fluorophenol	71%	25-121%
Phenol-d5	73%	24-113%
Nitrobenzene-d5	72%	23-120%
2-Fluorobiphenyl	86%	30-115%
2,4,6-Tribromophenol	65%	19-122%
Terphenyl-d14	72%	18-137%

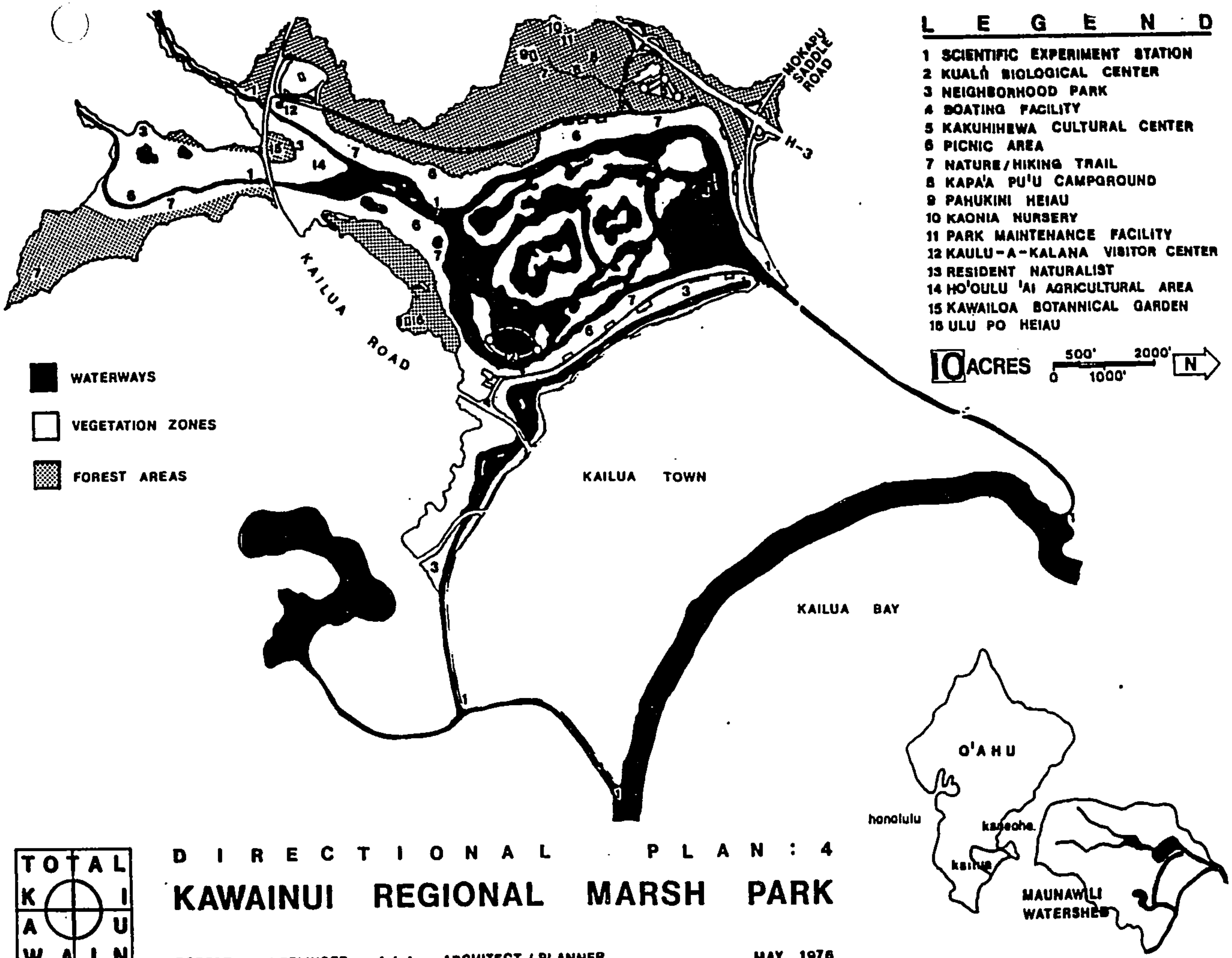
BRL: Below Reporting Limit.
RL: Reporting Limit.

Approved by: ___

REV4:1.89

KAWAINUI MARSH
FLOOD CONTROL PROJECT
OAHU, HAWAII

KAWAI NUI HERITAGE FOUNDATION
DIRECTIONAL PLAN NO. 4



TOTAL KI AU WAIN

D I R E C T I O N A L P L A N : 4

KAWAINUI REGIONAL MARSH PARK

ROBERT A. HERLINGER A.I.A. ARCHITECT / PLANNER

MAY 1976

KAWAINUI MARSH
FLOOD CONTROL PROJECT
OAHU, HAWAII

LITERATURE CITED

LITERATURE CITED

Allen-Wheeler, Jane 1981a. Archaeological excavations in Kawainui Marsh, Island of Oahu. Ms. Report prepared for Department of Planning and Economic Development, State of Hawaii. Department of Anthropology, Bernice P. Bishop Museum, Honolulu.

Allen-Wheeler, Jane 1981b. Archaeological reconnaissance survey and test excavations in Kailua, O'ahu: 83 Kihapai St. (TMK 4-3-57:65). Ms. Report prepared for Hawaii Association of Retarded Citizens. Department of Anthropology, Bernice P. Bishop Museum, Honolulu.

AECOS. 1981. Nutrient and Suspended Solids Budget for Kawainui Marsh, Oahu, Hawaii. Ms. Report prepared for Hawaii Coastal Zone Management Program, Department of Planning and Economic Development, State of Hawaii.

Athens, J. Stephen. 1983. Archaeological excavations in Kawainui Marsh, Island of O'ahu. Ms. Report prepared for Department of Planning and Economic Development. Department of Anthropology, Bernice P. Bishop Museum, Honolulu.

Athens, J. Stephen and Jerome V. Ward. 1991. Paleoenvironmental and archaeological investigations, Kawainui Marsh Flood Control Project, O'ahu Island, Hawai'i. Ms. Report prepared for U.S. Army Engineer Division, Pacific Ocean. International Archaeological Research Institute, Inc. for Micronesian Archaeological Research Services, Guam.

Bordner, Richard M. 1977. Archaeological reconnaissance of the proposed Kapa'a Landfill Site, Ko'olau Poko, O'ahu Island. Ms. Archaeological Research Center Hawaii, Inc., Lawa'i, Kaua'i.

City and County of Honolulu Department of Public Works. 1990. Kawainui Marsh Flood Damage Mitigation Project. Final Environmental Impact Statement. Prepared by M&E Pacific, Inc.

Clark, Jeffrey 1980a. Interim report on archaeological investigations at Kawainui Marsh, Island of O'ahu. Ms. Department of Anthropology, Bernice P. Bishop Museum, Honolulu.

Clark, Jeffrey 1980b. Phase I archaeological survey of Castle Estate lands around the Kawainui Marsh, Kailua, O'ahu." Ms. Department of Anthropology, Bernice P. Bishop Museum, Honolulu.

Clark, Jeffrey 1980c. Phase I archaeological survey of the slopes around the Kawainui Marsh, Kailua, O'ahu. In Marion Kelly and Jeffrey T. Clark, Kawainui Marsh, O'ahu: Historical and Archaeological Studies, pp. 29-73. Department of Anthropology, Bernice Pauahi Bishop Museum, Honolulu.

Conant, Sheila. 1981. A survey of the waterbirds of Kawainui Marsh. Ms. Report prepared for the Department of Planning and Economic Development, State of Hawaii.

Cordy, Ross. 1977. A cultural resources study for the City and County of Honolulu's permit request: Kawainui Marsh Sewerline (Oahu), Archaeological reconnaissance and pre-1850 literature search. Ms. U.S. Army Engineer District, Pacific Ocean Division, Honolulu.

Cordy, Ross. 1978 Test Excavations, Site 7, Kawainui Marsh, Kailua Ahupua'a, O'ahu and Determination of Effect. Ms. U.S. Army Engineer District, Pacific Ocean Division, Honolulu.

Chun, Michael and Gordon Dugan. 1981. Environmental aspects of Kapa'a landfill Kawainui, O'ahu, Hawaii. Ms. Water Resources Research Center. University of Hawaii at Manoa.

Dames and Moore. 1961. Preliminary site investigations, proposed land development, Kawainui Marsh, Kailua, Hawaii. Ms. Prepared for the Trousdale Construction Company, Honolulu, Hawaii. Dames & Moore, Consultants in Applied Earth Sciences, Honolulu.

Drigot, Diane C., and Muriel Seto. 1982. Ho'ona'auau no Kawai nui (Educating about Kawai Nui). Ms. Prepared for the University of Hawaii, Manoa President's Education Improvement Fund.

Elliott, M.E., and E. M. Hall. 1977. Wetlands and wetland vegetation of Hawaii. Ms. Prepared for U.S. Army Corps of Engineers, Pacific Ocean Division.

Engilis, A. 1988. Summary of waterbird distribution and status in Kawainui Marsh. Ms. Report prepared for Department of Land and Natural Resources Division of Forestry, State of Hawaii #17711 (27)

Environmental Consultants. 1977. Marine environmental survey of Kailua Bay. Ms. Prepared for U.S. Army Engineer District, Pacific Ocean Division, Honolulu.

Ewart, Ned. D., and Myra T. Tuggle. 1977. Archaeological investigation, Kawainui Swamp, Ko'olaupoko, Kailua, O'ahu Island. Ms. Report prepared for Environmental Communications, Inc. Honolulu. Archaeological Research Center of Hawaii, Inc., Lawa'i, Kaua'i.

FEMA Region IX Interagency Flood Hazard Mitigation Team. February, 1988. Interagency Flood Hazard Mitigation Report. In response to the January 8, 1988 Disaster Declaration (FEMA-808-DR-HI). Covering the City and County of Honolulu, Oahu, Hawaii.

Ford, J.I. 1975. Preliminary biological survey of Kawainui Marsh and the Maunawili-Kahanaiki stream system. Ms. Prepared for Water Resources Research Center. University of Hawaii at Manoa, Honolulu.

Griffin, C., and R. Browne. 1990 Genetic variation and hybridization in Hawaiian ducks and mallards in Hawaii. Ms. Prepared for the U.S. Fish and Wildlife Service.

Hammatt, Hallett H. et al. 1990. Sediment coring in Kawainui Marsh, Kailua, O'ahu, Ko'olaupoko. Ms. Report prepared for M & E Pacific, Inc., Honolulu. Cultural Surveys Hawaii, Honolulu.

Kawainui Marsh Technical and Policy Advisory Committee. 1983. Resource Management Plan for Kawainui Marsh. Ms. Prepared for Hawaii Coastal Zone Management Program, Department of Planning and Economic Development, State of Hawaii.

Kelly, Marion and Jeffrey Clark. 1980. Kawainui Marsh, Oahu: Historical and Archaeological Studies. Department of Anthropology. Bernice Pauahi Bishop Museum, Honolulu.

Kelly, Marion and Barry Nakamura. 1981. Historical study of Kawainui Marsh area, Island of O'ahu. Ms. Report prepared for Department of Planning and Economic Development, State of Hawaii. Department of Anthropology, Bernice Pauahi Bishop Museum, Honolulu.

Kikuchi, William K. 1976. "Prehistoric Hawaiian Fishponds". Science. July: 295-299.

Kraft, John C. 1980. Letter to Mr. Susumo Ono regarding corings in Kawainui Marsh. July 15, 1980.

Mc Allister, J. Gilbert. 1933. Archaeology of Oahu. Honolulu: Bernice P. Bishop Museum Bulletin 104.

Morgenstein, Maury. 1978. Geoarchaeological analysis of field remnants, Kawainui Marsh, Kailua, Oahu. Ms. Report prepared for U.S. Army Engineer District, Pacific Ocean Division, Honolulu. Hawaii Marine Research Inc., Honolulu.

Morris, F.A., M.K. Morris, T.S. Michaud, and L.R. Williams. 1981. Meadowland natural treatment processes in the Lake Tahoe basin: a field investigation. Environmental Protection Agency report EPA-600/4-81-026.

Pantaleo, Jeffrey and Paul L. Cleghorn. 1989. A reconnaissance survey of the proposed Windward Park, Kailua, O'ahu Island (TMK 4-2-14:2 and 4). Ms. Report prepared for DHM, Inc. Public Archaeology Section, Applied Research Group, Bishop Museum, Honolulu.

Smith, L.L. 1978. Development of emergent vegetation in a tropical marsh. M.Sci. Thesis, Botanical Sciences, University of Hawaii at Manoa.

Shallenberger, R.J. 1977. An ornithological survey of Hawaiian wetlands. Ms. Prepared for the U.S. Army Engineer District, Pacific Ocean Division, Honolulu. Ahuimanu Productions.

State of Hawaii, Department of Land and Natural Resources, New Year's Eve Storm, December 31, 1987-January 1, 1988, Windward and Leeward East Oahu. Circular C119, Honolulu, Hawaii.

State of Hawaii, Department of Health, Hawaii's Assessment of Nonpoint Source Pollution Water Quality Problems, July 1989. Ms.

State of Hawaii, Department of Health, Administrative Rules Title 11, Chapter 54, Water Quality Standards.

Stockdale, E.C. 1991. <u>Freshwater Wetlands, Urban Stormwater, and Nonpoint Pollution Control: A Literature Review and Annotated Bibliography.</u> Second Edition. Washington State Department of Ecology, Olympia, WA.

Swain and Huxel, 1971. Relation of drainage problems to high ground-water levels, Coconut Grove area, Oahu, Hawaii. Ms. Prepared by U.S. Geological Survey, Water Resources Division, Honolulu for the Department of Public Works, City and County of Honolulu.

U.S. Army Corps of Engineers. 1957. Design Memorandum, Kawainui Swamp. Oahu. Ms.

U.S. Army Corps of Engineers. 1964. Flood Control Project, Levee Cross Section, Rings 33 and 34 Honolulu Engineer District.

U.S. Army Corps of Engineers. 1977. Hawai'i Coral Reef Inventory. Island of O'ahu. U.S. Army Engineer District, Honolulu.

U.S. Army Corps of Engineers. 1981. O'ahu Coastal Zone Atlas. Produced by Aecos, Inc. for Harbors Division Department of Transportation. Financed in part by a federal grant from the Office of Coastal Zone Management.

U.S. Army Engineer District, Honolulu. 1988. Draft Environmental Assessment for Proposed Kawainui Marsh Flood Control Mitigation.

U.S. Fish and Wildlife Service. 1985. Recovery plan for the Hawaiian waterbirds. Ms. Portland, Oregon.

Watanabe, Farley K. 1988. Memorandum for the Record: Archaeological monitoring of Kawainui Marsh Levee and appurtenant dredging and vegetation removal operation, Kailua, Ko'olaupoko District, O'ahu Island. Ms. U.S. Army Engineer District, Honolulu.

KAWAINUI MARSH
FLOOD CONTROL PROJECT
OAHU, HAWAII

APPENDIX F - PUBLIC INVOLVEMENT

KAWAINUI MARSH FLOOD CONTROL PROJECT
OAHU, HAWAII
APPENDIX F. PUBLIC INVOLVEMENT
TABLE OF CONTENTS

KAWAINUI MARSH FLOOD CONTROL PROJECT
OAHU, HAWAII
APPENDIX F
PUBLIC INVOLVEMENT

1. **INTRODUCTION.** This appendix describes the process whereby the Corps and the City and County of Honolulu solicited input from the public once it became apparent that additional flood protection would be required following the New Year's 1988 flood. Several meetings were held to scope out issues, alternatives, designs, and other advice that were considered during planning and designing.

2. **PUBLIC INVOLVEMENT PROGRAM.**

a. **7 January 1988 Meeting**. The Corps arranged a meeting in the week following the New Year's catastrophe. Invited were representatives of key community organizations active in the marsh and selected government officials. The Corps explained that floodwaters over-topping the levee caused the disaster and that remedial measures were urgently needed due to dangerously high water levels remaining in the marsh. The reasons for the overtopping were discussed including excessive vegetation and floating mats blocking the movement of floodwaters towards Oneawa Channel. A Corps recommendation to cut an emergency ditch along the marsh side of the levee to relieve the marsh of excess water levels was discussed at length. Although there was general agreement, attendees urged proponents not to act hastily and to coordinate with various state and county regulatory agencies. Potential opportunities to incorporate environmental objectives into future flood mitigation measures were mentioned, including fish and wildlife enhancement and recreational enhancement. The Corps agreed to assign on-site archaeologists to monitor the County's excavation of the emergency ditch.

b. **Informal Public Opinion Surveys and Follow-up Meeting**. Within weeks of the flood, the Corps learned that it lacked authority and funds to implement emergency and other remedial measures. Management and maintenance of the Corps-built flood control project was transferred to the County upon project completion in 1966. The City and County took the lead.

Despite the lack of funds, an undergraduate volunteer student at the University of Hawaii in February 1988 agreed to an environmental class project under Corps supervision involving public involvement for future remedial action for the flood control project. The student (Swers, 1988) completed an environmental report based upon interviews and returned questionnaires involving a number of community and government environmental officials. This report was circulated to the participants and a meeting at the Corps was held on 23 April 1988. The report and meeting discussions focused on the opportunities to incorporate fish and wildlife, recreation, cultural and other environmental values into a flood control plan. There was general agreement reached on a central open waterway theme with meanders and additional open water habitat. There were also concerns expressed over drainage of the marsh. Representatives of the Kawai Nui Heritage Foundation agreed to consider modification of their directional plan #5 to incorporate flood control purposes. An official of the State Dept. of Land and Natural Resources (DLNR) announced its leadership role in implementing the state's Resource Management Plan for Kawainui Marsh and developing a State flood mitigation plan for the marsh. Thus, DLNR agreed to coordinate with the other residents and officials, and hold meetings as necessary to develop a multipurpose state plan for Kawainui Marsh.

c. **Meetings Involving Government Emergency Management and Flood Control Agencies**. The Corps received limited funds for preliminary topographic surveys and engineering analyses in April 1988. Several interagency meetings were held to discuss progress in the ongoing analyses and studies. After surveys were completed, a large meeting was held on 2 May 1988 involving many state, local, and federal officials. It was reaffirmed that water movement through the marsh was substantially impeded by the vegetation and floating mats. Removal of vegetation using specialized mechanical equipment was raised as an option at the meeting.

d. **Public Seminar by a Corps Aquatic Plant Control Specialist From Florida and Application to Kawainui Marsh**. On 16 June 1988 a Jacksonville Engineer District representative (William Zattau) presented an overview of aquatic plant control approaches at a meeting widely attended by the community groups and the government. Zattau concluded that a larger commercially available machine, Aquamog, was capable of excavating sediment, vegetation, or both to depths of 20 feet but would require off site disposal of materials. A smaller machine, the Cookie Cutter, would be capable of removing vegetation to depths of 30 inches and function as a floating lawn mower. The latter would be suitable for keeping waterways open as part of a maintenance program. Zattau made it clear that mechanical removal of vegetation from the marsh was feasible. The City and County is presently considering the use of a jet spray machine for maintaining and opening additional waterways.

e. **Draft Environmental Assessment (EA) and Public Meeting on Proposed Kawainui Marsh Flood Mitigation**. At the end of July 1988, the Corps completed preliminary engineering analyses for excavating an open waterway through the marsh and the Corps circulated a Draft EA prior to a public meeting convened by the Corps and County DPW held on 10 August 1988. The Corps analysis and supporting draft EA were based upon the premise that an emergency situation existed with only limited opportunity to evaluate a full range of feasible alternatives. At the public meeting over 60 oral and written comments were received with a majority of commentors objecting to the proposed waterway plan, questioning the basis of the emergency, and demanding a full EIS including full evaluation of all feasible flood control alternatives. A number of commentors, including the New Year's Day flood victims, urged that remedial action take place without delay.

An emergency declaration resulting from flood damages was never formally declared at that time. As a result of public and agency review of the draft EA and testimony at the meeting, the Corps, (as federal permitting agency) and the County DPW (as project proponent) made a proposal to process a joint federal and state EIS for flood mitigation. However, the Corps recommended that the City begin preparation of its own State EIS which resulted in the 1990 FEIS for blasting of open water channels.

f. **State EIS Preparation Notice and Notice of Intent to Prepare a Federal EIS**. Both the County DPW and Corps have published notices to prepare EISs. The Preparation Notice was published in the OEQC Bulletin on April 8, 1991. The Corps published its Notice in the Federal Register on October 11, 1988.

g **21 February 1990 Scoping Workshop**. This workshop was held at the Kailua Intermediate School. Presentations were made by the District Engineer, project engineer and EIS preparer. A number of issues were identified including concerns over the floating mat, flooding to residents, possible alternatives, time tables, costs and other environmental issues. Due to limited attendance the District Engineer recommended an additional scoping meeting to receive more community input.

h. **19 April 1990 Scoping Workshop**. This workshop was held at the Kailua Elementary School. Additional input was received about marsh drainage concerns, herbicidal spraying, flooding to residents, and other environmental issues. The City and County presented a preliminary analysis of marsh blast testing.

i. **Combined Federal and State Draft EIS**. Both the federal and Hawaii state government have passed laws and regulations on preparing and coordinating environmental impact statements (EIS). The National Environmental Policy Act of 1969 and implementing regulations (40 CFR 1500-1508 and 33 CFR 230 and 325) govern Corps and Federal EIS procedures while the Hawaii State EIS Law Chapter 343, Hawaii Revised Statutes govern the State EIS procedures.

A combined draft detailed project report and draft environmental impact statement (Draft DPR/EIS) was prepared according to requirements identified in ER 1105-2-100. These two documents, under a single cover, reflect a format used consistently by the Corps for most of its feasibility reports.

A formal public meeting was held during the review stage for the Draft DPR/EIS on May 28, 1991 in Kailua. The public comment period closed on 22 June 1991. Over 50 written comments were received The transcript from the public meeting is in the Public Involvement Appendix F.

The Corps and the City and County of Honolulu have evaluated all comments and alternatives and have selected one for implementation. It is Plan 3A, the combined levee raise and floodwall. The present document, a final EIS, constitutes a principal action to comply with state and federal EIS laws. This final EIS has been prepared and coordinated, taking into consideration the advice of the general public, agencies, and community groups. This final integrated report/EIS differs from the format in the draft in that the organization and content of two previously separate documents have been integrated together. This document will be submitted to the Mayor and the Governor for acceptance in accordance with state procedures. Federal EIS procedures shall be completed including the 30-day wait period and staffing of a record of decision to be signed by the Director of Civil Works. This FEIS recommends mitigation measures and monitoring requirements that should be carried forward and implemented during the construction and maintenance of the flood control improvements.

3. **REQUIRED COORDINATION.** The Corps and the City and County of Honolulu must comply with the provisions of various federal acts and local regulations. These federal and local regulations and associated agency coordination have been completed. A table showing the status of compliance with environmental statutes is shown in Appendix E, Environmental Appendix.

4. **SUMMARY OF COMMENTS RECEIVED.** Forty written comment and fifteen no-comment letters were received during the public review period of the Draft document. Most of the reviewers were opposed to the NED plan or concrete floodwall. Preference was given to an earthen levee raise over the floodwall. The majority of reviewers preferred a combination of alternatives that include in-marsh as well as levee modification to reduce the height of any levee raise as well as to benefit wildlife in pursuit of environmental enhancement. Detailed responses to each letter are provided in this appendix.

5. **REPORT RECIPIENTS.** A detailed listing of recipients and their mailing addresses is also provided in this appendix. These agencies and public-at-large were sent copies of the *Draft Detailed Project Report and Draft Environmental Impact Statement* in April 1991 and will receive this final report as well. In addition, other Federal agencies are being sent copies of this final report for environmental review.

KAWAINUI MARSH
FLOOD CONTROL PROJECT
OAHU, HAWAII
APPENDIX F

6. MAILING LIST

6. MAILING LIST

STATE AND CITY OFFICIALS

Councilman Steve Holmes
530 South King Street, Room 202
Honolulu, Hawaii 96813

Councilman John Henry Felix
530 South King Street, Room 202
Honolulu, Hawaii 96813

Senator Stan Koki
State Capitol, Room 203
Honolulu, Hawaii 96813

Representative Whitney Anderson
State Capitol, Room 419
Honolulu, Hawaii 96813

Senator Mary George
State Capitol, Room 222
Honolulu, Hawaii 96813

Honorable Daniel K. Akaka
United States Senate
109 Hart Senate Office Building
Washington, DC 20510

Honorable Daniel K. Akaka
United States Senator
Prince Kuhio Federal Building,
Box 50124
Honolulu, Hawaii 96850

Honorable Daniel K. Inouye
United States Senate
722 Hart Senate Office Building
Washington, DC 20510

Honorable Daniel K. Inouye
United States Senator
Prince Kuhio Federal Building,
Box 50123
Honolulu, Hawaii 96850

Honorable Neil Abercrombie
House of Representatives
1030 Longworth House Office
Building
Washington, DC 20515

Honorable Neil Abercrombie
Representative in Congress
Prince Kuhio Federal Building,
Box 50143
Honolulu, Hawaii 96850

Honorable Patsy T. Mink
House of Representatives
3201 Rayburn House Office
Building
Washington, DC 20515

Honorable Patsy T. Mink
Representative in Congress
Prince Kuhio Federal Building,
Box 50144
Honolulu, Hawaii 96850

Honorable Cynthia Thielen
House of Representatives
State of Hawaii
State Capitol
Honolulu, Hawaii 96813

Representative Jacki Young
State Capitol, Room 301
Honolulu, Hawaii 96813

CITY AND COUNTY OF HONOLULU

Mr. Benjamin B. Lee
Chief Planning Officer
Department of General Planning
650 South King Street
Honolulu, Hawaii 96813

Mr. Donald Clegg
Director
Department of Land Utilization
650 South King Street
Honolulu, Hawaii 96813

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

Mr. George Kekuna
Director
Oahu Civil Defense Agency
650 South King Street
Honolulu, Hawaii 96813

City and County of Honolulu
Department of Public Works
Division of Wastewater Management
650 South King Street
Honolulu, Hawaii 96813

Mr. Herbert Muraoka
Director, Building Department
City and County of Honolulu
Dept of Housing & Community Dev
650 South King Street
Honolulu, Hawaii 96813

Corporation Counsel
Honolulu Hale
530 South King Street
Honolulu, Hawaii 96813

Department of Public Works
Drainage Division
650 South King Street
Honolulu, Hawaii 96813

Mr. C. Michael Street
Director of Public Works
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Chief Michael S. Nakamura
Chief of Police
City and County of Honolulu
Police Department
1455 South Beretania Street
Honolulu, Hawaii 96814

Mr. Joseph Magaldi, Jr.
Director
Department of Transportation Svcs
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Mr. Lionel Camara
Fire Chief
City and County of Honolulu
Fire Department
1455 South Beretania St., Rm 305
Honolulu, Hawaii 96814

Mr. Kazu Hayashida
Manager and Chief Engineer
Board of Water Supply
City and County of Honolulu
630 South Beretania Street
Honolulu, Hawaii 96813

STATE OF HAWAII

Office of State Planning
Office of the Governor
State Capitol
ATTN: Harold Masumoto, Director
Honolulu, Hawaii 96813

State of Hawaii
Office of Hawaiian Affairs
Land Division
1600 Kapiolani Blvd., Suite 1500
Honolulu, Hawaii 96814

Mr. Tom Kam
Dept of Land and Natural Resouces
Div of Water and Land Development
1151 Punchbowl Street, Room 227
Honolulu, Hawaii 96813

Department of Hawaiian Home Lands
P.O. Box 1879
Honolulu, Hawaii 96805

Mr. Charles Toguchi
Superintendent
State of Hawaii
Department of Education
P.O. Box 2360
Honolulu, Hawaii 96804

DLNR
Div of Forestry and Wildlife
ATTN: Mr. Ron Walker
1151 Punchbowl Street
Honolulu, Hawaii 96813

Mr. Joseph K. Conant
Executive Director
State of Hawaii
Department of Budget & Finance
500 Ala Moana Boulevard, Suite 300
Honolulu, Hawaii 96813

University of Hawaii at Manoa
Reference Libraries
Hawaii Pacific Collection
Attn: Dr. Peacock (Curator)
University Avenue
Honolulu, Hawaii 96822

Director
Department of Business and
Economic Development
250 South King Street
Honolulu, Hawaii 96813

State of Hawaii
Director
Office of Environmental Quality
Control
220 South King Street, 4th Floor
Honolulu, Hawaii 96813

Dr. John C. Lewin
Director
Department of Health
State of Hawaii
P.O. Box 3378
Honolulu, Hawaii 96801

Office of Hawaiian Affairs
711 Kapiolani Blvd., Suite 500
Honolulu, Hawaii 96813

State of Hawaii
Department of Defense
Office of the Director of Civil
Defense
3949 Diamond Head Road
Honolulu, Hawaii 96816

DLNR
Div of Aquatic Res.
ATTN: Mr. Henry Sakuda
1151 Punchbowl Street
Honolulu, Hawaii 96813

Mr. Warren Lee
State Conservationist
Department of Agriculture
Soil Conservation Service
P.O. Box 50004
Honolulu, Hawaii 96850

Dr. John T. Harrison
Environmental Coordinator
University of Hawaii
Crawford 317
2550 Campus Road
Honolulu, Hawaii 96822

Mr. William Paty
Department of Land and Natural
Resources
P.O. Box 621
Honolulu, Hawaii 96809

State of Hawaii
Department of Defense
Office of the Adjutant General
3949 Diamond Head Road
Honolulu, Hawaii 96816

Mr. Mitsuo Shito, Executive Dir
State of Hawaii
Department of Human Services
Hawaii Housing Authority
P.O. Box 17907
Honolulu, Hawaii 96817

University of Hawaii at Manoa
(Libraries)
ATTN: Reference Libraries
University Avenue
Honolulu, Hawaii 96822

DLNR
State Historic Preservation Div
ATTN: Dr. Tom Dye
33 South King Street, 6th Floor
Honolulu, Hawaii 96813

Advisory Council on Historic
Preservation
Attn: Ms. Claudia Nissley
730 Simms Street, #401
Golden, Colorado 80401

FEDERAL

Mr. Jerry Leinecke
U.S. Fish and Wildlife Service
Pacific Islands Office
P.O. Box 50167
Honolulu, Hawaii 96850

Executive Office of the President
Council on Environmental Quality
722 Jackson Pl. NW
Washington, DC 20006

Mr. Tony Thomas
(CEWES-HR)
Waterways Experiment Station
P. O. Box 631
Vicksburg, MS 39180

The Hydrologic Engineering Center
U.S. Army Corps of Engineers
ATTN: Dave Goldinan
609 Second Street
Davis, CA 95616

U.S. Geological Survey
National Center
Reston, VA 22092

Dr. Kenneth Holt
Ctr for Env Health, Mail Stop F-29
Ctrs for Disease Control
US Dept of Health & Human Services
1600 Cliffton Road
Atlanta, GA 30333

Department of the Interior
Office of the Secretary
Office of Environmental Affairs
600 Harrison Street, Suite 515
San Francisco, California 94107-1376

Ms. Deanna M. Wieman
US Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105

Commander
Department of the Navy
Naval Base, Pearl Harbor
Box 110
Pearl Harbor, Hawaii 96860

Soil Conservation Service
Prince Kuhio Federal Building,
#4316
300 Ala Moana Boulevard
Honolulu, Hawaii 96850

Office of Environmental Project
Review
U.S. Department of the Interior
18th and C Streets, NW, Room 4239
Washington, D.C. 20240

Assistant Director for Archaeology
National Park Service
U.S. Department of the Interior
Interior Building
C St. Between 18th and 19th St., NW
Washington, D.C. 20240

Bureau of Oceans & International
Env & Scientific Affairs
U.S. Dept of State
OES Room 7831
Washington, D.C. 20520

Mr. John Naughton
Pacific Islands Env Coordinator
National Oceanic & Atmospheric Adm
Pacific Area Office - Southwest Reg
2570 Dole Street, Room 106
Honolulu, Hawaii 96822-2396

Pacific Area Director
U.S. Department of the Interior
300 Ala Moana Blvd., Room 6305
Honolulu, Hawaii 96850

U.S. Geological Survey
677 Ala Moana, Suite 415
Honolulu, Hawaii 96813

Director
Ofc of Ocean and Coastal
Resource Management
NOAA
3300 Whitehaven Street, N.W.
Washington, D.C. 20235

Office of Territorial and
International Affairs
Mail Stop MS, Room 4328
U.S. Department of the Interior
18th and C Streets, NW
Washington, D.C. 20240

Maritime Administration
U.S. Dept of Transportation
400 7th Street, S.W.
Washington, D.C. 20590

SPECIAL INTEREST

Sierra Club
Hawaii Chapter
Honolulu Group
P.O. Box 2577
ATTN: Lola Mensch
Honolulu, Hawaii 96803

Natural Resources Defense Council
ATTN: Susan Miller
212 Merchant Street #203
Honolulu, Hawaii 96813

Ms. Dana Kokubun
Director
National Audubon Society
Hawaii State Office
212 Merchant Street, #320
Honolulu, Hawaii 96813

Pohakupu Community Association
P.O. Box 1475
Kailua, Hawaii 96734

Ms. Hope Miller
President
Lani-Kailua Outdoor Circle
P.O. Box 261
Kailua, Hawaii 96734

Mr. Tim Correa
President
Aloha State RC Club
1270 Loho Street
Kailua, Hawaii 96734

President
Hui malama 'aina o Maunawili
305 Hahani Street, #282
Kailua, Hawaii 96734

Hawaiian Electric Co., Inc.
Environmental Department
P.O. Box 2750
Honolulu, Hawaii 96840

Sierra Club Legal Defense
Fund, Inc.
ATTN: Arnold L. Lum
212 Merchant Street #202
Honolulu, Hawaii 96813

Mr. Robert Merriam
President
Kawai Nui Heritage Foundation
P.O. Box 1101
Kailua, Hawaii 96734

Mr. Bob Rogers
President
Kainui Flood Victims Association
864 Kainui Drive
Kailua, Hawaii 96734

Ms. Phyllis Fox
President
Historic Hawaii Foundation
P.O. Box 1658
Honolulu, Hawaii 96806

Mr. Rick Scudder
Chair
Conservation Council for Hawaii
P.O. Box 2923
Honolulu, Hawaii 96802

Mr. Jim Slavish
President
Kailua Community Council
32 Kailua Road
Kailua, Hawaii 96734

Mr. Ed Stevens
Chair
Sierra Club, Hawaii Chapter
1100 Alakea Street
Honolulu, Hawaii 96813

Bishop Museum
Library
1525 Bernice Street
P.O. Box 19000A
Honolulu, Hawaii 96817

Life of the Land
19 Niolopa Place
Honolulu, Hawaii 96817

Dr. Roger Fujioka
Water Res. Center
Holmes Hall, #283
2540 Dole Street
Honolulu, Hawaii 96822

Maunawili Community Association
P.O. Box 943
Kailua, Hawaii 96734

Mr. George Duncan
President
Maunawili Estates Community
Association
1370 Kukana Place
Kailua, Hawaii 96734

Kailua Chamber of Commerce
P.O. Box 1496
Kailua, Hawaii 96734

Kuulei Community Association
c/o Mr. Theodore Gibson
169 Kuupau Street
Kailua, Hawaii 96734

Mr. Bruce Eilerts
President
Hawaii Audubon Society
P.O. Box 22832
Honolulu, Hawaii 96822

Mr. Henry Vincent III
Kailua Neighborhood Board
P.O. Box 487
Kailua, Hawaii 96734

Ms. Donna Wong
Hawaii's Thousand Friends
1525 Uluhau Street
Kailua, Hawaii 96734

Outdoor Circle
1110 University Avenue, #205
Honolulu, Hawaii 96826

Mr. Fred Schmidt
Documents Department - KS
The Libraries
Colorado State University
Fort Collins, Colorado 80523

Mr. Andrew Charles Yanoviak
Architect
Environmental Systems Planning
1188 Bishop Street
Honolulu, Hawaii 96813

Dr. Edmond Cheng
Department of Civil Engineering
University of Hawaii
2540 Dole Street
Honolulu, Hawaii 96822

Mr. Rick Ernenwein
National Park Service
P. O. Box 25287
Denver, Colorado 80225

Wilson Okamoto & Associates
1150 South King Street
Honolulu, Hawaii 96814

M&E Pacific
ATTN: Mr. James Dexter
1001 Bishop Street
Pauahi Tower, Suite 500
Honolulu, Hawaii 96813

Mr. Kevin R. Kennedy
c/o Coldwell Banker/McCormack
45-920 Kamehameha Highway
Kaneohe, Hawaii 96744

Dr. Edward R. Margulies
President
Kainui Estates Association
796 Kainui Drive
Kailua, Hawaii 96734

INDIVIDUALS

Dr. Sheila Conant
University of Hawaii
Department of General Science
2450 Campus Road
Honolulu, Hawaii 96822

Dr. Diane C. Drigot
1154 Uluopihi Loop
Kailua, Hawaii 96731

Ms. Muriel B. Seto
103 Hauoli Street
Kailua, Hawaii 96734

Mr. Marion Kelly
4117 Black Point Road
Honolulu, Hawaii 96816

Mr. Anthony Locricchio
903 Maunawili Circle
Kailua, Hawaii 96734

Mr. Robert Herlinger
391 Auwinala Road
Kailua, Hawaii 96734

Mr. James L. Watson
Watson/Escola Partners
30 Aulike Street, Suite 305
Kailua, Hawaii 96734

Mr. Norman Thompson
712 Oneawa Street
Kailua, Hawaii 96734

Mr. Grant O'Donnell
P.O. Box 474
Kailua, Hawaii 96734

Ms. Annetta Kinnicutt
341 Iliaina Street
Kailua, Hawaii 96734

Mr. David Babineau
Ms. Dorothy Rose Babineau
143 Pauahilani Place
Kailua, Hawaii 96734

Mr. Ed Bybee
Rother, Bybee, Chang and Rulton
733 Bishop Street
Honolulu, Hawaii 96813

Mr. John C. Kraft
University of Delaware
Department of Geology
101 Penny Hall
Newark, Delaware 19716

Mr. Larry Abbott
419 Kawainui Street
Kailua, Hawaii 96734

Ms. Camille Woodruff
319 B Kihapai Street
Kailua, Hawaii 96734

Mr. Stan Bergstrom
333 Aoloa Street, #218
Kailua, Hawaii 96734

Mr. Robert Lopes
327-A Kihapai Street
Kailua, Hawaii 96734

Mr. Ken Le Vasseur
47-389 Ahaolelo Road
Kaneohe, Hawaii 96744

Mr. Kenneth Miyashiro
551 Punaa Street
Kailua, Hawaii 96734

Mr. Peter W. Bowman
165 Kailuana Loop
Kailua, Hawaii 96734

Ms. Vicki Creed
1057 Lunaanela Street
Kailua, Hawaii 96734

Mr. Herman Carvalho
184 Kakahiaka Street
Kailua, Hawaii 96734

Mr. Rick Soehren
2651 6th Avenue
Sacramento, California 95818

Mr. Don Cole
465 N. Kainalu Drive
Kailua, Hawaii 96734

Moky and Ivalani Young
729 Hoopuni Drive
Kailua, Hawaii 96734

Mr. Rob Caveney
805 Kainui Drive
Kailua, Hawaii 96734

Ms. Thelma Chu
661-D Kihapai Street
Kailua, Hawaii 96734

Mr. Todd Hendricks
328 Kihapai Street
Kailua, Hawaii 96734

Mink and Yuen, Inc.
ATTN: George Yuen
100 N. Beretania Street, Suite 303
Honolulu, Hawaii 96817

Mr. Howard Sanchez
225 Kihapai Street
Kailua, Hawaii 96734

Ms. Carol Wilcox
111 Royal Circle
Honolulu, Hawaii 96816

Mr. Mack Hastert
2436 Sonoma
Honolulu, Hawaii 96822

Mr. Roy Hiram
Audreen K. Hiram
725 Hoopuni Drive
Kailua, Hawaii 96734

J. F. King
304 Akake Way
Kailua, Hawaii 96734

Mr. Van Beazlie
337-D Kihapai Street
Kailua, Hawaii 96734

Mr. Earl Neller
c/o Mr. Bion Griffin
836 Alahaki Street
Kailua, Hawaii 96734

Mr. Leo Burns
646 Papalani Street
Kailua, Hawaii 96734

Mr. & Mrs. James Kalawa
285-C Kihapai Street
Kailua, Hawaii 96734

Ms. Gail Uyetake
319 Opihikao Place
Honolulu, Hawaii 96734

Mr. Reginald B. Cockett
P.O. Box 55
Kailua, Hawaii 96734

Mr. Glenn Uyeshiro
436-D Ulupaina Street
Kailua, Hawaii 96734

Mr. Robert Merriam
616 Pamaele Street
Kailua, Hawaii 96734

Mr. Jim Anthony
P.O. Box 720
Kaawa, Hawaii 96730

Mr. John Stimson
1113 Hui Street
Kailua, Hawaii 96734

Mr. Ron Jackson
178 North Kalaheo Avenue
Kailua, Hawaii 96734

KAWAINUI MARSH
FLOOD CONTROL PROJECT
OAHU, HAWAII
APPENDIX F

7. CORRESPONDENCE

DEPARTMENT OF PUBLIC WORKS

CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

C. MICHAEL STREET
[redacted]
DIRECTOR AND CHIEF ENGINEER

IN REPLY REFER TO:
92-12-0232

July 14, 1992

Lt. Col. James T. Muratsuchi
District Engineer
U.S. Army, Corps of Engineers,
Honolulu District
Building 230
Fort Shafter, Hawaii 96858-5440

Dear Col. Muratsuchi:

Subject: Kawainui Marsh Flood Control Project

Pursuant to the City and County of Honolulu, City Council Resolution 89-510 authorizing the Mayor to enter into an agreement with the U.S. Army Corps of Engineers to prepare a feasibility study for the Kawainui Marsh Flood Control Project, the City supports the findings of the feasibility study called the Final Detailed Project Report and Environmental Impact Statement for the Kawainui Marsh Flood Control Project.

The City expresses its willingness and capability as the local sponsoring agency to provide the local cooperation required for the construction of the Kawainui Marsh Flood Control Project, Plan 3A - Combination Levee Raise and Floodwall. Upon completion of the project, the marsh will be transferred to the State in fee in about 1994 for operation and maintenance. The local cooperation requirements are subject to the provisions of the Local Cooperation Agreement under which the City and County of Honolulu agrees to:

1. Provide a cash contribution equal to at least five percent of total project costs. Assume all project costs over the $5,000,000 statutory Federal limitation under Section 205 of the Flood Control Act of 1948, as amended. The cash contribution is presently estimated at $5,000,000, subject to the availability of funds.

2. Provide all lands, easements, rights-of-way, relocations, and dredged material disposal areas, presently estimated at $200,000.

3. Operate, maintain, repair, replace, and rehabilitate the completed project including, but not limited to the levee, Oneawa Canal, and other improvements within the marsh according to regulations or directions prescribed by the Federal government up until the transfer of the marsh to the State is finalized.

4. Hold and save the Federal government free from all damages arising from the construction, operation, and maintenance of the project, except damages due to the fault or negligence of the Federal government or its contractors up until the transfer of the marsh to the State is finalized.

5. Prevent future encroachments that might interfere with proper functioning of the project and secure Corps of Engineers review and written approval of any planned marsh modification including resource management plans for hydraulic compatibility with existing improvements.

6. Participate in and comply with applicable Federal floodplain management and flood insurance programs, pursuant to Section 402, Public Law 99-662.

7. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR part 24, in acquiring lands, easements, and rights-of-way for construction and subsequent operation and maintenance of the project up until the transfer of the marsh to the State is finalized.

8. Perform such environmental investigations as determined necessary by the Federal government to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 U.S.C. 9606-9674, on land necessary for project construction and maintenance up until the transfer of the marsh to the State is finalized.

9. Execute a Local Cooperation Agreement (LCA) in accordance with Public Laws 91-611 and 99-662 between the City and County of Honolulu and the Department of the Army for the construction, operation, and maintenance of the project up until the time of transfer of the marsh to the State is finalized.

10. At the time of the fee transfer of Kawainui Marsh from the City and County of Honolulu to the State of Hawaii, the City's Local Cooperation Agreement with the COE shall either be transferred to the State or a new agreement shall be executed between the COE and the State for the operation and maintenance of Kawainui Marsh. At such time, the City and County of Honolulu shall no longer be responsible for the operation and maintenance of Kawainui Marsh.

This letter also serves to confirm that the COE, State, and City are of the understanding and agree that the project is a 100-year design plus freeboard.

Very truly yours,

C Michael Street

C. MICHAEL STREET
Director and Chief Engineer

APPROVAL:

JEREMY HARRIS
MANAGING DIRECTOR

cc: Department of Land and Natural Resources
Department of the Corporation Counsel (Lowell Wolf)
Department of the Budget

APPROVED AS TO FORM AND LEGALITY

Lowell Wolf
Deputy Corporation Counsel

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

REF:WRM-KO

JUL 8 1991

Mr. Sam Callejo
Director & Chief Engineer
Department of Public Works
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Callejo Sam

Kawainui Marsh Flood Control Project

As you know, the 1990 State Legislature authorized the transfer of your City and County of Honolulu's Kawainui Marsh to the State in connection with the proposed future management of the Marsh's ecological, cultural, and economic resources by our Department of Land and Natural Resources. A key requirement imposed by the Legislature in approving the State's acquisition of the Marsh was that the flood control project currently being developed by the U.S. Corps of Engineers be completed to the satisfaction of our Department. Needless to say, the matter of the public's safety from flooding was in the minds of the legislators when they approved the property transfer.

We have had the opportunity to review the Corps of Engineers' "Draft Detailed Project Report and Draft Environmental Impact Statement" for the Kawainui Marsh Flood Control Project. The following discussion includes those aspects of the project design which we consider to be of particular importance in negotiating the future transfer of the Marsh property:

With respect to the various alternative flood control schemes proposed and evaluated by the Corps, we find that either the floodwall alternative or the levee-raise alternative is acceptable, for they both accomplish the flood control objective directly, at comparatively lower capital and recurring maintenance costs. The latter maintenance-cost factor is of particular importance in viewing public safety and property damage reduction aspects from the long-term risk standpoint, when an assurance of adequate and stable funding for

operation and maintenance becomes critical. Also, we are happy to note that an engineering consideration was the attainment of flood control independent of future marsh conditions, but yet allowing for changes in marsh storage due to sedimentation and vegetation growth.

In connection with the Corps of Engineers' ongoing evaluation of the alternative plans, we had recommended that the Corps pursue a level of protection that is greater than the 100-year design flood used for plans-comparison purposes, given the potential high risks to life and property at the Coconut Grove community and environs. We might point out that the present structural measures being considered may result in a project very likely to fall within the purview of the State's new dam safety law which, besides requiring that the project construction plans and specs be approved by the Board of Land and Natural Resources, makes a dam owner liable for damages resulting from storms having recurrence intervals of up to 250 years. Here, your City's transfer of the Marsh to the State would, in effect, be an assignment of the liability burden to the State. Because the consequences of failure of the levee would be severe, overtopping should not be permitted; we note that despite the existing levee's having been designed for the Standard Project Flood, overtopping in the recent past had nonetheless occurred.

Clearing portions of the Marsh or excavating a channel paralleling the quarry road could also meet the flood control objective and be environmentally beneficial, but their inherently higher operating and maintenance costs, coupled with the limited capacity of Oneawa Channel and the uncertainty regarding the behavior of the floating vegetation mat during flood events, make them less attractive from the flood management perspective. We would, nonetheless, encourage the creation of ponds and the opening of waterways to enhance the Marsh's wildlife habitat, and we anticipate that such activities will, in time, be made an integral part of the wildlife management scheme implemented under the overall Kawainui Marsh Management Plan. In other words, we would prefer not to rely upon these within-marsh improvements for long-term flood control if continual funding to properly maintain these improvements cannot be guaranteed.

Our comments above are reflective of what we would find acceptable in the future when the flood control project is completed and your City readies its transfer of the Marsh property to the State. Essentially, we are asking that the proposed flood control works be modified to accommodate floods having a statistical recurrence interval of at least 250 years; preferably, the Standard Project Flood. This would raise flood protection for the vulnerable Coconut Grove residents to a level commensurate with the hazard potential of levee breaks due to floods of greater than the 100-year magnitude. The retention of the present channel alongside the levee or the opening of new waterways farther within the Marsh can be pursued as wildlife habitat enhancement measures, but we would not want to count on them as necessary components for flood control purposes.

Mr. Sam Callejo
July 8, 1991
Page 3

We would appreciate your emphasizing the foregoing points when conferring with the Corps in selecting the final plan for the flood control project. Please contact Manabu Tagomori at 548-7533 if you wish to discuss these points in more detail.

Very truly yours,

WILLIAM W. PATY

c: Lt. Col. James T. Muratsuchi,
Corps of Engineers

DEPARTMENT OF PARKS AND RECREATION

CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET
HONOLULU HAWAII 96813

FRANK F. FASI
MAYOR

May 9, 1991

Commander
Honolulu Engineer District
Fort Shafter, Hawaii 96858-5440

Attn: CEPOD-ED-PV

Gentlemen:

Subject: Kawainui Marsh Flood Control Project
Detailed Project Report and Environmental Impact
Statement, April 1991 Draft

Thank you for the opportunity to comment on the proposed alternative plans for control of flooding in Coconut Grove, Kailua. We have the following comments and recommendations.

The construction of a mile-long, 8-foot high concrete floodwall is aesthetically undesirable. We recommend that raising the existing levee be considered.

Thank you for the opportunity to comment on the control project.

Sincerely,

Walter Ozawa

WALTER M. OZAWA, Director

WMO:el

cc: Sam Callejo, Dept. of Public Works
Kailua Neighborhood Board No. 31

DEPARTMENT OF THE ARMY

U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT SHAFTER, HAWAII 96858-5440

JUL 23 1992

REPLY TO
ATTENTION OF:

Planning Division

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

Dear Mr. Ozawa:

Thank you for your comments on the Draft Kawainui Marsh Flood Control Project Report and Draft Environmental Impact Statement dated April 1991.

Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

Although the earthen levee raise alternative is the most compatible with the rural character of the marsh, it will fill over six acres of wetland as a result of the increased base width required. Several agencies have indicated that this amount of wetland loss is inappropriate when other alternatives exist to offer flood protection at even more reasonable cost. However, in light of the negative reaction to the higher floodwall received by the respondents to the draft, and after careful consideration of engineering, environmental, and economic factors, the Corps along with the City and County of Honolulu will be recommending a modification to the NED plan which fills 1.8 acres of wetland and has a concrete floodwall 4 feet in height. We will seek the necessary approvals required to deviate from the NED plan.

The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side. Compensatory wetland mitigation shall include conversion of fastland in the marsh near the levee to new wetland habitat. A levee raise will not preclude future marsh management scenarios, although marsh activities must be compatible with its flood control function.

With its landscaping in place, we believe this alternative will be acceptable to the community and offer the necessary flood protection at only slightly increased cost over the NED floodwall.

Thank you again for your comments.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and City - DPW

ROBERT A. MERRIAM
616 Pamawlo St.
Kailua, HI 96734

LTC Donald T. Wynn
District Engineer
Honolulu District, Corps of Engineers
Ft. Shafter, HI 96858-5440

Dear Colonel Wynn,

I have several comments and questions regarding the Draft DPR and Draft EIS for the Kawainui Marsh Flood Control Project.

First let me thank you for getting the document out in adequate time for serious review before the public meeting. I believe that extra time will increase the understanding and the level of questions at the meeting. Please accept these early comments of mine, not as my final word, but as an opportunity for your staff to have adequate time to consider them before the public meeting. These or related comments or questions will surely be raised there.

Although I will focus my comments for now on Appendix A, Hydrology and Appendix B, Design and Cost Estimates, there are two general observations which need to be made.

The complete document obviously is designed to serve more than one purpose. However, it would be much clearer for a person trying to evaluate the alternatives and their costs (which is as deep as many reviewers will want to go) if those alternatives had been presented in a more logical manner. The document could have had the DPR and its appendices together in front of the EIS and its appendices, some of which have appendices of their own.

Secondly the text of the alternative solutions and their comparisons could have been more clearly presented by some logical development, possibly:

Action	Result
1. No Corps Action	Floods continue even after C/C work
2. Raising the existing levee	
a. Earthfill up 10'	Protect against 100-yr flood
b. Floodwall up 10'	Same but cheaper
3. Quarry Road Channel	
a. Alone	Reduces height of needed floodwall to 6'. Total costs are some $8 million greater.
b. With training dike	Reduces height of needed floodwall to 5'. Total costs are greater by some $???
c. With marsh clearing	Reduces height of needed floodwall to 4' at an additional cost of $???
4. Back Levee	Can protect but not as cheap as floodwall.
5. Floodproofing	

The ??? indicate real uncertainty, as will be shown.

The 'without project condition' is said (p.2) to include the C/C plans for channels but not to include the emergency levee-side ditch, although the ditch is credited with significantly lowering inter-storm water heights. You state that to account for these effects, analyses with 6.5' water height at the start of the storm is used as well as 9.0'. However, the 9.0' starting height is used in the cost analyses and the C/C emergency and interior ditches are not included in maintenance costs. It appears therefore that a 'without previous action' condition is really being used, as well as 'without project'.

Given the above, why was a water level of 6.5' used for the levee overflow studies (Plates 53-57)? Why not 9.0' as for the others?

I am at a loss to understand why the document does not contain, unless I missed it, any information about the flow in Oneawa Channel. It does mention that dredging, at a cost of some $562,000, would be required to handle the flow of the Quarry Road and Marsh Clearing plans. Although the height of flow (and presumably the volume) in the Back Levee plan would appear to be as great as the QR and MC plans (compare Plates 55, 58, and 60), the BL plan only calls for the right bank of the Oneawa Channel to be raised to prevent marsh flood flows from entering Coconut Grove. How high? At what cost? Is that a cost effective alternate to dredging in the other plans?

Why does it cost $16/cy to remove the gravel for the levee raise and $30/cy for the floodwall?

I presume the difference in cost for the vegetation removal and disposal for the back levee plan and the Quarry Road and Marsh Clearing plans is related to the location rather than some inherent difference in the vegetation. Am I correct?

I am disappointed to find the statement (4.10.1 b.) "The preferred flood control solution is one which is independent of future conditions in the marsh." Restated, that says "We engineers do not want anything to do with vegetation control." Your use of a 25% contingency in all costs related to vegetation control measures and only 10% for structural measures is a further indication of your bias.

I am at a complete loss to determine the rationale for your use of the amount of 372,000 cy for vegetation removal and disposal in the Marsh Clearing plans. 136,000 cy obviously comes from the Quarry Road Channel, as does 220,000 cy of silt removal (please note, however, that the EIS portion of this document uses the amount 420,000 cy for silt removal in place of the 220,000 cy used here). The plan further assumes that the clearing of the vegetation, where dredging of silt is not a factor, encounters vegetation which is thicker than the vegetation met encountered in the channel clearing; about 3.5' thick as opposed to 2.5'. The statement that required vegetation clearing and disposal is 236,000 cy more in the Marsh Clearing plan than the Quarry Road plan is just plain sloppy work. A reasonable analysis (reasonable is an easy term for me to use since it is my analysis) follows:

We agree that something like 10% of the area of the marsh would be open water in ponds and channels, therefore 76 acres is a target. Envision a marsh clearing plan, such as the one I tried to describe to your planners several months ago, which is something like this:

1) 33 ± of those acres are included in the Quarry Road Channel.

2) 5 ± of those acres are now found in the emergency ditch created by C/C after the New Year's Storm.

3) 5 ± acres of new interior channels will have been opened up in the interior of the marsh by the blasting program of C/C.

4) 20 ± acres of open water will have been herbicided by the work of the C/C. (Note at this point that even if the C/C does not complete the alternative bid portions of their plan, the Marsh Clearing plan would start with some 63 acres of open water).

5) 5 ± additonal acres would be created by doubling the water area, perhaps by doubling the width of the emergency ditch throughout its middle third, and by trebling its width throughout the third of its length nearest the Onoawa Channel. Please note that this creates essentially no increased length of channel edge along which vegetation control would be periodically needed.

6) 10 ± acres of new channels AT APPROPRIATE LOCATIONS would be constructed to facilitate additional distribution of water throughout the marsh. With these 15 new acres there would now be more than 76 acres of open water within the marsh in a series of interconnected channels opening into Onawa Channel.

The point is this. This is the only plan which utilizes all of the flood control work up to this point. In addition to all the work of both the COE and C/C, some 15 acres of new, or enlarged channels are created. At the 4000 cy per acre amount used for vegetation clearing and disposal in the Quarry Road Channel plan, this would amount to some 60,000 cy of additional vegetation clearing and disposal compared to the Quarry Road plan, for a total of, say, 200,000 yards. The 372,000 cy called for in the Marsh Clearing plan is obviously an error, and overestimates the cost by more than $6 million. (Even if the C/C openings are ignored and all new clearing is assumed, the amount is still an overestimate.)

It is also important to take a look at the design of the floodwall which would be required. Your engineering drawings clearly show that a floodwall of 4' height or less would not require the sheet piling cutoff wall required by higher floodwalls. Why then does the Marsh Clearing plan include 49,100 SF of sheetpile at $38.00 per SF for a total of more than $2 million? From the floodwall heights you mention with this plan, perhaps $600,000 for sheetpile might be needed.

Speaking of floodwall heights, it is worthwhile to note the change in height of the floodwalls from the Kailua Road end to the Onoawa Channel end as one compares the Floodwall, Quarry Road Channel and Marsh Clearing plans. The slope along the top of the walls is about 8, 4, and 3 foot respectively, indicating that as more vegetation is removed, the basin acts more and more like a real basin as the original design assumed. This indicates, if there was any doubt, that the vegetation was the culprit.

In spite of this, your use of the 9.0' water height at the start of the design storm ignores all the interior vegetation clearing. I do not find any justification for using a 9.0' starting height in any plan which includes the Quarry Road Channel. Surely, if the 30'-50' emergency ditch (depending on which section of the report you believe) significantly lowered inter-storm water heights, then the 200' wide QR channel could be relied upon to do even more. Please explain to me the hydrologic conditions under which the QR plan would have a water height in the marsh of 9.0' at the start of the design storm.

You state "The floating vegetation mat on the marsh surface severely complicates flood control measures due to its instability and unknown/random behavior during flood events." I can assure you that the mat does not act in a 'random' manner. I personally believe that your concerns about the mat, while certainly legitimate at one level of analysis, are overstated. At the time of the New Year's flood the mat lay immediately adjacent to the dike; there was no channel such as the emergency ditch now provides. Water gradients then were obviously perpendicular to the dike, as they are now shown to be with levee overtopping. The mat rose with the rising water and because of the very steep gradients tended to stay adjacent to the dike rather than rising vertically. However, EVERY plan which includes the Quarry Road Channel shows that the gradient of flow will be toward the north, parallel to the levee, rather than perpendicular and toward the levee. Even the levee raise and floodwall plans show this to be true. Thus any large scale shifting of the mat would be toward pinching off the Quarry Road Channel rather than closing the emergency ditch. Therefore any plan which provides for additional open channel along the dike, and new interior channels along the flow gradient rather than across the gradient, should be preferred.

I am disconcerted also, by the plans which now indicate a height of 4.5 feet for the low-flow structure. The original plans were for a 3' height, based on tidal heights. I see no justification in your report, and know of no wildlife plan, which indicates that an increase is called for. Since the QR channel plan calls for dredging to -4', there will be plenty of deep water available for the species which prefer such. I say keep the low flow height at 3' for flood control planning; there appears to be no justification for changing it. Further, since this is obviously a feature which has nothing to do with flood control, shouldn't the costs be shown outside the flood control costs?

Since the construction management for the Quarry Road channel can be handled for only $1 million, I think the little extra clearing in the Marsh Clearing plan could be handled for the same. (Also, it shouldn't take 6 months longer.)

I had hoped that the time taken to prepare this plan would have resulted in some conscious effort to produce a plan likely to be acceptable to the public. I do not think that point has been reached yet. Your NED plan is nothing more than a new 10' basin on top of the old. By assuming the bottom basin is full, any necessity to maintain flow is dismissed and vegetation maintenance is the lower basin is unnecessary.

But an acceptable plan can be reached if we make an effort to prescribe management of the marsh vegetation in such a manner as to minimize the height of the floodwall.

I believe the slightly lower low-flow structure, a widened and maintained emergency ditch, an enlarged and maintained C/C intra-marsh channel system and the Quarry Road Channel with a floodwall of 4' can work and be cost effective if engineers and environmentalists in our community get together and try to make it happen.

Sincerely,

Robert A. Merriam

cc: DLNR
C/C Public Works
Kawai Nui Heritage Foundation
Interested parties

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 23 1992

REPLY TO ATTENTION OF:

Planning Division

Mr. Robert A. Merriam
616 Pamaele Street
Kailua, Hawaii 96734

Dear Mr. Merriam:

Thank you very much for your testimony at our public meeting on May 29, 1991 and for your written comments by letter dated May 10, 1991 on the Kawainui Marsh Flood Control Project.

Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to be as responsive as possible, complete the study process, and select a preferred alternative.

We have prepared annotated responses to your comments in the enclosed letter to address each of your particular concerns.

After consideration of engineering, environmental, and economic factors as well as agency and public input, the Corps along with the City and County of Honolulu have recommended a modification to the NED plan which lowers the height of the floodwall and fills less than two acres of wetland. The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side. We intend to seek the necessary approvals and provide compensatory wetland mitigation which will convert previously filled wetland in the marsh to new wetland habitat for wildlife.

Thank you again for your input in the planning process.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

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

DEPUTIES
KEITH W. AHUE
MANABU TAGOMORI
RUSSELL N. FUKUMOTO

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

DOFAW

May 20, 1991

Mr. Kisuk Cheung
Director of Engineering
Department of the Army
U.S. Army Engineer District, Honolulu
Building 230
Ft. Shafter, Hawaii
96858-5440

Dear Mr. Cheung:

Thank you for forwarding a copy of the Draft Detailed Project Report and Draft Environmental Impact Statement for the Kawainui Marsh Flood Control Project for review.

The following comments do not constitute official comments of the Department of Land and Natural Resources and are confined to the subject of impacts on wildlife and endangered species.

In general, the document discloses the possible impacts of the various alternatives on the habitats of resident and endangered wildlife. However, under Plan 5, "Back Levee and Channel", it is stated that there will be "no effects" on ecological attributes and wildlife. Given that under this plan a modified channel and berm will be created between the existing dike and Coconut Grove, this statement is misleading. Endangered coots and moorhens have been noted in the existing channel, makai of the dike, including the short tributaries of this channel extending towards the residential area. Certainly during the construction of a connection with the Oneawa canal and the new "back levee" there will be disturbance to the habitat of these bird species. Depending on the depth of the modified channel, and the new water flows inherent in this alternative, such habitat may be permanently effected. These possibilities should be discussed in the document.

In terms of long-term benefits to wildlife (and irrespective of costs) the "marsh clearing" alternative is most appropriate. It would create open water habitat for waterbirds while creating more storage capacity for flood control purposes. With the construction of a water control structure, manipulation of water levels for management purposes will be possible, and drainage of the marsh prevented. In conjunction with a moderate raising of

the existing levee, both flood control and environmental concerns will be addressed with this alternative.

It is noted that with the alternative selected by the Corps as most economically and environmentally acceptable ("floodwall atop the levee") there is no corresponding clearing of marsh vegetation other than what may be accomplished by the City and County of Honolulu. It would appear that this plan does not fully address the underlying problem of the raising of the marsh due to vegetative build-up by natural processes.

Thank you for providing an opportunity to comment on the draft document.

Sincerely yours,

Ronald L. Walker
Wildlife Program Manager

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 23 1992

REPLY TO ATTENTION OF:

Planning Division

Mr. Ronald Walker
Wildlife Program Manager
Division of Forestry and Wildlife
Department of Land and Natural Resources
State of Hawaii
1151 Punchbowl Street
Honolulu, Hawaii 96813

Dear Mr. Walker:

Thank you for your letter dated May 20, 1991 on the Kawainui Marsh Flood Control Study. Your involvement over the years with marsh wildlife issues is widely recognized. We have responded to other DLNR comments separately but are addressing your particular concerns as well. Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

The "no effects" statement on the table addressing environmental impacts associated with the "Back Levee and Channel" is incorrect. As stated in several locations of the DEIS this alternative carries perhaps the greatest environmental impacts of any of the alternatives. Thank you for bringing the error to our attention. This, along with several other alternatives, has not been carried forward for final analysis.

We agree with you that creation of open water will benefit some of the waterbirds in the marsh, and we have spent the last year intensively evaluating possible approaches to provide flood control that might also have ecological and recreational benefits. However, the in-marsh alternatives which were evaluated in the draft do not meet Corps prescribed engineering, economic or environmental criteria for flood control for the following reasons:

a. We have been unable to identify how much vegetation can be safely removed without jeopardizing the existing filtering capacity of the marsh vegetation for the marine receiving waters.

b. Direct connection of open water channels in the marsh to the Oneawa Channel is required to attain significant flood control improvements. This connection brings the risk of increasing sediment deposition and bacterial contamination into Kailua Bay during periods of heavy rainfall as well as other unknown ecological changes to the marsh. Note that even with the marsh clearing alternative, the levee must be raised to provide the necessary flood protection.

c. There are concerns that the floating mat of vegetation may block channels during a flood and render ineffective any flood control benefits with the attendant risk of overtopping the levee.

d. There are very high construction, disposal, and maintenance costs associated with vegetation removal making in-marsh work substantially more expensive than other alternatives.

Consequently, after careful consideration of engineering, environmental, and economic factors as well as agency and public input, the Corps along with the City and County of Honolulu have recommended a modification to the NED plan which lowers the height of the floodwall and fills less than two acres of wetland. The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side. We intend to seek the necessary approvals and provide compensatory wetland mitigation which will convert previously filled wetland in the marsh to new wetland habitat for wildlife. We seek your expertise regarding this conversion so that optimal conditions may be created for wildlife.

We believe that this compromise alternative, resulting from agency and public input, will be acceptable to the public and provide the needed flood protection for Coconut Grove. Thank you again for your input.

Sincerely,

Kisuk Cheung
Director of Engineering

Copy Furnished:

City and County - DPW

May 25, 1991

Commander, Honolulu Engineer District
ATTN: CEPOD-ED-PV
Ft. Shafter, HI 96858-5440

SUBJECT: Kawainui Marsh Flood Control

ATTN: Planning Division

My name is Robert H. Lopes. I have lived at 327 A. Kihapai Street since 1955. I've experienced all the flooding that has occurred in the last 35 years. I've also witnessed the contruction and maintenance of the existing flood control levee. During the construction of the levee, which changed the marshes natural flow of the exiting water from Kailua Stream to Kawainui Stream, there was no planning for an access way for which water would travel across the marsh except for the filtration through the marshes heavy vegetation. During the heavy rains the dense vegetation has obstructed the flow of exiting water and caused the marshes water level to exceed the existing levee.

After the 1988 flood, the construction of an emergency ditch along the levee's mauka side has provided an access channel for which water may exit unobstructed. The concern I have is whother the emergency channel and existing levee height is adequate to handle excessive heavy rains without exceeding the present levee height.

Based on the Kawainui Marsh Flood Control Project Report and Environmental Impact Statement Draft Report, I have come to the following conclusions:

The three plans which propose the creation of channels within the marsh would be very ecology minded but, produce a lower protection factor, higher cost to construct, with a critical reliance on maintenance of channels remaining free from obstruction. Even if the channels are maintained, present vegetation within the marsh, during a heavy rain, would float and probably obstruct the flow of the channel ways. The plans would not be eligible for federal funds and require total funding by the City and County of Honolulu. Based on available funds the project is likely to be done in increments with no set time frame for implementation and completion. Estimated cost is 24 million dollars.

Both the plans which propose the increased height of the existing levee would provide the maximum protection factor, low construction cost and minimum maintenance. The plans would be eligible for 5 million dollars of federal funds and could commence immediately. The estimated cost is 8 to 10 million dollars.

Since the objective and purpose of the Kawainui Marsh Project is flood protection, the best plan, in my judgement, is raising the levee with some type of fill that would provide the highest protection factor, blend with the natural surroundings, levy the lowest cost to us taxpayers and best serve the people of Hawaii.

Sincerely,

Robert H Lopes

Robert H. Lopes
327 A. Kihapai Street
Kailua, Hawaii 96734

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 2 3 1992

REPLY TO ATTENTION OF:

Planning Division

Mr. Robert H. Lopes
327-A Kihapai Street
Kailua, Hawaii 96734

Dear Mr. Lopes:

Thank you for your comments and testimony provided for the Kawainui Marsh Flood Control project.

Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

Your concern as to whether the emergency channel and existing levee height is adequate to handle excessive.heavy rains without exceeding the present levee height is well-founded. Our modelling of the existing marsh indicates that overtopping in any year has a probability of 10 percent. We believe that a timely solution to the flood problem is critical. We have documented your request for the earthen levee raise alternative.

Although the earthen levee raise alternative is the most compatible with the rural character of the marsh, it will fill over six acres of wetland as a result of the increased base width required. Several agencies have indicated that this amount of wetland loss is inappropriate when other alternatives exist to offer flood protection at even more reasonable cost. However, in light of the negative reaction to the higher floodwall received by the respondents to the draft, and after careful consideration of engineering, environmental, and economic factors, the Corps along with the City and County of Honolulu will be

recommending a modification to the NED plan which fills 1.8 acres of wetland and combines a lower levee raise with a concrete floodwall 4 feet in height. We will seek the necessary approvals required to deviate from the NED plan.

The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side. Compensatory wetland mitigation will include conversion of fastland in the marsh near the levee to new wetland habitat. A levee raise will not preclude future marsh management scenarios, although marsh activities must be compatible with its flood control function.

With its landscaping in place, this alternative should be acceptable to the community and offer the necessary flood protection at only slightly increased cost over the NED floodwall.

Thank you again for your in-depth review and input.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

WILLIAM W. PATY
BOARD OF LAND AND NATURAL RESOURCES

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

Copy DPW

REF: HP-JLE

MAY 30 1991

Kisuk Cheung
Director of Engineering
Department of the Army
U.S. Army Engineer District, Honolulu
Building 230
Fort Shafter, Hawaii 96858-5440

Dear Mr. Cheung:

SUBJECT: Department of the Army, U.S. Army Engineer District -- Detailed Project Report and Draft Environmental Impact Statement for the Kawainui Marsh Flood Control Project Kailua, Koolaupoko, O'ahu
TMK: 4-2

The draft environmental impact statement considers the impacts of six alternate plans. The first two of these, raising the levee and building a floodwall atop the levee, were the subject of an archaeological inventory survey draft report completed in February 1991. A final report of this work is not yet complete. We concurred with the draft findings of this survey that there were no historic sites within the levee project area and agree with the assessment in the draft environmental impact statement that these alternatives will have "no effect" on historic sites in the levee area.

The remaining four alternate plans, which include marsh clearing, a Quarry Road Channel connecting with Oneawa Channel, an extension to Oneawa Channel with a new "back levee," and flood proofing of approximately 2,030 homes in Coconut Grove, have not been the subject of archaeological inventory surveys and thus we are unable to offer detailed comments. However, the draft environmental impact statement notes that these alternate plans may have adverse

Kisuk Cheung
Page 2

effects on historic sites, an opinion with which we concur. In our opinion, the "back levee" and flood-proofing alternates would likely entail extensive archaeological excavations in order to mitigate their probable adverse effects outside of Kawainui Marsh. If any of these four alternate plans were chosen then we would require an archaeological inventory survey as the first step in the historic preservation process.

Should you have any questions, please have your staff contact Dr. Tom Dye at 587-0014.

Sincerely,

WILLIAM W. PATY, Chairperson and
State Historic Preservation Officer

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

DEPUTIES
KEITH W. AHUE
MANABU TAGOMORI
DAN T. KOCHI

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

May 28, 1991

REF:DAR-MI

Commander, Honolulu Engineer District
AATN: CEPOD-ED-PV
U.S. Army Engineer District, Honolulu
Building 230
Ft. Shafter, Hawaii 96858-5440

Dear Sir:

Thank you for the opportunity to review the joint Federal and City and County of Honolulu Draft Detailed Project Report and Draft Environmental Impact Statement for the Kawainui Marsh Flood Control Project.

From the perspective of aquatic biological resources, Plan 3 of the 6 action plans is clearly preferable, even though your calculated benefit/cost ratio is low. Fisheries values were not appropriately weighted in your benefit to cost comparisons and would in any case be hard to quantify in monetary terms. Basing a decision about the selection of a plan on Net NED Benefits, then, would be a serious error that would ignore the acknowledged high native fisheries values associated with the Marsh.

It should be recognized that there would be no concern about flooding today if construction had originally been denied on the natural flood plain. Loss of that flood plain to urban development has resulted in a serious degradation of fisheries habitats throughout the area. The higher cost reflected in the creation and maintenance of open water areas in Plan 3 is a proper and justifiable payback for the true environmental costs of the original development.

The open water areas defined in Plan 3 would improve the success of migration of our native amphidromous freshwater stream species through the Marsh. These species have declined markedly around Oahu as a result of increasing urbanization, and a high priority needs to be given to the preservation and restoration of their habitat to prevent them from sliding into an endangered status. In addition, we believe that the open area would be heavily used as nursery waters by marine species.

This is a rare case where flood control measures can be taken in concert with beneficial fisheries management. False economies must not again be allowed to prevail, as they once were when construction was allowed on the flood plain.

Sincerely,

WWPaty

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

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

DEPUTIES
KEITH W. AHUE
MANABU TAGOMORI
Dan T. Kochi

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

REF:OCEA:JN

JUN 12 1991

File No.: 91-468
Doc. No.: 0883E'
17 JUN REC'D

Lt. Col. Donald T. Wynn
District Engineer
U. S. Army Engineer District, Honolulu
Fort Shafter, Hawaii 96858-5440

Dear Colonel Wynn:

Subject: Department of the Army, U.S. Army Engineer District -- Detailed Project Report and Draft Environmental Impact Statement for the Kawainui Marsh Flood Control Project Kailua, Koolaupoko, Oahu THK: 4-2

Thank you for giving our Department the opportunity to comment on this matter. We have reviewed the materials you submitted and have the following comments.

Our Department's Historic Preservation Division has responded directly to the Department of the Army on this matter. Previous comments include the following review.

The draft environmental impact statement considers the impacts of six alternate plans. The first two of these, raising the levee and building a floodwall atop the levee, were the subject of an archaeological inventory survey draft report completed in February 1991. A final report of this work is not yet complete. We concurred with the draft findings of this survey that there were no historic sites within the levee project area and agree with the assessment in the draft environmental impact statement that these alternatives will have "no effect" on historic sites in the levee area.

The remaining four alternate plans, which include marsh clearing, a Quarry Road Channel connecting with Oneawa Channel, an extension to Oneawa Channel with a new "back levee," and flood-proofing of approximately 2,030 homes in Coconut Grove, have not been the subject of archaeological inventory surveys and thus we are unable to offer detailed comments.

However, the draft environmental impact statement notes that these alternate plans may have adverse effects on historic sites, an opinion with which we concur. In our opinion, the "back levee" and flood-proofing alternates would likely entail extensive archaeological excavations in order to mitigate their probable adverse effects outside of Kawainui Marsh. If any of these four alternate plans were chosen then we would require an archaeological inventory survey as the first step in the historic preservation process.

The Division of State Parks interests involve recreation activities associated with interpretive opportunities related to the natural and cultural features of the marsh. In view of our recreation interests and the general interests of the department in protecting the marsh, we are concerned about the general reliance on engineering solutions to the flood control problem with little understanding of the marsh, marsh sediment and the dynamics of floating vegetation mats.

The division is not aware of significant recreation impacts related to the various alternative flood control plans with the exception of the Plan 2 Floodwall. As indicated in the report, the existing levee is being used by the public as an exercise track and viewing trail for the marsh. As public trails, viewing stations and interpretive programs are developed around the edge of the marsh, considerable increase in use of the levee is likely. A concrete wall is expected to be a major detraction aesthetically and for viewing the marsh habitat on both sides of the levee. The wall could also become an attractive nuisance for graffiti, broken glass, etc.

The Land Management Division has no objections to the proposed flood control project provided that it is undertaken in consonance with the Kawainui Marsh Resource Management Plan. Land Management is now in the process of acquiring the remaining lands needed for the management plan.

Thank you for your cooperation in this matter. Please feel free to call me or Roy Schaefer at our Office of Conservation and Environmental Affairs, at 548-7837, if you have questions.

Very truly yours,

WWPaty

William W. Paty

JOHN WAIHEE
GOVERNOR OF HAWAII

REF:WRM-BM

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF WATER RESOURCE MANAGEMENT
P. O. BOX 373
HONOLULU, HAWAII 96809

JUN 25 1991

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

Commander, Honolulu Engineer District
ATTN: CEPOD-ED-PV
Ft. Shafter, Hawaii 96858-5440

Gentlemen:

Thank you for the Draft Detailed Project Report and Draft Environmental Impact Statement for Kawainui Marsh Flood Control Project.

We have reviewed the documents and have the following comments to offer:

1. The storms of March 19-23, 1991, appears to confirm your agency's analysis of the present flood control problems at the Kawainui Marsh. Since the rains had stopped in time, no overtopping of the levee occurred.
2. The flood wall alternative appears to be the most economical. However, since the flood wall would provide opportunities for graffiti and accordingly, an undesirable aesthetic view, the raised earth levee would also be acceptable to us.
3. None of the flood control alternatives will reduce the need to maintain vegetation and sedimention in the marsh. This maintenance will be required to retain the storage capacity of the marsh. As stated by your agency, we agree that the action of the vegetative mat during storms is unknown.
4. An open waterway to the Oneawa Canal with or without a water control structure is needed to direct water to the Canal. With this waterway, the water level in the marsh would be maintained at a lower level and any clogging during floods would not overtop the levee.
5. Design for greater flood events than the 100-year event should be considered as an added safety factor. However, limited funding and time to implement the flood control project are constraints that should not prevent its implementation. We believe that some flood control protection now is better than none and actions with or without COE help could be pursued later.

Thank you for the opportunity to comment. Thank you also for your assistance and support for this flood control project.

Very truly yours,

WILLIAM W. PATY

RECEIVED

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 2 3 1992

REPLY TO
ATTENTION OF:

Planning Division

Mr. William Paty, Chairperson
Department of Land and Natural Resources
State of Hawaii
1151 Punchbowl Street
Honolulu, Hawaii 96813

Dear Mr. Paty:

We wish to respond to your four letters dated May 28 and 30, June 12 and 25, 1991, regarding the Kawainui Marsh Flood Control project. We have responded separately to Mr. Ron Walker of your staff based on his letter of May 20, 1991.

Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

Since the State will be the ultimate owner and operator of the flood control project, your input and comments have been of great interest to us. Our previous letters to you dated July 19 and December 5, 1990 have solicited the status of the Department of Land and Natural Resource's (DLNR) implementation plans for the Kawainui Marsh Resource Management Plan. At that time, you were unable to provide us with specific information as your plans were still being formulated.

After careful engineering analysis of the marsh, and considering environmental and economic factors, as well as agency and public input, the Corps and the City and County of Honolulu have selected a combination alternative which includes a floodwall of lesser height (4 feet) than the NED plan, on top of an earthen levee raise which fills less than two acres of wetland. The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side. As you have noted, a levee modification will have "no effect" on historic sites unlike the in-marsh vegetation clearing alternatives which you state may have adverse effects on historic sites.

We have noted your Land Management Division's lack of objection to the project and their interest in ensuring consonance with the Kawainui Marsh Resource Management Plan. The recreational impacts that would arise with the concrete floodwall are noted in the FEIS. Levee access is presently controlled by the City and County of Honolulu.

Deviation from the NED plan (concrete floodwall plan) requires an exception to be granted by the Assistant Secretary of the Army for Civil Works. We shall seek the necessary approvals and identify appropriate compensatory wetland mitigation to include the restoration of previously filled wetland in the marsh near Oneawa Channel. We believe that this compromise alternative is consonant with the Kawainui Marsh Resource Management Plan.

Some of the lands that you own or are in the process of acquiring will be subject to the 100-year flood with the levee raise in place. The City and County of Honolulu and the Corps of Engineers' Real Estate representatives will be contacting you with regards to flowage easements required as part of the project implementation. Inundation limits are shown on Plate 4-A of Appendix B in the Detailed Project Report.

We shall continue to seek other Corps authority and funding, separate from flood control, for the creation of valuable open water habitat in the marsh that both Mr. Walker and your Division of Aquatic Resources' personnel, among others, have stated is desirable. We hope to assist the City and County of Honolulu in this endeavor.

Thank you again for your input, and we look forward to our continuing involvement with you as we implement cost effective flood control measures for the Coconut Grove residents.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

JB30

519 B Kihapai St
Kailua, Hi 96734
May 29, 1991

Commander, Honolulu Engineer District
ATTN: CEPOD-ED-EV
Fort Shafter, Hawaii 96858-5440

Dear Mr Cheung,

I am in favor of raising the earthen levee. In spite of the work the City & County has done in the marsh over the last two years, during a rainstorm in March of this year the water rose to within 6 inches of the top of the present levee. Compared with the rains before the '88 flood, this was a short rainy period.

I live one house in from the marsh. In the '88 flood the water was up to my chest. However I was luckier than my neighbors as my house is raised off the ground. There was 18" of water in the house

When the water receded there was a thick layer of mud over the entire floor. My son had to drill one inch holes in every room, bring in the garden hose and wash it out.

The floor has never recovered and of course everything non-washable was ruined up to 18" from the floor as well as paint - varnish - metal. I lost 7000 in reference books to say nothing of family picture albums and personal records.

Of course I would like to see the Marsh Clearing Heritage plan implemented.
But how can we wait!

page 2.

The federal government will fund up to $5 million for raising the earthen levee. The engineers assure us that the plan will keep back a flood similar to that of '88. The system has worked in California. An earthen levee is better looking and more dependable than a concrete wall.

Let us accept the plan so you can begin work in December!

Perhaps at some future date money can be found for clearing canals in the marsh. I think the canal on the Coconut grove side of the levee should remain.

I hope for a speedy decision and implementation.

Very truly yours,
Camille Woodruff

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

REPLY TO
ATTENTION OF:

JUL 23 1992

Planning Division

Ms. Camille Woodruff
319 B Kihapai Street
Kailua, Hawaii 96734

Dear Ms. Woodruff:

Thank you for your comments on the Kawainui Marsh Flood Control Project. We agree that a timely decision and implementation of a flood control solution is desirable.

Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

Your request for the earthen levee raise alternative has been documented. However, both the Corps and our local sponsor, the City and County of Honolulu, have agreed that after careful consideration of engineering, environmental and economic factors, a modification to the National Economic Development plan which combines the earthen levee raise with a much lower floodwall and fills less than two acres of wetland is the preferred alternative. The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side. We fully expect this alternative to be visually pleasing and acceptable to the community. Compensatory wetland mitigation will include the conversion of fastland in the marsh to new wetland habitat. The necessary approvals will be sought from the Assistant Secretary of the Army for Civil Works. Separate authority and funding will be sought to assist in opening up water in the marsh for wildlife purposes. Thank you again for your input.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

HAWAII'S THOUSAND FRIENDS

Ke aloha o ko kākou ʻāina, ʻOia ka mana kū paʻa. Pānoanoa ka ʻāina, Mānoanoa ka poʻe.
The Love of our land, is the power for us to stand fast. Rare is the land, many are the people.

May 29, 1991

Commander, Honolulu Engineer District
ATT'N: CEPOD-ED-PV
Ft. Shafter, Hawai'i 96858-5440

RE: Proposed Kawainui Marsh Flood Control Project
Kailua, Island of O'ahu, Hawai'i

Sirs:

Hawaii's Thousand Friends (HTF) is a community supported non-profit corporation dedicated to responsible land use, planning, and management in Hawai'i. The following observations are preliminary. A more detailed response to your document(s) will be submitted prior to your June 22, 1991 deadline.

Our cursory examination of the document(s) leaves us troubled by CoE's apparent philosophy (page 3, "Summary" of the "Main Report"), "One of the major considerations was that the best flood control solution be one which is independent of future conditions in the marsh. We would like to have this statement explained, since the legal goal of the NEPA process is to achieve "productive harmony" (Sec. 101).

We had anticipated a more sensitive and economical planning approach to Kawainui flooding at a much earlier date. We find the document(s) to be difficult and confusing for public review; it is apparently incomplete (some studies are not included); and the format does not fulfill NEPA requirements that an EIS be offered in plain language so that the public may clearly understand the import of proposed actions (Sec. 1502.8).

There may also be members of the public who have already responded to earlier City proposals, and who are unaware that their input is again desired for these particular proposals.

Since the intent of this public meeting is to receive review comments from the public, to encourage public involvement and facilitation, and to provide a clearly comprehensible, inter-disciplinary document, (NEPA Sec. 1501.2a, 1502.6, and 1502.d), we fear much discussion tonight will not address the merits or shortcomings of the project(s), but will become merely informational for those among us who are neither City nor Army Engineers, and are untrained in "bureaucratese."

This is, apparently, two documents in one, each having both yellow and white pages. There are two tables of contents, one for the CoE "Main Report," called the "Detailed Project Report" on the cover, in which one of the plans outlined has already been selected; the other for the City's "Draft Environmental Impact Statement (showing the CoE as a participant) with alternatives listed which are already discounted by the CoE. Adding to the confusion are references to an earlier City "Final" EIS, and earlier meetings, requests for public input, and actions already taken. Neither of the combined documents indicates that either is a NEPA document, although on the second page of the "Abstract" for the City's document we are advised that the actions proposed are so "assessed and documented" for both state and federal EIS requirements. There are separate and multiple appendices, figures, and agency responses. No earlier public comments appear to be included.

We hope that the above can be clarified for a public which cares a lot about the future management of Kawainui's waters, wildlife, cultural values, and vegetation. All of us "little people" out here want to make relevant responses. Credibility for the public agencies who are charged with our protection from flood is not presently high: candor and clarity could be a great help toward improving public perceptions.

Sincerely,

Muriel B. Seto

Muriel B. Seto,
HTF Member DLNR Kawainui
Marsh Advisory Committee

HAWAII'S THOUSAND FRIENDS

Ke aloha o ko kākou ʻāina, ʻO ia ka mana kū paʻa. Pānoanoa ka ʻāina, Mānoanoa ka poʻe.
The Love of our land, is the power for us to stand fast. Rare is the land, many are the people.

June 20, 1991

Commander, Honolulu Engineer District
Att'n: CEPOD-ED-PV
Ft. Shafter, Hawai'i 96858-5440

RE: Testimony Continuation from May 29, 1991 for
Proposed Kawainui Marsh Flood Control Project
Kailua, Island of O'ahu, Hawai'i

Sirs:

The May 29th public meeting confirmed our fears for a lack of public understanding of the City's DEIS, and the import of the CoE's NED plan (ostensibly Alternative #2). A discussion with a CoE staff member following the meeting brought into clear focus the "take it or leave it" attitude of the CoE regarding its NED plan, and the deplorable basis on which it rests, i.e., "... the best flood control solution be one which is independent of future conditions in the marsh." The p.35 claim that plan selection has not been made seems unlikely.

Another troubling aspect of the meeting was the hearing officer's apparent inability to discuss vegetation removal without using the phrase, "the vegetation is a great imponderable." Scoping meetings I attended held immediately following the tragic New Year's flood, to those held later (reported by attendees to others), focused on methodologies for vegetation and water management, some already beneficially in place. The NED plan reflects little of the earlier intent, nor is it philosophically consistent with solicited agencies' comments included in the City and County of Honolulu's portion of the confusing document. As noted, the "Great Wall" appears to be a consideration "independent of future conditions in the marsh."

The CoE advocacy position at the public hearing and within this copious document makes serious review of the City's alternatives more difficult. Also, while Dr. Steve Athens performed archaeological tests for this EIS, his work is absent for our review.

HTF requests, that it once again become a consulted party and that a subsequent public workshop be held, led by a professional trained in the behavioral sciences, experienced in running such workshops (not an engineer), in order to clarify alternatives, and to hold in check agency bias for a specific proposal. The EIS process is intended for public input and benefit, not to provide a forum for public agency project justification. The goal is "productive harmony."

We also hope for revised cost/benefit figures to be presented at that time, in response to questions already raised by credible persons and agencies known to us through our work on behalf of the Kawai Nui Marsh Advisory Committee to the state's Department of Land and Natural Resources.

In the Draft Detailed Project Report (Main Report?) Syllabus: 2. Purpose., we are told that the "Purpose of the study is to evaluate the Kawainui Marsh Flood Control Project..." (emphasis ours). In the Main Report (Detailed Project Report, page 1): 2. Study Purpose and Scope., we are told that the "purpose of this study is to evaluate the need to modify the Kawainui Marsh Flood Control project..."(emphasis ours). While these are not precisely the same purposes, we are more concerned that in each instance you apparently seek to remove the flood basin from future governmental responsibility. From the beginning, the basin has been an integral part of the flood control project. Surely, if part of the intent of the draft project before us is to remove flood basin responsibility from Honolulu (or any other subsequent public agency assuming title), this proposed radical change in the contract should be clearly spelled out for an interested public.

In the Summary of M&E Pacific, Inc.'s November, 1989 Draft Environmental Impact Statement for the City and County of Honolulu, the proposed flood control project was described, "The purpose of this action is to meet or exceed the design objective of 3,000 acre-feet of flood storage capacity established for the original Corps of Engineers' project." This is a far cry from a "flood control solution ... independent of future conditions in the marsh." Would acceptance of the NED alternative advocated here serve to alter that original responsibility?

If this is the underlying intent, the existing EIS may be considered to be deceptive. Also, is it appropriate for the CoE, using the DEIS as "Supporting Documentation," to advocate one project over the others so early in the process, under state/federal EIS requirements?

The claim that the Kawai Nui Marsh Flood Control project has failed is arguable: the structural component of the project, the dike, did not fail. The public should not now be penalized because mandated agencies:

a. allowed highway construction to bisect the marsh,
b. stood silently by while landfills were constructed within the flood plain,

c. allowed years of sewage effluent to enter the waters of the marsh without renewed state permits, and

d. refused to evaluate and comment on probable impacts of nearby projects which exponentially increased insiltation and water degradation, all of which led to the New Year's disaster (auto wreckers, adjacent landfills, quarry operations, valley subdivisions and golf courses, etal.). Public expressions of alarm down through the years were mostly ignored.

The project did not fail; responsible agencies failed, proven in the courts when Coconut Grove residents sued and won.

Item 3. PRIOR STUDIES, REPORTS, AND EXISTING WATER PROJECTS., references a November 1989 Reconnaissance Report to determine what measures were required to "modify" the project "in order to restore and continue the intended project flood protection." Public presumptions were that modifications would deal with insiltation, vegetation, and improved drainage management, some of which had already been effected, improving safety for Coconut Grove residents.

The public, most especially Coconut Grove, has a right to see Kawai Nui's resources finally managed under the City's original contract with the federal government, rather than government being allowed to continue to ignore urbanizing impacts on natural processes, while removing flood basin responsibility from future oversight. This document does not follow the 4.1 Planning Methodology, described on p.2., its exceptions adding to the confusion.

If a flood control "solution" exempted basin considerations (4.5. out of sequence, p.3), how long would it take for the new barrier to be breached due to ever more rapid eutrophication and infill, since upland impacts on the basin would be even more studiously ignored for flood control purposes? We fail to see the "national economic efficiency" or NED consistency "with protecting the Nation's environment" (4.2 National Objectives, p.3), under the NED plan proposed (4.2.a.). Why were funds not sought under the environmental quality (EQ) account, given Kawai Nui's "significant natural and cultural resources" (4.2.b.)?

After all, the area is now being evaluated for National Park purposes at Congressional request, and the state is developing implementation measures for the Management Plan which both the City and the CoE helped to frame. Kawai Nui's attributes include unique aquatic life, endangered exotic waterbird species, and national stature as a Cultural,

Prehistoric and Historic District. Economic weight, we believe, can be given, surely, for future benefits to result from world-class state or national park development already in process. More environmentally meaningful flood control will be a natural result of creative management.

There is now an opportunity for engineers to creatively improve the flood basin for the safety of residents, rather than trying to remove themselves from their contractual responsibilities.

In the 4.3.1.2. Climate description and in the DEIS, we not the absence of any data for Kapa'a Valley. We understand some data is available from studies effected for H-3 construction running through the Valley. Such existing studies and any records kept by the Ameron Quarry operation may be instructive for planning purposes, as we've been told that the "cloudburst" on that fateful New Years' caused a Quarry holding basin to burst as a result of the deluge, carrying additional silts into the marsh. Maunawili data alone may be insufficient to accurately identify storm patterns, as recent experience shows.

4.3.1.3. Winds and Waves. does not adequately identify the intensity of winds known to long-term residents which roar through the Nu'uanu gap during major Kona storms. These have historically devastated roofs and buildings lying makai of Kawai Nui, and have left heavy damage to the Kane'ohe Marine Corps Air Station, as well. Under the advocated NED plan, such information needs to be evaluated against the rigid structure proposed to tower over downwind residences. Would some winds be funnelled to intensification? Would powerful northeasterly winds bounce off the Great Wall to change air patterns for Coconut Grove during storms?

Throughout the document we find Other Fauna., Environmental Resources and Historical, Archaeological and Cultural Resources given short shrift. Hawaiian names for Hawaiian species are not used, nor are their cultural significance documented. For instance, such creatures as the native o'opu may be considered kupua. or altered lifeform, for the resident marsh goddess, Hauwahine - who is certainly perceived culturally as much more than a "lizard." Similarly, 'alae 'ula and 'alae ke'oke'o are the sacred siblings of the demigod, Maui, and kupua forms of their mother, the great goddess Hina. Along with the other endangered species of Kawai Nui, these creatures and others - both native and migratory - (the 'opae, 'awa. 'ama'ama, kolea, etc., etc.) are also CULTURAL ARTIFACTS of Hawaii's first residents.

We realize that it is difficult for engineers and hydrologists to include cultural sensitivity in describing the envirinmental resources of an area under their purview for flood control planning, but they are required to do so. Archaeology is not the sum of culture. Kawai Nui is more than a troublesome floodplain. Attendant to that are the uninterupted vistas which are so culturally important: from the Drive-in Theatre, or from Ulu Po Heiau, for instance, the Great Wall may appear small; from Kailua Town, however, and most especially in Coconut Grove, it will cut off significant views and vistas, in contradiction of the County's own standards, as well as for Hawaiian residents and visitors in touch with their cultural values.

Along these same lines, the early recommendations of archaeologists regarding treatment of isolated sites within the Kawai Nui Historical, Archaeological and Cultural District were rendered moot at the time the entire District was declared eligible for listing in the National Register of Historic Places. The recent re-discovery of what is probably Holo Makani Heiau on the slopes of abutting Ulumawao mountain near the Drive-in Theatre, seems pertinent to a cultural recognition of Kawai Nui's climate, as the name references the running of the wind (presumably through the Nu'uanu gap).

Hawaii's Thousand Friends could give a qualified approval to the City's Alternative #3, the Marsh Clearing Plan, with modifications. However, its cost/benefit projections are outrageously and unbelievably inflated, we believe. If the City were required to purchase appropriate equipment, and hire men whose sole job was to keep waters open, with the landfill nearby, or with an eye to dried grasses to be utilized for HPower, cost estimates would be appreciably less. Also, if both the CoE and the City were required to review project proposals impacting the marsh from elsewhere in the ahupua'a, new silts and alien intrusive plant species could be brought under constrol at sites of origin, rather than in the floodplain. We suggest that a revised EIS having more cogent structure, and re-worked economics, be made available for the workshop we have requested.

The claim that the silts entering the marsh are not a problem is ludicrous. And the academically-minded concentration on insiltation averages over a calendar representing geological time is irrelevant to planning within this here and now and for a human future. Jane Allen-Wheeler's document of her on-the-ground experience of the four to six feet of insiltation overlying lo'i walls makai of the highway, clearly visible in pictures taken in 1925 and shown in the Kelly and Clark work,

graphically and realistically demonstrate Kawai Nui's insiltation problems. Both documents are listed in your Bibliography but were apparently ignored in favor of extrapolations from data which can no longer be considered credible - in the manner in which you are using it - in the light of tragic experience.

In reviewing the City's Assessment Format for a Determination of Federal Consistency, we believe the City is inaccurate in denying the project is unlisted in the National Register, since the District is declared eligible for such listing. Also, as a wetland resource wholly within the Coastal Zone, are not Kawai Nui's banks considered "shorelines?" What of Kawai Nui's estuarine values, as they relate to subsistence and/or commercial fishing, especially with the ongoing planning for such enhancement? Would burning the removed dried marsh vegetation be suitable for burning for energy production? And how can the City ignore the incontrovertible fact that nearby soil erosion (old quarry, new quarry, autowreckers, old and new landfills) impacts the area?

We are unaware of any decision by state or federal wildlife experts to eliminate nesting islands in future planning to enhance wildlife habitat. The obsessive fear of the engineers for Kawai Nui's vegetation may be the product of an arrogant ignorance. Other marshes manage vegetation without damage to flood control. In addition to Montreal, Canada's Wye Marsh (whose resource manager testified before Hawaii's State Land Use Commission in support of DPED's petition to place additional Kawai Nui acreage under Conservation protection), we submit the enclosed photograph of the Cranberry Marsh of Valemount, British Columbia.

We would apologize for the jumbled nature of this response to the Report and DEIS, but would rather look forward to a more cohesive re-issued DEIS and public workshop to which w can make an orderly response as a consulted party.

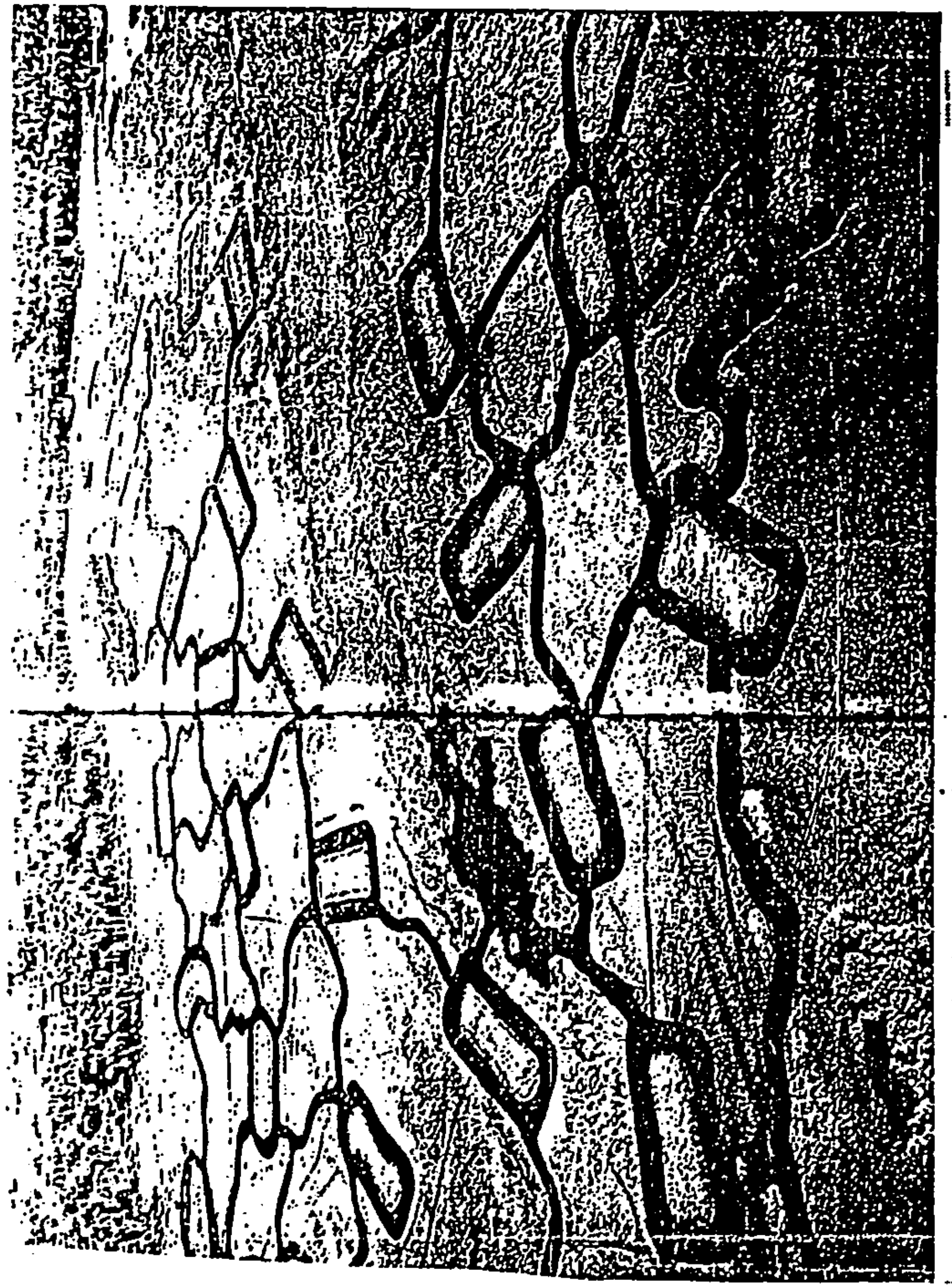
Finally, it should be abundantly clear that the GREAT WALL, (Plan #2) as presented by the CoE, is seen by us to hide an impounded but unseen form of water torture for the residents of Coconut Grove which could only burst upon them at some uncertain future time with even greater savagery than what they have already suffered. Please re-work planning if NED monies can be utilized.

Sincerely,

Muriel B. Seto

Muriel B. Seto, HTF Member
Kawai Nui Marsh Advisory Committee

cc: President's Council on Environmental Quality
President's Council on Historic Preservation
Region 9, Environmental Protection Agency
Sierra Club Legal Defense Fund



If ducks were engineers, they probably could not improve on renovated Cranberry Marsh near Valemount, British Columbia, a project of Ducks Unlimited. The islands and ... interconnecting waterways substantially increase the marsh's breeding and nesting areas. Since 1937 Chicago-based Ducks Unlimited has rejuvenated more than two million acres of wetlands in ... Canada with funds contributed mainly by U.S. hunters.

MURIEL B. SETO
103 Hau'oli St. Kailua, HI 96734

HAWAI'I'S THOUSAND FRIENDS

Hawaiian Cultural Sites Database
103 Hau'oli Street
Kailua, Hawai'i 96734

RECEIVED AS FOLLOWS

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 23 1992

REPLY TO ATTENTION OF:

Planning Division

Ms. Muriel B. Seto
c/o Hawaii's Thousand Friends
103 Hauoli Street
Kailua, Hawaii 96734

Dear Ms. Seto:

Thank you for providing testimony and written comments on the Kawainui Marsh Flood Control Project in your letters dated May 29 and June 20, 1991. We would like to take this opportunity to address your concerns. Since receiving public and agency comment letters in June, 1991 we have evaluated the extensive public input, initiated additional study efforts, and discussed the flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

The statement in our report that says the "...best flood control solution is one which is independent of future conditions in the marsh" is not a philosophy but a statement resulting from analysis of the floating vegetation mat. Flood protection must be provided regardless of future conditions in the marsh. The State of Hawaii Department of Land and Natural Resources has agreed with this analysis in their letter to our local sponsor, the City and County of Honolulu dated 8 July, 1991.

As you know, Kawainui Marsh has evolved this dense floating mat of vegetation over the years which now serves to impede and filter flood waters before they are discharged into the ocean. We and our consultants have determined that a levee raise is the only alternative that meets Corps criteria for engineering, economic and environmental factors because of: 1) high construction, disposal, and maintenance costs associated with vegetation removal; 2) concerns that the floating mat will block exit channels during a flood and render ineffective any flood control benefits; and 3) inability to identify how much vegetation can be safely removed without jeopardizing the cleansing ability of the marsh. All these concerns contribute to our reluctance to rely on marsh channels to protect the residents of Coconut Grove. We are seeking other authorities and funding independent of the flood control study to assist in the creation of open water in the marsh which we agree is essential to improving wildlife habitat.

The draft document contains highly technical engineering information and numerous supporting appendices for those individuals and agencies that either wish to review and comment or are required to do so. The document conforms to Corps reporting requirements as well as State and federal environmental impact statement (EIS) requirements. It is a combined Detailed Project Report and Draft Environmental Impact Statement (DEIS) under one cover in conformance with Corps planning guidance, hence the two tables of contents. We are unsure of which studies you refer to as not being included. The draft archaeological report which is summarized in the DEIS appendix is now available in final form. You were sent a copy of the final report in July, 1991. The flood proofing analysis is also now available in final form.

The Corps is required to identify the alternative which maximizes net flood control benefits and provides the necessary flood protection (National Economic Development Plan (NED)) but as stated in numerous locations throughout the document, a recommended plan will await public input. As stated on page 3 of the main report, "A plan other than the NED plan may be recommended. Its acceptance, however, requires an exception by the Assistant Secretary of the Army (Civil Works)."

The City and County of Honolulu Department of Public Works is our local sponsor. Their previous EIS has been incorporated by reference into our DEIS, hence our reference to it. The abstract of our joint DEIS clearly states that it is a NEPA document. As you know, however, NEPA is a process not a document. NEPA is our national charter for protection of the environment. It establishes policy, sets goals, and provides means for carrying out the policy. Detailed regulations have been drafted that allow us to implement NEPA. We have followed our Corps implementing regulations for NEPA regarding federal water resource development projects as well as the Council on Environmental Quality's (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500-1508). Previous public comments have been summarized in our scoping meetings and have served as the basis for development of the alternatives. Public comment letters as well as official agency correspondence are reproduced in the appendices. Public comments to the DEIS are included in the FEIS.

Another public workshop and a rewrite of the draft document would not contribute substantially to the NEPA process. We see no reason to repeat the study process when we have evaluated alternatives and clearly identified, with public and agency input, a federally implementable solution for flood protection at Kawainui Marsh. During our Kawainui Marsh Flood Control Study, we have held two public meetings, two public workshops, and nine ad hoc committee meetings, many of which you have attended. The Environmental Protection Agency has indicated that a final environmental impact statement that addresses all comments and concerns raised through the public input process would be a more expedient means to accommodate the NEPA process.

The following are responses to your specific comments:

a. At no time have we ever considered removing the flood basin from future governmental responsibility. However, there are limits to federal responsibility in the basin and the flood control project must accommodate future basin changes which are controlled by the City and County of Honolulu and the State of Hawaii.

b. The design objective of 3,000 acre-feet of flood storage established for the original Corps project is no longer relevant based on our revised hydrologic analysis. Changed conditions in the marsh and the watershed indicate that the required storage is now 5,400 acre feet. The 5,400 acre-feet of flood storage is provided by the recommended levee raise project.

c. The draft document did not advocate one alternative over another but identified the NED plan. As previously stated above and in the draft document, provisions exist for approval of other than the NED plan.

d. You are correct that the levee component of the flood control project did not fail. However, the functional requirement of the project to prevent flooding did fail. As you pointed out, changed conditions in the marsh and watershed led to the project failure; changed conditions beyond Corps control. Land use decisions surrounding the marsh are outside Corps jurisdiction, however, we too agree that controls over non-point source pollution which contribute to marsh changes should be implemented. Controls over non-point sources of pollution should help prolong the life of the marsh and improve water quality of streams which feed it.

e. In accordance with the terms and conditions of the project's operations and maintenance manual, we turned over the completed flood control project to the City and County of Honolulu, as local sponsor, to manage.

f. There are no funds to be sought under the environmental quality (EQ) account. The term account refers to a planning category. We have sought funds under Section 1135 of the Water Resources Development Act (1986) for environmental enhancement of the marsh's wildlife. We will continue to pursue other authorities for funding environmental enhancement.

g. The inherent values of the marsh and its surroundings have played a significant part in the evaluation of alternatives and in the final selection of a recommended plan. For example, in-marsh alternatives are expected to pose too great a risk to the receiving waters of Kailua Bay among other engineering and economic concerns. Therefore, a levee modification, Plan 3A in the FEIS, which reduces the height of the floodwall and fills the least amount of wetland is expected to have the least impact on the environment while providing the necessary flood protection. Compensatory wetland mitigation would include the conversion of fastland in the marsh to new wetland habitat. This alternative or others in the FEIS would not preclude the opportunity for future marsh management scenarios, although marsh activities must be compatible with its flood control function.

h. We have researched the availability of additional climate data specific to Kapa'a Valley. Such data is practically non-existent. A check with the State of Hawaii Department of Transportation showed that they did not collect any climatological non-hydrologic data for the H-3 construction. A check with Ameron revealed that they have about four years of informal rainfall records. Daily readings were taken from a small wedge-type rain gauge with a limited capacity. Ameron acknowledged that a holding basin did burst as a result of the 1988 New Year's flood but that most of the silt remained on their property and very little went into the marsh. Our study has utilized all available climate data.

i. The presence of the floodwall is not expected to have any noticeable effect on residences nearby or change air patterns during storms.

j. We have utilized Hawaiian names for animals in many sections of the draft. Your reference to Holo Makani Heaiu on the slopes of Ulumawao mountain near the Drive-In Theater has been discussed with the SHPO staff. At this time, its cultural significance has not yet been determined. Our draft document contains in the appendix the legend network prepared for the Directional Plan #5 by Robert Herlinger. In the FEIS, we have identified the established cultural significance of the marsh commensurate with the degree of potential impact from the proposed project, including additional public and agency input received in response to the DEIS.

k. We believe the cost estimates given for the in-marsh alternatives are not inflated nor outrageous. Because these alternatives are not being carried forward for final analysis, their cost estimates have not been refined as have those of the other alternatives. However, estimates can be made based on costs for the C&C channel clearing project, current levee raise alternatives and original cost estimates. Approximately $4 million would be required for dredging of Oneawa Channel and construction of the low flood wall needed to augment the open water to bring protection to the 100-year level. The C&C is paying nearly $2 million for five acres of open water channels as part of their project. Additional in-marsh alternatives would have created 33 or 76 acres of channels, costing in the range of $10-20 million based on the C&C costs. These figures are in the same range as those presented in the draft report.

l. The resultant loss of water storage in the wetland due to accelerated sedimentation has been evaluated with respect to the long-term effectiveness of the Kawainui Marsh flood control project. The rate of sedimentation in the marsh is directly related to the amount of soil exposed in the watershed, the size of the particles, the hydrologic regime, the presence or absence of channels, the configuration of channel flow, flow velocity, and vegetation. Vegetation itself contributes a substantial percentage of sediment to the marsh not only through its trapping effect but from addition of organic material through the natural decaying process. Analysis concludes that sedimentation rates differ throughout the marsh but that an average sedimentation rate in the marsh is on the order of 0.3 feet/10 years. Runoff sedimentation contributes 0.17 feet/10 years while the vegetation contribution is estimated at 0.13 feet/10 years. These figures are consistent with other estimates of marsh sedimentation rates with the exception of M&E Pacific's estimate of 0.9 feet/10 years which assumes a higher trap efficiency of the marsh, and an ARCOS (1981) estimate of 0.003 feet/10 years which is considerably lower by several orders of magnitude. Sediment cores from the marsh have been evaluated according to age versus depth using radiocarbon dating techniques. It has been determined that infilling of the Kawainui basin diminished considerably following conversion of the basin to a freshwater marsh and the period of Hawaiian agricultural influence. This is surprising and somewhat controversial in that the literature you refer to suggests a faster rather than a slower rate of sediment accumulation for the upper layers since human habitation suggesting that erosion from Hawaiian agricultural practices contributed to infilling of the marsh.

m. Our CZM consistency statement reflects the marsh's eligibility for listing rather than its actual placement on the register.

n. Kawainui Marsh's banks are not considered shorelines. They are man-made for flood control and drainage purposes.

o. The estuarine values of the marsh are documented in the draft and final EIS.

p. The Corps has had considerable experience in management of vegetation in marshes and waterways throughout the U.S. Consultation by our vegetation control people and our Waterways Experiment Station wetland experts indicates that although vegetation control is possible, removal of vegetation and associated sediments is very expensive and could jeopardize the receiving waters of Kailua Bay. Marsh clearance similar to the Cranberry Marsh of British Columbia photo you submitted would not provide dependable flood control and likely impact the recreational waters of Kailua Bay. Vegetation harvesting prior to the natural death of the plant is, however, recommended in our final document. Controlled harvesting of vegetation would likely prolong the life of the marsh. Thought was given to creation of nesting islands in the marsh for waterbirds early in our planning stages. Wildlife agencies have since requested that such consideration be dropped.

The Corps and the City and County of Honolulu are recommending a modification to the NED plan which combines the earthen levee raise with a much lower floodwall and fills less than two acres of wetland. The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side. Compensatory wetland mitigation will include the conversion of fastland in the marsh to new wetland habitat.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City & County - DPW

Testimony from
Mrs Dorothy Rose F. Babineau
143 Pauahilani Place.
Kailua 96734

I first became involved in Kawainui marsh, then called a swamp, in 1962.

Here it is, 29 years later, and I'm still involved in our marsh and the protection of its wildlife.

In 1962, the area looked like a pond — lots of open water. When effluent began its detour to the sea via the marsh, the green California grass and other strange vegetation took over and now you seldom see large expanses of open water with small islands here and there. I have wondered for years, why this growth was never removed or controlled.

I believe a group of us who are Neighborhood Board members, presented you with an excellent plan for the marsh which included the use of a machine to remove excess growth. Had this plan been implemented a year ago it may have saved me from testifying at your last meeting, and at this one. Perhaps you could have "Ducks Unlimited" as consultants!!

Every time those of us who care try to help our environment, all we get is TOO LITTLE, TOO LATE!!

With effluent, runoff from all the developments, siltation etc, we mankind ~~...~~ has been responsible

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 2 3 1992

REPLY TO
ATTENTION OF:

Planning Division

Mrs. Dorothy Rose F. Babineau
143 Pauahilani Place
Kailua, Hawaii 96734

Dear Mrs. Babineau:

Thank you for attending the Corps May 29, 1991 public hearing on the Kawainui Marsh Flood Control Project and for presenting testimony at that time. As you are aware, the designation of the marsh as a flood control basin by the Army Corps of Engineers has played a role in preventing its development and has thus facilitated wildlife protection, among other resource values of the marsh.

Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. We have deferred response to all comments received until now in order to complete the study process and select a preferred alternative.

We have spent a year intensively evaluating possible approaches to flood control that might also provide ecological and recreational benefits for the marsh. Seven major alternatives, including the no-action alternative, have been presented in our draft. Two of them include in-marsh vegetation clearing utilizing equipment to which you refer. However, the environmental impacts associated with clearing vegetation and linking open water channels with Oneawa Channel are expected to be significant. These include but are not limited to sediment deposition and bacterial contamination of Kailua Bay and loss of filtration by marsh vegetation. Also of great concern is the possibility of movement of the floating mat of vegetation during a flood event which might block channels and render flood control measures ineffective, with potentially catastrophic results for Coconut Grove.

We agree with you that open water is desirable from a wildlife perspective and are seeking other authorities and funding to assist in this area. As you know, the City and County of Honolulu is in the process of opening water in the marsh. Nevertheless, the residents of Coconut Grove require functional/reliable protection from the continuing threat of flooding.

After consideration of engineering, environmental and economic factors as well as agency and public input, the Corps, along with the City and County of Honolulu, recommends a modification to the National Economic Development plan which combines the earthen levee raise with a much lower floodwall and fills less than two acres of wetland. Compensatory wetland mitigation will include restoration of wetland from fastland in the marsh near Oneawa Channel. The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side. We believe that with landscaping in place, this alternative will be acceptable to the community. Thank you again for your comments.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

KAILUA NEIGHBORHOOD BOARD NO. 31
P.O. BOX 487 • KAILUA, HAWAII 96734

May 29, 1991

Commander, U.S. Army Corps of Engineers
Honolulu Engineer District
Attn: CEPOD-ED-PV
Ft. Shafter, Hawaii
96858-5440

Dear Sir:

Thank you very much for asking us to comment on your Kawai Nui Marsh Flood Control Project Environmental Impact Statement. The Kailua Neighborhood Board is very concerned with preventing flooding of our homes, streets, and businesses. However, we are also concerned with the environmental value of the Marsh and its surroundings. We are hopeful that a solution will be found that will address the concerns of everyone.

If you thought that sending out this massive publication to me would intimidate ordinary citizens into not responding to all of the technicalities involved you were wrong. Undaunted, we all waded through it.

It seems to me that the report is biased in favor of man-made structures. If the history of mankind on Earth can teach us anything it is that you can't fight Mother Nature. You need to find ways to work with the forces of nature rather than putting up huge structures in defiance. Therefore, it would seem that channeling the water by clearing the areas in which you want the water to go would make the most sense. Perhaps a combination of clearing channels in various parts of the Marsh in conjunction with a modified dike structure and flood control gates at the Oneawa Canal would be the best solution. This would be consistent with the ideas expressed in the Resource Management Plan for Kawai Nui Marsh put out by the Department of Planning and Economic Development which the residents of Kailua have consistently supported.

It also appears from this report that the City and County efforts of late will have no effect whatsoever. I know this to be a totally erroneous assumption. I can see the water moving in the opened up-channels. I can see the effects when we have a heavy rain. There is a noticeable difference and I think these improvements that have been made should be taken into consideration both in time estimated for marsh clearing and more importantly in the cost estimates given. These factors would change the numbers and perhaps give a more realistic picture of the proposed alternatives.

One of our primary goals should be the preservation of the wetlands for many reasons that we have stated several times before. If the Quarry Road channel and the present ditch makai of the dike are improved, the water storage capacity will be increased, the birds will have a more acceptable environment, the aesthetics of the wetland will remain undisturbed, and the homes will be relatively safe.

Just building a higher dike or wall will only necessitate building an even higher one in the future if plans for vegetation removal and for channeling water are not implemented. If these things are not done there will be a buildup of sedimentation and vegetation causing the same kinds of problems all over again, no matter how high a wall is built.

The Corps states that the major consideration is that the best flood control solution be one which is independent of future conditions in the Marsh. I don't see how you can plan for every eventuality when the situation changes on an almost daily basis and this is, as you stated, an unpredicatable, moving entity. Building a 22' (approx.) high wall to keep out the water means you expect an 18' flood of water to appear rather suddenly. This would appear to be a rather extreme measure and not very environmentally sound. Therefore, we would be in favor of a combination of solutions. A small 3' to 4' rise of the present dike, channeling both on the Quarry Road side and through the middle of the Marsh, dredging Oneawa Canal, flood gate structure at the Marsh end of the canal, and continuous vegetation removal to keep waterways clear.

I truly that some innovative thinking and some creative problem solving is needed to come up with the right solution for flood control in the Marsh, not just for the next heavy rain but for the long term future of Kailua and Kawai Nui Marsh, and all of us who reside here—the people, birds, animals, fish, and plants.

Sincerely,

Annetta Kinnicutt m.d.

Annetta Kinnicutt
Environmental Committee

Bonnie Heim

Bonnie Heim
Chair

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 23 1992

REPLY TO ATTENTION OF:

Planning Division

Ms. Annetta Kinnicutt
Ms. Bonnie Heim
Kailua Neighborhood Board
P.O. Box 487
Kailua, Hawaii 96734

Dear Ms. Kinnicutt and Ms. Heim:

Thank you for providing testimony and written comments on the Kawainui Marsh Flood Control Study. Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

We have spent the last year intensively evaluating possible approaches to flood control that might also have ecological and recreational benefits to the marsh. Federal participation in any project under Section 205 of the Flood Control Act of 1948 is strictly limited to flood control purposes.

Corps analysis, including our research facilities and headquarters review, indicated that the environmental impacts associated with vegetation clearing and linkage of open water channels with Oneawa Channel would be significant. Sediment loss into Kailua Bay, loss of filtration by the marsh of waters emanating from the upper watershed, high construction, disposal and maintenance costs, potential movement of the floating mat, and future unknown conditions of the marsh were just some of the major concerns preventing our reliance on any in-marsh flood control solution.

Engineering, economic and environmental concerns have forced us to reconsider in-marsh alternatives for the following reasons:

a. We have been unable to identify how much vegetation can be safely removed without jeopardizing the existing filtering capacity of the marsh vegetation for the marine receiving waters.

b. Direct connection of open water channels in the marsh to the Oneawa channel is required to attain any significant flood control but brings the risk of increasing sediment runoff into Kailua Bay during periods of heavy rainfall as well as other unknown ecological changes to the marsh. Note that even with the marsh clearing alternative, the levee must be raised approximately 4 feet to provide the necessary flood protection.

c. There are concerns that the floating mat of vegetation may block exit channels during a flood and render ineffective any flood control benefits with the attendant risk of overtopping the levee.

d. There are very high construction, disposal, and maintenance costs associated with vegetation removal making in-marsh work substantially more expensive.

e. Future marsh scenarios such as drought, fire, and changing sediment quantity and quality are unknown so impacts to an in-marsh flood control project would also be unknown. A levee raise will provide the necessary flood protection for the expected life of the project, regardless of future changes which might occur to the marsh, and it does not preclude implementation of marsh management actions in the future. Any marsh management actions, however, must be compatible with the flood control function of the marsh.

Let me clarify our position with respect to the work by the City and County of Honolulu. We are relying on the completion of their open water channels as the baseline condition from which we have evaluated our alternatives. Each of our alternative drawings shows their work as being in place. We agree with you that their efforts have improved water distribution in the marsh. In addition, open water is particularly desirable from a wildlife perspective and we are seeking other authorities and funding to assist the City and County in this endeavor. However, this open water alone does not provide the level of flood protection necessary for the residents of Kailua; hence, our additional joint study of flood control alternatives.

After careful consideration of engineering, environmental and economic factors as well as agency and public input, the Corps and its local sponsor the City and County of Honolulu have selected a modification to the NED plan which reduces the height of the floodwall and fills less wetland than an earthen levee raise would fill. Compensatory wetland mitigation will include the conversion of approximately two acres of fastland on the marsh side of the levee to wetland habitat.

Thank you again for your input and for your concern for the future of Kawainui Marsh.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

May 30, 1991

Commander, Honolulu Engineer District
Attention: CEPOD-ED-PV
Fort Shafter, Hawaii 96858-5440

Dear Sir:

Thank you for the opportunity to review the Detailed Project Report and Environmental Impact Statement for Kawainui Marsh Flood Control Project. We have the following comments and concerns.

Of the several alternatives offered, the least preferred is Plan 2, Floodwall. This plan suggests that a flood wall 7.5 feet tall running 6,200 feet, which appears to be the entire makai side of the marsh, is the most cost efficient means of flood control. If cost is the only consideration, this may be a viable alternative, but we do not believe that cost is the only concern.

It is equally important to the community to adopt a flood control plan that preserves the sense of a natural, open space land area. Kawainui Marsh is one of Kailua's most visible natural features. As open space, it provides the community a measure of tranquility and a sense of permanence. These special, non-quantitative features would be lost by running a concrete wall across one entire side of the marsh.

Plan 3 or 5 seems more reasonably designed to protect the aesthetic and natural features of the Marsh while providing adequate flood control. We recognize that the report indicates a potential to impact previously unidentified burial or archaeological sites, but we believe that through foresight and planning these sites can be protected while proceeding with either Plan 3 or 5.

711 Kapi'olani Blvd., Suite 500
Honolulu, Hawai'i 96813-5249
Ph: (808) 586-3777
Fax: (808) 586-3799

Again, thank you for the opportunity to review the project report. If we can be of any assistance to you in this project, please contact Linda Delaney, Land and Natural Resources Officer at 586-3777.

Sincerely,

Richard K. Paglinawan

RICHARD K. PAGLINAWAN
Administrator

RKP:jc

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 23 1992

REPLY TO ATTENTION OF:

Planning Division

Mr. Richard Paglinawan
Administrator
Office of Hawaiian Affairs
711 Kapiolani Boulevard, Suite 500
Honolulu, Hawaii 96813

Dear Mr. Paglinawan:

Thank you for providing comments on the Kawainui Marsh Flood Control Project in your letter dated May 30, 1991. Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

We have received several comments such as yours concerned about the impact of the NED plan floodwall on the viewplane of the marsh. The Corps is required to identify and recommend the alternative which maximizes net flood control benefits, and the National Economic Development Plan (NED plan). The concrete floodwall is the NED plan. Provisions are available for selecting a different plan if approved by the Assistant Secretary of the Army for Civil Works.

We are unable to recommend Plan 3 (Marsh Clearing) or Plan 5 (Back Levee) as you request for the following reasons:

Plan 3 (Marsh Clearing)

a. We have been unable to identify how much vegetation can be safely removed without jeopardizing the filtering capacity of the marsh vegetation for marine receiving waters.

b. Direct connection of open water channels in the marsh to the Oneawa Channel is required to attain any significant flood control but brings the risk of heavy sediment runoff into Kailua Bay during flood events and other unknown ecological changes to the marsh. Note that even with the marsh clearing alternative, the levee must be raised to provide the necessary flood protection.

c. There are concerns that the floating mat of vegetation will block channels during a flood and render ineffective any flood control benefits with attendant risk of levee overtopping.

d. There are very high construction, disposal, and maintenance costs associated with vegetation removal making in-marsh work substantially more expensive.

Plan 5 (Back Levee)

a. This alternative has perhaps the greatest environmental impacts associated with it of any of the alternatives outlined in the DEIS.

b. The State Historic Preservation Officer (DLNR) has written us stating that the "back levee" alternative would likely entail extensive archaeological excavations in order to mitigate its probable adverse effects.

Consequently, after consideration of engineering, environmental, and economic factors as well as agency and public input, the Corps, along with the City and County of Honolulu will be recommending a modification to the NED plan which combines the earth levee raise with a much lower floodwall and fills less than two acres of wetland. The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side. Compensatory wetland mitigation will include the conversion of fastland to wetland habitat of an area in the marsh next to the levee near Oneawa Channel. We shall continue to seek other Corps authority and funding to assist in creating open water bird habitat in the marsh.

Thank you for your comments.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

HOUSE OF REPRESENTATIVES
THE SIXTEENTH LEGISLATURE

STATE OF HAWAII
STATE CAPITOL
HONOLULU, HAWAII 96813

May 31, 1991

Commander, Honolulu Engineer District
ATTN: CEPOD-ED-PV
Fort Shafter, Hawaii 96858-5440

RE: Kawainui Marsh Flood Control Project
Draft Environmental Impact Statement

Dear Commander:

I am submitting written comments on the above referenced DEIS to supplement my oral comments made at the Public Meeting on May 29, 1991.

The primary goal of the Kawainui Marsh Flood Control Project must be to protect the Coconut Grove residents from future flooding and to preserve the integrity of the wetland.

The concrete floodwall alternative should be rejected. No testimony was received in support of this alternative. A concrete floodwall would negatively impact the recreational use of the levee, block tradewinds into the marsh, and mar the viewplane.

The DEIS did not contain an exhibit simulating the concrete floodwall alternative's impact upon the view into the marsh from ground level in Coconut Grove. The omission should be corrected in the Final Environmental Impact Statement.

The levee raise alternative has the benefit of providing immediate action to prevent future flooding with minimal impact upon the environment. The benefit to cost ratio is acceptable, and the total project cost is within the funds available from the Federal and local sponsor. Although approximately three acres of wetland would be filled, the vegetation clearance being performed by the City and County of Honolulu would compensate for the minimal wetland loss by the levee. Since a contract can be awarded before the end of this year and construction can be completed within 18 months thereafter, this alternative appears the most viable.

The levee raise alternative should be supplemented by other actions to open up more channels and water areas. In addition, long-range plans for this sensitive resource must be pursued.

Thank you for this opportunity to submit comments on the Kawainui Marsh Flood Control Project.

Yours Very Truly,

Cynthia Thielen
State Representative
19th District

CT:mmh

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 23 1992

REPLY TO ATTENTION OF:

Planning Division

Honorable Cynthia Thielen
State of Hawaii
House of Representatives
State Capitol
Honolulu, Hawaii 96813

Dear Ms. Thielen:

Thank you very much for your oral testimony and written comments on the Kawainui Marsh Flood Control Project. Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

As you succinctly stated in your letter, the "goal is to protect the Coconut Grove residents from future flooding and to preserve the integrity of the wetland". Your negative reaction to the NED floodwall alternative in our draft has been shared by others in the public sector. Consequently, as a result of agency and public input, a modification to the NED plan was developed and has become the preferred alternative. We will request a waiver from the Assistant Secretary of the Army for Civil Works in order to implement this alternative which combines the earth levee raise with a much lower floodwall and fills less than two acres of wetland. Our local sponsor has agreed to cover the additional costs associated with the preferred alternative.

We shall continue to seek other Corps authority and sources of funding to assist in opening water in the marsh for creation of wildlife habitat.

Thank you again for your involvement in this important project and for your support in selecting the best solution for flood control at Kawainui Marsh.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

University of Hawaii at Manoa

Water Resources Research Center

3 June 1991

MEMORANDUM

TO: Commander, Honolulu Engineering District
Attn: CEPOD-ED-PV
Ft. Shafter, Hawaii 96858-5440

FROM: Roger Fujioka, Acting Director
WRRC

SUBJECT: Comments to Draft EIS for Kawainui Marsh Flood Control Project

General Comments. The objectives and the available solutions to the problem at Kawainui Marsh and the Coconut Grove community are well stated in this report. It is clear that a great deal of effort was made to include all previous inputs into this report. This approach has its advantages and disadvantages. The advantage is the comprehensiveness of the report and of hearing all sides of the issue. The disadvantage is that the report is so long that it is difficult to read this report in its entirety to comment on. Moreover, because the report contains so many inputs as well as controversial points, it is not always clear what things are documented and what things are just beliefs. With regard to public reactions the perception of things may be as important as the facts.

Specific Comments. It should be made clear to all that the marsh is a natural sedimentation trap or basin. Moreover, the marsh uses physical and biological processes to improve the quality of the land-originated water before it is discharged into the ocean. There are several consequences when man attempts to control these natural forces. If the land-based water entering the marsh is quickly transported into the ocean, the marsh will not have the opportunity to improve the quality of the water and the quality of the receiving ocean can be expected to be impacted. If the natural processes are allowed to take place, one should expect more sedimentation entering the marsh and as a result a lower water storage capacity of the marsh. To maintain the high storage capacity of the marsh, some sedimentation removal or dredging will have to be done. Raising the height of the levee is a safety feature for the residents of coconut Grove. However, this act by itself will encourage more sedimentation build up in the marsh and the covering of archeological sites which were mentioned. The solution will need to address safety for the community, impact on the quality of the ocean water, the long term fate of the marsh as a marsh and the fate of the inhabitants of the marsh.

I wish to make one other comment. This involves the quality and impact of Kahanaiki Stream and Maunawili Stream which flows into Kawainui Marsh. It was reported that four sewage treatment plants at one time discharged into these two streams and added excessive nutrients to the marsh. Since sewage effluents are no longer being discharged into these streams, their impact should be deleted. The WRRC is currently monitoring the quality of these streams as well as the quality of water leaving Kawainui Marsh. These results and documented changes on Kawainui Marsh should resolve the impact of removing all sewage treatment plant discharges into Kawainui Marsh.

RSP:jm

cc: E. Murabayashi
M. Stahl

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440
JUL 2 3 1992

REPLY TO
ATTENTION OF:

Planning Division

Dr. Roger Fujioka
Acting Director
Water Resources Research Center
University of Hawaii
Holmes Hall
Honolulu, Hawaii 96822

Dear Dr. Fujioka:

Thank you for your memorandum dated June 3, 1991 on the Kawainui Marsh Flood Control Project. Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

We appreciate your general comments regarding the comprehensiveness of the document, as well as your specific comments especially with regard to the water cleansing abilities of the marsh and concerns about transporting water too quickly to the ocean. A marsh clearing alternative brings unknown and possibly significant impacts to the receiving waters. Hence, the Corps and our local sponsor, the City and County of Honolulu, have selected a modification to the National Economic Development Plan (NED Plan) which reduces the height of the levee and fills less wetland acreage. Because this compromise alternative is not the NED plan, this selection requires an exception to be granted by the Assistant Secretary of the Army for Civil Works. We are requesting that exception. We may also seek other authorities to assist in opening up additional water in the marsh for wildlife purposes consistent with flood control.

We have been extremely interested in the preliminary results of your water quality study which examines bacterial concentrations of the marsh waters and its contributing streams as well as Oneawa Channel. We believe that the elevated bacterial levels thus encountered support our concern about potential environmental impacts to receiving waters from open marsh clearing alternatives which expedite flood waters without benefit of passage through marsh vegetation.

The three primary alternatives (floodwall, levee raise and combination) will not affect the rate of sedimentation build-up in the marsh. The analysis presented in the EIS shows the build-up of sediment in the marsh will not degrade the protection of Coconut Grove for at least 100 years. Removing the sediment would not be cost effective for flood control.

References to the earlier sewage discharges in the marsh are to help document the historical changes in the marsh and to explain the growth of choking vegetation which has filled the marsh so extensively. We shall emphasize that these discharges are no longer occurring.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

JOHN WAIHEE
GOVERNOR OF HAWAII

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

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

In reply, please refer to:
File: EMD/CWB

June 4, 1991

Ref. No. 91-2-151X

H0603EA

Mr. Kisuk Cheung
Director of Engineering
Planning Division
Department of the Army
U.S. Army Engineer District, Honolulu
Building 230
Ft. Shafter, Hawaii 96858-5440

Attn: Commander, Honolulu Engineer District
ATTN: CEPOD-ED-PV
Ft. Shafter, Hawaii 96850-5440

Dear Mr. Cheung:

Subject: Joint Federal and City and County of Honolulu Draft Detailed Project Report and Environmental Impact Statement (April 1991) for the Kawainui Marsh Flood Control Project, Kailua, Oahu

Thank you for the opportunity to review and comment on the subject document. The Department has no specific comments to the overall contents. Basically, we are in agreement with the general comments and description on water quality.

Should you have any questions, please contact Mr. Eugene Akazawa, Supervisor of the Monitoring Section, Clean Water Branch, at 543-8309.

Sincerely,

BRUCE S. ANDERSON, Ph.D.
Deputy Director for
Environmental Health

ETA/rg

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 23 1992

REPLY TO
ATTENTION OF:

Planning Division

Dr. Bruce S. Anderson
Deputy Director for Environmental Health
State of Hawaii
P.O. Box 3378
Honolulu, Hawaii 96801

Dear Dr. Anderson:

Thank you for your letter dated June 4, 1991 on the Kawainui Marsh Flood Control Study, stating your acknowledgement of and agreement with our comments and description of water quality issues in the marsh and Kailua Bay.

Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

After consideration of engineering, environmental, and economic factors as well as agency and public input, the Corps and the City and County of Honolulu are recommending a modification to the National Economic Development plan. This plan combines the earthen levee raise with a much lower floodwall and fills less than two acres of wetland. Compensatory wetland mitigation will include the conversion of fastland near the levee to wetland habitat. We shall be coordinating our efforts with you as we construct this new wetland area.

Thank you again for your comments.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

Edward R. Margulies, M.D.
796 Kainui Drive
Kailua, HI 96734

June 5, 1991

Commander
Honolulu Engineering District
Fort Shafter, HI 96858

Attn: CEPOD-ED-PZ

Dear Commander:

This letter is being written to address the concerns I have personally, along with the members of the Kainui Estates Association, of which I am President, located on the eastern and of Kawainui Marsh.

We have read about the various alternatives for the marsh development. As I was unfortunately not able to attend the public meeting due to my son's graduation, Ms. Margo Stahl suggested I write to you. Briefly, our concern is first environmental/ecological and secondly, recreational. We would like to see open water alternatives as the choice, either by clearing the marsh partially or widening waterways, with an earthen dam being third choice if absolutely necessary.

We believe that the long-range goal of ecological development is for better wildlife habitat, especially some of the endangered species nesting there. That should be the ultimate goal towards which all plans are made. The secondary desire is that the area be accessible to the public if that can be done without disturbing the wildlife refuge.

We recognize this is all asking for an ideal solution for a difficult problem and we would be glad to discuss it further. For any further information, please call me at 732-2289 (work) or 262-5550 (home).

Thanking you in advance for your consideration, I remain.

Sincerely yours,

Edward R. Margulies, M.D.
President,
Kainui Estates Association

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 23 1992

REPLY TO ATTENTION OF:

Planning Division

Dr. Edward R. Margulies, M.D.
President
Kainui Estates Association
796 Kainui Drive
Kailua, Hawaii 96734

Dear Dr. Margulies:

Thank you for your comments on the Kawainui Marsh Flood Control Study provided in your letter dated June 5, 1991. Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed the flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select the preferred alternative.

We have spent the last year, following two public workshop scoping meetings, identifying and evaluating alternative flood control solutions for the residents of Kailua. We have evaluated a full array of such alternatives including those with ecological and recreational benefits such as the Kawainui Heritage Foundation's open marsh clearing alternative. However, we are unable to recommend the in-marsh flood control alternatives for the following reasons:

a. We have been unable to identify how much vegetation can be safely removed without jeopardizing the existing filtering capacity of the marsh vegetation and the marine receiving waters.

b. Direct connection of open water channels in the marsh to the Oneawa Channel is required to attain any significant flood control but brings the risk of increasing sediment deposition into Kailua Bay during periods of heavy rainfall as well as other unknown ecological changes to the marsh. Note that even with the marsh clearing alternative, the levee must be raised to provide the necessary flood protection.

c. There are concerns that the floating mat of vegetation may block channels during a flood and render ineffective any flood control benefits.

d. There are very high construction, disposal, and maintenance costs associated with vegetation removal making in-marsh work substantially more expensive than other alternatives. None of the in-marsh alternatives have flood control project benefits equal to project costs. Therefore, federal participation for in-marsh alternatives is not warranted.

Consequently, after consideration of engineering, environmental, and economic factors as well as agency and public input, the Corps along with the City and County of Honolulu will be recommending a modification to the National Economic Development plan which fills 1.8 acres of wetland and has combined a levee raise with a concrete floodwall 4 feet in height. The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side. Compensatory wetland mitigation shall include conversion of fastland in the marsh near the levee to new wetland habitat. A levee raise will not preclude future scenarios that you envision for marsh recreation and wildlife purposes, althoug marsh activities must be compatible with its flood control function. In fact, we will continue to seek other appropriate authority and funding to allow the Corps to implement a project solely for environmental enhancement.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City & County -, DPW

June 6, 1991

Commander, Honolulu Engineer District
Attn: CEPOD-ED-PV
Ft. Shafter, Hawaii 96858-5440

To whom it may concern,

On Wednesday, May 29, I attended a public hearing at Kailua Intermediate on flood control for Kawainui Marsh. I am a resident of Coconut Island and have strong opinions on needed flood control for our area.

During the hearing a few neighbors and myself expressed strong support for the earth levee raise plan. We all presented different testimony in support of this flood protection plan. We stressed that we are residents in this flood area.

The preferred plan has the proper cost-benefit ratio that the Federal Government wants. The cost will be $10 million, of which the Corp will put up $5 million and the City and County will put up $5 million.

Other alternatives exist but they are not cost-beneficial. Please remember that we are the ones that had 6 feet of water on Kihapai Street. We re-live a flood everytime it rains hard for a few hours.

In 1986 we bulldozed our old house at this same location. We built a new 2-story house above the Federally required 8.0 feet elevation. We built at 8.5 ft. Eventhough, we had almost 2 feet of muddy, brown, cold water in our new house.

The problem of flooding is still paramount. Look at the data for the April, 1989 and the March, 1991 near flooding of Coconut Grove when heavy rains drove the water level in the marsh to heights of 7.7 feet from a normal of 3.6 feet.

Please remember our plight. We are the flood prone residents of the area. We feel that the earth levee raise plan is the best for our area.

Sincerely,

Todd E. Hendricks

Todd E. Hendricks
328 Kihapai Street
Kailua, Hawaii 96734

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 23 1992

REPLY TO ATTENTION OF:

Planning Division

Mr. Todd E. Hendricks
328 Kihapai Street
Kailua, Hawaii 96734

Dear Mr. Hendricks:

Thank you for your testimony at the public meeting on May 29th and for your written comments dated June 6, 1991 on the Kawainui Marsh Flood Control Project. It is especially significant to hear from victims of flooding in Coconut Grove, and we want you to know that we have been working to bring you the necessary protection.

Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

As you stated in your letter, many of your neighbors have expressed strong support for the earthen levee raise because of its cost, appearance, and protection afforded. We are required to identify and recommend the alternative which maximizes net flood control benefits, the National Economic Development Plan (NED), the floodwall in this case. There are provisions for a waiver of selection of the NED alternative by the Assistant Secretary of the Army for Civil Works.

We have evaluated the comments received, both from the public and other agencies, and in concert with our local sponsor, the City and County of Honolulu, have selected a modification to the NED plan which reduces both the height of the floodwall and the amount of wetland filled to provide you and others in Coconut Grove with flood protection. We shall seek the necessary approvals. The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side. Compensatory wetland mitigation will include the restoration of fastland in the marsh to new wetland habitat. We will seek other Corps authority and funding to open water in the marsh for the wildlife habitat requested by other interest groups.

Thank you for your comments and support.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City & County - DPW

LAW OFFICES OF
BYBEE, CHANG & RULON
Suite 2057, Grosvenor Center - PRI Tower
733 Bishop Street
Honolulu, Hawaii 96813
Telephone: (808) 537-5311
Telecopier: (808) 531-2234

EDWARD J. BYBEE
NELSON S. W. CHANG
THOMAS A. RULON
HARVEY M. DEMETRAKOPOULOS

Mailing Address
Post Office Box 656
Honolulu, Hawaii 96809-0656

KAILUA OFFICE
Kailua, Hawaii 96734

June 7, 1991

Windward Sun Press
Attention: Editor
45-525 Luluku Road
Kaneohe, Hawaii 96744

Re: Marsh Flood Control

Dear Sir:

Because the marsh serves as a flood water catch basin, similar to a wash room sink, it must be kept clear and its drain outlets unplugged. To merely raise the levee wall a few feet as proposed, will mean when the next flood occurs (and one eventually will - some day) a much larger body of water will spill out and devastate a greater part of Kailua.

The better solution is, as K. N. B. member Annetta KiMicutt pointed out, removing the foreign vegetation and clearing and maintaining natural channels and outlets for the marsh to drain properly.

Finally, contrary to your news article, persons who live near the marsh do not want the levee raised, they just want the flood control they deserve as soon as possible.

Sincerely,

Ed Bybee

EJB/jms

cc: U. S. Army Corps of Engineers

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 23 1992

REPLY TO ATTENTION OF:

Planning Division

Mr. Ed Bybee
Bybee, Chang & Rulon
Grosvenor Center - PRI Tower
733 Bishop Street, Suite 2057
Honolulu, Hawaii 96813

Dear Mr. Bybee:

We received a copy of your letter to the editor of the Windward Sun Press and wish to respond to your comments. We appreciate your time spent providing testimony at public workshops and your interest in this project.

Since receiving public and agency comment letters in June, 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed the flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and to select the preferred alternative.

We have spent the last year evaluating approaches to flood control that might also have ecological and recreational benefits to the marsh. Corps analysis, including research facilities' and headquarters' reviews, indicated that the environmental impacts associated with vegetation clearing and linking open water channels with Oneawa Channel would be significant. Sediment movement into Kailua Bay, loss of filtration by the marsh of waters emanating from the upper watershed, high construction, disposal and maintenance costs, potential movement of the floating mat, and future unknown conditions of the marsh were some of the major concerns preventing reliance on any in-marsh flood control solution.

A proposed earthen levee raise would increase the height of the existing levee by a maximum of 8.5 feet at the Kailua Road end sloping gradually to the height of the existing levee at the Oneawa Channel. This levee raise would greatly increase the flood storage capacity of the marsh. The design objective of 3,000 acre-feet of flood storage established for the original Corps project is no longer relevant based on our revised hydrologic analysis. Changed conditions in the watershed as well as the marsh indicate that the required storage is now 5,400 acre-feet. The 5,400 acre-feet of flood storage is provided by the recommended levee raise project.

The potential environmental impacts associated with the in-marsh alternatives have caused us to reject them for the following reasons:

a. We have been unable to identify how much vegetation can be safely removed without jeopardizing the existing filtering capacity of the marsh vegetation and the marine receiving waters.

b. Direct connection of open water channels in the marsh to the Oneawa Channel is required to attain any significant flood control but brings the risk of increasing sediment runoff into Kailua Bay during periods of heavy rainfall as well as other unknown ecological changes to the marsh. Without the natural filtering capacity of the marsh vegetation, the Kailua Bay receiving waters could be significantly degraded by water outflows from the marsh. Even with the marsh clearing alternative, the levee must be raised approximately 4 feet and Oneawa Channel dredged 2 feet to provide the necessary flood protection.

c. The floating mat of vegetation may block exit channels during a flood and render ineffective any flood control benefits, with the attendant risk of overtopping the levee.

d. There are very high construction, disposal, and maintenance costs associated with vegetation removal which make in-marsh work substantially more expensive.

Consequently, after consideration of engineering, environmental, and economic factors as well as agency and public input, the Corps along with the City and County of Honolulu are recommending a modification to the NED plan which fills 1.8 acres of wetland and has a concrete floodwall 4 feet in height. The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side.

Compensatory wetland mitigation will include conversion of fastland in the marsh near the levee to new wetland habitat. A levee raise will not preclude future scenarios for marsh management purposes although marsh activities must be compatible with its flood control function.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

LEO BURNS
646 Papalani Street
Kailua, Hawaii 96734

June 14, 1991

Commander, Honolulu Engineer District
Att'n: CEPOD-ED-PV
Ft. Shafter, Hawaii 96858-5440

RE: Draft Detailed Project Report & Draft EIS
Proposed Kawainui Marsh Flood Control Project

Dear Sirs:

This referenced report proposes to study to evaluate the Kawainui Marsh Control Project for changing conditions resulting in failure to protect the community of Coconut Grove from severe flood damages and to establish flood control for Coconut Grove.

What this report does is, justify implementation of a plan, construction of a concrete floodwall, as the national economic development (NED) plan. It postulates that this plan provides the most economical benefit/cost ratio for 100 years of protection.

This conclusion is based on a number of assumptions and costs which are not adequately documented nor justified in this EIS. Additionally, environmental and social effects take a back seat to "low ball" estimates; i.e.,

1. Benefit/cost ratios are arrived at using inconsistent formulas:

The floodwall proposal over 100 years reflects an annual maintenance cost of $30,000. The annual cost of marsh clearing is tagged at $653,000. Is one to believe that construction of a wall in itself will forestall the propogation of vegetation? "Environmental changes will continue to occur within the marsh." (4.4 p.8)

2. Certain economic assumptions and exclusions are made which exclude lower cost alternatives:

Removal of 372,000 cubic yards of vegetation to a leeward landfill is projected at $12.50 cy for a construction cost of $5,812,500. Kapaa/Kalaheo Landfill is not available? An alternative of burning is rejected because it "is forbidden by law according to the D of H." My reading of the D of H letter dated Jan. 12, 1989 indicates that open burning rules permit it, that is permit open burning uder three circumstances. Burning marsh

vegetation for flood control purposes is not addressed. How do you conclude that it is forbidden? I seem to recall that the U.S. Fish and Wildlife Service has used open burning selectively on the Mainland. If approved, open burning or disposal of vegetation in the Kalaheo Landfill would enhance the b/c ratio.

Silt removal at the 220,000 cy level is priced at $8.80. Vegetation removal comes in at $17.70 per cy. A "sales aid" in the EIS is provided by AZTEC Development Co. It states that project cost estimates would be provided without obligation What are they? Where are they? Aquatics Unlimited in a letter dated Jan. 13, 1988 references documentation but no cost estimates are included.

3. The desire of residents is minimized:

"Planning Objectives" (p. 10) include "...enhance the environment; ...Evaluate alternatives on an engineering, economic, environmental and social basis and recommend a plan of implementation." The U. S. Fish and Wildlife Service in their letter dated July 12, 1990 recommend a program to regularly dredge open water areas to prevent a buildup of sediments. I therefore conclude that protection and enhancement of the wetlands are lacking in the concrete floodwall plan.

Whichever plan that comes to fruition limits Federal monies to $5,000,000. Additionally, the government is held harmless for all damages arising from the construction, operation, and maintenance of the project.

Public input is the next most important step in the planning process. Next, yes. To be ignored, no.

Sincerely,

Leo Burns

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440
JUL 2 3 1992

REPLY TO
ATTENTION OF:

Planning Division

Mr. Leo Burns
646 Papalani Street
Kailua, Hawaii 96734

Dear Mr. Burns:

Thank you for your letter dated June 14, 1991 on the Draft Detailed Project Report and Draft EIS for the Proposed Kawainui Marsh Flood Control Project. Since receiving public and agency comment letters in June, 1991, we evaluated the extensive public input, initiated additional study efforts, and discussed the flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and to select the preferred alternative.

Although we are required to identify the national economic development (NED) plan, we are not required to recommend it if a case can be made for a better alternative. The concrete floodwall remains the NED plan in the final document, but after consideration of public input and in consultation with our local sponsor, the City and County of Honolulu, we are recommending a modification to the NED plan. This alternative reduces the height of the floodwall from the NED plan and results in less wetland filled than an earthen levee raise alternative. The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side. We believe it will be an aesthetically pleasing compromise that is only somewhat more expensive than the NED plan.

Environmental and social effects have not taken a back seat in this decision. Federal participation in any work for flood control must meet engineering, economic and environmental criteria. Modifications to the existing levee are the only alternatives that meet these criteria. Our analysis has shown that a levee raise is required even with over 100 acres of

vegetation cleared from the marsh. However, such clearing brings risks of sediment and bacterial contamination to the receiving waters of Kailua Bay. Such a risk is not warranted in our opinion. Although environmental changes will continue to occur in the marsh, the levee modification and the necessary flood protection would be independent of these changes.

We have reconfirmed that at the present time burning of marsh vegetation is not permitted. The U.S. Fish and Wildlife Service is planning to study controlled burning of wetlands as a pilot project elsewhere in the state. Depending upon the results, burning may become appropriate at some future date for Kawainui Marsh.

Updated economic and construction costs have been included in our final document. The Kapa'a/Kalaheo landfill may become available but was not an option at the draft stage of consideration. Additional refinement of cost estimates for marsh clearing alternatives, such as for equipment purchased from AZTEC Development have not been obtained since this alternative was not carried forward due to engineering and environmental objections as well as for economic reasons.

Our analysis shows that channels in the marsh cannot meet Corps prescribed engineering, economic, and environmental criteria for flood control. However, we recommend a number of best management practices to reduce non-point source pollution, including ways to improve water quality and reduce sediment runoff into the marsh.

Thank you again for your interest and input.

Sincerely,

Kisuk Cheung
Director of Engineering

Copy Furnished:

City & County - DPW

ROBERT A. HERLINGER, A.I.A.   591 AUWINALA ROAD   KAILUA, HAWAII 96734
ph. 486-6331(O); 262-7238 (R)

June 17, 1991

HAND DELIVERED

Commander, Honolulu Engineer District
ATTN: CEPOD-ED-PV
Ft. Shafter, Hawaii 96858-5440

Subject: KAWAINUI MARSH FLOOD CONTROL PROJECT
Comments on Draft REPORT & EIS (April 1991)

TO WHOM IT MAY CONCERN:

As the Planning Consultant to the Kawainui Heritage Foundation I would like to make the following comments on the subject Report.

First of all I appreciate the opportunity to share my thoughts both verbally at the May 29,1991 Public Meeting and now in writing.

The document that you have compiled with the City and County is the result of a great effort by many people to bring together a wide variety of data into one tome.

With what I've learned over the past 18 years of planning related to Kawainui Marsh I tend to favor a flood control alternative that focuses on removal of vegetation and sediment coupled with a program of regular maintenance. However, with respect to your study, I find myself questioning two basic planning elements.

1. The planning methodology/process used.
2. A proper identification and understanding of the resource "patient" that needs "healing".

Planning Element #1

You have gathered much data/information and you have referenced much in your report; however, I feel that you haven't utilized these materials as the underlying base to develop your suggested alternatives for flood control.
I see planning as a spiralling process (see enclosed Directional Planning diagram). I recommend that you try an overlay process of working with the State's Resource Management Plan, the Kawainui Heritage Foundation's Directional Plan, and some of the other plans that you have referenced and see what kind of alternative evolves as you build upon an already established body of planning information. I would be willing to help in this process, as I have stated on previous occasions.

Planning Element #2

This identification of the "patient" will be a natural progression of the proper methodology. I have learned that it is the TOTAL ahupua'a/watershed of Kailua that should be addressed. This is the resource that when understood can direct us to the best solution to responsible flood control measures for Coconut Grove. I feel that your study continues a piecemeal, expediency approach to solutions rather than a more holistic view which we believe to be the more responsible approach. (see enclosed "TOTAL KAWAINUI" brochure) So I trust you can see why I have a problem with commenting on comparisons of alternatives and their impacts, if they don't relate to the TOTAL resource in question! It seems to me a case of addressing symptoms rather than causes of a problem.

Only if these two planning elements are addressed responsibly can one move on to the next step which is recommending planning alternatives based upon what was, what is, and what could be.

On another note, I would appreciate it if you would include in Appendix III the complete Directional Plan #5, which includes sheets 3,4,5,6 and 7 of the maps that I previously sent to you. All that is included in your report is sheet 7, the Long Range Plan, and your reproduction does not include all of the pertinent data on the plan so that it can be read. My reason for this request is that the Directional Planning process includes each of these planning overlays as part of the actual final plan. The titles of plan overlays to be included are: WATERSHED RESOURCE, CULTURAL ARCHAEOLOGY-LEGEND CHANT NETWORK, CULTURAL ARCHAEOLOGY-SITES, SHORT-RANGE PLAN, LONG-RANGE PLAN.

Please feel free to contact me if you have any questions about what I've stated, or if you would like to meet with me.

Sincerely,

Robert A. Herlinger

Robert A. Herlinger, A.I.A., Planning Consultant
Kawainui Heritage Foundation

encl.

cc KHF

KAWAI NUI

(A natural, cultural, recreational & educational, heritage area: Kailua, O'ahu)

WHAT WAS, WHAT IS, & WHAT COULD BE.. The story of a "WORLD-CLASS" RESOURCE, RIGHT IN YOUR BACKYARD!

THIS WEEKEND, HOW WOULD YOU LIKE TO take your family to a beautifully scenic area just 15 minutes from the heart of downtown Honolulu? A place where you could really relax, picnic, take a short hike along the marked trails bordering an active fishpond and occasionally stop at viewing stations to absorb panoramic views of Mt. Olomana and the majestic Pali as seen across the large open waterways of the marsh ponds.

HOW WOULD YOU LIKE TO visit the Kuali'i Biological/Educational Center near the entry to Kailua Town? Your children have already experienced this center during their recent school field trip. They've told you about their exciting walk through the underwater glass tubes where they viewed life below the surface of the waters of the marsh. They can't wait for you to listen to what they heard and learned during the self-guided tape tour, those cool discoveries of the richness of this resource: its water, fish, plants, and the dynamic happenings in nature, within this watershed, or ahu'pua'a, of Kailua.

HOW WOULD YOU LIKE TO visit the Kakuhihewa Cultural Center nestled into a natural setting on what used to be the dump? After hearing about the

wonderful experiences of your friends, you look forward to both viewing and participating in the early Hawaiian sports and games on a large, open field overlooking the waterways. Participation in Hawaiian craft classes, and the museum tours, are also high on your list. This might even be the day that the Halau Mohala Ilima performs at this particular site. They, along with other hula halau, regularly perform at a variety of sites within this natural, cultural, heritage area, Kawai Nui.

HOW WOULD YOU LIKE TO spend an upcoming weekend camping at Kapa'a Pu'u Campground, just mauka of the cultural center? This beautiful site is almost totally surrounded by the Ka Ohi'a Nursery, which supplies trees and plants for use by the State and County for their landscape beautification programs. The makai view encompasses wildlife sanctuary areas within the waters of the marsh. In glancing to the left you see the Halau Wa'a Boating/Fishing area, where you plan to go later on in the day for a relaxing canoe ride around the periphery of this 1000 acre wetland. I speak from firsthand experience, this is going to make your day!

NOW MAYBE YOU SHOULD HAVE STARTED by visiting the Kaula a-kalana Visitor Center? It's accessible by footbridge from the drive-in theatre site. From this strategic location you can view Maunawili Valley as well as look across the expanse of the marsh to Kailua Bay. Don't forget to pick up the map which tells you where the heiau, botanical gardens, archaeological research areas, and other points of interest are. Your attention will also be caught by the "**EXPERIENCE KAWAI NUI**" brochures which explain the variety of year-round opportunities for recreation and education for all members of your family.

NOW DON'T FORGET TO LEAVE YOUR CAR AT ONE OF THE PERIPHERAL PARKING AREAS, SO THAT YOU CAN BOARD THE KAWAI NUI ELECTRIC SHUTTLE BUS THAT WILL TAKE YOU TO YOUR DESTINATION!

FRIENDS, THIS IS NOT A DREAM! THESE ARE THE PLANNING COMPONENTS, THE REALITIES-TO-BE, OF THE KAWAI NUI HERITAGE FOUNDATION'S DIRECTIONAL PLAN.

Let me introduce myself. My name is Robert Herlinger and I am the Directional Planning Consultant to the Kawai Nui Heritage Foundation. In 1972 I was asked to help see what I could do to stop a shopping center from being built in the marsh. As an architect/planner, who had been involved very heavily with design processes, I was a little hesitant to get involved with this issue, but I did say I would like to know more before I made my decision. After seeing a slide presentation, and looking at the marsh, and talking to a few more people, I decided to get involved, but on one condition only. This condition was that instead of focusing on fighting proposals and the people that related to them, I would prefer to be a part of the team that put together a plan which presented an alternative built upon the best possible base information. So, in 1973 I began my planning relationship with Kawai Nui, using a planning process which I had developed in my architectural practice..a design/problem solving approach to planning which I call DIRECTIONAL PLANNING. In this process I saw myself as a link/scribe who interviewed all kinds of individuals/agencies/groups in an effort to gather information about the resource. I have transposed these

conversations into a graphic language, through sketches, to include the various concerns, values, and information received, as people were talking I tried to relate their input immediately to the actual site plan and topographic watershed model which I carried with me. The resulting visual images became the foundation for communication with others. Once I had gathered sufficient sketches and information, I would transpose them into a Directional Plan. This plan was then not only taken back to the people already interviewed, but my resource base was also expanded to include more sources. *(see Directional Planning Spiral diagram).*

Over the past 18 years, and with input from over 500 interviews, I have developed 5 Directional Plans, with the 5th completed in May, 1982, and the 6th underway. In this overlay approach I have identified the natural base of the watershed, addressed the historical and cultural richness of the area, and finally developed a plan for the future that honors this base while meeting public needs and values.

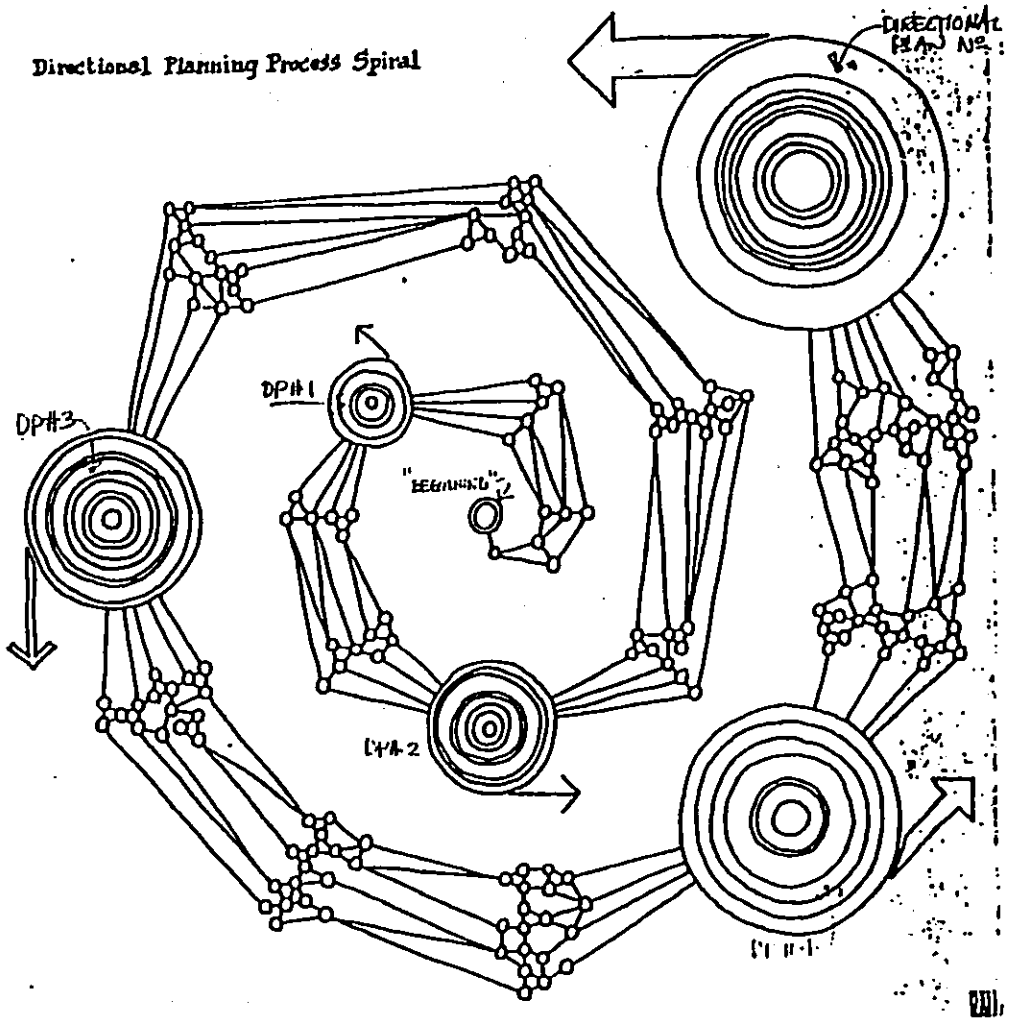
One of the most exciting and "revolutionary" concepts that sprang out of my work was the diagramming of some of the Hawaiian songs, chants and legends that relate to the Kailua area. This was accomplished through the selfless efforts of Kihei De Silva, who translated these materials from the Hawaiian language, and then mapped the information. I then took this information and transposed it into planning graphics so that our history became an active part or essential overlay in the planning process.

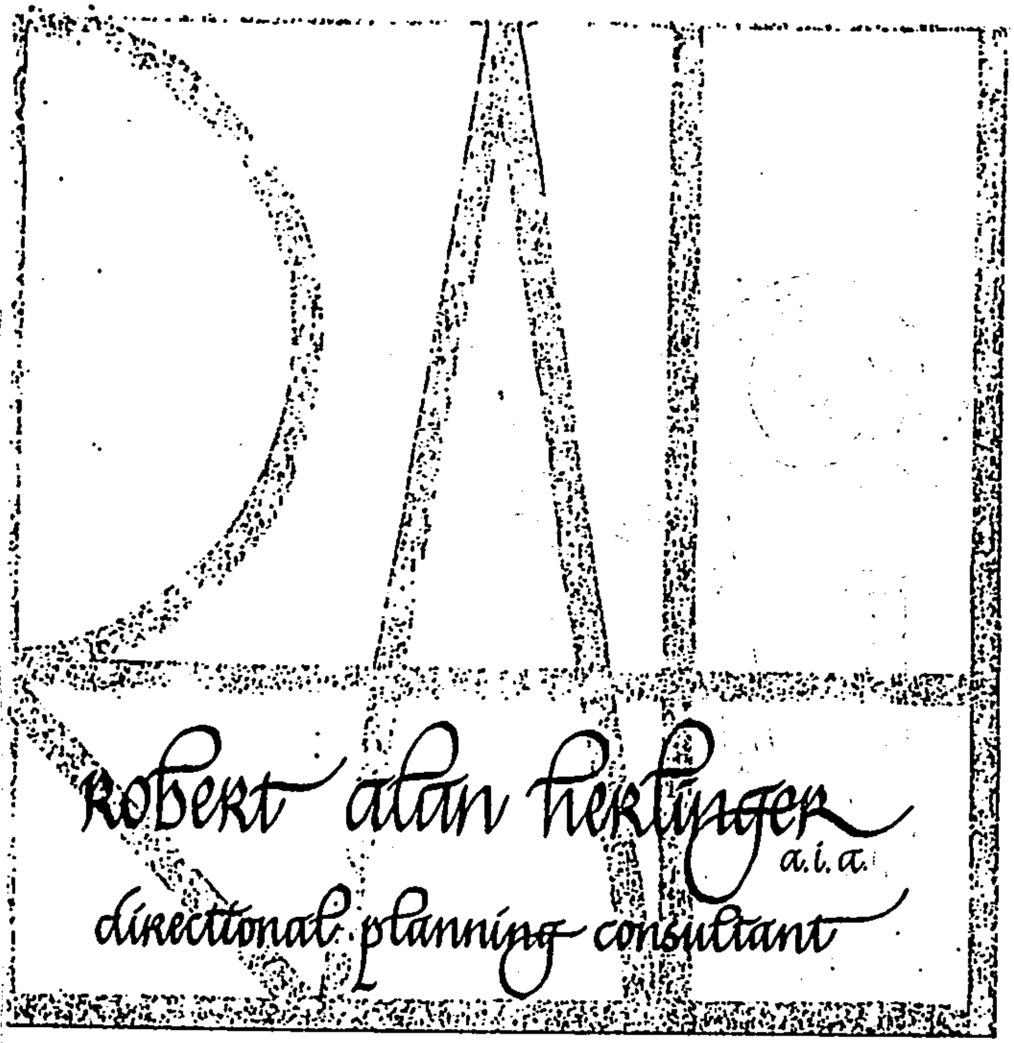
...

SO, if we honestly look at the land and see what was and what is AND if we sincerely value the cultural richness of our Hawaiian resources from the standpoint of what was and what is, THEN, based upon what the majority of us decide to value, <u>WE CAN MAKE INFORMED DECISIONS AND PLAN FOR OUR FUTURE, AND THE HAWAI'I THAT GENERATIONS-TO-COME WILL APPRECIATE AND RESPECT!</u> *(see Directional Plan #5)*

<u>YOU AND YOUR FAMILY</u> can expect to experience this <u>WORLD-CLASS RESOURCE CALLED KAWAI NUI!</u>

Directional Planning Process Spiral

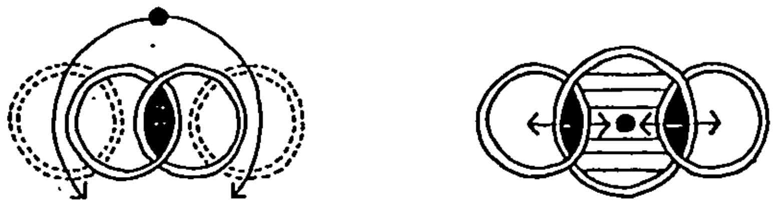




WHAT IS DIRECTIONAL PLANNING ?

Directional Planning is an alternate participatory planning process that facilitates the crystallization and focus of ideas for COMPREHENSIVE PLANNING EFFORTS and RESOURCE CONSERVATION and MANAGEMENT PROGRAMS.

It does this by becoming a LINK between governmental agencies, elected/appointed officials, scientists, planning professionals, developers, environmentalists, citizen advisory groups and the general public they represent, and other special interest groups.

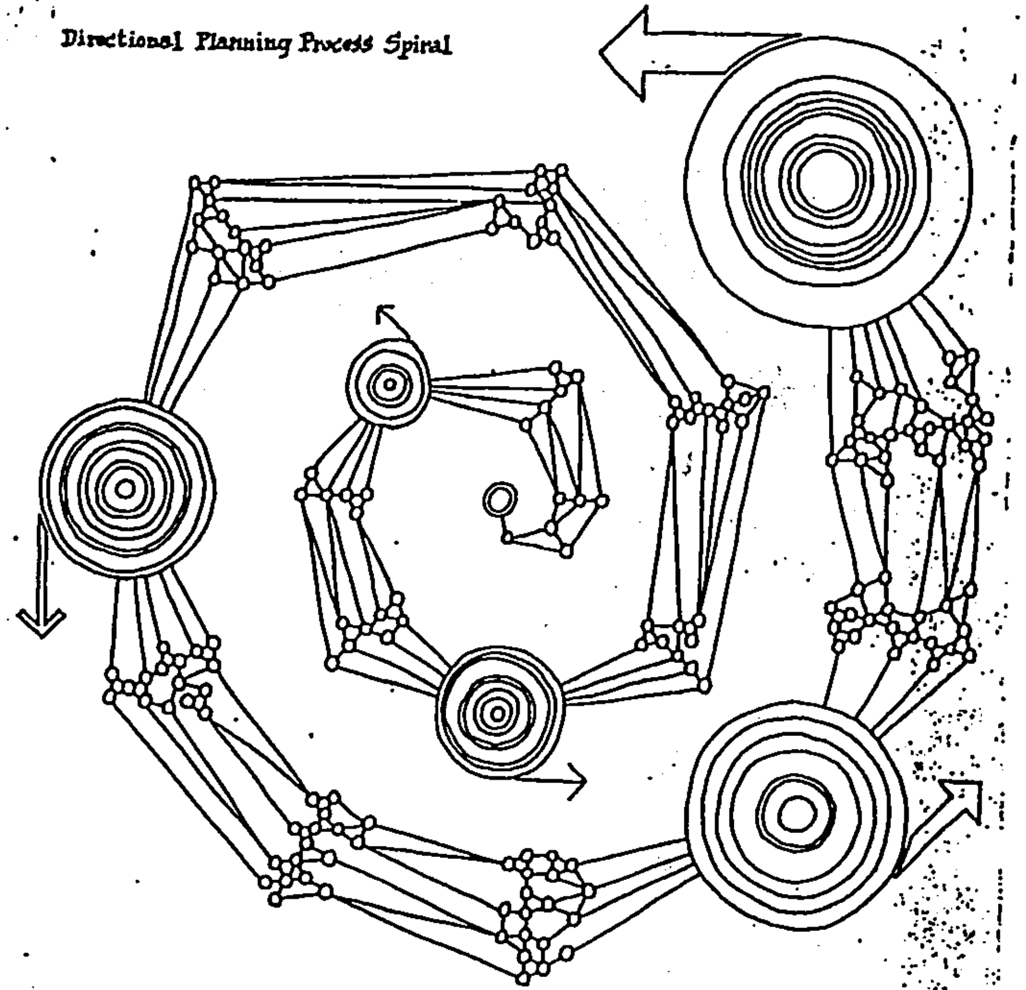


A LINK THIS ↑ WAY NOT THIS ↑ WAY

This link is established by transposing into a graphic language the various concerns of, and information from, individuals and groups such as those mentioned above. The resulting visual images become the foundation for communication between the other involved parties. Each individual/group is enabled to see the implication on the whole of his/their respective areas of concern. The visual images are then summarized in the form of a Directional Plan, which may include active steps which should be taken at that point in time. Many Directional Plans may occur in the life of a project leading to a Comprehensive Master Plan Direction.

Directional Planning is objective, relevant, responsive, logical and flexible. Since Directional Planning concurrently gathers, analyzes, communicates, plans, and packages the various planning inputs, redundant and extraneous efforts can be eliminated, and a plan direction occurs more quickly, efficiently, and economically.

Directional Planning Process Spiral



EXEMPLARY PROJECTS / EXPERIENCE

- 16 Years of professional experience as Architect/Planner (1961-present).
- Research work-"An International Language of Visual Communication" (1966-1969).
- Authored, tested and documented the Directional Planning Process (1974-1976).
- Chief Directional Planning Consultant to Adhoc Committee for Kawainui Marsh Park, Kailua, Hawaii (1974-present).

Kawainui Marsh consists of over 1200 acres within an ecologically delicate watershed. The potential significance of the marsh and its environs is worldwide due to its unique Hawaiian cultural richness, and the scientific, educational, and recreational possibilities in an area only 12 minutes from the urban heart of the State.

The Adhoc Committee consists of over 67 organizations (local and national) on a Statewide basis, who are interested in the preservation of the marsh as a nature park.

My Directional Planning included:

- Conducting over 250 interviews with governmental representatives, legislators, planners, scientists, Hawaiian activists, citizen groups and individuals;
- Developing 4 Directional Plans (last plan 5/76);
- Congratulations with Committee by Hawaii State Senate - Resolution #413 (1975)
- Leading the Kawainui Clinic (4/75), a unique workshop meeting which brought together representatives of the Federal, State, City and County agencies, legislators, scientists, citizens, and the press;
- Developing an exemplary application of the process to Coastal Zone Management.

- Developed and presented an audiovisual unit - "Half A Mountain Equals Zero", to help identify natural elements in Hawaii, which, if compromised, would be gone forever. (1974)
- Produced an audiovisual - "Graphics Aid Guide For Environmental Workshops" for the Environmental Education Association of Hawaii (1975).
- Volunteer art teacher at Kailua Elementary School (1975-1976).
- Developed "Ahupua'a 1976", a book proposal for environmental education, based upon an early Hawaiian planning ethic.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

REPLY TO ATTENTION OF:

JUL 23 1992

Planning Division

Mr. Robert A. Herlinger, A.I.A.
391 Auwinala Road
Kailua, Hawaii 96734

Dear Mr. Herlinger:

Thank you for your letter dated June 17, 1991 regarding the Kawainui Marsh Flood Control Study. Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

Your contributions to the Kawainui Marsh Resource Management Plan through the Kawainui Heritage Foundation are well known. We have included your Directional Plan #5 in our draft document. We have had difficulty in reducing your original detailed maps, which are quite large, onto 8 1/2 x 11 size sheets and appologize for any missing information as a result of our reproduction.

Let me address your questions with respect to our planning process and the "patient that needs healing". As you know, there are many possible approaches to planning issues. We take our planning guidance from Corps regulations (ER 1105-2-100) entitled Policy and Planning Guidance for Conducting Civil Works Planning Studies as well as from our implementing regulations for the National Environmental Policy Act (NEPA). These regulations require us to hold scoping meetings with the public to identify relevant issues and concerns related to the flood problems that must be addressed in our planning process.

We have certainly been aware of the great interest in the Kawainui Marsh Management Plan and have ourselves participated in its creation. We have spent the last year following two scoping meetings with the public, attempting to identify and evaluate potential flood control solutions for our "patient", the Coconut Grove residents of Kailua. We have evaluated a full array of such alternatives including those with ecological and recreational benefits such as the Kawainui Heritage Foundation's

open marsh clearing alternative to which you contributed. Unfortunately, we are unable to recommend the in-marsh flood control alternatives for the following reasons:

a. We have been unable to identify how much vegetation can be safely removed without jeopardizing the existing filtering capacity of the marsh vegetation and the marine receiving waters.

b. Direct connection of open water channels in the marsh to the Oneawa Channel is required to attain any significant flood control but brings the risk of increasing sediment runoff and bacterial contamination into Kailua Bay during periods of heavy rainfall as well as other unknown ecological changes to the marsh. Note that even with the marsh clearing alternative, the levee must be raised to provide the necessary flood protection.

c. There are concerns that the floating mat of vegetation may block channels during a flood and render ineffective flood control benefits with the attendant risk of overtopping the levee.

d. There are very high construction, disposal, and maintenance costs associated with vegetation removal making in-marsh work substantially more expensive and thus not implementable by the Corps.

Consequently, after consideration of engineering, environmental, and economic factors as well as agency and public input, the Corps along with the City and County of Honolulu will be recommending a modification to the NED plan which reduces both the height of the floodwall and the amount of wetland filled. The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side. We shall seek the necessary approvals and implement compensatory wetland mitigation by converting fastland in the marsh near Oneawa Channel to new wetland habitat. We will seek other Corps authority and funding to assist in creating open water in the marsh for wildlife purposes.

Thank you again for your comments.

Sincerely,

Siouk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

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

JP 5/91-1547

June 18, 1991

Commander
Honolulu Engineer District
ATTN: CEPOD-ED-PV
Ft. Shafter, Hawaii 96858-5440

Dear Sir:

Thank you for the opportunity to review your document, Kawainui Marsh Flood Control Project -- Detailed Project Report and Environmental Impact Statement (Draft). We have examined the material and have the following comments to make:

1. This office (Department of General Planning, City and County of Honolulu) will act as the accepting agency for the Final Environmental Impact Statement (FEIS). As such, please insure that we receive copies of all public comments regarding this document.

2. The Development Plan Public Facilities Map for the Koolaupoko Development Plan area was amended by Ordinance 88-89 to represent this project, and the project therefore conforms to our Development Plans.

3. The remaining comments relate to the Plan 2 -- Floodwall alternative:

   A. The FEIS should provide a more detailed explanation of the means for mitigating visual impacts (i.e., landscaping plan, treatment of the outer face of the wall).

   B. It would be useful to include in the FEIS retouched photographs of the Kawainui Marsh area showing the proposed floodwall.

   C. The exposed portions of the floodwall should inhibit vandalism (e.g., graffiti), and should be designed to be sensitive to the rural character of the area (e.g., a blank concrete face would be inappropriate). The FEIS should explain in greater detail how this can be accomplished.

   D. The FEIS should explain more clearly the means for mitigating access disruption to the marsh due to the floodwall and should discuss possible design solutions. Access should be accommodated at reasonable intervals and not just at a single point (i.e., the ITT property).

   E. The floodwall will screen the marsh from the adjacent community. The FEIS should therefore explore how surveillance and security will be provided for the resultant secluded area.

Should you have any questions regarding our comments, please contact Jamie Peirson at 523-4485.

Sincerely,

BENJAMIN B. LEE
Chief Planning Officer

BBL:lh

cc: Department of Public Works
U.S. Army Corps of Engineers

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 23 1992

REPLY TO ATTENTION OF:

Planning Division

Mr. Benjamin B. Lee
Chief Planning Officer
Department of General Planning
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Lee:

Thank you for your comments dated June 18, 1991 on the Kawainui Marsh Flood Control Project - Draft Detailed Project Report and Environmental Impact Statement. Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

As you indicate, your office will act as the accepting agency for the Final Environmental Impact Statement in fulfillment of Chapter 343, HRS. Copies of all public comments regarding the draft have been included in the final EIS.

The majority of your comments pertain to the floodwall which was identified as the NED plan in the draft stage and has retained this status into the final stage of planning. Although we are required to identify the plan that maximizes the national economic development benefits, we are not required to recommend it if a case can be made that another alternative is more acceptable. As a result of the negative reaction to the NED plan by the Kailua Community and other public and agency input, a compromise alternative, which reduces the height of the floodwall, was developed and has become the preferred alternative. This alternative combines the earth levee raise with a four-foot high floodwall and fills less than two acres of wetland. The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side. We shall seek the necessary approval and develop compensatory wetland mitigation to include conversion of fastland in the marsh near the levee to new wetland habitat. A levee raise will not preclude future marsh management scenarios

although marsh activities must be compatible with its flood control function.

As you request, the FEIS will include retouched photos of the marsh showing the view obstruction caused by a levee raise. Means for mitigating aesthetic impacts have been included in the final design. We believe that the compromise alternative will reduce the concerns you raised regarding vandalism, surveillance, and impact on the rural character of the area. The preferred alternative will not disrupt current access. Additional access may be provided, if desired by the City and County in the future. The need for surveillance and security will be greatly reduced by the low floodwall.

Thank you again for your comments and suggestions. We believe that the recommended plan provides the necessary flood protection in a way that will be aesthetically pleasing and environmentally acceptable.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

26 JUN 1991

United States Department of the Interior

IN REPLY REFER TO:

OFFICE OF THE SECRETARY
Office of Environmental Affairs
600 Harrison Street, Suite 515
San Francisco, California 94107-1376

June 20, 1991

ER 91/461

Commander, Honolulu Engineer District
U.S. Army Corps of Engineers
Fort Shafter, Hawaii 96858-5440

Dear Commander:

The Department of the Interior has reviewed the Detailed Project Report and Draft Environmental Impact Statement for the Kawainui Marsh Flood Control Project, Kailua, Oahu, Hawaii and has the following comments.

Cultural Resources

1. Figure 10 - "Archeological Resources in the Vicinity of Kawainui Marsh." The National Register boundary shown for Kawainui Marsh was arbitrarily established in 1979 using aerial photographs rather than through standard scientific pedestrian survey and testing. The extent of modern disturbance as well as the extent of archeological sites was not known at that time and it is not know now. The marsh, however, has long been recognized as part of a larger and highly important prehistoric cultural and economic unit. Not all Hawaiian archaeologists agree with the currently depicted boundary, some believing the entire watershed should form the National Register archeological district.

2. The present study provides archeological survey and coring data only for Plan 1 (levee raise) and Plan 2 (floodwall). We cannot evaluate the actual or potential impact to cultural resources without similar survey data for alternative Plans 3 through 6; thus, the project appears to be not in compliance with section 106 of National Historic Preservation Act of 1974 (as amended).

3. Surveys should be conducted in all potential project impact areas regardless of the survey boundaries depicted in Figure 10. For example, very little is known archaeologically about the western half of the archeological district, and random burials are known to occur in the Kailua flood proofing zone (Plan 6) which is outside the boundary

Thank you for the opportunity to review this document.

Sincerely,

Patricia Sanderson Port
Regional Environmental Officer

cc: Director, OEA (w/orig. incoming)
Reg. Dir., FWS
Reg. Dir., NPS

United States Department of the Interior

IN REPLY REFER TO:

OFFICE OF THE SECRETARY
Office of Environmental Affairs
600 Harrison Street, Suite 515
San Francisco, California 94107-1376

July 11, 1991

ER 91/461

Commander, Honolulu Engineer District
U. S. Army Corps of Engineers
Fort Shafter, Hawaii 96858-5440

Dear Commander:

The Department of the Interior submitted comments on the Draft Environmental Impact Statement for the Kawainui Marsh Flood Control Project, Kailua, Oahu, Hawaii which were due on June 17, 1991. We request that the U. S. Army Corps of Engineers (COE) accept the following comments as a supplement to our previous comments.

GENERAL COMMENTS

The development of flood control alternatives to provide suitable protection for the Coconut Grove community and to conserve important wetland resources has been in evolution since 1988. The concrete floodwall proposal has been identified as the National Economic Development (NED) alternative. The concrete floodwall optimizes economic benefits with minimal adverse impacts to wetland values and functions.

The construction of the concrete floodwall would not result in the filling of any wetland habitat nor generate any direct or secondary impacts to the hydrology of Kawainui Marsh or to water quality within Kailua Bay. In this context, the concrete floodwall alternative is environmentally acceptable. We believe that this alternative is superior to project proposals that require the filling of wetland habitats and provision of compensatory mitigation.

The concrete floodwall alternative should incorporate removal of emergent vegetation and sediments within Kawainui Marsh and removal of dense, introduced emergent vegetation from the interior of the marsh as integral features of this alternative. In selecting the concrete floodwall alternative, the critical issues of reduced storage capacity of Kawainui Marsh and increased sedimentation and growth of emergent vegetation need to be addressed. The concrete floodwall alternative should provide opportunities to recover and enhance wetland habitats for endangered waterbirds and migratory waterfowl.

SPECIFIC COMMENTS

Page 1. Prior Studies, Reports, and Existing Water Projects. The original design for the Kawainui Marsh Flood Control Project included a water control structure at the head of Oneawa Canal. The purpose of the water control structure was to prevent saltwater intrusion into the marsh and to "regulate the outflow from the swamp." (Kawainui Swamp Flood Control Design Memoranda. 1957. U.S. Army Engineer District, Honolulu). However, the water control structure was never constructed as part of the original flood control project.

The design features of the original flood control project should be incorporated as a central component of any project improvement selected by the COE. Thus, for all project alternatives, the water control structure should be incorporated as a central project feature in accordance with the 1957 Design Memoranda. The draft Detailed Project Report (DPR) should be amended to incorporate the water control structure for all project alternatives.

Page 37. Biological Resources. 3.4.2 Birds. Statements in this section should be corrected to reflect that provisions for listing endangered and threatened species are authorized under section 4 of the Endangered Species Act of 1973, as amended. Provisions for interagency consultation are authorized under section 7 of the Endangered Species Act.

Page 47. Sediment Disposal and Wetland Fill. 4.3.2 Mitigation. Open water channels within the existing wetland are under construction by the City and County of Honolulu as a separate flood control project. These open water areas will be constructed regardless of the outcome of the Federal flood control project. Thus, the open water channels constructed by the City and County of Honolulu cannot be recounted as mitigation for the Federal project. Compensatory mitigation separate from the City and County of Honolulu's project would be necessary to offset unavoidable adverse impacts to wetland resources.

Pages 46 to 49. Sediment Disposal and Wetland Fill, Conclusions and Page 7. Appendix I and Pages 1 to 7. Evaluation of the Effects of the Discharge of Dredged or Fill Materials, Kawainui Marsh Flood Control Project, Section 404(b)(1) Guidelines, Factual Determination. The draft Environmental Impact Statement (EIS) misinterprets the U.S. Fish and Wildlife Service's (Service) July 12, 1990, Biological Opinion regarding mitigation for wetland fills. The draft EIS incorrectly assumes that the consideration and selection of a project alternative that would avoid filling wetlands is not necessary since mitigation has been identified in the Biological Opinion.

The discussion in the Biological Opinion regarding mitigation pertain to compensation of unavoidable impacts to endangered species and should not be treated as a means for compensating adverse impacts. Avoidance of adverse impacts is particularly applicable since less environmentally damaging alternatives which provide the necessary level of flood protection are available. In this context, the concrete floodwall alternative is preferred over the earthen levee proposal.

The factual determination under the Clean Water Act's section 404(b)(1) guidelines is incorrect in stating "an earthen levee raise may be a more desirable alternative than a floodwall, despite its minor wetland fill component, especially in light of the proposed Service mitigation associated with it." The section 404 (b)(1) guidelines clearly state "no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences" (40 CFR 230.10(a)). As identified in the draft EIS, the concrete floodwall alternative does not require any wetland fill, and it is also identified as the NED plan alternative.

The 1990 Memorandum of Agreement (MOA) between the U.S. Environmental Protection Agency and the Department of the Army states "Compensatory mitigation may not be used as a method to reduce environmental impacts in the evaluation of the least environmentally damaging practicable alternatives for the purposes of requirements under section 230.10(a)" (II.C.1). The discussion of mitigation in the Biological Opinion applies to the compensation of unavoidable impacts only, and it should not be used to justify the selection of the earthen levee proposal over the concrete floodwall alternative. The final EIS should be corrected to identify the concrete floodwall alternative as being in compliance with the section 404(b)(1) guidelines and the 1990 MOA.

Thus, the Service disagrees with the conclusion "that an earthen levee raise and not a concrete floodwall would become the environmentally preferred alternative if the "two for one" wetland replacement in the form of open water creation is implemented." This conclusion is based on a misinterpretation of the Biological Opinion, and is inconsistent with the section 404(b)1) guidelines and the 1990 MOA.

<u>Page 20. Description of Specific Alternatives Including No Action. 2.2.5. Oneawa Channel extension with new "back levee."; and Page 54. Plan 5: Back Levee. 4.5.1.9</u>. The draft EIS is inconsistent in presenting information on the amount of wetland fill required for construction of the new back levee and extended Oneawa Channel. In section 2.2.5, Description of Specific Alternatives Including No Action, the draft EIS states that 2 acres of wetland fill will be required for construction of the new back levee. However, in section 4.5.1.9, Plan 5: Back Levee, the draft EIS does not include information on wetland fill or mitigation for wetlands impacted. According to the draft DPR, the extended channel and new back levee will require 5 acres of wetland fill. The discrepancy between the draft EIS and DPR should be corrected in the final documents.

<u>Page 56. Mitigation 4.5.2.6</u>. Any relocation of endangered waterbird nests without specific authorization from the Service could be considered take under section 9 of the Endangered Species Act of 1973, as amended. Nest relocation was not authorized in the incidental take statement included in our Biological Opinion and should not be misconstrued as mitigation.

<u>Page 74. Fish and Wildlife Coordination Act 6.2.5</u>. The Fish and Wildlife Coordination Act (FWCA) reports, which were prepared in accordance with section 2(b) of the FWCA are an integral part of the COE planning process. The purpose of the report is not only to report significant information on fish and wildlife resources in the project area but to ensure that these

resources receive equal consideration in the COE's planning process. For this particular project, a formal transfer of funds to complete the required 2(b) report was not necessary.

<u>SUMMARY COMMENTS</u>

The marsh clearing alternative provides the maximum benefits to wildlife resources, including migratory waterfowl and shorebirds and endangered Hawaiian waterbirds. However, this alternative is the most expensive and provides the lowest net NED benefits. Under the current guidance regarding the selection of civil works projects, this alternative is not likely to be selected.

The concrete floodwall alternative is the least expensive and has the highest net NED benefits. An added attraction to this alternative is that no filling of wetland habitat would be necessary and no significant impacts to the hydrology of Kawainui Marsh would occur.

However, the COE appears disinclined to select this alternative because of the potential impacts to the viewplanes of Kawainui Marsh and the apparent opposition by the community.

Instead, the levee raise alternative which includes filling of wetland habitat and compensatory mitigation is being suggested as the environmentally preferred alternative. The concrete floodwall avoids adverse impacts, rather than attempting to compensate adverse impacts by providing compensatory mitigation. Thus, we believe that the concrete floodwall is the environmentally preferred alternative over the levee raise proposal.

If you would like to discuss these issues further with Fish and Wildlife Service, please call Andy Yuen at (808) 541-2749

Sincerely,

Patricia Sanderson Port
Regional Environmental Officer

cc: Director, OEA (w/orig. incoming)
Reg. Dir., FWS
Reg. Dir., NPS

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 2 3 1992

REPLY TO ATTENTION OF:

Planning Division

Ms. Patricia Sanderson Port
Regional Environmental Officer
United States Department of the Interior
Office of Environmental Affairs
600 Harrison Street, Suite 515
San Francisco, California 94107-1376

Dear Ms. Port:

We wish to thank you for your two letters dated June 20 and July 11, 1991 regarding review of our Kawainui Marsh Draft Detailed Project Report and Environmental Impact Statement. Although your second letter was received following the close of the public review comment period we have accepted it as a supplement to your previously submitted comments.

Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

The following statements respond to the comments contained in your June 20, 1991 letter:

1. The National Register boundary shown in Figure 10 is the official boundary of the historic site as shown on the request for eligibility submitted to the Keeper. Although some archaeologists may believe the boundary should be drawn differently, no amendment to the eligibility request has been submitted.

2. Our NEPA document has incorporated by reference the previously prepared state EIS published in June 1990 by our local sponsor, the City and County of Honolulu, as stated in our joint federal/state draft EIS.Additional archaeological survey and coring data for the interior of Kawainui Marsh associated with that study are available from the City and County of Honolulu. During the planning process, it became apparent that neither the in-marsh nor the floodproofing alternatives would be feasible because of economic, engineering or environmental considerations.

We believe there was no need to perform expensive archaeological surveys for alternatives which would not be carried forward to the Final EIS.

3. The archaeological surveys performed by the City and County of Honolulu, and the Corps included all the areas of potential impact. There is no requirement to perform surveys in areas which will not be affected by the project.

The following statements respond to the comments contained in your July 11, 1991 letter:

<u>General Comments</u>

Federal participation in any work for flood control under Section 205 authority must meet engineering, economic, and environmental criteria. Modifications to the existing levee are the only alternatives that meet these criteria. Four different levee modifications have been evaluated in detail in our final document and all are feasible.

The National Economic Development Plan (NED), identified in the draft project report of April 1991, retains its NED status into the final report. However, as a result of the negative reaction to it by the Kailua community and other public and agency input, a compromise alternative which reduces the height of the floodwall and fills less wetland than the earthen levee raise alternative was developed and has become the recommended plan. Compensatory wetland mitigation for the less than two acres of wetland impacted by this alternative shall result in the conversion of fastland in the marsh near the estuary end to new wetland habitat.

The City and County of Honolulu is completing the removal of emergent vegetation and sediments within the marsh along the alignment outlined in their final EIS of June 1990 and this open water has become the baseline condition for our proposed levee modification. Detailed discussion of the sediment and vegetation issues you have raised can be found in our final document.

Specific responses to your comments follow.

Page 1. <u>Water Control Structure</u>: The incorporation of a water control structure in the original design for Kawainui Marsh was not made for flood control purposes. The structure was originally proposed as part of a project to allow for irrigation pumping activities in the marsh and to inhibit salinity intrusion as a result of such pumping. When the decision was made to abandon the irrigation practice, salinity concerns were dropped and adjustments were made to the flood control project. These adjustments included a reduction in the levee height .5 feet and the exclusion of the water control structure. We see no reason to include the structure at this point as part of the proposed flood control project.

Page 32. Birds: The authority for listing endangered species has been changed from Section 7 to Section 4 as you suggested.

Page 47. Compensatory Wetland Mitigation: As you recommend, the open water channels being created by the City and County of Honolulu will not be recounted as mitigation for wetland fill associated with a levee raise. Instead, conversion of previously filled land near the Oneawa Channel into new wetland habitat will compensate for the less than two acres of wetland filled by the recommended alternative.

Pages 46-49, etc. Section 404(b)(1) Guidelines, Factual Determination: You are correct in your statement that avoidance of adverse impact to wetland can be attained with the selection of the concrete floodwall (NED plan) alternative. However, other impacts associated with this alternative have been raised by the community which is quite opposed to the height of the floodwall. Although we still believe that an earthen levee raise is more in keeping with the wilderness character of the marsh, a compromise alternative that fills less wetland and reduces the height of the floodwall appears to be the most prudent way of achieving the desired flood protection. We believe that the conversion of fastland to wetland near the estuary end of the marsh will be of greater environmental benefit than avoiding the filling of wetland altogether.

Page 20. Thank you for identifying the discrepancy in amount of wetland filled for the "back levee" plan in our draft document. This alternative has been dropped from final analysis for engineering, economic, and environmental reasons.

Page 56. Nest relocation is no longer an issue since in-marsh alternatives have been dropped from the final array of alternatives. Thank you for pointing out the lack of authorization for nest relocation in the incidental take statement associated with our Biological Opinion.

Page 74. We have received the draft 2(b) report from the USFWS in accordance with the provisions of the Fish and Wildlife Coordination Act. It has been placed into our final EIS. As you indicate, a formal transfer of funds was not necessary. We have also included a copy of the State of Hawaii's response to the draft 2(b) report in the final EIS.

In summary, we hope that you will concur with our analysis that a compromise levee modification, resulting from public input and comment, that fills a minor amount of wetland and reduces the height of a floodwall is the most acceptable approach to the solution to flood control for Coconut Grove residents. Compensatory wetland mitigation will likely create a more valuable wetland habitat for endangered waterbirds than would be lost by the levee modification.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW
US Fish and Wildlife Service
Regional Director

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Pacific Area Office - Southwest Region
2570 Dole St. Honolulu, HI 96822-2396
PH: (808)955-8831 FAX: (808)949-7400

June 20, 1991 F/SWR13:JJN

Kisuk Cheung
Director of Engineering
U.S. Army Corps of Engineers
Building 230
Fort Shafter, HI 96858-5440

Dear Mr. Cheung:

The National Marine Fisheries Service (NMFS) has received the Draft Detailed Project Report and Draft Environmental Impact Statement (DEIS) for the Kawainui Marsh Flood Control Project, Kailua, Island of Oahu, Hawaii. Due to insufficient staffing we are unable to conduct a complete review of the subject documents. However, we have been involved in the early planning stages of the proposed project and wish to submit the following abbreviated comments and recommendations.

The major concern of NMFS with regard to the Kawainui Flood Control Project is the possibility of increasing sediment load within Kailua Bay through both the Oneawa Channel and Kaelepulu Stream outlets. One of the major beneficial functions of Kawainui Marsh is to act as a natural flood storage basin and sediment trap for runoff from Haunawili Valley and other upland areas, thereby protecting water quality and biota of Kailua Bay from pulses of fresh water and sediment during heavy rains. Kailua Bay contains a diversity of habitats and supports fishery resources of particular importance to recreational fishermen. In addition, there is an abundant green turtle population in the bay with a concentration of these turtles found in close proximity to the outlet of Oneawa channel, apparently attracted to benthic algae growing in this area.

In view of the above, NMFS recommends against implementation of any of the alternations which would potentially increase sedimentation of Kailua Bay and adjacent marine environments. Basically these would be Alternatives 3, 4, and 5. Although no preferred alternative has been established, Alternative 2 (flood wall atop the levee) has been identified as the National Economic Development (NED) Plan and would increase the flood storage capacity of the marsh while maximizing protection of the estuarine and marine environments downstream from the proposed project. In addition, no wetland fill would be required under Alternative 2. NMFS recommends the selection of Alternative 2 as the preferred alternative.

Sincerely yours,

John J. Naughton
Pacific Islands
Environmental Coordinator

cc: F/SWR, Terminal Is., CA
FWS, Honolulu
EPA, Region 9 (E-4)
Hawaii State Div. of Aquatic Res.
Hawaii CZM Program

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 23 1992

REPLY TO ATTENTION OF:

Planning Division

Mr. John Naughton
Pacific Islands Environmental Coordinator
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Pacific Area Office-Southwest Region
2570 Dole Street
Honolulu, Hawaii 96822-2396

Dear Mr. Naughton:

Thank you for your comments on the Draft Detailed Project Report and Environmental Impact Statement for the Kawainui Marsh Flood Control Project. Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

We concur with your concerns regarding the possibility of increasing sediment load within Kailua Bay through both the Oneawa Channel and Kaelepulu Stream outlets with some of the alternatives described in our draft document. The natural buffering abilities of the marsh should not be jeopardized without knowing a great deal more about the functions of the marsh. The in-marsh alternatives which were evaluated in the draft do not meet Corps prescribed engineering, economic or environmental criteria for flood control for the following reasons:

a. We have been unable to identify how much vegetation can be safely removed without jeopardizing the existing filtering capacity of the marsh vegetation for the marine receiving waters.

b. Direct connection of open water channels in the marsh to the Oneawa Channel is required to attain significant flood control improvements. This connection brings the risk of increasing sediment deposition and bacterial contamination into

Kailua Bay during periods of heavy rainfall as well as other unknown ecological changes to the marsh. Note that even with the marsh clearing alternative, the levee must be raised to provide the necessary flood protection.

c. There are concerns that the floating mat of vegetation may block channels during a flood and render ineffective any flood control benefits with the attendant risk of overtopping the levee.

d. There are very high construction, disposal, and maintenance costs associated with vegetation removal making in-marsh work substantially more expensive than other alternatives.

The concrete floodwall, identified in our draft as the National Economic Development Plan (NED), has retained that status into our final document. However, as a result of the negative reaction to it by the Kailua community, and in light of agency and other public input, a compromise alternative that reduces the height of the floodwall and fills less wetland than the earthen levee raise is the recommended plan. The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side.

Compensatory wetland mitigation for the 1.8 acres affected involves conversion of previously filled wetland near the estuary end of the marsh to wetland habitat for endangered waterbirds. Please advise us with respect to any recommendations you may have regarding restoration of this wetland area.

Thank you again for your comments. We believe that the recommended alternative is the most appropriate means of providing the necessary flood protection for the residents of Coconut Grove.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

John Stimson
1113 Hui St.
Kailua, HI 96734

June 20, 1991

Commander
Honolulu Engineer District
Attn: CEPOD-ED-PV
Ft. Schafter
Hawaii 96858-5440

Dear Sirs,

The point of these remarks is that there is no need for further construction of barriers or other civil-engineering projects in the marsh. I am opposed to spending funds unnecessarily on public works projects such as the Kawainui flood protection project, and wish the City would be more careful about where it permits structures to be built. Inevitably the issuance of permits for marginal building sites winds up costing the taxpayers.

In this particular case my review of the documents included in "Kawainui Marsh Flood Control Project" do not suggest that more structures need to be built in the marsh, but rather, further consideration should be given to opening-up the waters of the marsh to: 1) increase through flow rates 2) lower the resistance the marsh presents to water flow, 3) increase the marsh's capacity to absorb the volume of flood waters at least temporarily, and 4) restore a marsh severely damaged by human actions.

Three figures in the report lead me to the conclusion that only marsh clearance is needed to eliminate the threat of flood damage..

1) The New Year's storm produced 68×10^6 cf in 24 hours (Estimated from information in Fig. 10) at gauging station 2450.

2) Oneawa channel can carry approximately 6.75×10^3 cfs.
In 24 hours it can discharge 5.6×10^8 cf

3) The water level in the marsh at the marsh-end of Oneawa Channel is approximately 2.5' above mean sea level, the top of the dike is 10' above mean sea level

4) If the marsh's area is estimated at 750 acres, (3.3×10^7 ~~sq ft~~), it's volume above 2.5'(MSL) is $3.3 \times 10^7 \times 7.5'$, which equals ~~$2.5 \times 10^8$~~ cu ft. This could be considered the marsh's storage volume.

So, in its present configuration (and assuming for the moment no outflow through Oneawa Channel) the marsh can contain ~3 times the runoff of the New Year's storm (virtually a 100 year storm, pg. 9 of Draft), if its water level were at 2.5' above mean sea level.

With the channel running at 6.75×10^3 cfs, 24.3×10^6 cf could be drained from the marsh/hour. This is 1/3 of the volume of the New Year's storm.

Put in a different way, at its peak Makawao Stream (Gauging Station 2540) which represents 84% of the inflow to the marsh during the New Year's storm, registered 2800 cfs, which is less than 1/2 of the Oneawa channel's output rate.

I think the conclusions are obvious. In its present configuration the marsh, channels and existing dike are sufficient to afford safety from floods, but the marsh needs to be cleared of some of its vegetation to increase flow rates through the marsh. As the impact statement points out, much of this vegetation is probably attributable to the discharges of the 4 sewage treatment plants which once discharged into the marsh. The heavy vegetation is a legacy of a long period of neglect of the marsh. Much of this vegetation can float and move. Two steps should be taken to remove it. It should be staked or anchored to prevent it from moving into channels and spreading, and it should be harvested. The dried harvest should be sent to the garbage to energy facility. Removal and burning will aid in the removal of nutrients from the marsh, and if allowed to stay, by for example killing it, and allowing it to sink, the nutrients will only continue to be available to stimulate further growth of vegetation. These nutrients were partly put there by sewage disposal.

I do not favor the expenditure of money on a civil engineering - construction project in the marsh and would instead favor that monies only be used to restore the marsh. This restoration as pointed out in the calculations above will assure the safety of the residents of Coconut Grove, and will reclaim an attractive and biologically useful body of open water.

Sincerely,

John Stimson

John Stimson
Associate Professor, Zoology

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, HONOLULU
FORT SHAFTER, HAWAII 96858-5440

JUL 23 1992

REPLY TO ATTENTION OF

Planning Division

Dr. John Stimson
1113 Hui Street
Kailua, Hawaii 96734

Dear Dr. Stimson:

Thank you for your letter dated June 20, 1991 commenting on the Kawainui Marsh Flood Control Project. Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

We appreciate the time and effort your analysis required; however, we believe that you misinterpreted some of the data. The following is a brief summary of our study results as they relate to your comments.

a. Makawao stream gage station 2540 represents only about 19% of the flow into the marsh, since it gages only about 2.04 square miles of the 10.62 square miles total drainage area above the marsh.

b. Total inflow into the marsh for the 1988 New Year's flood is estimated to be 7,800 acre-feet (339 x 10^6 cf), or about 2,000 acre-feet more than your calculated capacity for the marsh. Based on a gage that recorded water levels within the marsh from 1967 to 1979 (the gage was relocated in 1979 to the Oneawa Channel), we found that marsh water levels have quickly risen and slowly recede. We used 6.5 feet msl as a starting point to begin flood routing and subsequent design of the levee. We selected this starting water surface elevation of 6.5 feet msl because intense storms are often preceded by short wet weather which tend to raise the marsh water levels. The average high water level taken from the 1967 to 1979 records indicates that a marsh water surface elevation of 6.5 feet msl is a reasonable marsh water level to begin flood routing. For your information, marsh water

levels reached 7.5 and 7.7 feet msl in April 1989 and March 1991 respectively.

c. The capacity of Oneawa Channel is approximately 6.75 x 10^3 cfs as you stated; however, if the water had unobstructed access to Oneawa, the rate of outflow would approximately equal the rate of inflow. We have estimated the peak inflow for the 100-year design flood to be 21,300 cfs or about 3 times the capacity of Oneawa Channel. For this reason, the marsh clearing alternatives would require increasing the capacity of the Oneawa Channel by dredging, widening or both.

d. The continuing cost of equipment, labor and transportation to remove harvest the marsh vegetation would be very high and burning has been determined to be illegal by the Department of Health.

e. We do not believe that the floating mat can be "anchored", and its unpredictable movement would make open channels in the marsh unreliable for flood control.

As you can see from the above summary, the development of open water in the marsh is a complex issue with many ramifications. We believe that the levee raise alternative is the most cost-effective way to provide reliable flood protection to the citizens of Coconut Grove. A combination floodwall with earthen levee raise which lowers the height of the floodwall from that of the NED plan, and reduces the amount of wetland fill associated with the earthen levee raise alone, will accommodate the need for flood control in the most environmentally acceptable manner. The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side. This alternative will not preclude the opportunity for marsh management scenarios which incorporate additional open water for wildlife habitat.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

OFFICE OF STATE PLANNING
Office of the Governor
STATE CAPITOL, HONOLULU, HAWAII 96813 TELEPHONE (808) 548-3063

Ref. No. P-2067

June 20, 1991

Commander
Honolulu Engineer District
Ft. Shafter, Hawaii 96858-5440

ATTN: CEPOD-ED-PV

Dear Sir:

Subject: Kawainui Marsh Flood Control Project, Kailua, Oahu, Draft Detailed Project Report and Environmental Impact Statement

We have reviewed the detailed project report and environmental impact statement for the proposed Kawainui Marsh Flood Control project. We offer the following comments.

A Coastal Zone Management (CZM) objective is to reduce hazard to life and property from flooding. It is evident that the marsh conditions that led to the 1988 flood need to be reevaluated and additional flood control measures implemented. Thus, we recognize that a flood control measure is sorely needed in Kawainui Marsh and support the intent and purpose of the proposed project.

In the designs of alternatives, however, there are several other CZM objectives and policies that need to be considered. They are to preserve valuable coastal ecosystems of significant biological importance, minimize disruption or degradation of the wildlife habitat, insure that new developments are compatible with their visual environment, preserve historical resources, promote and preserve recreational opportunities and access, and preserve water quality. In our view, these objectives and policies are relevant to each of the flood control proposals.

First of all, we are concerned that the COE may not have considered the marsh as a dynamic system. The unresolved issues listed on page 8 of the DEIS may significantly affect the outcome of a flood event after the flood control measure has been implemented. For example, it has been stated in the DEIS that the vegetation mat may clog the waterways during a flood. Yet, the action of the floating mat during flood conditions is listed as an unresolved issue. It also states on page 67, that the in-marsh plan would also require a small levee raise and the floating mat is still unpredictable during flood events and may block water channels. It concludes that it would be prudent for the levee to

be high enough to protect the community from the flood. The implication is that plan 3 may not be effective for flood control. With the exception of plan 3, the other alternatives do not appear to consider both flood control and resource management. We believe that an effective flood control measure must consider the marsh and the entire watershed, including the nearshore coastal area as an interrelated system, and that any action taken may affect the system in various ways. Therefore, the action of the floating vegetation mat should be a major factor in clarifying the flooding problem and in designing alternative control measures.

We also suggest that other alternative designs be explored to assure that the project's purpose and related environmental and CZM concerns can be accommodated. Perhaps combining some of the alternatives described in the document could produce more popular and engineeringly sound solutions. The proposed alternatives for the in-marsh flood control measures should be improved to mitigate the effects of sediment flushing into Kailua Bay. The feasibility of using a sediment trap should be discussed in the EIS. If the plan is revised to retain most of the sediment within Kawainui Marsh, the in-marsh plans would be preferable since they would both improve the wildlife habitat and provide for flood control. Another example is to consider combining plans 1 and 2, levee and floodwall raise, respectively. The levee could be elevated about 4-5 feet and a lower floodwall, perhaps 3-4 feet, could be built. This alternative could reduce the area of wetland which would need to be filled and thus have fewer impacts on the wildlife habitat. In addition, it could enhance public access and recreational opportunities if the levee were designed to accommodate increased use by the community. For example, a bike/jog/walking path over the levee could be incorporated into the proposal. We suggest that this idea be explored and discussed in the EIS.

We note that the DEIS discusses the possibility of finding archaeological resources during implementation of the alternatives. However, the document should clarify that if certain alternatives will be implemented, that the applicant will coordinate archaeological studies with the State Department of Land and Natural Resources' Historic Preservation Office.

Finally, the document does not discuss the status of the emergency ditch after the proposed flood control measures are implemented. We understand that the ditch was a temporary measure to drain water from the marsh during the period of high water level directly after the 1988 flood. The ditch apparently has also worked well after the recent rainstorms during March of this year. However, according to Ms. Margo Stahl of your staff, the COE does not recommend using the emergency ditch as a permanent flood control measure for the 100-year storm event. In addition, the DEIS was written without including the emergency ditch in the baseline conditions. This indicates that the ditch is not necessary for flood control. The DEIS should discuss in detail what role, if any, the emergency ditch would have in the flood control proposals.

Commander
Page 3
June 20, 1991

Thank you for allowing us the opportunity to comment on this proposal. If you have any questions, please contact Lorene Maki of our staff at 548-3961.

Sincerely,

Harold S. Masumoto
Harold S. Masumoto
Director

cc: Mr. Ron Walker, DLNR

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 23 1992

REPLY TO ATTENTION OF:
Planning Division

Mr. Harold S. Masumoto
Director
Office of State Planning
State Capitol
Honolulu, Hawaii 96813

Dear Mr. Masumoto:

Thank you for your review dated June 20, 1991 of the Kawainui Marsh Flood Control Project, Draft Detailed Project Report and Environmental Impact Statement. Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

As the result of your comments, in particular, we have evaluated a combination of two levee raise alternatives which reduces the height of the floodwall and requires less than two acres of wetland fill. The rsulting new alternative, 3A, would combine a lower levee raise coupled with a concrete floodwall having a maximum hiehgt of 4 feet on top of the levee. The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side. This compromise alternative, which is only slightly more expensive than the floodwall alone will provide the necessary flood protection and be more acceptable to the community than the higher floodwall associated with the NED plan. Landscaping will minimize the appearance of the modification and compensatory wetland mitigation will restore a previously filled area in the marsh to wetland habitat.

We appreciate your concern about the marsh system as it relates to the Coastal Zone Management Program. We understand that control of non-point sources of pollution are now within your purview and that recommendations for best management practices to control such pollution will be initiated for the Maunawili watershed. Ultimately this will benefit the marsh and the water bodies which feed it. However, our analysis of alternatives which remove vegetation and sediments from the marsh for flood control purposes failed Corps engineering, economic and environmental criteria.

As you know, the City and County of Honolulu, our local sponsor, is implementing construction of open water channels in the marsh. This open water serves as the baseline condition for the proposed flood control project and is expected to be maintained for the life of the project. The floating vegetation which now borders the open water has already started to encroach back into the channel. The further action of the floating mat under flood conditions remains speculative and further reliance on more open water for flood control is considered too risky. That is why we placed the subject in the unresolved issues category in the draft.

The levee design will accommodate recreational use such as a biking/jogging or walking path with approval by the City and County of Honolulu. Access to the levee is controlled by the City and County of Honolulu.

An archaeological survey along the alignment for the proposed levee modification located no historic properties. Coordination with the State Department of Land and Natural Resources' Historic Preservation Office has been ongoing and a letter of no effect has been received from that office.

The status of the emergency ditch has been clarified in our final document. The emergency ditch by itself is not a significant flood control channel because the ditch capacity is only 1,700 cubic feet per second, which is much less than the 100-year design inflow (21,300 cfs) into the marsh and outflow (6,750 cfs) through the Oneawa Channel. Widening the ditch would not have a significant effect on the design of the flood control alternatives. The primary function and need for the ditch is to lower the water level in the marsh between storms. You are correct that the draft was written without including the emergency ditch in the baseline conditions. It continues to be excluded from such conditions but can remain in place if maintained by the City and County of Honolulu.

Thank you again for your review of the draft document. We believe that the compromise alternative that you recommended will serve to provide the necessary flood control and is consistent with Hawaii's coastal zone management program. We respectfully request your concurrence with our CZM consistency determination at this time.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

THE LANI-KAILUA OUTDOOR CIRCLE
P.O. BOX 261
Kailua, Hawaii 96734
June 21, 1991

Commander, Honolulu Engineering District,
US Army Corps of Engineers,
Attention: CEPOD-ED-PV
Fort Shafter, Hawaii 96858-5440

RE: The Draft Detailed Project Report and Environmental Impact Statement. Ka'wai Nui Marsh Flood Control Project at Kai'lua, Island of Oahu, Hawaii, April, 1991.

Dear Sirs,

Thank you for your consideration of these comments regarding the form and substance of this draft document which are being respectfully submitted within the prescribed response period. However, since this is of necessity being posted from the mainland, we ask your forbearance in the slight delay in arrival time.

In an overview of the document, we find it to be an apparent attempt to amalgamate two distinctly different kinds of documents, as the title describes, which, unfortunately, is neither a proper environmental impact statement nor perhaps a proper detailed project report. The rationale for this attempt to combine them, placing the EIS as the first item of the section titled "Supporting Documentation", can only be conjectured. However, at the least, the result seems to subvert the intent of the process provided for in NEPA and State environmental law regarding the necessity for independence of consideration of the environmental impact of the proposed alternatives for the project, and perhaps could be viewed as in non-compliance with the law since the "preferred alternative" is identified. In many aspects within the document there seems to be an attempt to justify it as such. Regrettably, it certainly will cause unnecessary delay and added expense to sort out material from a single document and write two additional, but proper documents allowing for the carrying out of an approriate project.

Further, as to form, no proper archeological report relative to the alternatives proposed appears in the EIS part of the document. Since this area has been declared eligible for inclusion on the National Register of Historic Places as a cultural complex this would seem essential. The various charts, within the document ascribe evaluations of impact without full supporting evidence. The letter from an archeologist appearing in the appendix does not draw on the large body of pertinent recognized scientific work done in this area as is required in a scientifically oriented archeological report for a draft EIS. Since this draft document is being circulated, presumably to satisfy the requirement for the assessment of such impact by others, it unfortunately falls short of its mission in this regard.

The NED process under which the proposed project is being carried out calls for "federal environmental protection pursuant to national environment statutes". Unfortunately, therefore, it is necessary that we question this document as a valid one to pursue the flood control needs of Kai'lua. In this regard, we call for a public workshop to be held as soon as possible. In that forum, it seems appropriate that consideration of the EIS portion of the document he made to appraise its consistency with NEPA regarding the "productive harmony" that each alternative creates. Also, two aspects of this document, among others, that relate to this requirement will be cited below.

The highlighting of the philosophy that "the best flood control solution be one which is independent of future conditions in the Marsh" certainly does not seem to be one consistent with the "productive harmony" requirement. The document seems to be based upon an assumption that the area is an "imponderable" one, the term used by a representative of the federal agency responsible for flood control in discussing the project. It is stated in the document that it is not necessary to limit the expertise used for this project to that available within the agency. Therefore, it is suggested that appropriate expertise be sought elsewhere to assist in expeditiously getting on with the augmentation of the existing flood control project based upon necessary understanding of the area. To ignore the conditions as they are and estimated to be could place the entire project in jeopardy.

Specific concern, in this regard, is raised that the assumption seemingly used for the purpose of this project, that current insiltation rates for the flood storage basin may be gleaned by averaging the accumulation of the last 6,000 years, needs to be evaluated. The document states under "Existing Hydrolic Conditions, that the "Annual project condition surveys have indicated that the City and County has maintained the outlet channel and levee in an acceptable manner", however nothing is mentioned about their efforts to control proliferation of vegetation and insiltation through their own projects and others for which they have permitted. As a member of the state's Ka'wai Nui Technical and Policy Advisory Committee, I, and other members, questioned at length the Committee respresentative from the responsible federal agency for flood control about the current capacity and we were assured that the infilling of the basin was not jeopardizing its soundness. In the light of the 1988 flood the proposed augmented project will need new assessments made on sound scientific methodology to apply to all of the alternative proposals. As was suggested earlier, it is not possible to ignore what is happening to the bottom of the basin in calulating flood storage capacity even as one may be trying to raise the sides of the basin to assure capacity. To deal only with the present surface of the water as the starting point for measuring future capacity seems imprudent for all alternative proposals.

In the light of the NED objective of "increasing the value of the nation's output of goods and services and improving national economic efficiency", as well as the "productive harmony" NEPA requirement, it is disappointing that the "preferred alternative" does not seem to be in concert with the State of Hawaii's Ka'wai Nui Resource Management Plan to which both sponsoring agencies to this document signed off. Nor does this alternative seem to satisfy the above mentioned NED objective since the federal government funded, through their Coastal Zone Management program, the State's Plan, and yet there seems to be no consideration of coordinating with the Plan. As to a statement in the document that the nesting islands referred to in that Plan are not longer under consideration, presumably placed there to show that the Marsh Clearing alternative would not be consistent with the implementation of the Plan -I could find no substanciation of that position.

It is regrettable that the proposed augmentation of the flood control project misses the opportunity afforded, in the interest of national efficiency, to enhance the resource to which the national government has so generously contributed and as called for in its mandate. Perhaps the re-evaluation of the cost/benefit considerations at the time of the requested public workshop can rectify this situation so that such enhancement will be included, along with questions being raised by others regarding the cost/benefit portion of your evaluations.

So too would the aesthetic component input to the cost/ benefit considerations be beneficial. The negative aspects of the "preferred alternative" in this regard would certainly be a cost. The Lani-Kailua Outdoor Circle has committed a great deal of time, energy and much of its resources to enhance this and other aspects of Ka'wai Nui Marsh. We hope that our request, most respectfully submitted, for reconsideration of the document through a public workshop, to be held a soon as possible, will assist you in your efforts to provide, a sound flood protection plan expeditiously.

Yours very truly,

Sandra Braun

Sandra Braun
for Hope Miller, Representative,
The Lani-Kailua Outdoor Circle

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

REPLY TO
ATTENTION OF:

JUL 2 3 1992

Planning Division

Ms. Sandra Braun (For Hope Miller)
The Lani-Kailua Outdoor Circle
P.O. Box 261
Kailua, Hawaii 96734

Dear Ms. Braun:

Thank you for your letter dated June 21, 1991 regarding the Draft Detailed Project Report and Environmental Impact Statement for the Kawainui Marsh Flood Control Project.

Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select an agency preferred alternative.

The style and format follow Corps reporting requirements as well as State and Federal EIS requirements. It is a combined Detailed Project Report and DEIS under one cover in conformance with the Corps planning guidance (Engineering Regulation 1105-2-100). The Environmental Protection Agency (EPA) review of our document indicated no difficulty with the format since they are familiar with our regulation.

We state in several locations throughout the document that no preferred alternative has been selected. We are required to identify and recommend the National Economic Development Plan (NED) which maximizes the net flood control benefits and provides the necessary flood protection. However, provisions are available for selecting a different plan if approved by the Assistant Secretary of the Army for Civil Works. The concrete floodwall has received negative reaction from the community.

Consequently, after considering engineering, environmental, and economic factors, as well as agency and public input, the Corps and the City and County of Honolulu have selected a modification to the NED plan which combines the earth levee raise with a much lower floodwall and fills less than two acres of wetland. The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side. We shall seek the necessary approval and develop compensatory wetland mitigation to include restoration of fastland in the marsh near the levee to new wetland habitat.

The draft archaeological report which is summarized in the DEIS appendix is available in final form.

We have evaluated alternatives and identified, with public and agency input, a federally implementable solution for flood protection at Kawainui Marsh. During our study, we have held two public meetings, two public workshops, and nine ad hoc committee meetings. Therefore, we do not plan to hold an additional public workshop.

Flood protection must be provided regardless of future conditions in the marsh. The dense floating mat of vegetation has evolved over the years and now serves to impede flood waters before they are discharged into the ocean. A levee raise is the only alternative that meets Corps criteria for engineering, economic and environmental factors because of: 1) high construction, disposal, and maintenance costs associated with vegetation removal; 2) concerns that the floating mat will block exit channels during a flood and render ineffective any flood control benefits; and 3) inability to identify how much vegetation can be safely removed without jeopardizing the cleansing capability of the marsh.

We have not ignored the bottom of the basin and the issue of sedimentation. The resultant loss of water storage in the wetland due to accelerated sedimentation has been evaluated with respect to the long term effectiveness of the Kawainui Marsh flood control project. The rate of sedimentation differs throughout the marsh but an average figure of 0.3 feet/10 years has been calculated and is consistent with most other estimates of sedimentation rates. At this rate, the flood control project will not be compromised during its life expectancy. However, sedimentation should be controlled to prolong the life of the marsh and we have made recommendations in our final document regarding the control of non-point sources of pollution.

We believe that the preferred alternative will be aesthetically acceptable and will conform with both the Kawainui Marsh Resource Management Plan and the State Coastal Zone Management (CZM) Program as evidenced by our CZM Consistency

Statement in the environmental appendix. We have no authority to undertake the resource enhancement that you request in this study. However, the selected flood control plan will not foreclose other measures for resource enhancement. We will continue our attempts to obtain funds under other authorities for environmental projects in the marsh.

Thank you for your comments and suggestions. I hope that I have addressed them to your satisfaction.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

TO: Mayor Frank Fasi, c/o Dept. of General Planning
U.S. Army Corps of Engineers
Director, Department of Public

From: Carol Wilcox
111 Royal Circle
Honolulu, HI 96816

Re: Kawainui Marsh Flood Control

Date: June 22, 1991

Comments on Kawainui Marsh Flood Control
Draft Environmental Statement

I appreciate the opportunity to comment on this EIS, especially since it is prior to the selection of a preferred alterative. I would like to urge the selection of alternative four, i.e., 4) construct meandering waterways connected to Oneawa Channel by way of a water control structure. This is the only alternative which has environment and habitat enhancement built into the goal of flood control.

The opportunity to enhance this extremely important marsh, if implemented, will not only affect the immediate project site, but will improve instream habitat and water quality both up and down stream of Manawili stream, will enhance the public's enjoyment, and will protect important water quality of water entering Kailua bay, an important recreation area.

The entire Manawili system, from mountain to Kailua Bay, will depend on what happens at Kawainui Marsh. Cost should not be the prevailing consideration in selection of alterative. The long term economic benefits to be gained by a good environmental solution will far outweigh the more immediate cost.

Carol Wilcox

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 23 1992

REPLY TO ATTENTION OF:

Planning Division

Ms. Carol Wilcox
111 Royal Circle
Honolulu, Hawaii 96816

Dear Ms. Wilcox:

I am responding to your letter to Mayor Frank Fasi dated June 22, 1991 regarding the Kawainui Marsh Flood Control Project and note your interest in the marsh clearing alternative.

Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

We agree with you that habitat improvement and creation of open water are desirable and have spent the last year intensively evaluating all possible approaches to provide flood control that might also provide ecological and recreational benefits. However, the in-marsh alternatives which were evaluated in the draft do not meet prescribed engineering, economic or environmental criteria for flood control for the following reasons:

a. We have been unable to identify how much vegetation can be safely removed from the marsh without jeopardizing the existing filtering capacity of the marsh vegetation for the protection of the marine receiving waters.

b. A direct connection of open water channels in the marsh to the Oneawa Channel is required to attain significant flood control improvements. This connection brings the risk of increasing sediment runoff and bacterial contamination into Kailua Bay during periods of heavy rainfall as well as other possible ecological changes to the marsh.

c. There are concerns that the floating mat of vegetation may move as occurred in the 1988 flood and block the channels during a flood.

d. There are very high construction, disposal, and maintenance costs associated with vegetation removal making in-marsh work substantially more expensive than other alternatives and economically infeasible.

Although the Corps is required to identify and recommend the National Economic Development Plan (NED), provisions are available for selecting a different plan if approved by the Assistant Secretary of the Army for Civil Works. After consideration of engineering, environmental, and economic factors as well as agency and public input, the Corps along with the City and County of Honolulu have selected a modification to the NED plan as the preferred alternative. It combines the earth levee raise with a much lower floodwall and fills less than two acres of wetland. The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side. We shall seek the necessary approval and develop compensatory wetland mitigation to include restoration of fastland in the marsh near the levee to new wetland habitat.

We believe that the preferred alternative will be acceptable to the public and provide the needed flood protection for Coconut Grove. We will continue to seek other funding authorities to permit our involvement in wildlife enhancement projects in the marsh. Thank you for your input.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

June 21, 1991

Commander
Honolulu Engineer District
ATTN: CEPOD-ED-PV
Fort Shafter, HI 96858-5440

Commander,

Like many others, we were victims of the 1988 New Year's flood so it was with great interest that we attended the May 29th Public Meeting regarding the fate of Kawainui Marsh. However, we were very disturbed by the flood control plans that were presented.

We were most disturbed by those plans that called for increasing the height of the existing levee, whether by adding more earth, or, heaven forbid, a brick wall!

We have spoken with several of our neighbors and we all agree that a better plan would be to clear out the Marsh itself and leave the levee as it is. Adding to the levee seems a band-aid solution at best. Let's treat the disease not the symptoms.

Also, is it really necessary to destroy one of the most serenely beautiful views left on this crowded island? Building up the levee would do this. We would rather endure another flood ~~than~~ than see that happen. After all, material possessions can always be replaced – natural beauty can't.

Thank you,

Mr. + Mrs. James Kalawa
285-C Kihapai St.
Kailua, HI 96734

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 23 1992

REPLY TO
ATTENTION OF:

Planning Division

Mr. and Mrs. James Kalawa
285-C Kihapai Street
Kailua, Hawaii 96734

Dear Mr. and Mrs. Kalawa:

Thank you for your comments on the Kawainui Marsh Flood Control Project in your letter dated June 21, 1991. Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

We appreciate your interest in a flood control solution other than a levee raise. We have intensively evaluated possible approaches to flood control that might also provide ecological and recreational benefits to the marsh. We have no authority to undertake the resource enhancement that you request in this study. However, the selected flood control plan will not foreclose other measures for resource enhancement, although such measures must be compatible with the flood control function of the marsh.

Corps analyses, indicates that the environmental impacts associated with vegetation clearing and direct linkage of open water channels with Oneawa Channel would be significant. Sediment loss into Kailua Bay, loss of filtration by the marsh of waters emanating from the upper watershed, high construction, disposal and maintenance costs, potential movement of the floating mat, and future unknown conditions of the marsh were just some of the major concerns preventing our reliance on any in-marsh flood control solution.

Engineering, economic and environmental concerns have forced us to reject in-marsh alternatives for the following reasons:

a. We and our consultants have been unable to identify how much vegetation can be safely removed from the marsh without jeopardizing the existing filtering capacity of the marsh vegetation for protection of the marine receiving waters.

b. A direct connection of open water channels in the marsh to the Oneawa channel is required to attain any significant flood control but brings the risk of increasing sediment runoff into Kailua Bay during periods of heavy rainfall as well as other possible ecological changes to the marsh. Note that even with the marsh clearing alternative, the levee must be raised.

c. There are concerns that the floating mat of vegetation may move as occurred in the 1988 flood and block channels during a flood.

d. There are very high construction, disposal, and maintenance costs associated with vegetation removal making in-marsh work substantially more expensive and economically infeasible.

After careful consideration of these and other factors, as well as agency and public input, the Corps and its local sponsor the City and County of Honolulu have selected a modification to the NED plan which reduces the height of the floodwall and fills less wetland than an earthen levee raise would fill. The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side. Compensatory wetland mitigation will include the restoration of previously filled wetland on the marsh side of the levee near the Oneawa Channel.

Thank you for your interest and suggestions.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Centers for Disease Control
Atlanta GA 30333

July 30, 1991

Kisuk Cheung
Director of Engineering
U.S. Army Engineer District, Honolulu
Building 230
Ft Shafter, Hawaii 96858-5440

Dear Mr. Cheung:

We have completed our review of the Draft Environmental Impact Statement (DEIS) for Kawainui Marsh Flood Control Project. We are responding on behalf of the U.S. Public Health Service.

We have reviewed the Draft EIS for potential adverse impacts on human health. On page 28 mosquitoes are identified as a health concern, but it is stated that various hardy species of mosquito fishes found in the marsh "normally" control mosquito populations. It is unclear as to the extent of current mosquito problems in the area, including the concern for vector-borne diseases. We suggest that the Final EIS indicate if there is a current problem or not, who has responsibility for mitigation if the need were to arise, and if any of the alternatives would have adverse public health impacts in regard to mosquito populations.

Although Kawainui Marsh currently is not considered a "hot spot" for Leptospirosis due to a lack of recreational activity, this situation potentially could change in the future since Leptospirosis is apparently prevalent in the study area. The DEIS fails to indicate if residents in the area have been informed of the potential risks in the Marsh and proper mitigation. When a Preferred Alternative is identified in the Final EIS, any potential increases in recreational activity should be examined for potential impact regarding this disease.

Thank you for the opportunity to review and comment on this document, and for including us on your mailing list to receive a copy of the Final EIS, and future EIS's which may indicate potential public health impact and are developed under the National Environmental Policy Act (NEPA).

Sincerely yours,

Kenneth W. Holt

Kenneth W. Holt, M.S.E.H.
Special Programs Group (F29)
National Center for Environmental
Health and Injury Control

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 23 1992

REPLY TO ATTENTION OF:

Planning Division

Dr. Kenneth W. Holt, M.S.E.H.
Special Programs Group (F29)
National Center for Environmental
Health and Injury Control
Centers for Disease Control
Atlanta, Georgia 30333

Dear Dr. Holt:

Thank you for your letter dated July 30, 1991 with comments on the Kawainui Marsh Flood Control Project. We understand you are responding on behalf of the U.S. Public Health Service. Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

At this time, we are recommending a modification to the existing flood control levee through a combination earthen fill and floodwall. No marsh dredging other than that associated with the local sponsor's activities are anticipated. We do not believe that our project will have an impact on the mosquito population in the marsh or the potential for increased exposure to the Leptospirosis bacterium to the public.

Thank you for your review of our document.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

ANDREW CHARLES YANOVIAK • AIA • ARCHITECT
ENVIRONMENTAL SYSTEMS PLANNING • URBAN DESIGN CONSULTATION

22 June 1991

Commander, Honolulu Engineer District
ATTN: CEPOD-ED-PV
Corps of Engineers
U. S. Department of the Army
Fort Shafter
Honolulu, Hawaii 96858-5440

Re: Kawainui Marsh Flood Control Project / Kailua, Oahu, Hawaii

Ladies and Gentlemen:

In accordance with your request, I am hereby submitting written testimony in addition to the verbal comments made at two public hearings and in private meetings with your Planning Division staff on the above referenced matter.

First of all, I would like to Thank You for allowing Colonel Donald T. Wynn, project planner Jim Pennaz and environmental planner Margo Stahl to make public presentations, and respond to the extent of their capabilities with an 'open-minded' approach to several questions and comments.

As you undoubtedly are well aware, the U.S. Army Corps of Engineers does not have the best reputation for preserving or conserving our natural environmental resources. This is especially true with 'wetlands', and there have been several articles in the past few years about the negative aspects of irreparable harm and injury caused primarily by their inept actions.

Community and widespread government participation in the above referenced matter has been extremely limited, and I would hope that the U.S. Army Corps of Engineers would reconsider their current position that two public hearings are sufficient. For example, a private organization

CENTURY SQUARE/SUITE 3011 • 1188 BISHOP STREET • HONOLULU • HAWAII • 96813
CABLE ADDRESS YANOPLAN • (808) 545-7592/(808) 533-4158
CHARTER MEMBER BUCKMINSTER FULLER FOUNDATION

Commander, Honolulu Engineer District
ATTN: CEPOD-ED-PV
Corps of Engineers
U. S. Department of the Army

Re: Kawainui Marsh Flood Control Project / Kailua, Oahu, Hawaii

known as 'Ducks Unlimited' will be making another presentation in Kaneohe, Hawaii before the end of June 1991; however, the Corps appears to be ignoring their input and potential impact on Kawainui Marsh.

Apparently, the Kaneohe Ranch (Castle Estates) and the State Department of Land and Natural Resources (DLNR) Fish and Wildlife Division has been working very closely with 'Ducks Unlimited' on the restoration, preservation, conservation, and revitalization of Hamakua Marsh which abounds Kawainui Marsh and was once a part of it, as well as Kaelepulu Stream, Pond, and Wetlands. The recent 'Ducks Unlimited' slide show presentation before the Kailua Community Council of 'before-and-after' unhealthy and devastated wetlands and wetland areas that were restored and revitalized by their organization in naturally nurturing them back to their original more healthy state (without employing massive man-made engineering structures) was quite impressive. The DLNR reportedly has also been able to preserve and conserve major wetland areas throughout the State of Hawaii in an environmentally sensitive manner, without resorting to destructive measures and major engineering structures.

Kawainui Marsh is the largest, most precious, and most fragile wetland in the entire State of Hawaii; and, it requires very special treatment and a very special approach to keep it alive, healthy and well. Landscape architect-planner-ecologist Ian McHarg, author of 'Design with Nature', very clearly presents the vital and essential interdependent interrelationships between wetlands and bays, sand dunes, vegetation, trees, grasses, inland streams, ponds, surface hydrology, subsurface

Commander, Honolulu Engineer District
ATTN: CEPOD-ED-PV
Corps of Engineers
U. S. Department of the Army

Re: Kawainui Marsh Flood Control Project / Kailua, Oahu, Hawaii

geology, etc.; yet, the Corps of Engineers has admittedly omitted many of these very important factors and elements in their 'Kawainui Marsh Flood Control Project: Detailed Project Report and Environmental Impact Statement' (Draft/April 1991).

According to Colonel Wynn, the Corps of Engineers is only addressing 'flood control' and not 'environmental control' of Kawainui Marsh. This particular approach is, in and of itself, fundamentally flawed and therefore has a very high probability of potentially being environmentally disastrous to not only Kawainui Marsh, but also to Kailua Bay, Kaelepulu Stream, etc.

The City and State Governments look up to the Federal Government for greater resources of knowledge and experience as well as funds to handle large scale environmental planning projects. Kawainui Marsh may very well be beyond the in-house capabilities of the City, State, and the U.S. Army Corps of Engineers, National Park Service, Soils Conservation Service of the Department of Agriculture, etc. Kawainui Marsh may require a concerted approach of government agencies and private ecological and environmental systems planning consultants on an unprecedented scale of development. Just taking one design element alone, the hydrological sheet flow analysis of the Koolau watershed affecting Kawainui Marsh and Kailua Bay, the Corps Draft (April 1991) is seriously flawed. No consideration whatsoever is given to the Kapaa Valley watershed and Kapaa and other streams, the Kalaheo Hillsides, Kaelepulu Stream, etc. No consideration whatsoever is given to the current massive destruction of Maunawili Stream and the five streams and ten tributaries that feed it, as a direct consequence of the permitted Royal

Commander, Honolulu Engineer District
ATTN: CEPOD-ED-PV
Corps of Engineers
U. S. Department of the Army

Re: Kawainui Marsh Flood Control Project / Kailua, Oahu, Hawaii

Hawaiian Golf Course developments. No consideration whatsoever, was given to the removal of the existing 'dike road earthen dam' and the reconnection of the Kaelepulu Stream with the Kawainui Marsh, which undoubtedly triggered the irreversible effects we are currently witnessing and attempting to respond to with a fair degree of exhibited incompetence.

Kawainui Marsh wants to be an absorbant and swelling 'sponge' type 'wetlands' environment in conjunction with its vital linkage support systems with Kailua Bay, Maunawili Valley, Kapaa Valley, Mount Olomana, etc. Common sense dictates that no 'sponge' type marsh mat will be created or enhanced by channelizing, fragmenting, or desecrating the 'wetlands' further. By virtue of the current joint actions of the City, State, and Federal Governments, Kawainui Marsh is currently being transformed in a rapid manner, from a 'wetland' environment into an unsightly 'wooded bog'.

Major environmental systems planning projects such as dealing effectively with the vitality of Kawainui Marsh and its surrounding environs, will undoubtedly require innovation and creativity in problem-solving. For example, the reef runway at the Honolulu International Airport would not have been possible without the 'tetrapod'. The fundamental design problem at Kawainui Marsh is how to convert what has essentially become a 'hardpan' mat, into an absorbant and swelling macromolecular sponge. Rarely, if ever, have 'wetlands' in recent years been converted into flood zones or ponding basins. Normally, excessive hydrological sheet flow storm waters that are being shed and unabsorbed in urbanized mountainous terrain, are collected in ponding and siltation basis before they are permitted to enter marshes or 'wetlands'.

One of the major fallacies with the study and publication sponsored by the U.S. Army Corps of Engineers for the 'Kawainui Marsh Flood Control Project' (Draft/April 1991), is that only alternative 'courses of action' are listed for preferential review and comment and eventual selection. There has been no attempt whatsoever, to list, define, and analyze exactly what the environmental systems problems are, that are begging for real comprehensive solutions to complex problems. As many community and government agency members realized and expressed, some of the alternatives are problematic and will in fact, create worse problems for the Kawainui Marsh, the Koolau Watershed, the Kaelepulu Stream, and the Kailua Bay water and marine life quality.

It is highly recommended that this particular study be reinitiated in the proper manner with the best ecological consultants available. A viable approach that is currently being taken on the U. S. mainland is to employ environmental systems planners and landscape architect-planner ecologists to determine what nature is doing along its vital circulation 'life-lines' and how much space it needs in unbuilt buffer zones and greenbelts to accomplish its mission. In this manner, a win-win-win situation is created for government, community, and private enterprise with planned use developments located in organized fashion, to provide and nurture healthy, natural environments.

Once the real problems are stated for Kawainui Marsh and its surrounding environs, they can be prioritized and analyzed accordingly.

Also, once solutions are offered for community and government agency consideration and input, an evaluation matrix should be prepared listing all of the decision-making variables. These actions would facilitate informed and constructive contributions to community planning.

In addition to the individual maps in the April 1991 Draft EIS and Detailed Project Report prepared by the Corps, there should be a composite overlay map with an appropriate legend. This would present a comparative analysis of the different boundary conditions illustrated for the land-use, zoning, 100-year inundation limits, various flood levels for different proposed plans, vegetation limits, etc. This approach would delineate sensible density limits and boundary conditions for man-made developments and buffer zones on the fringe of the Kawainui Marsh.

In the event that some or all of the existing residences in the Coconut Grove area of Kailua are misplaced, then the Corps of Engineers should take appropriate actions to condemn, remove, replace, reconstruct, etc. as necessary, as they have done in other mainland areas where they have constructed dams or participated in stream or lake conservation projects.

In the event that you have any questions on any of the above review comments, please do not hesitate to contact me. Thank You again, for the opportunity to participate in this very important environmental planning project for the Kailua Community. Aloha,

Andrew C. Yanoviak, AIA, CSI

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 23 1992

REPLY TO ATTENTION OF:

Planning Division

Mr. Andrew Charles Yanoviak
Architect
Environmental Systems Planning
1188 Bishop Street
Honolulu, Hawaii 96813

Dear Mr. Yanoviak:

Thank you for providing testimony and written comments regarding the Kawainui Marsh Flood Control Project. I am responding to your letter dated June 22, 1991. Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

The Army Corps of Engineers has been entrusted with protection of our nation's waterways which include wetlands. Much has been learned over the years regarding the values of wetlands by scientists and engineers both within and outside of the Corps.

We appreciate your interest in another public workshop but do not feel that it would contribute substantially to the NEPA process. We see no reason to repeat the study process when we have evaluated alternatives and clearly identified, with public and agency input, a federally implementable solution for flood protection at Kawainui Marsh. Thus far we have held two public meetings, two public workshops, and nine ad hoc committee meetings. Some of my staff have also participated in your own meetings of Save Mount Olomana to discuss Kawainui Marsh.

We are familiar with the good efforts of Ducks Unlimited and hope that they might provide some assistance in creating open water habitat in the marsh. As you know, Kawainui Marsh has evolved a dense floating mat of vegetation over the years which now serves to impede and filter flood waters before they are discharged into the ocean. We have determined that a levee raise is the only alternative that meets Corps criteria for engineering, economic and environmental factors because of: 1) high construction, disposal, and maintenance costs associated

with vegetation removal; 2) concerns that the floating mat will block exit channels during a flood and render ineffective any flood control benefits; and 3) inability to identify how much vegetation can be safely removed without jeopardizing the cleansing ability of the marsh. All these concerns contribute to our reluctance to rely on marsh channels to protect the residents of Coconut Grove over many years. We are seeking other authorities and funding independent of the flood control solution to assist in the creation of open water in the marsh which we concur is essential to improving wildlife habitat.

Our authority under Section 205 of the Flood Control Act of 1948, as amended, restricts us to flood control only. We have sought funds under Section 1135 of the Water Resources Development Act (1986) for environmental enhancement of the marsh's wildlife. Unfortunately, we were denied such funding. We will continue to pursue other authorities for funding environmental enhancement projects, perhaps in concert with Ducks Unlimited.

Land use decisions surrounding the marsh are outside Corps jurisdiction. Our analysis for flood control purposes however, indicates that current and anticipated watershed development will not pose any threat to our flood control project. Nevertheless, we agree that the water quality of the streams that feed into the marsh require improved non-point source pollution controls to protect Kawainui Marsh and prolong its life as a marsh.

We also agree that channelizing the marsh will violate the "sponge" mat that has been serving to filter floodwaters emanating in the watershed before they reach the receiving waters of Kailua Bay.

The composite map you recommend has been considered but due to the complexity evident in the other maps, we believe that a single map depicting all of the various analyses would be too difficult to decipher.

Floodproofing rather than condemnation was considered as an alternative. However, costs associated with dislocating people for temporary or permanent periods of time far outweigh any flood control benefits compared with other flood control solutions. A modification to the existing levee which lowers the height of a proposed floodwall and reduces the amount of wetland fill appears to be the most expedient method of providing the necessary protection and the most environmentally benign as well.

Thank you again for your interest and involvement in a solution to the flooding problems in Coconut Grove.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

June 21, 1991

Lieutenant Colonel Donald T. Wynn
Honolulu District Engineer
U.S. Army Corps of Engineers
CEPOD-ED-PV
Building 230
Fort Shafter, Hawaii 96858

Dear Colonel Wynn:

The Environmental Protection Agency (EPA) has reviewed the Draft Environmental Impact Statement (DEIS) for the Kawainui Marsh Flood Control Project, Kailua, Island of Oahu, Hawaii. Our comments on this DEIS are provided pursuant to EPA's responsibilities under the National Environmental Policy Act (NEPA); the Council on Environmental Quality's Regulations for Implementing NEPA (40 CFR 1500-1508); and Section 309 of the Clean Air Act.

The DEIS identifies the need to develop and implement flood control measures in and/or adjacent to Kawainui Marsh to enhance flood protection for residents of the Coconut Grove Subdivision. Within the EIS framework, seven alternatives, including no action, are identified and discussed. In addition, several other alternatives were initially considered and not carried forward for various reasons. A preferred Alternative was not identified. Since this is a Corps of Engineers Project, there will be no formal Section 404 permit application, although the DEIS does attach a "Section 404(b)(1) Factual Determination". The attached comments are a consolidation of those prepared by several EPA reviewers.

On November 15, 1988, our office, as a result of our review of the Notice of Intent (NOI) to prepare this EIS, provided comments which offered initial recommendations to those preparing the document. Although a portion of our recommendations were incorporated, many were not. This is reflected in our finding that the DEIS generally continues to lack the specificity necessary to conduct thorough side by side evaluations of the alternatives presented. Inasmuch as a preferred alternative was not identified, we must rate each of the alternatives individually. The following is a synopsis of our individual ratings:

Raise Levee Alternative:	EC-2
Floodwall Alternative:	EC-2
Marsh Clearing Alternative:	EC-2
Quarry Road Channel Alternative:	EC-2
Back Levee Alternative:	EC-2
Flood Proofing Alternative:	LO-2

An EC-2 rating reflects the reviewers concerns that there may be potential environmental impacts associated with a specific proposal which should be avoided either through application of mitigation measures or modifications to the proposal. The rating also indicates that the DEIS does not contain sufficient information for EPA to fully assess those potential impacts. Within the information framework provided in the DEIS, note that all of the flood control alternatives, except the flood proofing proposal have been rated as having environmental concerns. For the most part, those concerns involve sediment contaminants, wildlife, wetland fill, and marsh dynamics, although there are other alternative-specific concerns as indicated in our detailed comments. We have rated the flood proofing alternative, again within the information base provided, as Lack of Objection (not having significant impacts). As indicated by the numeric figure in the rating however, this alternative also does not contain sufficient information for a complete review. Attached is a more detailed summary of EPA's rating definitions.

We suggest that your NEPA efforts be focused on fully developing the range of flood control alternatives within the context of our comments, and establish a position for recommending a preferred course of action to your decisionmakers. In addition, while further refining the alternatives we encourage you to closely examine marsh nutrient and sediment loading and make every effort to incorporate actions to minimize such loading into your ultimate plans for flood control to the maximum extent possible.

We appreciate the opportunity to review this DEIS. Please send three copies of the FEIS to this office at the same time that it is filed with our Washington, D.C. headquarters. If you have any questions, please do not hesitate to contact me at 415-744-1510, or your staff may contact Mr. David Farrel at 415-744-1574.

Sincerely,

Deanna M. Wieman
Director, Office of External Affairs

Enclosures

cc: City & County of Honolulu,
Department of General Planning

City & County of Honolulu,
Department of Public Works

USFWS, Honolulu

National Marine Fisheries Service, Honolulu

SUMMARY OF RATING DEFINITIONS AND FOLLOW-UP ACTION

Environmental Impact of the Action

LO—Lack of Objections
The EPA review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

EC—Environmental Concerns
The EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferre alternative or application of mitigation measures that can reduce the environmental imp EPA would like to work with the lead agency to reduce these impacts.

EO—Environmental Objections
The EPA review has identified significant environmental impacts that must be avoided in order to provide adequate protection for the environment. Corrective measures may requ substantial changes to the preferred alternative or consideration of some other project alternative (including the no action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

EU—Environmentally Unsatisfactory
The EPA review has identified adverse environmental impacts that are of sufficient magn tude that they are unsatisfactory from the standpoint of environmental quality, public health or welfare. EPA intends to work with the lead agency to reduce these impacts. I the potential unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the Council on Environmental Quality (CEQ).

Adequacy of the Impact Statement

Category 1—Adequate
EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project action. No further analysis or data collection is necessary, but the reviewer may sugg the addition of clarifying language or information.

Category 2—Insufficient Information

The draft EIS does not contain sufficient information for EPA to fully assess environmer impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectr of alternatives analyzed in the draft EIS, which could reduce the environmental impacts the action. The identified additional information, data, analyses, or discussion shoulc included in the final EIS.

Category 3—Inadequate
EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analyzed in the draft EIS, which should be analyzed in order to reduce the potentially significant envir mental impacts. EPA believes that the identified additional information, data, analyses discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the NEPA and/or Section 309 review, and thus should be formally revised and made available for pu comment in a supplemental or revised draft EIS. On the basis of the potential significa impacts involved, this proposal could be a candidate for referral to the CEQ.

*From: EPA Manual 1640, "Policy and Procedures for the Review of Federal Actions Impacti the Environment."

EPA REGION 9 COMMENTS ON KAWAINUI MARSH FLOOD CONTROL PROJECT DEIS

GENERAL COMMENTS:

POLICY

Cumulative impacts of all proposed actions (both federal and non-federal) need to be defined. How will impacts identified in DEIS be affected by the City and County of Honolulu's Kawainui Marsh Drainage Improvement Project, i.e., cumulative disturbance to wildlife, deterioration of water quality, sediment loading, use of herbicides, etc. If projects are to be conducted subsequent to one another, duration and extent of impacts should be discussed as the projects relate to one another. Reference 40 CFR 1508.25.
Much of the discussion throughout the DEIS is presented with incomplete or unavailable information, which precludes an effective evaluation of alternatives. This issue falls under the purveyance of 40 CFR 1502.22. Much more information should have been discussed in the DEIS and, in our opinion, must be discussed in detail in the FEIS for the decisionmaker to have a basis for appropriate decisionmaking.

Options within alternatives are presented to the reader throughout the document. This is good, as long as each option is discussed in sufficient detail for the reader to evaluate that alternative on its own merits. If this type of presentation is used, it would be advantageous to the reader to have a matrix depicting each major project proposal (alternative) with each optional action within the proposal cross-referenced with impacts. Without a more definitive set of proposals, the discussion becomes open-ended with respect to evaluating alternatives. Another, albeit more cumbersome, way to present such a set, would be to expand the list of alternatives incorporating each single optional action as one distinct alternative. For instance, your EIS identifies a Marsh Clearing Alternative. Within that Alternative there exist several optional actions, e.g., dispose dredged material at an upland site; dispose of the material in other areas of the wetland, etc. These could be presented as distinct alternatives, each describing in sufficient detail the range of impacts, etc., allowing the decisionmakers to be more precise in their evaluation and selection of an appropriate alternative.

WILDLIFE

We recommend close coordination with USFWS throughout development of FEIS and during life of project. As noted in the FWS letter, dated July 12, 1990, additional consultation may be required as scope of proposals become more clearly defined. This also suggests that FWS proposals do need to be more clearly defined with enhanced specificity.

The discussion on p. 49 includes the statement that "adjustments to water levels in the marsh pose some risk of botulism to the avian population of ducks". Expand this statement by being more specific about cause-effect and what you propose to do to minimize problems as they relate to the flood control proposals.

The DEIS on p. 54 suggests that "the greatest significant impact of a flood control project on the waterbirds of Kawainui would take place if draining of the marsh occurred". Explain the implication here...are there plans to drain the marsh in association with these proposals?

The discussion on p. 56 includes mention of "treating plant problems with grass carp or white amur" but notes that the fish could be viewed as a "biological hazard". Please define "biological hazard" in the context of your discussion. Is this discussion speculative or are you actually considering introducing these fish as part of the proposed "marsh maintenance"? Please clarify and expand discussion to fully identify potential impacts of both the plant problems and plant management alternatives.

SEDIMENTS

On p. 1 the DEIS states, "accumulating sediments have displaced approximately 400 acre-feet of flood storage capacity of the marsh since its construction". We suggest, for longevity of flood control, your proposal include an evaluation of sediment transport into the marsh in conjunction with the National Pollution Discharge Elimination System (NPDES) stormwater permit requirements for the City and County of Honolulu and with the Best Management Practices (BMP) requirements of the Hawaii Department of Health Nonpoint Source (NPS) program. This should include proposals to minimize sedimentation, even though the DEIS suggests that vegetative decay contributes substantially to the sediment load in the marsh. Refer also to our related comments on vegetation.

Given any of the alternatives, how long would it be before sedimentation becomes a problem to the same degree it is now? That is, will reoccurring removal of sediments still be required to make these flood control alternatives effective in the long term?

The discussion on p. 25 suggests that construction of a golf course in Maunawili Valley would increase volume of water runoff in a 100 year event less that 10 acre-ft...which you consider insignificant (in terms of the total 7600 acre-ft predicted inflow). Although this may appear insignificant in relative terms, how significant is it in terms of increasing flood related impacts to residents of Coconut Grove? What about sedimentation over time? How would such projects diminish the effectiveness of the flood control proposals over time? Your discussion also includes a second golf course option.Is such an option being proposed? Are there other proposals which would increase the volume of sedimentation? These should be detailed and presented in terms of probable impacts to flood prone residents.

We recommend that a "sediment budget" be calculated to support your contention regarding non-retention of sediment from upland sources. The suggestion that "sediment passes through the marsh and into Kailua Bay" on p. 29 does not mesh completely with your statement on p. 43 that "very little deposit of sediments has been documented at the mouth of Oneawa Canal as it enters Kailua Bay", nor with your statement on p. 54 which suggests "heavy sediment runoff during flooding events". Please clarify.

Without actual data concerning heavy metals, we cannot provide specific substantive comments on impacts, etc. We suggest this important information be appended to FEIS and discussed in more detail within the body of the document. This information is also important in deciding disposal methods for several alternatives. The DEIS advises, on p. 30 that "the toxicity of these metals is not very great in normal aquatic environments and only become released and available for absorption in acidic environments". Please relate the Kawainui Marsh to a "normal" aquatic environment and, inasmuch as you imply that areas of the marsh are low in pH, identify which metals are now being released and project anticipated release levels given sediment disruption from channelization etc. Also include a discussion of anticipated impacts to the ecosystem which would result from such releases and describe the mitigation measures you would employ to minimize the release of metals.

Without specific heavy metals data, it is questionable whether soils and vegetation containing heavy metals should be used as a landfill and/or a cover for a closed landfill (as proposed on p. 37), given that digestion (decomposition) of the vegetation would result in acidic conditions which could accelerate release of heavy metals from the disposed soils. This scenario needs more evaluation and discussion in FEIS, if it is to be considered. What would be done to minimize/curtail release of metals?

Disposal of sediments which could contain heavy metals in "selected wetland areas that are determined less valuable habitat", as described on p. 47, should not be considered mitigation. As your definition suggests, these metals could leach out and find their way back into "valuable habitat" areas. We suggest you reform the definition. We also suggest that any sediment disposal which involves deposition of heavy metals into wetlands not be considered an option.

The discussion on p. 47 concerning trucking of sediments suggests some leakage would occur, "...and present an aesthetic problem." No mention is made, however, of the potential for other impacts from such leakage. For instance, what about hazardous waste implications and is there a potential for health problems? What can be done to prevent/minimize leakage...is truck bed lining feasible? What cleanup actions would be proposed?

FLOODING

Will any of the alternatives contribute to possible downstream flooding along Oneawa Canal? If so, define extent of flooding expected.

Channel restructuring alternatives should consider a truly meandering channel to reduce velocity and expand marsh water storage capacity during high water, and thus minimize downstream impacts from peak discharges even more than that being proposed.

The paragraph concerning rapid sea level rise on p. 50 should discuss implications of proposals exacerbating flooding in Coconut Grove as a result of sea level rise, should that occur.

VEGETATION

Discuss the implications associated with vegetative removal on water temperature, and how the temperature change would affect aquatic organisms. How often would vegetation removal have to be accomplished for it to be an effective flood control measure, and what are the ongoing impacts from iterative disruption to the ecosystem? Who will do the ongoing marsh "maintenance?" Has a plan been established? Whichever alternative is selected, how long will it be before vegetation becomes a problem to the same degree it is now? How quickly would new growth be anticipated, and in what form?

The EIS needs expert judgement on "how much vegetation should be removed, how often it should be removed, and from what areas of the marsh." Statements such as that presented on p. 52 do not allow the reader to appropriately evaluate proposals. The EIS needs to include some rational assumptions based on available information or the proponent needs to complete necessary studies to determine best way to proceed.

WATER CONTROL STRUCTURE

Since this structure appears to be "of serious concern" (ref. p. 7) as it relates to (unknown) marsh dynamics, we recommend a discussion, in the FEIS, of what could be expected in terms of marsh dynamics based on your experience related to the 1988 flood.

Information is also needed in the FEIS on the height of the proposed control structure. If there are varying heights being considered, your discussion of potential impacts should relate to each of the options.

DISPOSAL

Alternative disposal sites and methods should be presented in detail in FEIS. This should be part of the decisionmaking process, not added later "...once the flood control alternative is selected...", as suggested on p. 22. Effects cannot be appropriately identified nor evaluated without specific information on optional disposal means under consideration.

GROUNDWATER

The discussion on p. 26 suggests that "contamination of the extensive groundwater resources..." is of primary concern. However, the discussion does not provide details concerning the marsh surface water - groundwater interaction. Of primary interest is what effects dredging and channelization would have on this interaction. The FEIS should include this information.

CONSTRUCTION

Physical features of access roads and impacts (turbidity, deterioration of water quality, generation of fugitive emissions, etc.) should be detailed in the FEIS. Specifics, such as duration of activities, on the "rock rapids" as identified on p. 23 should also be provided.

WATER QUALITY

The discussion presented on p. 27 of the DEIS suggests that additional studies need to be conducted to determine variables in water quality within the marsh. This also implies that sources

of contaminants are uncertain, for instance, within the emergency ditch. It is important to have that information available to assist in determining appropriate mitigation and to ascertain effects of proposals on water quality. Data should be provided in the FEIS to verify assumptions regarding pH levels. How much do non-point sources contribute to marsh pollution (nutrient loading)? Can this be mitigated as part of the overall flood-control program, i.e., to help minimize growth of undesirable vegetation? In addition, any point sources should be identified and mitigation discussed in the same context.

HEALTH

The discussion on p. 28 indicates that "leptospirosis is prevalent in Kawainui Marsh", but that the area is not a "hot spot due to the lack of significant recreation activity", yet several of the alternatives being offered suggest that recreation activities might be enhanced. Please clarify this relationship and provide information on possibility of exacerbating conditions prompting leptospirosis. Also of concern is the implication that levee heightening alternatives would enhance walking, riding, etc. on the levee, despite current (apparent) restriction of such activities in the form of signs and gates. Is the DEIS suggesting these current restrictions be removed once the selected flood control measure is implemented?

NUTRIENT LOADING

On p. 58 of the DEIS, you state that "cattle and horses graze on California Grass near Kailua Road and may contribute both pathogens and relatively high nutrient levels into the marsh." Given that, we suggest that it might be more appropriate to re-define your "level of insignificance" as a decrease in grazing as opposed to maintaining grazing at its current level. Please estimate the number of grazing animals and their projected impact on marsh nutrient loading. Consider options to minimize this impact as a part of the maintenance scheme, and include this information in the FEIS.

For reasons explained in other comments presented herein, we suggest that all of the flood control alternatives be accompanied by proposals to reduce nutrient loading.

AIR QUALITY

Use of equipment during "construction" activities will generate impacts on air quality. Estimate extent and duration of such impacts on an alternative by alternative basis and provide specific mitigation measures to be used in the FEIS.

CULTURAL RESOURCES

An archeological survey has not been performed along proposed alignments nor in other areas of proposed disruption. This should be accomplished and results provided in FEIS.

We recommend close coordination with SHPO to ensure regulatory requirements are met and cultural resources are afforded appropriate consideration and protection.

<u>ALTERNATIVE-SPECIFIC COMMENTS:</u>

Floodwall Alternative

FLOODING

If the water were to reach the floodwall, would the nature of the wall, i.e., straight, concrete - accelerate flows through the marsh into Oneawa Canal sufficiently to present a flooding problem to residents downstream of the confluence? The FEIS should discuss associated implications and the means you would propose to eliminate such impacts.

Marsh Clearing Alternative

SEDIMENTS

The discussion on p. 19 suggests that a "feasibility test" is necessary "to determine viability of digestion of marsh grasses". This information should be provided in the FEIS.

On p. 44 of the DEIS, it is stated that "heavy metal levels of the Oneawa Channel sediments are presently unknown". This needs to be determined and identified (quantified) prior to selection of alternative, <u>not</u> prior to excavation, and discussed in the FEIS. If material cannot be landfilled, alternative disposal methods need to be described and evaluated in the FEIS.

As described on p. 48, the DEIS presentation concerning sediment disposal takes the form of a "should do" discussion rather than specifically explaining what <u>would</u> be done. Disposal plans should be sufficiently developed to allow the reader to fully evaluate the proposal. The DEIS also suggests that it "doesn't appear" that using dredged spoil to create low islands "will be pursued, at this stage". Please be more definitive. Is this option no longer viable? Can we assume it will not be pursued at any stage?

Discussion presented on p. 51 indicates that "sediment reaching the bay from the marsh has the potential of impacting coral, recreational beaches, etc.". Specifically, what are the impacts? What are plans to minimize the impacts? Expand this discussion in the FEIS.

Would siltation basins and maintenance dredging in Oneawa Canal be required? Open-ended statements such as that presented in the DEIS do not provide sufficient information on which to evaluate the proposal.

On p. 57, the DEIS, offers monitoring of heavy metals in sediments as a mitigation measure. Monitoring by itself is not a mitigation. (Refer to definition of mitigation provided in 40 CRF 1508.20). Rather, the reader needs to know what would happen as a result of your monitoring efforts? And, what contingencies are available to minimize impacts should first level efforts be ineffective? This discussion should be included in the FEIS.

The discussion on p. 65 suggests that stockpile sites may be a temporary aesthetic impact...no mitigation is proposed. We encourage you to explore the possibility of hauling "disposal" materials directly to a permanent disposal site as opposed to temporarily stockpiling.

WATER QUALITY

How would this alternative affect low-flow distribution in the marsh? Would water be confined to newly constructed channel? If channel is constructed to accommodate only high-flows, can we assume it will be devoid of water and vegetation during low-flow regime? Please clarify and discuss the environmental implications in the FEIS.

On p. 57, please quantify "short periods of time" as in "...will likely lower water quality below state water quality standards for short periods of time". In addition, are there other potential Hydrogen Sulfide problems other than that identified?

WILDLIFE

The discussion on p. 47 concerning anaerobic conditions present in sections of the marsh suggests disruption would result in "localized habitat loss and <u>other</u> impacts". Define "other" impacts.

Explain what is meant by defining mitigation as to: "avoid loss of this estuarine habitat", as presented on P. 56. Are you implying that you would create a similar habitat nearby to offset the elimination of the existing habitat? Please clarify in the FEIS.

CONSTRUCTION

Reference is made on p. 48 to "temporary fill access roads". Identify the proposed roads and discuss the process of filling and removing fill and its implications on water quality of marsh. This should be included in the FEIS.

Who is responsible to "manage water elevations" at control structure?

HERBICIDES

The discussion on p. 51 indicates that "sediment reaching the bay from the marsh has the potential of impacting coral, recreational beaches, etc". Specifically, would use of herbicides also impact these entities and if so, to what extent? Over time, could we expect that the sediments would contain residual herbicides from their use in the marsh? Discuss implications and propose mitigation measures in the FEIS. This comment applies to all alternatives which would use herbicides.

In reference to the herbicide discussion on p. 53, what effect would the proposed (undefined) herbicide have on non-selected plants? What herbicide(s) would be used, and in what quantity, and how often? What are anticipated residual effects on fauna? What dangers are there to humans? Is there a plan to curtail human/animal entrance into area while herbicide is active? This information should be provided in the FEIS.

VEGETATION

The discussion on p. 48 concerning vegetation should specifically explain what would be done as opposed to suggesting what should be done.

AESTHETICS:

Discuss the aesthetic implications associated with the supplemental heightening of levee to ensure 100 yr. flood protection (within context of this alternative).

Quarry Road Alternative

WILDLIFE

The DEIS does not contain appropriate discussion of mitigation for loss of preferred nesting areas which would result if this Alternative were implemented. FEIS should include that discussion after coordination with USFWS.

WATER QUALITY

How would this alternative affect low-flow distribution in the marsh? Would water be confined to newly constructed channels? If channels are constructed to accommodate only high-flows, assume they will be devoid of water and vegetation during low-flow regime. Please clarify these items in the FEIS.

CULTURAL RESOURCES

Your discussion on p. 49 suggests that "impacts to cultural resources are unknown at this time". The EIS is the place to discuss impacts to cultural resources, however, to do so the project proponent must complete all necessary survey work prior to completing EIS. This hasn't been done as of this review. All survey work should be completed and documented prior to FEIS, and the alternatives should be discussed with cultural resource specifics included.

POLICY

The "if...then" discussion in section 4.3.8 does not allow for a complete evaluation of the alternative. The discussion provided does not describe what would be done (should this alternative be selected), it merely suggest things that need further consideration. Reference 40 CFR 1502.9 and 40 CFR 1502.14, which outline the need for presenting a "meaningful analysis" which offers a "clear basis for choice". We would like to see your discussion expressed in the FEIS in terms of offering a "clear basis for choice".

CONSTRUCTION

The discussion on p. 62 suggests that the "ITT" parcel which DLNR hopes to acquire for an interpretive center..."may be impacted by levee modifications". Describe the impacts and proposed mitigation program in the FEIS.
The plan on p. 65 indicates a "training dike" may be constructed. The FEIS should indicate if the dike would be constructed or not. In addition, please define what is meant by "training".

Back Levee Alternative

WETLANDS

Page 31 of the Project Report attached to the DEIS indicates this Alternative would involve filling 5 acres of wetlands, (two acres of fill on the marsh side, as shown in the DEIS, Table 1). A discussion of this, however, is not included in Section 4.3, "Sediment Disposal and Wetland Fill". The FEIS should present this discussion, including mitigation proposals and any additional meaningful information related to the proposed fill.

LAND

The FEIS should discuss the implications of acquiring non-government land as indicated on p. 45. Is the land actually available? Who would acquire? What are the related environmental concerns?

CONSTRUCTION

As provided on P. 52, only <u>suggesting</u> that an additional water control structure <u>may</u> be required is speculative and cannot be evaluated. Discussion of this in the FEIS should take the form of...should the structure be required, the impacts would be; the mitigation would be; etc. Without appropriate information at this stage, and should another structure be required, additional environmental documentation would be necessary. Is the purpose of an additional water control structure the same as that presented on p. 60, "...to prevent stagnation of Oneawa Channel..."? Please clarify.

Is it possible to divert Coconut Grove runoff as described on p. 60? The discussion needs to be expanded...what would the diversion entail, what are the impacts, etc.?

VEGETATION

How much California Grass would be destroyed in the canal realignment effort described on p. 54, and what type of vegetation would be planted as a replacement? How long would the area remain denuded and what are the impacts to water quality from sediments? We recommend that you include these topics in the FEIS.

WILDLIFE

Explain what is meant by defining mitigation as to: "avoid loss of this estuarine habitat" as presented on p. 56. Are you implying that you would create a similar habitat nearby to offset the elimination of the existing habitat? Please provide a mitigation plan and describe who is responsible for its implementation, monitoring, and corrective actions should they become necessary.

Floodproofing Alternative

GENERAL

Your discussion is generally limited to identification of potential impacts, e.g., "increased traffic, air pollution, noise, etc. but the impacts are not described in terms of extent, duration, etc. What are the "safety concerns" identified with this alternative...especially those differing from other alternatives? DEIS notes that historic and/or cultural resources "are likely but unknown...". Please provide rationale for your assessment of "likely". What resources are likely? And, what would be done to mitigate impacts? These topics should be addressed in the FEIS.

Raise Levee Alternative

CONSTRUCTION

If the discussion such as that presented on p 47 is to include optional sources of fill, the FEIS should discuss potential impacts of using materials from all the sources, e.g., considering Oneawa Canal may contain heavy metal deposition, what are the implications of use?

Discussion on p. 50 states: "<u>If</u> the fill required for this alternative is free of contaminants it should not impact water quality". Contaminated fill should not be used. Where will fill come from and what would be done to ensure contaminated fill is not used? If Oneawa dredge is being considered, at what levels of contamination would that consideration no longer be viable?

WETLANDS

Although it is stated in the mitigation section on p. 53 that the USFWS has recommended a 2 for 1 wetland loss replacement (with open water), it's not clear what your intent is. How is that replacement going to take place, and exactly where? Supply more details on mitigation in the FEIS.

WILDLIFE

Define what is meant on p 57 by a "temporary loss of fishery habitat." What are the effects of this loss?

WATER QUALITY

Define "dangerously low" DO levels as presented on p. 57. At what point would action be taken to increase DO levels, and who would be responsible for this corrective action?

Sediment Reduction Alternative (not actively being considered)

SEDIMENTATION

This alternative was rejected from further consideration in part because "evidence is mounting that the major contributor to sedimentation to the marsh comes...from deposition of decaying vegetation..." We suggest preparers provide the evidence that this is actually the case. We would encourage using this alternative (at least in conjunction with other alternatives) to reduce inflow sedimentation and at the same time take steps to reduce nutrient loading to minimize rate of vegetative growth. It would be preferable in the long term to minimize maintenance as much as possible, and one way to approach such minimization is to control the rate of vegetative growth and sedimentation naturally. We recommend additional discussion of this alternative in the FEIS.

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT SHAFTER, HAWAII 96858-5440

JUL 2 3 1992

REPLY TO ATTENTION OF:

Planning Division

Ms. Deanna M. Wieman
Director, Office of External Affairs
U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, CA 94105

Dear Ms. Wieman:

Thank you for your in depth review of our Kawainui Marsh Draft Environmental Impact Statement dated June 21, 1991. We wish to respond to each of the major areas you have identified. Since receiving public and agency comment letters in June, 1991 we have evaluated the extensive public input, initiated additional study efforts, and discussed the flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process, be responsive to as many reviewers as possible, and select a preferred alternative.

On November 15, 1988, as a result of our Notice of Intent (NOI), you provided comments which offered initial recommendations to those preparing the EIS. Following the 1988 New Year's flood, an emergency condition existed as we sought relief from the flood threat as quickly as possible. The City and County of Honolulu undertook the task of EIS preparation without federal participation at that point. We then rejoined their effort following the publication of their final EIS in June, 1990 and after our determination, through our Reconnaissance Report, that a federal interest for a permanent flood control solution appeared justified.

We have refined our list of alternatives to those which are implementable by the Corps and have better established a position for recommending a preferred course of action. We have also identified those in-marsh alternatives which may be undertaken by local agencies without Corps participation. The analysis of marsh nutrient and sediment loading that you requested has been included in the FEIS although we consider this information and other in-marsh research less relevant with our subsequent refinement of alternatives that address the levee alone. We have determined that a levee raise is the only alternative that meets

Corps engineering, economic and environmental criteria and are no longer considering in-marsh alternatives for flood control. However, a levee raise will not preclude future scenarios that may be envisioned for marsh management purposes. Future marsh activities must be compatible, however, with the flood control function of the marsh.

General Comments:

POLICY

Our FEIS addresses the issue of cumulative impacts.

You state that "much more information should have been discussed in the DEIS and must be discussed in detail in the FEIS for the decision maker to have a basis for appropriate decision making". We incorporated by reference (40 CFR 1508) the previous City and County of Honolulu FEIS which addresses most of your questions and which we used to evaluate the in-marsh alternatives. In particular, the heavy metal analysis and sediment evaluation that we used to evaluate potential impacts from marsh clearing were derived from their consultant's study as well as from our own consultant's analysis. We have incorporated the heavy metal information you requested in the FEIS appendix.

Responses to your specific comments follow:

WILDLIFE

We have coordinated closely with the USFWS and shall continue to do so through project construction. The "additional consultation that may be required" refers to Section 7 consultation not the usual coordination that is ongoing on a regular basis. Re-initiation of Section 7 consultation would have been required if the marsh clearing alternatives were pursued. However, as previously mentioned, these have been dropped from the final array of alternatives. The risk of botulism becomes moot with the dropping of a water control structure associated with the in-marsh alternatives. This water control structure was deemed necessary with in-marsh alternatives that posed the risk of accidentally draining the marsh. The impact associated with the emergency ditch is addressed in the FEIS.

The use of white amur as a vegetation control agent was identified as a "biological hazard" since it is presently restricted from importation into the Hawaiian Islands and has presented problems of competition with native species where introduced elsewhere on the mainland. However, it has been known

to be highly effective in controlling vegetation in selected areas. We are not presently anticipating the introduction of this species into the marsh.

SEDIMENTS

We state that "accumulating sediments have displaced approximately 400 acre-feet of flood storage capacity of the marsh since project construction". This is considered insignificant and within the scope of our flood control alternatives over the 100 year economic life of the project. Vegetation decay is a major contributor to the sediment. Our analysis concludes that sedimentation rates differ throughout the marsh but that an average sedimentation rate in the marsh is on the order of 0.3 feet/10 years (195 acre-feet). Runoff sedimentation contributes 0.17 feet/10 years (110 acre-feet) while the vegetation contribution is estimated at 0.13 feet/10 years (85 acre-feet). These figures are consistent with other estimates of marsh sedimentation rates with the exception of M&E Pacific's estimate of 0.9 feet/10 years which assumes a higher trap efficiency of the marsh, and an AECOS (1981) estimate of 0.003 feet/10 years which is considerably lower by several orders of magnitude. Sediment cores have been evaluated by researchers working in various portions of the marsh. A number of interpretations have been offered for the cause of geomorphic changes in the marsh and the time period in which they occurred. As yet, none of the explanatory models have been fully agreed upon by the scientific community.

In addition, the Corps does not control practices that contribute sediment runoff into the marsh. These controls are placed with other local agencies. We have included suggestions to control non-point source water quality pollution which should help prolong the life of the marsh. The agreement which transfers control and maintenance or the marsh will include monitoring of the marsh for future unexpected changes. Recurring removal of sediments is not expected to be necessary to prolong the preferred flood control alternative.

Sediment does pass through the marsh during large flood events yet does not become deposited at the mouth of Oneawa Channel. Currents in the Bay carry it away from the area.

As stated on page 30 of the DEIS, the exact levels of heavy metals analyzed from sediment in Kawainui Marsh has been documented in the City and County of Honolulu's FEIS. We indicate that the marsh has trapped some heavy metals, particularly copper, chromium, iron, nickel, and zinc. With the exception of cadmium, and perhaps mercury, both of which occur in much the same concentration in the areas sampled, the heavy metal burden is substantially greater in the sediments at the upstream end of the marsh. We go on to say that based on the available data presented in the City and County's FEIS, the quantities of heavy metals (RCRA EP Tox extraction method) in marsh sediments and vegetation samples are below the standards established by EPA for landfill disposal purposes. Nevertheless, we believe there exists the potential for leaching of these metals into the biological environment for the in-marsh alternatives. The data on heavy metals from the City and County research has been appended in the FEIS as you requested.

We agree with your discussion concerning the definition of significant, not mitigable with respect to sediment disposal and wetland fill. This definition is rewritten in the FEIS. The discussion of transportation of sediments in trucks is expanded to include your additional concerns.

FLOODING

The potential for downstream flooding exists with the in-marsh alternatives. The capacity of Oneawa Channel would require enlargement to accommodate additional flow from in-marsh alternatives. Increasing the meandering nature of the channels would increase their potential for blockage during flood events. The impact of sediment on receiving waters would still be significant.

None of the proposals would exacerbate flooding in Coconut Grove as a result of sea level rise.

VEGETATION

There is no "expert judgment" obtainable on how much vegetation should be removed, how often it should be removed, and from what areas of the marsh. Just as it is difficult to predict how much rain forest can be safely removed, how much mangrove can be removed, or other ecologically valuable resources, how much marsh vegetation can be safely removed without jeopardizing water quality, sediment loss or other ecological balances cannot be predicted. We know of no studies available that provide this guidance either in Hawaii or elsewhere. This difficulty contributed to our decision not to carry forth the in-marsh alternatives for flood control into our final analysis. Vegetation removal is not a necessary component of our flood control solution. Vegetation can be harvested and removed regularly prior to the death and decay of the living material to decrease its contribution to sedimentation in the

marsh, although this is not vital to maintenance of the flood control function.

WATER CONTROL STRUCTURE

There is no known information available on marsh dynamics for any marsh that can be called upon to evaluate the effect of a water control structure in Kawainui Marsh. Since in-marsh alternatives have been dropped from further consideration, the water control structure discussion is moot. The origins of the need for a water control structure are discussed in the FEIS.

DISPOSAL

Disposal options for the relatively small amount of waste material from the preferred alternative have been identified in the FEIS.

GROUNDWATER

The subject of groundwater in the DEIS refers to the upstream Maunawili Valley area, not the marsh proper. The water surface in the marsh is the surface of the groundwater. There will be no dredging in the marsh associated with the preferred alternative.

CONSTRUCTION

There will be no access roadways, temporary fills or associated impacts from construction of the preferred alternative.

WATER QUALITY

The flood control project will have no impact on water quality in the marsh except for temporary periods of time during construction of wetland from fastland associated with mitigation for wetland fill. Other construction impacts associated with the various alternatives are described in the FEIS.

HEALTH

Recreational activity is not expected to change with the construction of the preferred alternative. Incidence of Leptospirosis is not expected to increase as a result of the flood control project.

NUTRIENT LOADING

We have adjusted our "level of insignificance" as you have suggested to a decrease in grazing as opposed to maintaining grazing at its current level. It may be desirable to eliminate grazing activity in the marsh until a determination can be made as to its impact on marsh nutrient loading.

AIR QUALITY

We do not anticipate that air quality standards will be exceeded in residential areas during reconstruction of the levee. Fugitive emissions and dust will be temporarily generated but will be controlled through contractual arrangements.

CULTURAL RESOURCES

Our NEPA document is a companion to the previously prepared state EIS published in June 1990 by our local sponsor, the City and County of Honolulu. As stated in our joint federal/state draft EIS this earlier document has been incorporated by reference into the joint draft document that you have reviewed. Additional archaeological survey and coring data for the interior of Kawainui Marsh associated with that study are available from the City and County of Honolulu. During the planning process, it became apparent that neither the in-marsh nor the floodproofing alternatives would be feasible alternatives because of economic, engineering or environmental considerations. Therefore, there was no need to perform expensive archaeological surveys for alternatives which would not be carried forward to the Final EIS.

Alternative-Specific Comments:

Most of your comments address alternatives which are no longer being considered. Nevertheless, we have addressed your questions to the extent possible.

Floodwall Alternative

This alternative has been carried forward into the FEIS. A modification to this alternative has become the preferred alternative.

FLOODING

Velocity vectors have been calculated in the FEIS with respect to the floodwall issue you have raised. Our calculations indicate that no erosion will occur along the floodwall during the project design flood.

Marsh Clearing Alternative

This alternative has been dropped from further consideration for reasons previously stated.

SEDIMENTS

The viability of digestion of marsh grasses is no longer being considered as a component of the flood control project.

Oneawa Channel sediments will not be dredged as part of the flood control project. Heavy metal analysis of these sediments is, therefore, not required. The use of dredged spoil to create low islands is not included as part of this flood control project.

Impacts associated with sediment reaching Kailua Bay involve degraded water quality including clarity, smothering of coral and other substrate, aesthetic changes, and deposition of sediment on white sand recreational beaches. Bacterial contamination emanating from Oneawa Channel and Kaelepulu Stream have been identified as a contamination source of the bay by the University of Hawaii Water Resources Research Center.

No on-site stockpiling areas are anticipated. Disposal materials will be hauled to a permanent, suitable, disposal site.

WATER QUALITY

Information on the impact of water flow and distribution in the marsh within the City and County of Honolulu created channel is presently being obtained by them. This information will be valuable for any future expansion of constructed channels or additional open water in the marsh.

WILDLIFE

Localized habitat loss and other impacts associated with anaerobic conditions refers to potential toxicity from hydrogen sulfide as well as aesthetic concerns associated with perceptible odors. However, information obtained thus far suggests that this will not be a problem.

Mitigation referred to in the DEIS about avoiding the valuable estuarine habitat in the marsh was to flag its importance. The proposed mitigation utilized its broadest definition which includes avoidance and selection of another alternative (e.g., wetland losses).

CONSTRUCTION

There are no proposed temporary fill access roads or water control structures under consideration.

HERBICIDES

The use of herbicides is not anticipated with any of the levee raise alternatives presented in the FEIS. The City and County of Honolulu is using RODEO to control floating plants in the marsh and along the edges of the open water channel. This herbicide has been approved for use in wildlife refuges. No long term impacts are anticipated with its use. Cumulative impacts associated with herbicides are addressed in the FEIS.

VEGETATION

Suggestions are made with respect to vegetation in the FEIS although the preferred alternative is designed to function irrespective of future marsh conditions and does not rely on vegetation control to work.

AESTHETICS

The levee raise alternatives, including those previously identified in the DEIS, would be landscaped to be aesthetically acceptable.

Quarry Road Alternative

This alternative has been dropped from further consideration although the City and County of Honolulu is presently implementing construction of a similar channel in the marsh but not connecting to Oneawa Channel.

WILDLIFE

Nesting sites were not discovered during creation of the City and County channel alignment.

WATER QUALITY

Information useful to understanding low flow conditions on channels in the marsh is anticipated from the newly created channel constructed by the City and County of Honolulu.

CULTURAL RESOURCES

See previous comment under cultural resources.

POLICY

We have presented information in Chapter 4 of the FEIS which shows a clear basis for choice among the final list of alternatives.

CONSTRUCTION

Back Levee Alternative

This alternative has been dropped from the final array of alternatives.

WETLANDS

You are correct in identifying the lack of discussion of wetland fill associated with the back levee alternative in Section 4.3 of the DEIS. Thank you for bringing this to our attention. Our FEIS addresses this issue in greater detail.

LAND

A discussion on acquiring both government and non-government land is included in the FEIS with respect to flood inundation limits.

CONSTRUCTION

The purpose of the additional water control structure was to prevent stagnation of the extension of Oneawa Channel. Diversion of Coconut Grove runoff for a temporary period of time during construction of the back levee alternative would have been difficult and was not evaluated at the draft stage of the document.

VEGETATION

Several acres of vegetation would have been destroyed and require several months to regrow. Water quality would have been degraded during construction and until vegetation regrowth.

WILDLIFE

See discussion of mitigation for loss of estuarine habitat above.

Floodproofing Alternative

This alternative has been dropped from further consideration.

GENERAL

You are correct that quantitative information associated with impacts from this alternative were not included in the DEIS. During planning stages it became apparent that this alternative would not be feasible for environmental, social, economic, or engineering reasons. We did not devote limited resources to quantifying impacts for an alternative that could not be implemented.

Raise Levee Alternative

This alternative has been included in the FEIS.

CONSTRUCTION

Only uncontaminated sources of fill will be used for construction of the levee raise.

WETLANDS

Details on compensatory wetland mitigation are included in the FEIS and will include restoration of previously filled wetland in the marsh near Oneawa Channel to new wetland habitat. Construction of this wetland will be undertaken with input from state and federal wildlife agencies.

WILDLIFE

The recommended 100-year level of protection does not include dredging. If Oneawa Channel were dredged for the Standard Project Flood level of protection, then suspended sediments associated with dredging of Oneawa Channel would likely reduce oxygen levels and reduce the ability of fishes to survive during dredging activities.

WATER QUALITY

Dissolved oxygen levels would be monitored during dredging activities of Oneawa Channel associated with the in-marsh alternatives and the back levee alternative. Dredging would be temporarily suspended if D.O. levels were found to be less than state water quality standards.

Sediment Reduction Alternative

This was never included as an alternative by itself. See discussion of sediments on page 3 of this letter.

SEDIMENTATION

We agree that much can and should be done to extend the life of Kawainui Marsh by controlling non-point sources of pollution and controlled harvesting of vegetation. Such suggestions are included in the FEIS although the Corps cannot incorporate these suggestions as part of the recommended plan. Vegetation control practices are not required to prolong the life of the flood control project.

After consideration of engineering, environmental, and economic factors as well as agency and public input, the Corps along with the City and County of Honolulu will be recommending an earth levee raise which fills 1.8 acres of wetland and includes a concrete floodwall with a maximum height of four feet. Compensatory wetland mitigation will include conversion of fastland in the marsh near the levee to new wetland habitat.

Thank you again for your review and comments on the draft. We look forward to your comments on the FEIS.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

KAWAI NUI HERITAGE FOUNDATION
P.O. Box 1101
Kailua, Hawaii 96734

June 21, 1991

Mr. Kisuk, Cheung
Director of Engineering
Department of the Army
U.S. Army Engineer District, Honolulu
Building 230, Ft. Shafter, Hawaii
96858-5440

Dear Mr. Cheung:

Thank you for this opportunity to review your Draft Detailed Project Report and Draft Environmental Impact Statement for the Kawainui Marsh Flood Control Project.

Enclosed is a copy of the brochure detailing the goals and objectives of our Foundation. Please include in the Appendix of your revised Draft EIS, along with these comments, so that all reviewers will understand the basis upon which our organization's perspective is built.

This short statement is to acknowledge your attempts to involve us at various stages of this project's evolution. However, our Foundation regrets to report that the subject document is inadequate, internally inconsistent, and incomplete in its current form. Details of this statement are provided in the separate testimonies submitted by various individual citizens who are also Foundation members, as well as by other credible organizations such as the State of Hawaii Department of Land and Natural Resources, The University of Hawaii Environmental Center, Hawaii's Thousand Friends, and our own Foundation planner, Mr. Robert Herlinger, A.I.A. Consequently, we conclude that the requirements at 40 CFR Part 1502.9 have not been met: "if a draft statement is so inadequate as to preclude meaningful analysis, the agency shall prepare and circulate a revised draft of the appropriate portion." We further strongly recommend that you hold another public meeting, preferable a two-way workshop, conducted by a trained facilitator, in which there is free interchange and clarification of all issues. In true partnership, we may be able to find a flood control alternative that is socially, politically, and environmentally acceptable as well.

Sincerely,

Diane Drigot

Dr. Diane Drigot, Vice President

Enclosure

Dr. Diane Drigot
1154 Uluopihi Loop
Kailua, HI 96734

June 21, 1991

Mr. Kisuk Cheung
Director of Engineering
Department of the Army
U.S. Army Engineer District, Honolulu
Bldg. 230
Fort Shafter, HI. 96858-5440

Dear Mr. Cheung:

Thank you for sending me a copy of the Draft Detailed Projet Report and Draft Environmental Impact Statement(EIS) for the Kawainui Marsh Flood control Project for review.

My comments represent myself as an individual, taxpaying citizen who lives near and enjoys recreational and environmental educational activities on and in association with the Marsh; is the author of an educational sourcebook about the marsh cited in your Draft EIS bibliography; is a founding board member and current Vice President of the Kawai Nui Heritage Foundation; a trained professional with B.A., M.S., and Ph.D. in natural resources management from esteemed universities (Barnard College, Columbia University, and University of Michigan), whose M.S. thesis and Ph.D. dissertation covered methods for more effective public involvement in water resources and national park planning, respectively; has nine years professional experience managing the endangered wildlife, historic, and related resource management programs associated with another major O'ahu wetland, and with approximately 15 years of experience as a preparer and/or reviewer of environmental assessments and environmental impact statements required under state and federal laws.

My comments are numbered in the paragraphs which follow for ease of your addressal when I receive feedback from you regarding each area of concern raised:

1. Despite the good intentions of your responsible staff, your inclusion of the "Detailed Project Report" and the Draft "Environmental Impact Statement" for the Kawainui Marsh Flood Control Project in one document is unwieldly, redundant, misleading, self-contradictory, and confusing to the public.

For example:

(a) An EIS customarily begins with a "Summary" (required by 40 CFR Part 1502.12), and is to contain a "full and fair" discussion of significant environmental impacts" of all

"reasonable alternatives"(40 CFR Part 1502.1) and is to avoid taking an advocacy position on any one alternative(Section 11-200-13 of title 11 State EIS Rules). Yet this document begins with a "Syllabus" of "the project" and defines the project as "Plan 2 (Concrete Floodwall on Level)"as the apparent chosen plan because it is the National Economic Development (NED) Plan.

(b) After wading through 38 pages of description of the obviously preferred NED Plan and associated Figures, the reader comes across a title page, "supporting documentation" which is followed by yet another title page "Draft Environmental Impact Statement," and then the Abstract of the Draft EIS.

(c) Buried within the project section text preceding the Draft EIS (which reflects an obvious bias toward Alternative 2 or the NED Plan), the reader encounters a "one liner" on page 35 which says "however, selection of a recommended plan will not be made until public involvement is completed."

This is one of many examples of how this Draft EIS, with related documents nested within it, wrapped around it, or incorporated by reference, violates EIS preparation procedures dictated by the President's Council on Environmental Quality that say:

- Environmental information must be made available to citizens before decisions are made and action is taken (40 CFR part 1500.1(b))the
- Environmental impact statements shall be written in plain language and may use appropriate graphics so that decisionmakers and the public can readily understand them (40 CFR Part 1502.8)
- Environmental impact statements shall be "analytic" rather than "encyclopedic" (40 CFR Part 1502.2)
- Environmental impact statements shall state how alternatives considered in it and decisions based on it will or will not achieve the requirements of section 101 dealing with "productive harmony," and of section 102 (1) dealing with interpreting and administering all policies of the United States-- including those favoring a "NED" analysis--in accordance with the policies set forth in this Act (i.e., NEPA).

2. Other reviewers, such as the written testimony of 10 May 91 submitted by Mr. Robert Merriam (a retired forest hydrologist, Kailua resident, and President of the Kawai Nui Heritage Foundation), have pointed out numerous additional examples of internal inconsistencies, inaccuracies, and

insufficiently explained assumptions behind the benefit/cost ratios assigned to each alternative and associated maintenance costs. Why, Mr. Merriam points out, for example, does it cost $16 per cubic yard to remove gravel for the levee raise and $43 per cubic yard for the flood wall? Why is a 25% contingency used in relation to costs of the vegetation control alternative and only 10% for the structural alternatives? These examples are merely illustrative of how this document inadequately attends to 40 CFR part 1502.14(b) which tasks federal EIS-preparers to "devote substantial treatment to each alternative"... "so that reviewers may evaluate their comparative merits."

3. Another particularly disturbing deficiency in the Main Report of this document is the unsubstantiated statements (p. 3, 11-12) that the "best flood solution (is) one which is "independent of future conditions in the marsh," yet "reflects future development conditions in the marsh watershed." How can the "best" flood solution be one that totally ignores the central biophysical entity of the watershed and the acknowledged source of the flooding problem--the built up mat of vegetation (p. 1-2 of the EIS Summary)--as a result of the cumulative neglect over the years of the City and County of Honolulu to maintain the 3,000 acre-feet flood storage capacity established for the original Corps of Engineers' Project? In plain language, it the NED Plan (Alternative 2) is built, the effect will be to raise the height of the marsh "bathtub" walls, to keep rising "bath-water" from overflowing, while ignoring a "clogged drain." In the long run, even the walls of an elevated levee will be exceeded, if further, unchecked development of marsh vegetation and silt accumulation in the marsh watershed cdontinues. Imagine the devastating effects on Coconut Grove of an event such as the Teton Dam collapse in such an instance!

4. Without substantiating evidence from consulted experts with expertise in botany, marshes, floating mat behavior, the report merely states that the behavior of such a floating mat is "unknown/random during flood events" (p. 12) and "infamous for clogging waterways elsewhere in the world." (p. 5). Then, it is dropped from further analysis in the Cost/Benefit Analysis of alternatives. Thus, the document fails to adequately fulfill 40 CFR Part 1502.23 that "when a cost-benefit analysis is prepared, discuss the relationship between that analysis and any analyses of unquantified environmental impacts, values, and amentities."

5. Another area of the Draft EIS wherein unquantified environmental impacts, values, and amentitites are inadequately addressed is in the discussion of historic preservation requirements and values.

(a) Thus, on page 61 of the Draft EIS text, the report correctly but incompletely states the potential areas of concern for a determination of affect of the various alternatives on historic/archaeological/cultural values by referring to the "material evidence" of the marsh's significance (eg., heiau, habitation sites, walls, etc.) It goes on to discuss levels of significance of impacts in terms of direct or no direct "physical effect" of various alternatives. It totally ignores the required discussion of more intangible cultural values and traditions associated with the marsh which contributed to its eligibility determination. Thus, for example:

(i) no where in the Draft EIS does it adequately discuss the cultural values of the eligible property, as they relate to the proximity of the Hawaiian Tree of Life, the Makalei--whose legendary location is in the marsh; the proximity of the lands of Waiauia, sacred to the chiefs of this portion of O'ahu, or the fact that the marsh is the residence of the guardian goddess Hauwahine, revered in legend, chant, mele, and dance--both ancient and modern. (See Chapter 2 of my book, Ho'oma'auao Ho Kawai Nui, that you cite as a reference, for some details).)

(ii) It is furthermore challengeable that an extremely obtrusive earthen levee or flood wall would have "no direct physical effect" on the historic integrity of this eligible property as it states on page 61 of the Draft EIS. It does not appear to be understood or even discussed that other than physical effects can impact cultural values. For example, views and vistas from within and around this area may be culturally significant.

(iii) Input on these matters can be obtained from cultural anthropologists and native Hawaiian organizations and individuals or groups who revere the traditions of the marsh in mele, dance, chant, and religious ceremonies. For many of these individuals/groups, traditional forms of public involvement in modern western society (letter writing, public hearing attendance) will not reach them to cover their concerns. Other, less quantifiable but professionally-legitimate forms of research are need to get the missing information for this assessment of affect section--eg., interviews, archival research, participant/observation, etc. Such research expertise resides in the National Park Service, for example, and is accessible through the Center for Hawaiian Studies at the University of Hawaii. Mr. Nathan Napoka at the State Historic Preservation Office can further guide you on this matter. Also, relevant expertise may be available from a National Park Service team presently evaluating Kawai Nui Marsh for eligibility to National Park Status as part of the Ka Iwi Shoreline National Park Proposal. The National Register Bulletin #38, Guidelines for Evaluating and "Documenting Traditional Cultural Properties"

A3 of 9

D4-19

by the U.S. Dept. of Interior National Park Service Interagency Resources Division offers further guidance. I understand that one of the authors of that publication, Dr. Thomas F. King, will be in Honolulu in July to conduct an advanced course in historic preservation and might provide a readily accessible source of expertise on this matter.

(iv) Along the same lines of the above comment about the cultural values of scenic vistas being adversely impacted by an obtrusive floodwall or levee, I find the statement indefensible on page 5 of your Draft CZM Consistency Form that no signficant adverse visual impacts are anticipated from any of the project alternatives.

(b) Please verify that the second-hand rendering of the boundary of the so-called "Kawai Nui Marsh archaeological district" in Figure 10 of the Draft EIS is the same one that was accepted by the Keeping of the the National Register in 1979. I recommend that you include the text and map of the original eligibility determination in the Appendix of this EIS and consult it directly when making an assessment of affect.

(c) You have failed to include a copy of the report of your consulting archaeologist, Dr. Steve Athens, in the appendices of the Draft EIS and have further failed to incorporate it by reference or provided information about where it is reasonably available for inspection by potentially intdrested persons within the time allowed for comment, as required in 40 CFR Part 1502.21. This further substantiates that you are expecting meaningful public input on an incomplete and inadequate document. This matter is of direct personal concern since I attended the public hearing on May 29 and wrote down in the index card you submitted to me inviting my comment that I specifically wanted to review a copy of the Athens report during the public review period. Yet, no one provided me with a copy of the report or information about where and when I might view this copy. As a "consulted party" to this EIS process, I view this as inadequate coverage of the rules under 40 CFR part 1502.19 on Circulation of the EIS. This omission is one of the many reasons why the public needs to have an opportunity to review a revised Draft EIS, after having opportunity to review documents ommitted from this early Draft, in order to conclude meaningful analysis of alternatives as required under 40 CFR Part 1502.9 governing NEPA documents.

(d) Correct p. 37 of the Draft EIS where Kridler's rock--an informal name credited to a natural feature of the marsh--fails to recognize an alternate Hawaiian name attributed to this resource--Pohaku o Hauwahine. Then, one of the maps in the Appendix III misspells Pohakupu as Pohakapu. Please correct.

6. I would like to point out that your sentence on page 5 of the Draft EIS that "Opinions expressed at public workshops were that aesthetics of the marsh would be improved with more natural meandering waterways..." Aesthetics are not the only aspect of marsh attributes that might be improved. When waters, flood or otherwise, are disbursed through a series of meandering waterways, is it not true that the sediment filtering capacity of the marsh thus works more efficiently as well and might improve overall water quality in Kailua Bay, especially after a heavy rain?

7. Your statement in Table 3, p. 9 of the Draft EIS that full compliance with Section 7 requirements of the Endangered Species Act is legally indefensible until you have chosen an alternative, made an assessment of affect, and received U.S. Fish and Wildlife Service concurrence with your assessment. If the implemented alternative involves direct loss of wetland acreage, such as in the earthen levee alternative, then the statement that a "two for one" creation of similar habitat areas within the marsh for every acre lost should be enacted (p. 7 of the Draft EIS) must be converted into an enforceable Memorandum of Agreement in order to have any meaning, rather than a mere wish statement in the EIS.

8. I am concerned about the unsubstantiated results of your economic analysis summarized in Table 7 of the Project document preceding the Draft EIS text. For example, it states that the Marsh Clearing (Plan 3) alternative will improve water quality, reduce annual damages by the same amount as the structural alternatives, increase recreational values (boating and wildlife viewing) and yet is economically unsound. How can that be without taking into account, for example, the enhanced revenues (both direct and indirect) accrued to the community and the state of an enhanced wetland enjoyed as a State or possibly a National Park(currently undergoing evaluation as such), and from improved fisheries surrounding this island as a result of improved nursery possibilities for marine life? Per Section 102 (2) (c) (iv), an EIS must address the impact of the action on long term productivity enhancement and your narrow economic analysis fails to take such revenue-stimulating values into account. There are experts with international renown, yet locally available, who are skilled at methods of internalizing these natural values into the Cost/Benefit analysis process. For example, Dr. Maynard Hufschmidt at the East West Environmental and Policy Institute may be one source of expertise available to you.

9. Another area of economic concern as a taxpaying member of this community is the over [illegible] million of compensation paid out by the City in response to lawsuits filed by flood control victims regarding the City's negligence to maintain the 3,000 acre-feet of flood retention basin in the Marsh, as required by the original flood control project. It we

A549

continue to favor flood control alternatives (floodwalls, levees) heavily biased toward structural solutions while continuing to ignore or pay token attention to the vegetation clearing/sediment removal requirements to reduce flooding hazards, we continue to endure outpayments of millions of dollars of City revenues as a result of future inevitable lawsuits, not to mention the costs of lawsuits that may be filed if this Draft EIS document deficiencies are not adequately addressed. All this needless expenditure of funds because the Cost/Benefit formulas ignore the acknowledge and directly "treat" the "disease" that caused the last flood--the overgrowth of vegetation. These lawsuit costs should be directly internalized into the document under the socio-economic consequences section for the Alterantives of "No Action" and Plans 1 and 2 that ignore the dynamics of the marsh altogether.

10. On the subject of consulted expertise, no where in the Draft EIS do you state that you had a qualified botanist/wetland expert involved in development of the alternatives or assessment of impacts. Perhaps that is why we were told at your May 29 public meeting by your district engineer that the floating mat is an "imponderable." Imponderable perhaps to an engineer, but not necessarily to a wetland expert. Please provide evidence that such a person was consulted in the preparation of such statements, as well as any written background material provided by him/her so that the public may have a meaningful basis to analyze and react to your statements regarding the "imponderable" behavior of the marsh's biological attributes.

11. Your analysis of sedimentation flows and rates are also in need of further substantiation by credible expertise. It appears that your analysis is based exclusively on traditional engineering core samples and underutilizes or ignores rich analyses and interpretations of more detailed core borings performed by archaeologists such as in the report by Jane Allen-Wheeler which you cite but obviously do not utilize. The cross-section of human uses and variable rates of sediment accumulations through time revealed in a careful analysis of such borings by skilled archaeologists can reveal valuable lessons in predicting future behaviors of the marsh and flooding risks if the sediment factor is not adequately addressed in the shaping of effective flood alternatives. We have no way of evaluating whether the most recent study performed by Dr. Athens adequately addresses these points as the public has not bee provided an opportunity to review his work or evaluate how his findings may have been incorporated into the analysis of alternatives.

12. I am concerned that you do not acknowledge the valuable role played by the U.S. Marine Corps Amphivious Assault Vehicles that were deployed during emergecy conditions to help create the emergency ditch on the marsh side of the existing levee that you have chosen to exclude from further analysis as part of the existing environment of the marsh and as a basis for future flood control calculations. The successful use of these versatile military vehicles for weed clearing--although not part of their normal military mission--provide tangible proof that mechanical weed clearing does work and can be done quickly and efficiently if the right skills and machinery are applied to the task. Yet, this action is not used as the basis of making various assumptions in your cost/benefit analysis of various alternatives which is an unfortunate oversight which can still be corrected. Commercially-available equipment, some of which is described in this Draft EIS, can be applied to the same task in the future in order to preserve and sustain the flood control values of additional open waterways elsewhere in the marsh. (Plan 3 Alternative.)

13. I am sorry to conclude that your efforts at public involvement to date remain minimal and amateurish when you consider the wealth of data supported and reported by the Army Corps of Engineers over the years on how to involve citizens more effectively in water resource planning. You rely heavily on an unpublished undergraduate survey (Saness, 1988) and ignore the readily available expertise in the consulting community on how to conduct public workshops, and identify/ distinguish between public issues and management concerns. For example, a historic, Army-Corps supported classic on how to develop more effective two-way communication between technical planners and the public during the water resource planning process was The Comunication-Participation Experiment in the Susquehana River Basin by Drs. Borton and Warner, Institute for Water Resources Report 70-6. As indicated in their related article in Environmental Education, edited by J. Swan and W. Stapp (Sage Publications, J. Wiley & Sons, 1974):

> The experience in the Susquehanna Study focused attention upon important points throughout the planning process where public values and preferences can be expressed. For example, values and preferences should be considered as much a part of formulating the criteria for identifying planning alternatives as they are a means for evaluating the various alternatives once they are formulated. This is particularly important since technical planners understandably tend to select and evaluate plan alternatives and strategies that are specifically authorized as "mission" responsibilities of their parent agency or that are especially "in vogue" with their peer group in the planning profession(i.e., the NED alternative). Frequently, these are not in agreement with the ideas, values, and preferences of those who are to

be directly affecteed by the plans.(p. 26B)

Another Army-Corps supported classic by MATHEMATICA, INC., "The Implications of the Net Fiscal Benefits Criterion for Cost Sharing in Flood Control Projects," an Institute for Water Resources Report for the U.S. Department of Army Corps of Engineers' Center for Economic Studies (Sep. 71), defines effective citizen participation as: "frequent interaction between the planner and various public interests" that results in the development of a set of alternative plans which satisfy the water resource problems and needs, and which are socially, politically, and environmentallly acceptable as well."

In the spirit of these Army Corps of Engineers' supported recommendations and in response to the federal requirement at 40 CFR Part 1502.9 that "if a draft statement is so inadequate as to preclude meaningful analysis, the agency shall prepare and circulate a revised draft of the apppropriate portion," I highly recommend that there be additional opportunity for public comment in the form of:

(1) another meeting (a real workshop, two-way flow of information this time), conducted by a professional, experienced facilitator (not a project proponent), in which all the questions raised and inconsistencies and inadequacies pointed out in all the public review comments submitted thus far be directly addressed, and

(2) that these comments be internalized into a revised text of a more acceptable revised Draft EIS resubmitted for written public comment again.

14. Thank you for the opportunity to comment at this time. I look forward for your specific addressal of all the concerns raised above in a return letter and revised text of the Draft EIS where appropriate.

Sincerely,

Diane Drigot

Diane Drigot, Ph.D.

Copy to:
President's Concil on Environmental Quality
Region 9, Environmental Protection Agency
Kawai Nui Heritage Foundation & other Citizen Groups
Sierra Club Legal Defense Fund
National Wildlife Federation
Other State and Federal Agencies
The Environmental Center, Univ. of Hawaii
Others

19 of 19

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 23 1992

REPLY TO ATTENTION OF:

Planning Division

Dr. Diane Drigot
Vice President
Kawai Nui Heritage Foundation
P.O. Box 1101
Kailua, Hawaii 96734

Dear Dr. Drigot:

Thank you for your two separate letters both dated June 21 on the Kawainui Marsh Draft Detailed Project Report and Draft Environmental Impact Statement for the Kawainui Marsh Flood Control Project. Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed the flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process and select a preferred alternative.

We wish to respond to your comments in the order presented in your letter.

1. The draft document conforms to Corps reporting requirements as well as State and Federal EIS requirements. It is a combined Detailed Project Report and DEIS under one cover in conformance with Corps planning guidance. It is similar to all of our Feasibility Study documents with the EIS component set in different colored paper. The draft document contains numerous supporting technical appendices for those individuals and agencies that either wish to review and comment or are required to do so. You are incorrect in stating that the document violates EIS preparation procedures. The DEIS clearly begins with the abstract and summary as recommended by CEQ regulations. The document also clearly states that although the Corps is required to identify the alternative which maximizes net flood control benefits and provides the necessary flood protection (National Economic Development Plan (NED)), a recommended plan will await public input. As stated on page 3 of the main report, "A plan other than the NED plan may be recommended. Its acceptance, however, requires an exception by the Assistant Secretary of the Army (Civil Works)."

2. We have received comment letters from over 50 reviewers of the draft document, many with valuable suggestions and thoughtful analysis. We have adjusted our analyses where appropriate in our FEIS as a result of this input. Mr. Merriam has provided some excellent input. We have addressed his comments separately.

3. The statement in our draft that says the "...best flood control solution is one which is independent of future conditions in the marsh" has resulted from analysis of the floating vegetation mat. Flood protection must be provided regardless of future conditions in the marsh. The State of Hawaii Department of Land and Natural Resources (DLNR) has agreed with this analysis in their letter to the City and County of Honolulu dated July 8, 1991.

As you know, the dense floating mat of vegetation which has evolved over the years now serves to impede and filter flood waters before they are discharged into the ocean. We and our consultants have determined that a levee raise is the only alternative that meets Corps criteria for engineering, economic and environmental factors because of: a) high construction, disposal, and maintenance costs associated with vegetation removal; b) concerns that the floating mat will block exit channels during a flood and render ineffective any flood control benefits; and c) inability to identify how much vegetation can be safely removed without jeopardizing the cleansing ability of the marsh. All these concerns contribute to our inability to rely on marsh channels to protect the residents of Coconut Grove. The design objective of 3,000 acre-feet of flood storage established for the original Corps project is no longer relevant based on our revised hydrologic analysis. Changed conditions in the marsh and watershed indicate that the required storage is now estimated at 5,400 acre-feet. The 5,400 acre-feet of flood storage is provided by the recommended levee raise project. We are seeking other authorities and funding independent of the flood control study to assist in the creation of open water in the marsh which we concur is essential to improving wildlife habitat.

4. We have consulted a number of experts with expertise in marshes and vegetation including our staff at the Aquatic Plant Control Operations Support Center, Jacksonville, Florida and the Waterways Experiment Station in Vicksburg, Mississippi. We have addressed the issue of vegetation in relation to our cost-benefit analysis.

5a-d. We have discussed the cultural values of the marsh to the extent that our project might impact these values. The views and vistas will not be impacted from the flood control project. The project will not be obtrusive. The National Register

boundary shown in Figure 10 is the official boundary of the historic site as shown on the request for eligibility submitted to the Keeper. The findings from our draft archaeological report were summarized in the DEIS appendix. It is available in final form and you were sent a copy in July, 1991. We have included the Hawaiian name attributed to Kridler's rock in the FEIS and corrected the spelling of Pohakupu.

6. Your comment about meandering waterways is noted.

7. Full compliance with Section 7 requirements at the draft stage is a correct statement in Table 3. We have received the biological opinion from the USFWS which concurred with our assessment that a levee modification would not jeopardize the continued existence of any endangered species. Compensatory wetland mitigation will be created in consultation with the USFWS and DLNR.

8. Although we have stated that the marsh clearing plan has many benefits including improved water quality in the marsh through removal of vegetation and creation of deeper water bodies in the marsh, it is likely to exact a heavy environmental toll on the receiving waters of Kailua Bay and negate any positive contributions.

9. Our analysis of the "no action" alternative addresses the issue of a continuing flood threat to residents of Coconut Grove. All applicable flood control benefits have been included in our analyses.

10. Your concern about the use of the term "imponderable" in describing the vegetation has been explained by the District Engineer, Col. Wynn when he used it at the public meeting on May 29. A transcript of the meeting is included in the appendix of the FEIS. As stated previously, many wetland and vegetation experts have been consulted in the planning stages of the flood control project including: Dr. William Zattau, Dr. Robert MacArthur, Waterways Experiment Station, and others. The Corps has considerable experience in management of vegetation in navigable waterways throughout the U.S.

11. We have evaluated the literature and analyzed core sediments in order to determine the impact of sedimentation on any loss of water storage in the wetland. Our analysis concludes that sedimentation rates differ throughout the marsh but that an average sedimentation rate in the marsh is on the order of 0.3 feet/10 years (195 acre-feet). Runoff sedimentation contributes 0.17 feet/10 years (110 acre-feet) while the vegetation contribution is estimated at 0.13 feet/10 years (85 acre-feet).

These figures are consistent with other estimates of marsh sedimentation rates with the exception of M&E Pacific's estimate of 0.9 feet/10 years which assumes a higher trap efficiency of the marsh, and an AECOS (1981) estimate of 0.003 feet/10 years which is considerably lower by several orders of magnitude. Archaeologists do not agree on the rate of infilling of the marsh or the time period in which infilling occurred. Sediment cores from the marsh have been evaluated according to age vs depth using radiocarbon dating techniques. It has been determined by Athens that infilling of the Kawainui basin diminished considerably following conversion of the basin to a freshwater marsh and the period of Hawaiian agricultural influence. This is surprising and somewhat controversial in that the report by Jane Allen-Wheeler you refer to suggests a faster rather than a slower rate of sediment accumulation for the upper layers since human habitation, suggesting that erosion from Hawaiian agricultural practices contributed to infilling of the marsh.

12. The contribution of the U.S. Marine Corps Amphibious Assault Vehicles is acknowledged. Perhaps they can be utilized again in opening waterways in the marsh for wildlife purposes.

13. Another public workshop and a rewrite of the draft document would not contribute substantially to the NEPA process. We see no reason to repeat the study process when we have evaluated alternatives and clearly identified, with public and agency input, a federally implementable solution for flood protection at Kawainui Marsh. During our Kawainui Marsh Flood Control Study, we have held two public meetings, two public workshops, and nine ad hoc committee meetings, many of which you attended. The Environmental Protection Agency has indicated that a final environmental impact statement that addresses all comments and concerns raised through the public input process would be a more expedient means to accommodate the NEPA process.

You have been under the impression that the Corps is in a "firm position to invest in the raise levee alternative rather than a mix of flood control alternatives which include vegetation removal, open water/channel creation, and sediment removal". Our April 1991 Draft DPR/EIS clearly states that the baseline conditions of the flood control project must reflect the open water channels that our local sponsor, the City and County, is presently creating. In addition, our final EIS includes suggestions for sedimentation control including harvesting of vegetation and other "Best Management Practices" for controlling non-point source pollution to the wetland, although beyond our authority for flood control purposes. Kawainui Marsh has served as an invaluable protector of the water quality of Kailua Bay by filtering storm water and treated effluent prior to exiting

the marsh and entering the receiving waters of the Bay. Great care must be taken not to jeopardize this natural buffer.

In 1988 we examined several alternatives for providing immediate relief following the New Years' 1988 flood in a draft Environmental Assessment which you discuss in some of your letters to our Congressional delegates. We held several workshops prior to the preparation of that draft and a public meeting to receive public comment. The urgency for relief which we believe still exists today was reflected in our recommendation at the time to clear vegetation and sediment from an open channel to directly connect with the Oneawa Channel and the bay. We identified many concerns including water quality impacts. Since that time, the City and County of Honolulu has completed NEPA documentation to construct a similar channel in the marsh as proposed in 1988, albeit much narrower, but not connect it to Oneawa Channel for environmental and hydrologic reasons. We have supported this effort and in many ways believe the additional time has enabled greater analysis of potential impacts. Unfortunately, because the City's channel does not connect to Oneawa Channel it cannot perform sufficient flood control to prevent the levee from overtopping. Thus, we have pursued analysis of levee modifications, among other alternatives, resulting in the April 1991 Draft EIS, jointly with the City and County of Honolulu.

We evaluated an alternative provided by your organization, the Kawai Nui Heritage Foundation, which would result in over 75 acres of open water interconnecting channels. This alternative still required a levee raise. Corps analysis, including our laboratories on the mainland, of this and the other in-marsh alternatives concluded that the channels would not be reliable during flood events, that the costs associated with these alternatives were too high to warrant federal participation, and that the potential water quality impacts to Kailua Bay were too great a risk.

As previously stated, although the Corps is required to identify and recommend the NED plan, provisions are available for selecting a different plan if approved by the Assistant Secretary of the Army for Civil Works. Consequently, after consideration of engineering, environmental, and economic factors as well as agency and public input, the Corps and the City and County of Honolulu have selected a modification to the NED plan which combines the earth levee raise with a much lower floodwall and fills less than two acres of wetland. The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side. We seek the necessary approval and develop compensatory wetland mitigation to include conversion of fastland in the marsh near the levee to new wetland habitat. A levee raise will not preclude future marsh management scenarios although marsh management activities must be compatible with the flood control function of the marsh.

There has been sustained and useful citizen input by yourself and many others throughout the planning stages of the project. Thank you for acknowledging our involvement of your organization in the planning stages of the flood control project. We value and require this interaction. Such community interaction has been occurring since the 1988 flood through a series of public workshops, meetings and seminars sponsored by the Corps. I am hopeful that upon completion of this process we shall have a flood control project that you will support.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

University of Hawaii at Manoa

Environmental Center
A Unit of Water Resources Research Center
Crawford 317 • 2550 Campus Road • Honolulu, Hawaii 96822
Telephone: (808) 956-7361

June 22, 1991
RE:0585

Mayor, City and County of Honolulu
c/o Department of General Planning
650 South King Street
Honolulu, Hawaii 96813

Dear Mayor Fasi:

Draft Environmental Impact Statement (DEIS)
Kawainui Marsh Flood Control Project
Koolaupoko, Oahu

This project intends to provide flood protection to the Coconut Grove residential community located in the town of Kailua. Presently, Kawainui Marsh is a natural 640 acre flood control basin, with a 6,850 foot long protective earthen levee, and a 9,470 foot long channel (Oneawa Channel) which runs from the northern end of the marsh into Kailua Bay. Flood protection improvements are being made by the City and County of Honolulu by opening 10,000 linear feet of waterway and creating approximately 30 acres of open water to distribute and store stormwater runoff more efficiently and reduce the potential for flooding. Floodwaters overtopped the existing levee and flooded homes in Coconut Grove on January 1, 1988, indicating the necessity of the additional protection which the City and County of Honolulu and Corps of Engineers propose through this project. The following alternatives have been evaluated in an effort to develop plans to reduce the flood hazard: 1) construction of 23,760 linear feet of meandering waterways with a 76 acre area connected to Oneawa Channel by way of a water control structure; 2) raising the height of the existing levee by 6 to 8 feet; 3) construction of a concrete floodwall on top of the existing levee which would raise the height of the existing levee 6 to 8 feet; 4) construction of a single open waterway along the Quarry Road side of the marsh connecting to Oneawa Channel by way of a water control structure; 5) construction of an additional levee on the Coconut Grove side of the levee; 6) floodproofing homes subject to flooding in Coconut Grove by raising ground floor levels above the flood hazard; 7) no action or Corps-sponsored improvements; City and County of Honolulu will nevertheless implement the proposed vegetation removal plans to better disperse water within the marsh.

RECEIVED

Our review and subsequent comments on the Kawainui Marsh Flood Control Project were prepared with the assistance of Paul Ekern, (Emeritus) Water Resources Research Center; Michael Graves, Anthropology; and Alex Buttaro of the Environmental Center.

Archaeology

Our reviewers expressed serious concern over the lack of sufficient archaeological information and documentation that should have been provided in the DEIS. If Mr. Athens' letter in Appendix I is merely a summary, we recommend the full length report be provided as an appendix to the Final EIS (FEIS).

Sedimentation

Our reviewers note that this document should have a more thorough analysis of sedimentation rates in order to better address the problem and costs of maintenance of channels and waterways in the Marsh.
Sedimentation rate estimates based soley on core samples need to be better defended, since the rates of sediment input, in-basin storage, and final output are critical determinants of the channel capacity. A sediment balance should be included in the FEIS consisting of the aforementioned considerations.

In light of the fact that one of the main natural functions of the Marsh is sediment trapping, our reviewers found that a major deficiency of this document is its inadequate assessment of the sediment balance.

A summary of the sediment curves from the 1990 FEIS, and annual rates of sediment produced through normal weathering processes in the watershed should be included in the appropriate sections describing sedimentation.

Our reviewers expressed concern over the scarcity of information discussing and documenting the potential effects of marsh and channel clearing and dredging upon Kailua Bay. Both the City and County's and this project's marsh clearing alternatives may result in significant increases in the rate of sediment delivery to Kailua Bay during peak flows. To what extent will sedimentation of Kailua Bay occur for the various alternatives, and what environmental consequences are associated with each?

Water Budget

Section 3.2.1 (page 26) mentions studies by Swars and Smith which arrived at similar water budget figures. However, a City and County estimation follows which appears to contradict the evapotranspiration to water input ratio of the two previously cited studies. The City and County estimates that evapotranspiration is equal to the marsh inflow, while the two other studies estimate inflow to be 300% higher than evapotranspiration. How is this contradiction reconciled, what are the numerical water budget figures arrived at by the City and County, and which figures more accurately describe the actual water budget? We assume the figures given are based on an average calculation over an extended period of time. However, because the water budget for low and high flow extremes is of much greater importance to this project, an accurate estimation of such extremes should be included in the FEIS.

Engineering and Cost Analyses

Our reviewers noted numerous discrepancies, contradictions, and inconsistencies in the analyses of the requirements and costs of the various alternatives offered in Appendix B.

For instance, why does it cost $30 per cubic yard to remove gravel for the floodwall, and $16 per cubic yard for the levee raise alternative?

Why did the levee overflow studies use a level of 5.5', instead of the 9' level used for the other alternatives (Appendix B, Plates 53-57)?

We noted many more estimations which were unclear or confusing, and therefore, we suggest the entire engineering cost analysis be more clearly and thoroughly presented.

December 31, 1987 - January 1, 1988 Flood

Our reviewers suggested that it may be useful to note the tidal level during the New Year's Eve flood of 1988. Did the Marsh flood during high tide?

Visual Impact (Aesthetics)

The photos provided in Figure 3 of the project report might be used to reflect the visual impact of the proposed concrete wall if the wall was artificially inserted through computer generation or by photographic "doctoring."

What will be the visual impact of the concrete wall and various levee options upon open space between Coconut Grove and the Marsh, and the larger resource management area?

The earthen levee currently consists of a very light colored fill that some reviewers have found aesthetically displeasing and lacking visual continuity with the surrounding green areas. If the earthen levee alternative is chosen, will earth tone (brownish) fill be used rather than the "high-contrast" color used on the existing levee. If the raised levee fill is to be the same color, we would consider this to be a negative visual impact that was not disclosed in the document.

Following a description of the Corp's visual impact assessment (VIA), the statements are made that aesthetic assessments are "largely subjective," and "the use of the visual impact analysis is extremely

difficult" (Section 4.9, pages 63-64). Do the aesthetic impact descriptions in the following sections reflect a VIA analysis, and, if so, were the conclusions from that analysis sufficient in light of the VIA difficulty and subjectivity disclaimers? Although visual impacts of the concrete floodwall and earthen levee described from the perspective of Coconut Grove residents is very important, we find that, given the large dimensions of the earthen levee and concrete floodwall, their assessment from all surrounding viewplanes is at least equally important and warrants analysis. The more comprehensive and "holistic" analysis we suggest is necessitated by this area's important open space and environmental continuity considerations. The entire area is an aesthetic resource for its many residents and the Hawaii tourist industry, and therefore it follows that extended visual impacts of the levee have broad social and economic implications on community and state levels respectively.

Why were there no aesthetic assessments comparing the varying wall height alternatives? What is the aesthetic difference between the levee, the concrete wall, and the lower wall described in the marsh clearing alternative?

Historic Life Cycle of the Marsh

Our reviewers note the DEIS lacked an analysis of the pre-Hawaiian vegetation and the effect of early slash and burn practices on sedimentation rates from the years 750 to 1250 AD. We note that studies done on Molokai (Riley, T. 1973. Wet and Dry in a Hawaiian Valley. Dissertation Submitted to the Graduate Division of the University of Hawaii) during this period and in Pearl Harbor approximately 650 to 700 years ago (Ruhe, R. 1965. Nature of Parent Materials in Oahu, Hawaii. Soil Science Society Proceedings) show a burst in sedimentation rates associated with these agricultural practices.

When did California Grass come to dominate the Marsh area? This information may be important in assessing the historical sedimentation of the Marsh and could facilitate assessment of marsh sedimentation rates and maintenance costs.

Unspecified Commitment to Mitigation

Our reviewers were disturbed by the extensive use of the word "should" throughout the DEIS, when describing mitigative measures for potentially serious environmental problems. We find the use of this word vague, indefinite, and unsettling. Although not mandated by EIS Rules, it is in the best spirit of development actions and environmental considerations to inform the decisionmaker as to what impacts "will" or "would" be taken in the event of serious environmental damage. Our reviewers find the language used unsettling, because it implies that some of the mitigative measures proposed may not be implemented in the event of a serious environmental crisis caused or contributed to by this project.

Confusing Format of the DEIS document

Our reviewers generally were unsure of the purpose of the Main Report located in approximately the first 40 pages of this document. A DEIS normally does not incorporate a format with a "Main Report" prefacing the required DEIS disclosures. This Report is confusing to the reader, because the document neglects qualification of its significance in the context of the DEIS as a whole. The reader and decisionmaker may misinterpret the Main Report as a functional component the DEIS, when it actually endorses the Army Corp's position in favor of the concrete floodwall (Plan 2). Section 11-200-13 of Title 11 EIS Rules, specifically prohibits project advocacy in EIS's, and although the front section is labeled as a "Main Report," it may be misunderstood as part of the EIS document and therefore reflective of EIS guidelines, informational structure, and content requirements, which it is not. At a minimum, the purpose of this section should be appropriately explained prior to the syllabus, and its relation to the EIS should be clearly contextualized. Additionally, since this is primarily a DEIS, the Main Report should either follow the DEIS report or be issued under a seperate cover so as to minimize confusion.

While maintaining separate tables of contents for different parts of a document is understandable, it is highly unconventional for a book or document to neglect a table of contents that summarizes the entirety of its contents, as is the case with this DEIS. This structural deficiency should be corrected in the FEIS.

Our reviewers had difficulty with the general document structure which they referred to as "tedious" and "confusing." These comments may reflect, in part, the duplicity of information and different purposes of the DEIS and Main Report. The reader should not have to wade through both these reports and should be clearly directed where to go to obtain appropriate EIS information. Section 11-200-17 of the Rules addresses EIS style, and states,

> "In developing the EIS, preparers shall make every effort to convey the required information succinctly in a form easily understood, both by members of the public and by public decision makers."

Additionally, Section 1502.8 of NEPA regulations requires that the EIS be documented in plain english so that the public may clearly understand the significance of the proposed action.

Given the fact that Environmental Center reviewers had difficulty understanding the format of this document, in can be reasonably induced that the public at large may also find it confusing, therefore warranting appropriate clarifications in the FEIS.

Physical Makeup of DEIS Document

We highly commend the preparers of this document for using recycled paper in its manufacture. However, we did encounter difficulties with the pages and front and back covers tearing off due to the sharp edges of the metal binding rods. A different binding which better preserves the physical integrity of the document should be considered for incorporation in future EIS preparations.

Lack of Consideration for the Future

The "Main Report" states, "The purpose of this study is to evaluate the need to modify the Kawainui Marsh Flood Control project because of changed conditions in the drainage basin (section 2.1, page 1). Our reviewers were therefore surprised by the apparent contradictions in sections 4.1 (page 3), and 4.10.1 (page 12) of the "Main Report," which both stated the Corp's "best" and "preferred" flood control solution is "one which is independent of future conditions in the marsh." How can the Kawainui Marsh flood plan claim to offer protection 100 years into the future, and similtaneously ignore future marsh conditions in design considerations? Do the project design plans and decisions incorrectly assume the Marsh is a static entity? Do other future and potential uses and plans for the marsh have no bearing upon the project choice?

National Economic Development (NED) Plan

The statement is made that "The NED objective is achieved by increasing the value of the nation's output of goods and services and improving national economic efficiency" (section 4.2, page 3 of the "Main Report"). The Army Corps should offer a better explanation that describes the applicability and importance of such national economic priorities to Kawainui Marsh. Our reviewers had difficulty understanding how the very different and apparently contradictory goals of optimizing national economic efficiency, and local environmental, social, and cultural policies will be reconciled. Does the Army Corps intend to recommend the NED plan, and if so, on what basis are other non-NED considerations subordinated to this plan?

Coastal Zone Management Act

Although the Coastal Zone Management (CZM) objective of reducing hazard to life and property from flooding is well addressed in the design alternatives, other CZM objectives need to be considered. The FEIS should adequately address the manner in which this project's alternatives will impact the CZM objectives of minimizing disruption and degradation of wildlife habitat, preserving valuable coastal ecosystems with significant biological importance, promotion and preservation of recreational access and opportunities, preservation of water quality, ensuring that new developments are compatible with their visual environment, and preservation of historical resources.

Kawainui Marsh Resource Management Plan

The Final EIS should more thoroughly disclose the impacts of the various alternatives upon the objectives of the Kawainui Marsh Management Plan, which seeks to protect compatible natural, cultural, and economic resources through management and control of existing and future land uses, to provide for public use and enjoyment of the existing and potential resources of the Marsh, and to provide for a centralized and consistent means for reviewing and regulating land use and development in the primary study area.

Relative Importance and Applicability of Pertinent Plans and Policies

We had difficulty understanding this document's representation of the interrelationships and conflicts of the several environmental and economic plans and policies applicable to this marsh project. A comparison of overlapping and conflicting goals between the NED plan, the Hawaii Waterbird Recovery Team plan, and the CZM and Kawainui Marsh Resource Management Plans should be clearly presented so as to help balance and lend insight into each plan's relative importance and relationship to one another.

General Summary

Our reviewers expressed serious concern over various aspects of the DEIS's structure and format which they found to be very confusing and difficult to read. We also found the discussion of various environmental and economic policy considerations very difficult to understand without comparisons between each to determine their relative importance to the Project. Additional information, studies, and analyses should be provided on sedimentation, water budgeting, archaeology, aesthetics, costs, and benefits in the FEIS. The justifications for these requests are provided by EIS Rules Sections 11-200-14, 11-200-16, and 11-200-17, which require that relevent data be obtained, necessary studies be conducted, and all relevant and feasible consequences and implications of an action be disclosed and evaluated.

By combining existing alternatives and incorporating input acquired through this phase of the EIS process, the Corps should be able to synthesize some creative and "holistic" new approaches to be offered as additional alternatives in the FEIS.

The floodwall atop the levee alternative does not incorporate any

clearing of marsh vegetation other than what is proposed by the City and County of Honolulu. We are very concerned that this plan may not adequately address the serious underlying problem of Marsh eutrification and vegetative buildup resulting from natural and human processes.

This project presents an excellent opportunity for the Army Corps of Engineers to implement a plan which is sound from both engineering and environmental perspectives, and which also considers seriously the unique and extremely valuable cultural and environmental resources of Kawainui Marsh.

Thank you for the opportunity to review this document and we hope you will find our comments helpful.

Sincerely,

John T. Harrison, Ph.D.
Environmental Coordinator

cc: OEQC
Department of General Planning
✓U.S. Army Corp of Engineers
Department of Public Works
Roger Fujioka
Paul Ekern
Michael Graves
Alex Buttaro

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

JUL 23 1992

REPLY TO ATTENTION OF:

Planning Division

Dr. John Harrison
Environmental Coordinator
University of Hawaii at Manoa
Environmental Center
Crawford 317
2550 Campus Road
Honolulu, Hawaii 96822

Dear Dr. Harrison:

We wish to respond to your letter to Mayor Frank Fasi dated June 22, 1991 regarding the Draft Environmental Impact Statement for the Kawainui Marsh Flood Control Project. Since receiving public and agency comment letters in June 1991, we have evaluated the extensive public input, initiated additional study efforts, and discussed flood control alternatives with the City and County of Honolulu. Response to all comments received has been deferred until now in order to complete the study process, be as responsive to the reviewers as possible, and select a preferred alternative.

We wish to respond to your comments in the order presented in your letter.

<u>Archaeology</u>:

The draft archaeological report which is summarized in the DEIS appendix is now available in final form. A copy can be obtained upon request. There will be no impact to historic properties from the levee modification alternatives.

<u>Sedimentation</u>:

We have evaluated the literature and analyzed core sediments in order to determine the impact of sedimentation on any loss of water storage in the wetland. We have prepared a sediment analysis which is included in our FEIS. Our analysis concludes that sedimentation rates differ throughout the marsh but that an average sedimentation rate in the marsh is on the order of 0.3 feet/10 years (195 acre-feet). Runoff sedimentation contributes 0.17 feet/10 years (110 acre-feet), while the vegetation contribution is estimated at 0.13 feet/10 years (85 acre-feet).

These figures are consistent with other estimates of marsh sedimentation rates with the exception of M&E Pacific's estimate of 0.9 feet/10 years which assumes a higher trap efficiency of the marsh, and an AECOS (1981) estimate of 0.003 feet/10 years (2 acre-feet) which is considerably lower by several orders of magnitude. Our information obtained from soil borings, bottom surveys and work on the Kaneohe Dam suggests that there is minimum soil deposition that would affect flood storage.

Archaeologists do not agree on the rate of infilling of the marsh or the time period in which infilling occurred. Sediment cores from the marsh have been evaluated according to age vs depth using radiocarbon dating techniques. It has been determined by Athens that infilling of the Kawainui basin diminished considerably following conversion of the basin to a freshwater marsh and the period of Hawaiian agricultural influence. This is surprising and somewhat controversial in that the work of Jane Allen-Wheeler suggests a faster rather than a slower rate of sediment accumulation for the upper layers since human habitation, suggesting that erosion from Hawaiian agricultural practices contributed to infilling of the marsh.

As you know, Kawainui Marsh has evolved the dense floating mat of vegetation over the years which now serves to impede and filter flood waters before they are discharged into the ocean. We and our consultants have determined that a levee raise is the only alternative that meets Corps criteria for engineering, economic and environmental factors because of: 1) high construction, disposal, and maintenance costs associated with vegetation removal; 2) concerns that the floating mat will block exit channels during a flood and render ineffective any flood control function; and 3) inability to identify how much vegetation can be safely removed without jeopardizing the cleansing ability of the marsh. All these concerns contribute to our decision not to rely on marsh channels to protect the residents of Coconut Grove from flooding.

<u>Water Budget</u>:

Our hydrology is devoted to flood flow analysis. A detailed water budget is not necessary to the design of the flood control project. We have included information that presently exists with respect to normal flow conditions in the marsh. We cannot comment on the differences associated with various research findings.

Engineering and Cost Analyses:

The engineering and cost analysis has been revised and updated for the final report. Many of the items in the cost estimate have not changed such as the cost of gravel removal for the floodwall and levee raise alternatives. The cost estimates show $30 per cubic yard to remove gravel for the floodwall and $16 per cubic yard for the levee raise because the gravel must be hauled away for the floodwall but can be used as fill material for the levee raise. The cost of hauling and disposal is $14 per cubic yard. The overflow studies used 6.5 feet msl for the initial water surface elevation, not 5.5 feet msl as shown in the report. This typographical error has been corrected for the final report. The 6.5 and 9.0 feet msl initial marsh water surface elevations were used as minimum and maximum starting elevations for a sensitivity analysis. The 6.5 feet msl elevation was used for design.

December 31, 1987- January 1,1988 Flood:

The highest tide level reached on New Year's Eve 1988 was about 2.4 feet msl which corresponds to high tide level. This high tide level was used in the overall project design.

Visual Impact (Aesthetics)

The present levee is constructed of material dredged from Oneawa Channel. The "high contrast" color you refer to is unclear. Perhaps you are referring to the grey rock spread on the top of the levee to promote maintenance vehicle access.

A quantitative VIA analysis was not performed. We agree that the open space and environmental continuity aspects of the levee should be maintained. The levee modification alternatives will not be visually obtrusive or displeasing. The preferred alternative will be landscaped to blend into the surrounding environment. The floodwall will be colored and textured on the marsh side and will resemble a moss rock wall on the Coconut Grove side. A visual representation will be presented in the FEIS.

Historic Life Cycle of the Marsh:

Please see comments under archaeology and sedimentation above.

Unspecified Commitment to Mitigation:

The EIS is not the forum to commit to mitigation. It is intended to provide environmental information to the decision maker. It recommends mitigation to reduce impacts that are identified. We are unable to guarantee that mitigation proposed in the EIS will, in fact, be implemented. The Record of Decision, however, will detail the mitigation to be implemented and will be signed following the 30 day public review period for the FEIS.

Confusing Format of the DEIS document:

The draft document conforms to Corps reporting requirements as well as State and Federal EIS requirements. It is a combined Detailed Project Report and DEIS under one cover in conformance with Corps planning guidance. It is similar to all of our other Feasibility Study documents that you have reviewed with the EIS component set in different colored paper. The draft document contains numerous supporting technical appendices for those individuals and agencies that either wish to review and comment or are required to do so. This adds to its size and confusion as well as introducing some redundancy. Our final document will be of a different format with an integrated report and FEIS under a single cover. We hope that this new format will be more readily understood.

Physical Makeup of DEIS Document:

Binding costs were kept to a minimum in the draft. We hope that the final document will present less difficulty in this area.

Lack of Consideration for the Future:

We do not believe that the statements you refer to are contradictory in nature. Flood protection must be provided regardless of future conditions in the marsh. We have not ignored future marsh conditions, but since they cannot be accurately predicted or controlled, the flood control solution must work nevertheless. That is the intent behind the statement regarding "independent of future conditions in the marsh".

National Economic Development Plan (NED):

Although the Corps is required to identify and recommend the plan that maximizes net benefits (NED), provisions are available for selecting a different plan if approved by the Assistant Secretary of the Army for Civil Works. Consequently, after careful consideration of engineering, environmental, and economic factors as well as agency and public input, the Corps along with the City and County of Honolulu have selected a modification to the NED plan which combines the earth levee raise with a much lower floodwall and fills less than two acres of wetland. We shall seek the necessary approval and develop compensatory wetland mitigation to include conversion of fastland in the marsh to new wetland habitat.

Coastal Zone Management Act:

We refer you to the CZM Consistency Determination in our FEIS which addresses the flood control project in relationship to CZM objectives and policies. Our preferred alternative was developed from input received by the Office of State Planning which oversees the State CZM program.

Kawainui Marsh Resource Management Plan:

Flood control improvements are an integral component of the Kawainui Resource Management Plan. Although many reviewers had hoped that the flood control project could help implement this Plan or assist in obtaining information of relevance to the Plan, we do not believe that our planning process is the forum in which to obtain such information. A modification to the existing levee will not preclude future marsh management scenarios, although marsh activities must be compatible with its flood control function.

Relative Importance and Applicability of Pertinent Plans and Policies:

Our authority for this study limits us to flood control. The other plans you mention primarily address resource management or enhancement. Our flood control authority cannot be used to implement these resource management plans. The preferred alternative will not preclude future marsh management scenarios.

General Summary:

We believe that we have obtained all the information necessary to evaluate the environmental impacts of the proposed project alternatives and have presented these in our FEIS. The modification to the NED plan is a compromise solution which should be acceptable to the public. We shall continue to explore other potential authorities for creating open water in the marsh for wildlife purposes.

Thank you again for the Environmental Center's comments and detailed review.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copy Furnished:

City and County - DPW

DOCUMENTS DEPARTMENT · KS
THE LIBRARIES
COLORADO STATE UNIVERSITY
FORT COLLINS, CO 80523
(303) 491-1879

June 20, 1991

U.S. Army Engr. Dist., Honolulu
Ft. Shafter, 96858-5440

Dear Margo Stahl:

If available, please send us one copy of the following document. The citation for it is listed in the May 3, 1991 Federal Register. (We have the citation. Please send the document).

Draft Environmental Impact Statement, Kawainui Marsh Flood Control Project, Coconut Grove Residential Area, Implementation, Island of Oahu, City and County of Honolulu, HI

including all supporting appendices and documents.

Please inform us, before sending, if there is a charge, or if you cannot supply. Please return a copy of this letter with your reply.

Thank you.

Fred C. Schmidt

Fred C. Schmidt
Head, Documents Dept.

FCS/kls

STATE OF HAWAII
DEPARTMENT OF HUMAN SERVICES
HAWAII HOUSING AUTHORITY
P. O. BOX 17907
HONOLULU, HAWAII 96817

IN REPLY REFER TO:
91:PLNG/797

June 20, 1991

Mr. Kisuk Cheung
Director of Engineering
Department of the Army
Commander, Honolulu Engineer District
Fort Shafter, Hawaii 96858-5440

Dear Mr. Cheung:

RE: KAWAINUI MARSH FLOOD CONTROL PROJECT - EIS

Thank you for the opportunity to review the Kawainui Marsh flood control project. We find that the proposed alternate solutions to the flood problem do not impact any of our housing projects and support the intent of the proposed action to augment flood protection for the community of Coconut Grove.

Please contact either myself (848-3230) or Liana Tamura (848-3255) should you have any questions or need further assistance.

Sincerely,

MITSUO SHITO
Executive Director

JOHN WAIHEE
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF DEFENSE
OFFICE OF THE ADJUTANT GENERAL
3949 DIAMOND HEAD ROAD, HONOLULU, HAWAII 96816-4495

EDWARD V. RICHARDSON
MAJOR GENERAL
ADJUTANT GENERAL

MYLES M. NAKATSU
COLONEL
DEPUTY ADJUTANT GENERAL

May 16, 1991

Engineering Office

Mr. Kisuk Cheung
Director of Engineering
U.S. Army Engineer District, Honolulu
Building 230
Fort Shafter, Hawaii 96858-5440

Dear Mr. Cheung:

Kawainui Marsh Flood Control Project.

Thank you for providing us the opportunity to review the above subject project.

We have no comments to offer at this time regarding this project.

Sincerely,

Jerry M. Matsuda

Jerry M. Matsuda
Lieutenant Colonel
Hawaii Air National Guard
Contracting & Engineering Officer

cc: CEPOD-EDOPV

NATIONAL GUARD
Americans At Their Best.

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

June 14, 1991

TO: BENJAMIN B. LEE, CHIEF PLANNING OFFICER
DEPARTMENT OF GENERAL PLANNING

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

SUBJECT: DRAFT ENVIRONMENTAL IMPACT STATEMENT DATED APRIL 1991 REGARDING THE PROPOSED KAWAINUI MARSH FLOOD CONTROL PROJECT, TMK: 4-2-16: 1; 4-2-13: 22

We have no objections to the proposed Kawainui Marsh Flood Control Project. The proposed project will not affect our water system facilities.

If you have any questions, please contact Bert Kuloka at 527-5235.

cc: ✓Corps of Engineers
Department of Public Works
OEQC

JOHN WAIHEE
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
SEVEN WATERFRONT PLAZA, SUITE 300
500 ALA MOANA BOULEVARD
HONOLULU, HAWAII 96813
FAX (808) 543-2641

JOSEPH K. CONANT
EXECUTIVE DIRECTOR

IN REPLY REFER TO:
91:PLNG/2804jt

June 17, 1991

TO: Dept. of General Planning
City & County of Honolulu

FROM: Joseph K. Conant
Executive Director

SUBJECT: Detailed Project Report and Environmental Impact Statement for the Kawainui Marsh Flood control Project.

Thank you for the opportunity to review the subject report. We have no comments to offer.

JKC/JT:eks

c: U.S. Army Corp of Engineers
Dept. of Public Works, C&C, Honolulu
Office of Environmental Quality Control (with EIS)

POLICE DEPARTMENT
CITY AND COUNTY OF HONOLULU

FRANK F. FASI
MAYOR

MICHAEL S. NAKAMURA
CHIEF

HAROLD M. KAWASAKI
DEPUTY CHIEF

OUR REFERENCE SG-LK

June 7, 1991

TO: BENJAMIN B. LEE, CHIEF PLANNING OFFICER
DEPARTMENT OF GENERAL PLANNING

FROM: MICHAEL S. NAKAMURA, CHIEF OF POLICE
HONOLULU POLICE DEPARTMENT

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT (EIS) FOR KAWAINUI MARSH FLOOD CONTROL, KAILUA, OAHU, TMK: 4-2-16:1; 4-2-13:22

We have reviewed the above-referenced EIS and support the flood control improvement program for the Kawainui Marsh.

Although we have no comments to offer at this time, please keep us informed of the project development. We can then respond more appropriately as to the impact the selected plan would have on police services in the area.

Thank you for the opportunity to provide comments.

MICHAEL S. NAKAMURA
Chief of Police

By Barry N. Fujii
BARRY N. FUJII
Acting Assistant Chief of Police
Support Services Bureau

cc: U.S. Army Corps of Engineerv
Department of Public Works
OEQC

JOHN WAIHEE
GOVERNOR

CHARLES T. TOGUCHI
SUPERINTENDENT

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

OFFICE OF THE SUPERINTENDENT

May 21, 1991

Commander, Honolulu Engineer District
ATTN: CEPOD-ED-PV
Ft. Shafter, Hawaii 96858-5440

Dear Sir:

SUBJECT: Kawainui Marsh Flood Control Project Report and Draft Environmental Impact Statement Kailua, Island of Oahu, Hawaii

Our review of the subject project indicates that it will have negligible impact on the public schools in the area.

Thank you for the opportunity to comment.

Sincerely,

for Charles T. Toguchi
Superintendent

CTT:jl

cc: T. Nakai
S. Loo

AN AFFIRMATIVE ACTION AND EQUAL OPPORTUNITY EMPLOYER

BUILDING DEPARTMENT
CITY AND COUNTY OF HONOLULU
HONOLULU MUNICIPAL BUILDING

FRANK F. FASI
MAYOR

HERBERT K. MURAOKA

PB 91-588

May 16, 1991

Commander, Honolulu Engineer District
Attn: CEPOD-ED-PV
Ft. Shafter, Hawaii 96858-5440

Gentlemen:

Subject: Kawainui Marsh Flood Control Project Draft Detailed Project Report and Draft Environmental Impact Statement

This is in response to your letter dated April 22, 1991. We have reviewed the subject document and have no comments to offer.

Thank you for the opportunity to review the document.

Very truly yours,

HERBERT K. MURAOKA
Director and Building Superintendent

cc: J. Harada
General Planning Dept.
Public Works Dept.
Office of Environmental Quality Control

JOHN WAIHEE
GOVERNOR
BRIG. GEN. EDWARD V. RICHARDSON
DIRECTOR OF CIVIL DEFENSE
ROY C. PRICE, SR.
VICE DIRECTOR OF CIVIL DEFENSE

STATE OF HAWAII
DEPARTMENT OF DEFENSE
OFFICE OF THE DIRECTOR OF CIVIL DEFENSE
3949 DIAMOND HEAD ROAD
HONOLULU, HAWAII 96816-4495

PHONE (808) 734-2161

May 13, 1991

HICOPO

Commander
Honolulu Engineer District
Building 230
Fort Shafter, Hawaii 96858-5440

ATTENTION: CEPOD-ED-PV

Dear Sir:

We have reviewed the April 1991 joint Federal and City and County of Honolulu Draft Detailed Project Report and Draft Environmental Impact Statement for the Kawainui Marsh Flood Control Project and have no comments to offer.

Sincerely,

ROY C. PRICE, SR.
Vice Director of Civil Defense

(P)1525.1

MAY 16

City and County of Honolulu
Department of General Planning
650 South King Street
Honolulu, Hawaii 96813

Gentlemen:

Subject: Kawainui Marsh Flood Control
Kailua, Oahu
DEIS

Thank you for the opportunity to review the subject document. We have no comments to offer.

Should there be any questions, please have your staff contact Mr. Ralph Yukumoto of the Planning Branch at 548-7192.

Very truly yours,

TEUANE TOMINAGA
State Public Works Engineer

RY:bk
cc: Honolulu District Engineer, U.S. Army Corps of Engineer
OEQC

... 2 133

JOHN WAIHEE
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF DEFENSE
OFFICE OF THE ADJUTANT GENERAL
[illegible] DIAMOND HEAD ROAD, HONOLULU, HAWAII [illegible]

EDWARD V. RICHARDSON
BRIGADIER GENERAL
ADJUTANT GENERAL

MYLES M. NAKATSU
COLONEL
DEPUTY ADJUTANT GENERAL

May 16, 1991

Engineering Office

Mr. Kisuk Cheung
Director of Engineering
U.S. Army Engineer District, Honolulu
Building 230
Fort Shafter, Hawaii 96858-5440

Dear Mr. Cheung:

Kawainui Marsh Flood Control Project

Thank you for providing us the opportunity to review the above subject project.

We have no comments to offer at this time regarding this project.

Sincerely,

Jerry M. Matsuda
Jerry M. Matsuda
Lieutenant Colonel
Hawaii Air National Guard
Contracting & Engineering Officer

cc: CEPOD-EDOPV

NATIONAL GUARD
Americans At Their Best.

Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 9684[illegible]

William A. Bonnet
Manager
Environmental Department

ENV 2-1
EIS
JA/G

May 22, 1991

Commander
Honolulu Engineer District
Attention: CEPOD-ED-PV
Fort Shafter, Hawaii 96858-5440

Dear Commander:

Subject: Joint Federal and City and County of Honolulu Draft Detailed Project Report and Draft EIS for Kawainui Marsh Flood Control Project

We have reviewed the subject DEIS, and have no comments at this time on the proposed development in the subject area. HECO shall reserve comment pertaining to the protection of existing power lines bordering the development area until construction plans are finalized.

Sincerely,

William A. Bonnet

An HEI Company

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

IN REPLY REFER TO
11000
Ser 00F2(238)/1348
28 MAY 1991

From: Commander Naval Base, Pearl Harbor
To: Commander, Honolulu Engineer District (CEPOD-ED-PV)

Subj: DRAFT DETAILED PROJECT REPORT (DDPR) AND DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS) FOR THE KAWAINUI MARSH FLOOD CONTROL PROJECT

Ref: (a) CDRUSAEDPO (HD) Planning Division ltr of 22 Apr 91

1. We have reviewed the combined subject DDPR and DEIS forwarded by reference (a) and have no comments to offer.

2. Thank you for the opportunity to review the draft document and request a copy of the final document.

W.K. Lew

W. K. LEE
By direction

DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
HONOLULU MUNICIPAL BUILDING
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

JOSEPH M. MAGALDI, JR.
DIRECTOR

AMAR SAPPAL
DEPUTY DIRECTOR

TE-2554
PL91.1.169

May 30, 1991

MEMORANDUM

TO: BENJAMIN B. LEE, CHIEF PLANNING OFFICER
DEPARTMENT OF GENERAL PLANNING

FROM: JOSEPH M. MAGALDI, JR., DIRECTOR

SUBJECT: KAWAINUI MARSH FLOOD CONTROL
DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)
TAX MAP KEY: 4-2-16: 1; 4-2-13: 22

This is in response to the DEIS submitted for our review by the Office of Environmental Quality Control on May 9, 1991.

Based on our review, we have no objections to the subject project at this time.

Should you have any questions, please contact Lance Watanabe of my staff at local 4199.

JOSEPH M. MAGALDI, JR.

cc: Department of Public Works
U. S. Army Corps of Engineer
Office of Environmental Quality Control

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

P. O. BOX 50004
HONOLULU, HAWAII
96850

May 24, 1991

Mr. Kisuk Cheung
Director of Engineering
US Army Corps of Engineers
Honolulu District
Building 230
Ft. Shafter, Hawaii 96858-5440

Dear Mr. Cheung:

Subject: Draft Detailed Project Report and Draft Environmental Impact Statement (DEIS) - Kawainui Marsh Flood Control Project, Kailua, Oahu, Hawaii

Thank you for letting us review the above-mentioned document. We have no comments to offer at this time and would appreciate the opportunity to review the final EIS.

Sincerely,

ACTING
WARREN M. LEE
State Conservationist

cc:
City and County of Honolulu, Department of General Planning for the Mayor of Honolulu, 650 South King Street, Honolulu, HI 96813
Honolulu District Engineer, US Army Corps of Engineers, Building 230, Ft. Shafter, HI 96858, ATTN: Margo Stahl
L. Higa, City and County of Honolulu, Department of Public Works, 650 South King Street, Honolulu, HI 96813
Office of Environmental Quality Control, 220 South King Street, 4th Flr., Honolulu, HI 96813

FIRE DEPARTMENT
CITY AND COUNTY OF HONOLULU
1455 SOUTH BERETANIA STREET, ROOM 300
HONOLULU, HAWAII 96814

FRANK F. FASI
MAYOR

LIONEL E. CAMARA
FIRE CHIEF

DONALD S. M. CHANG
DEPUTY FIRE CHIEF

June 4, 1991

TO: BENJAMIN B. LEE, CHIEF PLANNING OFFICER
DEPARTMENT OF GENERAL PLANNING

FROM: LIONEL E. CAMARA, FIRE CHIEF

SUBJECT: KAWAINUI MARSH FLOOD CONTROL
KAILUA, OAHU - TMK: 4-2-16:1; 4-2-13:22

We have reviewed the application for the above subject request and have no objections to the proposal.

Should you have any questions, please contact Acting Assistant Chief Attilio Leonardi of our Administrative Services Bureau at 943-3838.

LIONEL E. CAMARA
Fire Chief

AKL:ny

Copy to: U. S. Army Corps of Engr. (M. Stahl)
City & County Public Works (L. Higa)
OEQC (EIS report attached)

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

P. O. BOX 50004
HONOLULU, HAWAII
96850

May 24, 1991

15

Mr. Kisuk Cheung
Director of Engineering
US Army Corps of Engineers
Honolulu District
Building 230
Ft. Shafter, Hawaii 96858-5440

Dear Mr. Cheung:

Subject: Draft Detailed Project Report and Draft Environmental Impact Statement (DEIS) - Kawainui Marsh Flood Control Project, Kailua, Oahu, Hawaii

Thank you for letting us review the above-mentioned document. We have no comments to offer at this time and would appreciate the opportunity to review the final EIS.

Sincerely,

ACTING
WARREN M. LEE
State Conservationist

cc:
City and County of Honolulu, Department of General Planning for the Mayor of Honolulu, 650 South King Street, Honolulu, HI 96813
Honolulu District Engineer, US Army Corps of Engineers, Building 230, Ft. Shafter, HI 96858, ATTN: Margo Stahl
L. Higa, City and County of Honolulu, Department of Public Works, 650 South King Street, Honolulu, HI 96813
Office of Environmental Quality Control, 220 South King Street, 4th Flr., Honolulu, HI 96813

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

DEPUTIES
JOHN P. KEPPELER, II
DONA L. HANAIKE

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

REF:WL-LC

Mr. C. Michael Street
Acting Director and Chief Engineer
Department of Public Works
City and County of Honolulu
650 S. Beretania Street
Honolulu, Hawaii 96813

Dear Mr. Street:

This is in response to your March 20, 1992 letter requesting that we review the comments from the Corps of Engineers (COE) concerning the Kawainui Marsh Flood Control Project.

Since the 100-year flood design, plus a three feet freeboard, exceeds the 250-year design, the project, as designed, is acceptable. Also, since the marsh is considered to be a flood plain, it does not need to comply with the Hawaii Dam Safety Act of 1987.

Please contact Mr. Manabu Tagomori at 587-0230 if you have any questions.

Very truly yours,

WILLIAM W. PATY

c: Corps of Engineers
Div. of Forestry & Wildlife, DLNR

8. PUBLIC MEETING

KAWAINUI MARSH FLOOD CONTROL PROJECT
PUBLIC MEETING
May 29, 1991

This is essentially a verbatum transcript of the public meeting; however in a few places the transcript tape was garbled, so the document has been edited. These areas are shown underlined and in italics for identification.

LTC Wynn:

Welcome to the Kawainui Marsh Flood Control Project public meeting. If you're in the wrong building, please feel free to leave at this point in time. I would like to say happy anniversary, although it has been a little longer than a year since I was last in this auditorium talking about Kawainui Marsh. It was a year ago last February that I first came in to talk about Kawainui Marsh. Since that point in time, a lot of work has been done, a lot of studying has been done and the end result is the study that we sent out at the beginning of May to all the people that were interested in this project. That is what we are going to be discussing tonight. We're going to be discussing the seven alternatives. Prior to getting into that, I'm going to go through some administrative details.

First and most importantly, the rest rooms are out that door and I'm told they're highly visible.

Secondly, if you have not completed the sign-in cards when you came in, we have some cards that will allow you to express your desire to be heard during tonight's public meeting or to getting subsequent distribution of materials. So I urge you to sign-up on those cards if you have not done so.

The way we're going to run the testimony at this meeting tonight is, I'm going to have a brief presentation by some of my personnel on what is in that study. I realize that many of you have read through it and that's going to be redundant, and I apologize. But I want to make sure that we're all starting with the same information, and I have been working my people vigorously to keep them from talking too much tonight. So I'm shooting for 15 minutes to cover the seven alternatives and 15 minutes to cover the environmental impacts. You're going to have to understand that because I'm constraining my people on that they're not going to get into a lot of the details that they would have liked to have done. So I want to apologize for that, but I feel that it is much more important to get your viewpoint out there than to listen to them regurgitate what's been said. I'm going to ask all the public officials if they wish to make any type of statements or speech. I'll be asking the federal delegates first and then state and then county in that order of priority. Then I'll have the general public come in the order they've signed up at the door. That's the order of first come, first served type business. If everything goes well, we should be done by 10:00 p.m. or earlier. I will ask all of you to constrain all of your comments to not more than 5 minutes. This will allow everyone to have the opportunity to be heard. If we have any time at the end of this meeting, and if everyone has been able to express their opinion, then I will have everybody else who wishes to speak or add anything at this time. I am shooting for the 10:00 finish on this. I think we have to clean up and get out of here by 10:00. So that's how it's going to work. Are there any questions on the administrative details before we get into it? Okay, no questions. Let's see if I've covered everything.

I have been asked by my people to remind you that we're right now going under a program that's called a Continuing Authorities Program for this particular flood control project. What that means is that the federal government's limit is constrained to $5M. All the federal expenditures on this type of project *can't exceed* $5M, federal expenditure. Any additional funds have to be made up by the local sponsors, City and County or other forms of revenues, but the federal participation is $5M and what I'm also concerned about under this particular authority, you'll hear a little more on this later, is the benefits-to-cost ratio. The benefit-to-cost ratio in any decision we make or any alternative we choose must be greater than one. So that means that the benefits have to be at least (dollar amount) the same as the cost.

So I'd like you to keep that in mind when we get down that road and it will be emphasized again. Okay, without further ado, I'm going to ask

Jim Pennaz to *explain* the engineering on this and come up and present the alternatives.

James Pennaz:

I have a slide show for you this evening. The project we're working on tonight is the Kawainui Marsh Flood Control Project. Tonight's public meeting is the last (*public*) event that we have prior to construction. Tonight we're looking for public input to help the local sponsor, City and County of Honolulu and the Army Corps of Engineers come to a rational decision on what's to be done.

The Kawainui Marsh is located on the island of Oahu on the windward side next to Kailua and Coconut Grove. The project study began as a result of a flood that occurred in Dec 31, 1987 and January 1, 1988. At that time, water entered the Kawainui Marsh from the Maunawili basin, came across the open field in this area and flowed into the open water area. A heavy mat in the marsh at that time constricted the water flow and prevented the water from passing north to the Oneawa Channel. This is a mat out here, here is a levee right along here, this is Kaelepulu Channel that goes into Enchanted Lakes, and this is Coconut Grove.

The marsh mat prevented water from going down to Oneawa and water then overtopped the entire levee for a distance of around 5,300 ft down to about this point over here. Here you see Kaleheo High School, H-3 is in the background and Mokapu Saddle Road. The mat thickness varies from open water up to 3 1/2 ft in depth. These pictures were taken shortly after the flood and as you can see there is no open water in these areas, that's because there is a mat on the marsh that floats up and down with the water. Here's looking back towards the southern end of the marsh and open water. Water, after overtopping the levee, then went through Coconut Grove and back into the Oneawa Channel and then out to the ocean.

Shortly after the flood, the emergency ditch was created on the marsh side of the levee. That's this open water here. The ditch was constructed as an emergency measure to help keep the water in the marsh and prevent further flooding. In July of 88 the City and County went in and made an additional improvement to the levee and to the channel on the marsh side. The City and County widened this channel and they also raised the flood control levee from a height of 9.5 ft mean sea level (MSL) to 10 ft MSL. Since that time this emergency ditch has done what it was intended to do and probably kept the levee from overtopping since that time.

The authority we're using for this study, as Colonel Wynn mentioned, is the Section 205 Flood Control Act of 1948. What this does is to give the Corps of Engineers the authority to spend up to $5M on any flood control project. We selected the Continuing Authorities Program because this allows us to implement a flood control project here very quickly as compared to an authorized project which can take anywhere from 10 to 15 years to construct.

The project that we studied encompasses all of Kawainui Marsh including the Maunawili drainage basin, Coconut Grove and the flood control levee. We had scoping meetings with the public in February and April of 1990 at which time we asked for public input. This helped us get an idea of what should be done to provide flood protection to the Coconut Grove area. We received input from the public at that time, and we also received input from the Waterways Experiment Station in Vicksburg, Mississippi, our Hydrologic Engineer Center in Davis, California as well as other technical people and the City and County.

Those meetings lead to the creation of a mathematical model, a very sophisticated model which we ran on a Cray Y-MP supercomputer. This model takes into account all the alternative projects that we developed with the public and laboratory people. We ran different inflow hydrographs through the marsh and came up with various water levels within the marsh that were verified with the computer model. We can put in different alternatives and come up with these water levels that you see here for a particular event for a particular time.

The first alternative we looked at was the levee raise alternative. This is an earthen levee raise. Total cost for this project is $10M with an average annual cost of $933k. This cost includes the cost of operation and maintenance as well as the amortization cost of $10M. The benefits that you see are the average annual damages prevented by this project. Those damages include damages to structures, damage to contents of peoples' homes, damage to cars and yard damage. The levee raise alternative has a benefit-to-cost ratio of 1.9 which means that for every dollar invested into this project, there's at least a $1.90 return. As Col Wynn pointed out, for any project that the Federal government can provide support to, the project needs to have a benefit cost ratio that exceeds 1.0. The levee raise project does that.

Here is an artist's conception of the earth levee raise. Earth would be placed 7-8 ft high on top of the existing levee. This entire project would take place entirely on the marsh side of Kaelepulu Channel. Here you see the existing levee with an emergency ditch on the marsh side. This levee raise would rise to about a 10 ft crest width. It would go back down and fill part of the wetland area down here. There would be about 3 acres of wetland fill with this particular alternative. This is a park down here, near the Oneawa Channel. The park would be used as a construction area for our contractors. After the contractors complete construction, the park will be restored to equal or better condition. Some levee raise would take place in this area although the levee raise would not be as high as it gets closer to the Oneawa Channel.

The second alternative that was developed was the concrete flood wall. This alternative turned out to be the cheapest one at $8.2M. It had the highest benefit-to-cost ratio of all the alternatives we looked at. This is the National Economic Development (NED) plan because it is the cheapest plan that provides flood control benefits. The plan consists of a concrete flood wall sitting entirely on top of the levee roughly 7 1/2 to 8 ft high and would extend a distance of 6,300 ft from Kailua Road to the Oneawa Channel.

Here you see an existing sensor that the City established to monitor water levels in the marsh. The levee raise would be about this high. The City, in the past few days, have put some pipes on top of the levee to give you an idea how high the levee raise and the flood wall would be. So if you'd like to go out there the pipes will give you an idea of how high the levee raise would be. This is an artist's conception to give you an idea of how high the raise would be. This is the existing levee and the man would not be able to see over the floodwall towards Coconut Grove. He could only look towards the marsh side. The earth levee raise would go to the same height as the concrete flood wall, but people could walk on top of it. Here you see an example of where the levee raise would go. As I mentioned earlier, this wetland area on the Coconut Grove side would be filled partly with the earth levee raise but would take place entirely on the marsh side of the Kaelepulu Channel.

Another alternative we looked at is called the Quarry Road Channel plan. This plan had a benefit-to-cost ratio of 0.9 although we believe the cost may be brought down somewhat to make it closer to a benefit-cost-ratio of 1. This alternative does incorporate about 5 acres of City and County marsh clearing work that has been done to date. The City and County's work is shown on the pictures near the front of the room. The Quarry Road Channel would extend from the Oneawa Channel along the back side of the marsh and to the open water on the southern end of the marsh.

A water control structure would be constructed near the Oneawa Channel entrance from the levee to Quarry Road. The control structure would be about elevation 4 1/2 ft msl or lower and would keep salt water from entering the marsh and would allow some control of water flow within the marsh.

This is the marsh clearing alternative which involves creating about 76 acres of open water within the marsh. This 76 acres is in addition to the work that has been done by the City and County. The marsh clearing plan has a very high cost, although we believe we can cut this cost somewhat by using different construction methods or looking more closely at some of the cost estimating we have done. The marsh clearing plan has a high average annual cost because the maintenance cost of the channels is high. The marsh clearing plan has a benefit cost-ratio of 0.6. We do have doubts as to whether or not the costs could be sufficiently reduced to make the benefit/cost ratio greater than 1.0. This slide shows some of the open water at the southern end of the marsh that would be connected to three new channels. The Quarry Road Channel, on the west side, would follow the City and County work. There would be a middle channel, and another channel connecting to the emergency ditch that was created in July of 1988. This plan has about 76 acres of open water area. In addition to clearing this area within the marsh, we would also raise part of the levee. The Quarry Road Channel plan would have a levee raise of about 5 ft. The marsh clearing plan, which includes all 3 of the channels, shown, would have a levee raise of about 4 to 4 1/2 ft. In addition, the Oneawa Channel would have to be dredged because water stored at the southern end of the marsh would more quickly reach the outlet channel. And with more water entering the Oneawa Channel, we'd have to either dredge to make it deeper or we'd have to put concrete walls on the side to keep water from overtopping the Oneawa Channel banks. The area south of the model airplane field would be the site of the work and storage area. One of our technical problems with the marsh clearing and Quarry Road Channel plan is that some of the channels could be cut off or reduced in size by movement of the mat. We know that the mat within Kawainui Marsh floats up and down with the floods. We are concerned that the mat may choke-off some of the channels we're depending on for flood control.

We have another alternative that's called the back levee and channel plan. This has a benefit-cost ratio of 1.1 which meets our economic criteria. However, we believe the cost may go up slightly with some refinements in the cost estimates. This back levee plan is a somewhat complicated hydraulic plan in that the existing levee is kept in place and culverts through the levee are used to transmit water into a channel behind a levee. This would be connected to the Oneawa Channel down here and another levee would be constructed on the Coconut Grove side of that extended channel..Kaelepulu Channel would then be relocated about 30 ft towards Coconut Grove. This would take some private property from the Coconut Grove side of Kaelepulu Channel. Here you see where that would take place. This water would go through the levee, there would be an extended channel here and Kaelepulu would be moved 30 feet towards Coconut Grove.

We're required under the Executive Order 11988 to also look at non-structural alternatives. Flood proofing is one of those non-structural alternatives. This involves raising 688 houses that are currently post on beam construction and 397 homes that are slab on grade construction. The homes would be raised above the 100-year flood level. The floodproofing plan has a cost of $27.7M with a benefit-to-cost ratio of 0.6. Floodproofing would not solve the problem of water overtopping the flood control levee.

Here is a summary of all the alternatives along with cost and the benefit-cost ratios. As you can see, the cheapest plan is the floodwall at $8.2M and followed by a levee raise at $10M. This slide shows the approximate construction time required for all the various alternatives.

Colonel Wynn: Okay Jim, thank you. That was not quite 15 minutes. He will be followed by Margo Stahl discussing the environmental impacts.

Margo Stahl: Good evening. I'd like to welcome you and to reiterate the fact that we've been kept very busy during this last year incorporating the issues and concerns that you raised over a year ago at our scoping meetings. As a result of your input, as you see, there are a wide variety of alternatives that are quite different from each other. We included in the project scope the entire watershed area from the mountains to the sea, we looked at the issue of new development in Maunawili, we looked at the issue of golf course development, and we've come out with a document that hopefully you all had an opportunity to review. If you recall the yellow section in the document is the draft environmental impact statement. That can stand on its own but it's been incorporated into the draft report so that the decision maker can have a single document to provide environmental issues as well as the economic and engineering issues. The meat of the EIS is the impact section and that is Chapter 4. The impacts were evaluated from a resource base analysis. That means we looked at the alternatives and evaluated them with respect to major resources within the marsh; whether it would be water quality, wildlife resources, aesthetic resources, recreational resources, etc. But at the meeting tonight, we'll be looking at the alternatives again and the impacts that we've identified as being of special concern. We've also proposed mitigations to reduce those impacts and I'll be mentioning that as well.

What are the major impacts associated with the earthen levee raise alternative? Number one, of course, is the issue of wetland fill. The Army Corps of Engineers is particularly sensitive to the issue of wetland fill. And since the expanded base of the earthen levee would take additional wetland, we've looked at that issue in great detail. As Jim mentioned earlier, this particular portion of the marsh that would be utilized to increase the base would be along this part of the marsh next to Kaelepulu Drainage canal. This side has been selected rather than the preferred waterbird habitat on the other side of the levee for the base expansion. Again, this is the artist rendition. In order to go up in height, we must go out and that's why additional land, approximately 3 acres, of wetland (primarily California grass) would be needed. The USFWS has indicated in their biological opinion that filling this wetland would not jeopardize the continued existence of waterbirds in the marsh. But they have recommended that for every acre of wetland we fill, that 2 acres of open water be created in the marsh, as mitigation for that wetland fill. And as you heard tonight, the City and County is in the process of opening up water in the marsh. That could be quite readily used by waterbirds. Some of the other environmental impacts for the earthen levee raise concern the issue of view plane loss. If we're raising the levee, what effect will that have on the residents? Their view will be curtailed and they will not have the same views that they have now, in exchange for that additional protection. We will lose the use of the park that was mentioned, temporarily, and there would also be, of course, the construction impacts, noisy trucks and odors. But the issue of the view plane loss is the more important of these issues. In addition to the concerns that we have about the loss of view plane by the residents, even though there are only a few of them along the levee, we're concerned about the view of the levee raise from elsewhere in the marsh. We've gone around to see what impacts there might be to the view plane from other spots around the marsh, including the Ulu Po Heiau, which is pretty close to the existing levee. But as you can see, this is the levee, along this line, sorry my hands are shaking. From the Ulu Po Heiau, an increase in the levee, whether it be a concrete raise or an earthen levee raise, will not be noticeable.

What are the environmental impacts associated with the flood wall? Well some of them are the same, particularly with respect to the view plane loss, since the raise is to the same height. In addition we have aesthetic differences between the concrete wall and earthen levee raise; the concrete wall being completely different from the wilderness characteristics of the marsh. We can reduce the impact of the floodwall appearance by planting materials to soften and color the wall. There will be noise, certainly, from the driving of sheet pile required by construction of the flood wall. That would not be necessary for the earthen levee raise. We would certainly have changes in the recreational experience. There is a difference between walking on a raised levee and having instead, a wall next to you blocking the tradewinds. There would be the same temporary loss in park use and construction related impacts. There would be an additional impact which can be considered a benefit. Because the wall would act to prevent access to the area, feral animals - wild dogs and cats that presently prey on the wildlife as well as rodents and mongoose, would be prevented by the presence of the wall from moving in and out of the marsh. To what extent that would benefit the wildlife, we presently don't know, but the USFWS has indicated they consider this aspect a positive one. Again, this is the cross section of the floodwall with potential landscaping to soften the view.

Open Water. There is perhaps no greater desirable environmental quality of the marsh than open water. That is, open water provides additional habitat for endangered waterbirds, enhances fishery resources, and is certainly aesthetically beautiful. So as you've heard the Corps did evaluate two in-marsh alternatives addressing open water. The Quarry Road Channel which is really a waterway, is somewhat an expansion or elaboration of the emergency measure proposed in 1988. In order to provide flood protection, open water must be connected to the Oneawa exit channel and it is at that point where we connect, that the greatest environmental impacts arise. That has to do with the issue of sediment in the marsh. Our consultants have talked about and looked at the properties of the sediments, what can mobilize and move out of the marsh into the Oneawa Channel into Kailua Bay. That is of great concern. As you can see, this picture was taken after the New Year's '88 flood event. Sediment-laden waters were able to exit the marsh without any connection to open water and out to Kailua Bay. This is a phenomenon common along the shores of Oahu. The water control structure could be designed to accommodate the migration of native species that have to move from the ocean into the marsh's freshwater environment. But there are other effects and they have to do with the unknown archaeological resources that may be present along the alignment. The main concern is the potential movement of the mat which could block the exit of the marsh flood waters. Regardless, we would still have to raise the levee about 5 ft.

The other open water alternative would be the open marsh clearing, which would help clear vegetation from over 100 acres, total, but the same concerns dealing with the sediment issue to an even greater extent exist with this alternative. Again, we would have to dredge Oneawa Channel. There are ways to mitigate the issue of sediment movement. There are certain construction practices, certain silt screens that we can use, but we don't feel comfortable being able to prevent significant amounts of sediment from moving out of the marsh during a major flood event. The same other impacts as we saw with the Quarry Road Channel exist with respect to archaeological resources; the concern about the movement of the mat and the need to raise the levee approximately 4 ft. Kawainui Marsh, like other marshes in the world, is a buffer between the land and the sea. It is a living sewage treatment plant that can convert nutrients, whether it is human sewage or cattle manure into vegetation, which has obviously been a problem in the marsh. But no one really knows how much marsh vegetation can be cleared without jeopardizing the actual cleansing abilities and its natural tendency to act as a buffer.

The environmental impacts associated with the back levee alternative which is accommodating the extension of Oneawa Channel along the levee are these: The primary concern is the loss of the estuary in the marsh. The estuary end of the marsh is part of the marsh nearest to Oneawa Channel. At that point we have some of the brackish water in Oneawa meeting the fresh water from the marsh. Bullrush vegetation and a different environment exists. Fishery potential is greatest here. This area would be lost with the back levee alternative. In fact, this alternative perhaps carries the greatest of the environmental impacts of any alternatives we looked at. In addition to the loss of the estuary, we have concerns dealing with the realignment of the Kaelepulu drainage canal. The loss of land, water quality issues, visual changes, the potential for burials along the alignment are all of concern. This is Coconut Grove again and Kaelepulu drainage canal. If major construction occurred along this waterway, then we would anticipate downstream impacts to water quality affecting the wetlands along Hamakua Drive, which is presently a habitat for waterbirds.

The last alternative is, of course, the flood proofing alternative and certainly the disruption to the Coconut Grove community would be tremendous in order to raise these homes. Our major concern is that the levee will continue to be overtopped.

So as you see, each of the alternatives that we evaluated comes with its own set of environmental impacts. We have tried to address each of those impacts and to propose mitigation to reduce those impacts.

Colonel Wynn: Thank you Margo. We're going to have the testimony period at this point. Before we do I would like to recognize some public officials that we have in the audience tonight. We have Earl Arruda from Congresswoman Mink's office. Please stand, thank you. There's Representative Cynthia Thielen State Representative, Steve Holmes from the City Council, Douglas Tom from the Office of State Planning, Ronald Walker from State Department of Land and Natural Resources (DLNR), Chi-Pin Chang from the State DLNR, and the last gentleman Sam Callejo from the City Department of Public Works. Speaking for Representative Mink is Mr. Earl Arruda, please come up.

Earl Arruda: Good evening. This is a message that Representative Mink has given to me to read at this public hearing tonight.

I want to thank the Army Corps of Engineers and the City and County of Honolulu for this opportunity to submit my statement for the record on the flood control alternatives for Kawainui Marsh as discussed and assessed in the April, 1991 Draft Detailed Project Report and Draft Environmental Impact Statement.

I believe the draft report and EIS document represent a thorough study of the avenues available to protect Coconut Grove and the wider Kailua community from any further damage and flooding as occurred during New Year's, 1988.

Coconut Grove has been subject to a number of floods in the last century, and the flood control measures of the Territory of Hawaii, the Army Corps of Engineers and the City and County of Honolulu through the years have been only partially, and temporarily, effective in the face of changing conditions in the surrounding community and the marsh itself.

The need for a durable and truly effective plan of flood control for Kawainui Marsh is critical to the safety of the homes and residents of Coconut Grove, and to the long-term ecology of this uncommon natural and cultural resource.

By all relevant measures of consequences and mitigations, the Earthen Levee Raise should be the recommended course of action for Kawainui Marsh. This alternative appears to offer the least environmental impacts and adverse social effects to the area because:

1. The impact of construction activities will be minimal through the observation of proper precautions;

2. The required 3 acres of wetland fill created by the levee raise will be located on less valuable wetbird habitat than other areas of the marsh;

3. Water quality should not be affected by the 3 acres of wetland fill, provided the fill material is free of contaminants;

4. The destruction of about 3 acres of vegetation by the fill on the Coconut Grove side of the existing levee will be insignificant because this growth is non-native to the marsh and not considered prime habitat for water fowl;

5. Endangered coots, stilts, moorhens and ducks known to inhabit the marsh are expected to return to the immediate area of the levee raise once construction has ceased and activity return to normal;

6. No fish or other aquatic species habitat will be permanently destroyed through water quality degradation;

7. No significant impact is anticipated on the waters of Kailua Bay because of sediment runoff during construction or after completion of the project;

8. No historical sites or properties will be affected by the levee raise in the area of Coconut Grove. An archaeological survey for the entire marsh is strongly recommended, however, to assure that no sites are inadvertently damaged or destroyed under any circumstances;

9. The expanded earthen raise will not affect access or recreational use of the levee once construction activity has ceased. Better control of such use within the marsh, such as jogging, walking and sightseeing, is recommended through vigilant, park-type security;

The earthen levee raise alternative is not without some negative impacts, such as the blocking of view planes for certain homes in Coconut Grove, disturbance to native waterbird populations and alteration of some environmental regimes in the marsh, and the cost of construction of the new levee structure.

The social and economic effects of the raised levee alternative to Coconut Grove and greater Kailua, however, far outweighs these impacts. The need for action is undeniable, and the choices before you range from relatively insignificant, though hardly inexpensive, to unmitigable.

The citizens of this community deserve no less than their government's best effort to relieve them of the potential for great loss and harm from another massive rainstorm such as they experienced just two-and-a-half years ago. Delay is unthinkable, and I urge you to proceed in all due consideration and dispatch.

My sincere appreciation again to you all for allowing me to testify through my representative Mr. Earl Arruda of my Honolulu District Office. Aloha and mahalo.

Colonel Wynn: Thank you Mr. Arruda. I would like to now call on State Representative Cynthia Thielen.

Cynthia Thielen:

I would like to the thank the Army Corps of Engineers for holding this public hearing as well as the City and County and State Board (DLNR)for being present as well. I am sure everyone here agrees whole heartedly that we cannot let Coconut Grove flood again.

The residents lived through a horrendous experience. No one wants them to have to repeat that. However, what we may not agree upon is the method by which we will prevent that flood occurring again. I find it unfortunate that among the renderings that were presented tonight, that there was no rendering showing what that floodwall would look like at probable ground level. And I think that is something everyone here would like to take a look at - the concrete wall that jets up into the air, blocking the view and blocking the tradewinds, and that they would be seriously concerned about that method of flood proofing.

The other, obviously, that could have been a part of the presentation, I'm sorry it wasn't; I would recommend highly that it be in the final environmental impact statement, showing the view from the ground level looking toward the marsh but with that view actually obscured with a concrete cement barrier.

I think that raising the levee would be the most cost effective plus the cost to benefit ratio may be one of the better ones. Therefore, it possibly should be the one to be selected. I have concerns about that again. At least if it is raising the levee you have the earth, you have the planting, you have the ability to go up to the top and have the view both in the marsh and then back out to the bay. So in some ways that could create, for all except the adjacent land owners, an acceptable solution. I think that it is extremely important that we listen to those land owners that would be living by one of these barriers and listen to what they have to say, because that is important. They will be deeply affected by whatever barrier is created between them and the marsh, and so, I would like to close my remarks so that would leave ample time for those land owners to speak, and I thank you again for coming out to the community.

LTC Wynn: Thank you Representative Thielen. Have I missed any public official which wishes to speak at this time? Now we are going to start going through the cards that were presented in the order that they came in. First presenter will be Todd Hendricks.

Tom Hendricks:

My name is Todd Hendricks. I'm a resident of Kihapai Street which I guess I could call myself a flood victim.

I lived on Kihapai Street since 1974. We bull-dozed our house in 1986 and built a two-story house in 1986 which meant all the City and County flood regulations were mandated by the federal government. We were told to make our base elevation slab 8 ft. We made it 8 1/2 ft, and during the flood unfortunately, we had 22 inches of mud water and you know what else in our house. I've saved some of the artifacts to show you two of them, and then I'll get on. This is from one of the cars that we drained and notice the color of our favorite flood water here. There are two liquids in here. So obviously I have a little of gasoline and a little bit of floodwater. What we did of course was drain our gas out of our cars to try and get our cars running so that we could start our lives again and go to the stores and things. The rest of all the books in the house looks something like this.

I'm not the only one here, there's other residents that had this problem happen. I've lived through the worst one and many of the other residents have been doing this for 20 years. It's been about 3 1/2 years since the flood. As far as we're concerned, I talked to a lot of residents in Coconut Grove and even met with a few people over the last three or four weeks and it was a very interesting meeting.

It's been 3 1/2 years and to us the problem of flooding is still paramount, and if you're not sure what paramount means the dictionary says: Paramount is ranking in higher preeminent. In other words a problem of largest quantity. I can give you two examples of the fact that flooding is still a problem. For instance tonight, this nice strong tradewinds with 25-30 knot winds. All we need is the front to come in from the ocean, from the northeast. It takes only a day and a half to get flooding. Let me give you two examples of why we think and why we really want one of these five plans that have been presented. Look at the April 1989 issue of flooding. This was a rain storm after our January 88 flood. There's two of them I want to give you an example of, then I'll move along.

One is the April 1989 rain storm. On Tuesday April 4th we started having heavy rains. It went on and off for a couple days. Starting again on Friday, Saturday April 8, 1989 at 11:15 in the morning, the levee was, there is a meter stick at what I call the church end to the levee closer to Kailua Road. There is a stick over there. The elevation was 5.5 ft that was Saturday April 8. Sunday April 9, 11:15, it got to 7.3 ft. That was April 1989.

March of 1991 we had a few days break, then one day, it was actually a couple days, 2 days, March 1991 the rain lasted all day and into the evening. At 8:00 at night the rain stopped. I went down to the levee to look at the level, it was 7.7 ft. Street level of Kihapai Street is 6.0 ft.

We still have a very serious paramount problem of flooding. We have to do something. Those are only two examples of what can happen if we don't make a change. We need flood protection. We need help in our area. We think one of the best possible plans that can be and should be used is the earthen levee raise plan. What we have here is kind of neat. We have the City's data, there's not going to be anymore studies, this is the end of the studies, we have the M&E Pacific which was hired July of 1989 to do mitigation studies, which is really neat. Sam Callejo and the people with the City and County then came up with their EIS statement, City and County, M&E Pacific, November 1989. Very good. They have attempted and have started to do marsh clearing which will help us some. It is a water storage plan the way I see it. What we have now in my final statement is this plan here. This is the one Corps of Engineers is presenting. I thank you for your time and presentation. This is an economic issue right now. The only alternative as far as we can see is the earthen levee raise plan. I can walk over there and Colonel Wynn is going to give me $5M and Mr. Callejo is going to give me $5M and if you can sign the check tonight then we can get things going by December. Now if we look at the *other* alternatives, which were kind of neat, I'm sorry that won't happen. I'm just sorry it won't happen. We're not going to come up with $25M, we're not going to come up with $60M.

So again, let's give us some protection so we don't have to go through this again. So I don't have to go out for 4 hours in my boat, pick-up 100 people shining flash lights on Kihapai Street and then let them stay over at my house overnight. I'll stop. Thank you.

LTC Wynn: Thank you Mr. Hendricks. I'd like to say that generally at a public meeting we listen to the statements and we don't make any response. If you have any questions or points that need clarification as long as it is very short, we'll try to answer them in a particular public meeting. I want to make sure that there's an understanding of communication back and forth here. Generally, we don't do that but for this particular meeting it might be a good idea. Are there any questions that you have Mr. Hendricks?

Tom Hendricks: If the Corps decides to maybe do the levee raise plan, is it something that we could easily do in the near future?

LTC Wynn: Yes. I'm trying to remember if it was, I think it was an 18-month construction, John, John is that correct?

John Pelowski: Yes

LTC Wynn: Okay, depending on which *alternative is selected*, we could award such a contract by December of 91. Thank you for asking that question. The next person is Mr. Larry Abbott.

Larry Abbott:

Hello, I'm Larry Abbott. I live on Kawainui Street. I'm a member of the Kawainui Heritage Foundation, I sit on the Board, and I also belong to the Surf Club.

I'd like to address the issue of vegetation. One alternative that wasn't discussed in the statement, and I have seen it used effectively in the southeastern United States, Okefenokee Swamp and in the everglades, for creating open water and limiting vegetation. It has been very effective in those areas, and I think it would be very effective for our marsh. There are many things about fire management that make it a good type of management.

First is that it's safe. Between the marsh and the city of Kailua there is a ditch, a levee and a channel that would protect the city.

Secondly, Hawaii has district fire management for sugar cane all the time on the leeward side of the island.

Third, fire management is a proven economical method in the southeastern part of the United States. I'm sure we have a high cost to benefit ratio. Very high. The requirements could be held in the palm of your hand.

Fourth, I think it's a better alternative than aerial spraying of toxic herbicides. Those have long lasting effects on the marsh, on the marsh wildlife and possibly on the future of the marsh. Thank you.

LTC Wynn: Mr. Abbott I am going to try to answer your question. You raised a very important point.

Margo Stahl: We did look into fire management, but unfortunately it's illegal right now *in Kawainui Marsh*. We've been told that burning the marsh vegetation is not allowed, it doesn't fall under agriculture practice but that's not really the main problem. Even though the vegetation on the surface of the mat could be burned, the mat itself is a substrate and burning contributes to a regrowth from nutrients that are mobilized from the burning of the marsh. So eventually vegetation does grow back. You must poison the mat and then physically remove it to do what you are talking about.

LTC Wynn: Next is Mr. Harry Harvey.

Harry Harvey:

I'm from Coconut Grove and I've lived there for 24 years along the canal. You talk about dams being built, but you don't mention anything about where the water is going to go after it gets over there. That's what caused the last flood. If the channel is blocked, it's only about 4-5 ft deep, at one time it was 7 ft, but I lived along there when it was built and it keeps caving in. From Kihapai Place homes along that area are sinking. The place where I'm living is down 7 inches from what it was, and also the back of the yard where the fence is, it used to be 15 ft but now it's less than 7 ft now with the channel caving in. That could be fixed by putting up a dam across there with automatic pumps. What would keep the water down and from falling out all the time. Now I think the canal should be concreted in. It's a sight. A lot of garbage goes down there, and if you talk about a levee on one part, you could put a wall along the outer side of the channel as the levee, same as you did with the others. And since you raised it 5 ft, it hasn't made as much difference from looking out from the ground levee of the park, but most people look across there and they look at the mountains more than of the channel.

I worked for Hawaiian Dredging for 19 years and I started construction in 1930. I've built a lot of dams along the Mississippi River and all over the United States. I've seen a lot of flood control built. I think if you go to California, all the channels are concreted in. I think you talk about building a big levee along the end, but you got to get the water out once it comes in and that's the problem. I think where you dredge between here and from Enchanted Lakes to the ocean, that's where you've got to concentrate a little more on when the water does come, that you can get it out, pump it out and still have your blockade, and you have a certain levee ties in, where the water doesn't go up. Most of the time it's blocked. You don't go down. That was the main cause of the flood the last time. Cause I was by there, I live there. The water was 7 ft deep. I think it should be considered concreting that canal and all the way through. It will take care of a lot problems. As far as we're talking about environment, looking over the levee, people wouldn't notice a levee out there, because you look more at the sky and the mountains than the marsh.

We should take into consideration how to get the water, when it does come over, into the ocean. So that's the main thing. To try and figure out where the water is going to go and not just try to hold it back. But this last rain we had in the marsh, the 5 ft levee did save Coconut Grove, with the old levee it would have gone over. So I think you should consider how to get the water into the ocean Thank you.

<u>LTC Wynn:</u> Thank you Mr. Harvey. What we're trying to do, the levee raise and the floodwall alternative was designed against a 100-year storm and again, the initial alternative is to prevent the levee from overtopping;

with that much water regardless what type of channels were available to the ocean or not to the ocean. Next is Mr. Robert Herlinger.

Robert Herlinger:

My name is Robert Herlinger. I am a planning consultant to the Kawainui Heritage Foundation. I just have a couple of comments and observations, but I didn't have time to go through the bible there.

One of my main thoughts was, that, just to realize that planning the protection of the resource from the standpoint of flood control should not be mutually exclusive to the resource preservation and enhancement and so now it's been going on for the past at least 20 years in the community and with the state resource management plan. It seems to me that because the state has a resource management plan and the citizens have a resource plan that's been evolving over the past 18 years, my feeling is that those shouldn't be referenced items in your study, but should be basically planned to be built upon and so that each solution that I'm not referencing any specific solution that we need to come up with. It's clearly a thing that needs to be addressed, obviously this is the whole reason is the flood control, but I think it should be visually exclusive and the concepts related to resource preservation that have been already developed and already learned, and we should build upon that base. Those should be base drawings to me, and I would like to see them up on those slides and then your solutions over those drawings and the input that the state has come up with in the resource management plan. Then we can have a solution to not only deal with flood control, but also can be a integral part of an eventual preservation and park plan that's been put forth in the primary area that the state has designated. So that's just a comment. I don't like to see those referenced diagrams, I'd like to see something that you build upon, and I didn't quite see that. Thank you.

LTC Wynn: Thank you Mr. Herlinger. We did use the State's marsh management plan as basis for the alternatives of the marsh clearing. We have looked through it carefully and all that's being done by the City and County, as far as the City and County's plan, and we've looked very carefully at all of the data in their EIS, and we've attempted to build on that. One thing that we are constrained by is that the money under this report has to be devoted to flood protection. So it has to be in conjunction with flood protection, so we're all for the marsh plans except that we are constrained by money in flood protection. Next is Mr. Robert Merriam. I'd like to say that Mr. Merriam whom I know read through the entire study cover to cover. I would like to congratulate you on that.

Robert Merriam:

Thank you Colonel. That's not really quite true, and tonight I'd just like to comment on a couple sections. Those are Appendices A and B which have to do with hydrology and design of the projects and the costs thereof.

Secondly, I'd like to say that these statements are mine. I am identified with a couple of Kawainui Marsh organizations, who I'm sure will be making written statements to you, but up to this point these are my own.

My personal feeling is this: That is, that any proposal which does not deal with the vegetation in the marsh, is not a real solution. It's simply increasing the size of a project that monstrously failed in 1988. I definitely have a personal feeling that the 9-foot levee raise or floodwall, which it may be easy to step back and say, well that's not really much, without some vegetation clearing within the marsh will not be an acceptable solution, if it could be demonstrated, that with the addition of some clearance, we could reduce the height of that levee raise or that flood wall. As Jim said the height we're talking about is approximately 9 ft above the present Kailua Road end without any vegetation clearing down to approximately 4 or 5 feet with some vegetation clearing. I personally feel that a 5 ft levee raise is a hell of an advantage over a 9 ft one. Again, personal thoughts.

The failure of the plan in the first case was because the vegetation in the marsh failed. That again could be demonstrated with the data you have which shows that the distribution of flood waters within the marsh significantly lowers again the height of the wall that would be needed and significantly creates a more level water surface within the marsh. I appreciate the concerns about the floating mat. I think it is overstated in your plan. I do believe that whatever plan that is put in, it needs to be built upon the existing emergency channel. Adding some additional waterways may be appropriate when we know where all of those things are and living with a 4 ft levee raise rather than a 9 ft. Thank you.

LTC Wynn: Thank you Mr. Merriam. That was extremely precise.
Mr. Merriam pointed out several errors in the study that we have made and they will be corrected. One thing that we would like to address is the statement of the floating mats. If there is anything with regards to this particular study that is perhaps the hardest to deal with. I have to say that we took an extremely conservative position on that because we are dealing with flood control. We simply don't know how that mat is going to behave in flood conditions. Mr. Merriam could be very right. We could be over stating that in the study we have. On the other hand, if we don't have a scientific knowledge which allows us to say exactly how it will operate and so because we are dealing with flood control we've taken a very conservative type approach and say frankly if we don't know, we are going to assume the worst, which is that the hardship might be to Coconut Grove homes. Is that a reasonable position? We're dealing with flood control and I find by accepting an unknown as a given, I accept essentially increasing the risk to the people who would be damaged by the flood. I'm not able *myself* to make a decision for that, risk is something you have to accept for yourself. I understand exactly what you're saying Mr. Merriam, we have wrestled every technical basis we can to try and pin that down a little bit better because it is an unknown. We haven't been successful *as of* today. Next speaker is Mr. Louis Torres.

Louis Torres:

My name is Louis Torres. I live at 319-C Kihapai, my back door is the marsh. The alternatives.

One earthen. I believe that would be the best way because you go around the Sacramento area, they have dams, they don't have any problems. If you remember when they built Likelike Highway, that extension when they made that third lane, within a week they had graffiti all over the walls. I don't believe a wall is good. And those of you that believe that channel opening is good, should go to Bangkok and see what happened when they dredged the channel from the ocean because they get flooded every time it rains. That's all I have to say.

LTC Wynn: Thank you Mr. Torres. I have been to Sacramento and Bangkok. Ms. Annetta Kinnicutt?

Annetta Kinnicutt:

I'm Annetta Kinnicutt and I'm speaking for the Kailua Board. Thank you for asking us to come out.

The neighborhood board is very concerned about preventing flooding in the streets and businesses. However we are also very concerned of the environmental values of the marsh surrounding. We're hopeful that a solution would be made for the concern for everyone. It seems to me that the report is biased in favor of the man-made structure. If the history of mankind are to teach us anything is that you can't fight Mother Nature. We need to find a way to work with the question of nature rather than putting huge structures.

Therefore, it is deemed that channeling water and clearing the areas in which you want the water to go makes more sense. Perhaps the combination of clearing the channel at various places within the marsh in conjunction with the modified dike structure and flood control gate in the Oneawa would now be the best solution. This would be consistent with the ideas described in the resource management plan which the residents of Kailua will support. It also appears in this report that the City and County efforts have no effect whatsoever. I gather that strongly *from* water levels that you quoted, the same water levels before and after the City project, and I know that this is totally erroneous in that I could see the water moving in the channels. I could see the effect in heavy rains. There was a noticeable difference and I think these improvements that have been made should be taken into consideration in both the time estimated for marsh clearing and more importantly, the cost estimates given. These factors will change the numbers and perhaps be a little more realistic. One of our primary goal should be the preservation of the wetland for many reasons we have stated before. In the Quarry Road Channel *if* a present ditch makai of the dike were improved, the water source will be increased, the birds will have a more settled environment, and the aesthetics of the wetland will remain undisturbed.

It is a combination of these things that's to be done. Just building a higher dike in the water will only necessitate building even a higher wall in the future if vegetation removal and channeling the water are not permitted. It would just be a build-up of sedimentation and vegetation, and we'll have the same problem no matter how high the waters go.

The Corps states the major consideration is that the best flood control solution be one which is independent from future conditions in the marsh. I don't see how you can plan every eventuality when the situation changes on almost a daily basis. Building a 22 ft (approximately) high wall to keep out the water 18 ft flood of water rather suddenly. This appears to be an extreme measure and not very environmentally sound. I truly feel innovative and creative thoughts are for you to come up with the right solution on flood control for not just for the next heavy rain, but the future of Kailua and Kawainui Marsh and all the people, the animals and the birds, the fish. Thank you very much.

LTC Wynn: I appreciate your comments and they were very well stated. I take it that you support the marsh clearing plan to a certain extent?

Annetta Kinnicutt: Well, a combination of plans. I will be sending you a letter.

LTC Wynn: I would appreciate that very much. I think that once you get a handle on that movement of the mat we've talked about, and we're very concerned about reaction of that because that is a very extensive proposition. I think that I would probably be inclined to support something like that, if I knew that the clearing would be maintained in flood conditions. We'll appreciate seeing your letter very much. Mr. Van Beasly.

Van Beasley:

First I'd like to say that there are only two types of people in the entire room. These are the people who can go to sleep at night when it's raining and raining and raining. We are the other types of people who cannot sleep at night whenever it rains and rains. I am 74 years old, and I have lived right at the exact edge of Kawainui Meadows, Swamp, whatever you want to call it since October 1948. What I'm supposedly doing here tonight is simply to let people know who have never experienced any water in their homes what it's like.

Number one, it's not water. It is swamp water, rain water, sewage and cesspool water and that is the kind of mixture you get, in addition there is silt. It is either red or brown silt. After you drained out the water, in my case I have been flooded out in 4 ft of water in 1951 and also of course in 1988 and two times before in smaller floods. Once the water leaves, you end up with a hersey chocolate look completely throughout all the floors. It's about 1/8 to 1/16 inch thick. In order to get that out you need a high pressure hose.

We had no warning, absolutely in either case, no warning. In the early flood, no one came around except the Red Cross. No one from the City and County, no one else. I had to carry my three-month old daughter over my head and break through a window in order to climb out. The only way we knew there was a flooding was because a neighbor came knocking on our door, and we were lucky that we got out in time. It raises pretty fast. Later I'm going to mention how fast it raised in 1988. We were sent by the Red Cross, bless them, up to the girls' home. No screens. My little three-month old daughter's face was so red from mosquito bites, we weren't sure she was going to survive. Then we don't know where to go. We don't have any family here. I've been here this long, my wife's family is all on the Big Island. You don't know where to go, you don't know what you're going to eat and so forth.

The 1988 flood the Oceanic *and Atmospheric Administration (the weather people)*, what you might call it out here in the sky goofed. Waimanalo was emphasized, but no mention whatsoever of Kailua. In fact we had Kailua volunteers, civil service workers in Waimanalo, working their butts off not knowing their own homes were being flooded. So there are a lot of basic problems besides the environmental aspects. Environmental protection seems to avail a meeting such as this, the flood victim seems to be almost on the outside looking in. While others have too great an influence on what is going to be done, if anything about flood protection for us. We are all part of the environment. People are the environment. Let's not forget that.

What is environment. Environment is a complex of all external physical conditions and circumstances around all of us that affect and influence all living things and all living conditions. That's what we're talking about. What has been my family's experience without flood protection? We live as close as you can get to the marsh. Rain and marsh water as I mentioned and what it includes, and in 1988, there was some fireworks, they were not the regular fireworks, about at 1:15 we went to bed. My wife and daughter who was visiting us was making a lot of noise, I was going to ask them to hold it down. I put my foot down ...

LTC Wynn: Mr. Beasley could you please sum it up.

Van Beasley: Yes, I'll sum it up. We could hardly even get out of our house in time before we could run out. You cannot open a hinged door when you got the water that's already up to 3 ft. All you can do is turn off the electricity, use the sliding door to get out. The cars wouldn't start. My wife is less than 5 ft tall and Mr. Hendricks here came down our little lane with a dingy, and by that time the water was already up to my wife's chest. She could not get in. We finally had to push her in. Mr. Hendricks had us in his house. This is what it is all about, and we're never going to get any flood control unless we get going on something. Thank you.

LTC Wynn: Ms. Camille Woodruff.

Camille Woodruff: I live at 319-B Kihapai and I'm a neighbor of these people. I don't need to tell you my horror story, mine was not as bad as his, but I would not want to live through that again. I'm in favor in raising the earthen levee because this is a desperate situation. We really and truly need rescuing, and if we don't take the $5M now and have something built and lets hope it's the levee and not the stone wall, we could have another flood. Todd told you about the water raising in March and how it was only 6 inches to go before it would come over the levee. I'd like to see the canals in the swamp and I'd like to see us work with nature and I'm worried about all the vegetation in the marsh too, but something has to be to be done now not next December and not wait a couple of years to get a whole lot of money. So lets take the $5M and we'll get $5M from the City then we'll all feel a lot better. Thank you.

LTC Wynn: Thank you Ms. Woodruff. I'd like to say that when I was out at the levee it was about 8.4 ft, the levee was 10 ft on that particular day, and I think that Sam was out there either before or after that, I think we just missed each other, but we were both praying like hell, I'll tell you that. Mr. Robert Lopes.

Robert Lopes:

Good evening. My name is Robert Lopes. I have lived at 327-A Kihapai Street since 1955. I've experienced all the floods that has in the last 35 years. I've also witnessed the construction and maintenance of the existing flood levee. During the construction of the levee, which changed the marshes natural flow of exiting water from Kailua Stream to Kawainui

Stream, there was no planning for access way for which the water can travel across the marsh except for the filtration through the marshes heavy vegetation. During the heavy rains the dense vegetation has obstructed the flow of the existing water and caused the marshes water level to exceed the existing level.

After the 1988 flood, the construction of an emergency ditch along the levee's mauka side has provided an access channel for which water may exit unobstructed. The concern I have is whether the emergency channel and existing levee height is adequate to handle the excessive heavy rains without exceeding the present levee height.

Based on the Kawainui Marsh Control Project Report, the Environmental Impact Statement Draft Report, I have come to the following conclusions.

The three plans which were proposed the creation of channels within the marsh would be very ecology minded, but produce a lower protection factor, higher cost to construct, with a critical reliance on maintenance channel widening free from obstruction. Even if the channels are maintained, present vegetation within the marsh, during heavy rains, would float and probably obstruct the flow of the channel ways. The plans would not be eligible for federal funds and require total funding by the City and County of Honolulu. Based on available funds the project is likely done in increments with no set time frame for implementation for completion. Estimated cost is $24M.

Both the plans which propose the increased height of the existing levee would provide the maximum protection factor, low construction cost and minimum maintenance. The plans would be eligible for $5M of federal funds and could commence immediately. The estimated cost is $8-$10M.

Since the objectives of the Kawainui Marsh project is flood protection, the best plan, in my judgement, is raising the levee with some type of fill that would provide the highest protection factor, blend in with the natural surroundings, levy the lowest cost to us taxpayers and best serve the people of Hawaii. Thank you.

LTC Wynn: I am told we have extra copies of our study in the box over there. Next is Mr. Norman Thompson.

Norman Thompson:

I've been around for a while too. I came out here from North Dakota in 1938, 63 years ago. I live in Kailua, we built a house here 75 years ago. On the last flood that we had in 1987 and ended up in 1988, I saw the water coming down Oneawa Street. It trickled on the street. It didn't even go over the curb. Within 15 minutes there was 2 1/2 ft of water in the yard.

Where is all that water coming from? It didn't seep through somewhere. That again will be, problem regardless of what you do here unless you can get the water started running back in the beginning part of the marsh. I wasn't sitting out there on the dike, but I could just image what happened.

It came over in a wave and it had to come over in a wave or it couldn't have gotten over the Oneawa Street in 15 minutes. It came out of the drains and you could see the water coming out of there being 4 ft high. They were going up and down on boats just on Oneawa Street.

The reason for that I think is pretty evident if the growth and accumulation of all of the leaves and California grass out there, and I don't know if there's any real solution at this time. What we need to do is not put up another dike, who knows that the flood water isn't going to come over 15 ft high next time. Whatever it is. I was told that the time that the dike was put in there that there was no fear of having a flood even if we had a 100-year flood. Well, we didn't have a 100-year flood apparently, and I said that in 90, when we had the meeting here before, it was a 500-year or 1000-year flood.

So what are we going to have the next time? They don't know. Why don't we go the way it was suggested by the Corps of Engineers in 1990 to put in two streams. Each one of them 200 ft wide, all the way down to Kailua Road or close enough to it. I know that that is a possibility with the money that you have and that it is possible to do it with the money you have to go along the channel there along the right hand side and the Quarry Channel I suggest that let's do as much as we can putting in a channel down through there then we'll get down to the area were we have clear water.

In other words, we need that water to start moving as soon as it gets done at that end, not when it gets over to the dike because it will not get over to the dike. So let's do it that way, but one way you could save some money I believe and that is to eliminate that dike that they put in there from that clear area to the shore. Certainly its good to have it. I think if you get the water moving through that clear channel and going down the channel there by Quarry Road, you'll have a great deal of that water right from the beginning and you won't have the big accumulation of water there that done so much damage. So I hope that you will consider that, and I thank you for letting me speak tonight.

LTC Wynn: Mr. Thompson do you support the Quarry Road Channel alternative?

Norman Thompson: Yes.

LTC Wynn: One of the things that we've attempted to do in the modeling we got is to predict fairly well the storm position such as it was in Dec 1987. The Kawainui Marsh was hit with about 21,000 cu ft per second of water inflow. *So anything we're going to do to expedite the flow must be designed to take 21,000 cu ft per second. The maximum flow for Oneawa Channel is about 6,000 cu ft per second.* So if we took the water and went straight through the Oneawa Channel it would not be able to accept that, so we have to do something. So the combination of things has to be looked at from the point of hydrology. Next is Muriel Seto.

Muriel Seto: I do not wish to say anything, thank you.

LTC Wynn: You're welcome to do so. That's all the cards we have tonight. Is there any one that we've missed? Did you submit a card? I apologize.

Dorothy Rose Babineau:

You heard all the technical stuff from everybody else and mine is just from the heart. I first became involved in Kawainui Marsh, then called a swamp in 1962. Here it is, 29 years later, and I'm still involved in our marsh and the protection of its wildlife. That's a hell of a long time to keep on giving testimony.

In 1962 the area looked like a pond; lots of open water. When effluent began its detour to the sea via the marsh, the green California grass and other strange vegetation took over and now you seldom see large expanses of open water with small islands here and there.

I have wondered for years why this growth was never removed or controlled. I believe that a group of us who are neighborhood Board members, presented you with an excellent plan for the marsh, which included the use of a machine to remove excess growth. I don't remember the name of the machine, but I think it cost $500,000.00 which is a lot less than $3M or $5M. Had this plan been implemented a year ago it may have saved me from testifying at your last meeting, and at this one.

Perhaps you could have "Ducks Unlimited" as consultants! Everytime those of us who care try to help our environment, all we get is too little, too late! With effluent, runoff from all the developments, siltation, etc., we, that is mankind, has been responsible for this mess. Now let us begin the solution not by bucking Mother Nature as my friend Annetta put it, but by following her lead! You can thank me now.

LTC Wynn: Thank you Dorothy. I saw someone's hand raise when I asked if I missed anyone. Ken Thompson?

Ken Thompson:

Thank you for giving me the opportunity to speak. I live at 775 Kahoa Drive which is directly on the edge of the marsh. I work for the City and County of Honolulu as a fire fighter and was involved in the evacuation of a number of people in the terrible night of 1988. This is the first public meeting I've attended so a lot of the information I have received is *new, and* I really didn't have time to digest it. But there are a couple things that stand out in my mind.

The first is that personally, and a couple of my neighbors, we don't want a concrete wall in the back of our yard. The last thing in the world that I want to see out in my back yard is a concrete wall. If it's got to be raised, the levee has to be raised, and judging by all the projects that have been proposed in all the cases the levee needs to be raised. So if it has to be raised, lets do it with a better type of wall.

The second thing I ask is that you don't take away our back yard. The canal is already chewing away the banks, we already have an erosion problem. We ask you not to encroach any further on that. It seems to me that the major problem is getting rid of the water. In other words we have this enormous basin, we need to hold the water until the channel on either side can disburse it to the ocean. We need to accelerate that process, lets get the water out as quickly as we can.. That seems to be one of the major problems. To give my brief account, my wife was out by the walkway in the garage, she went up stairs to get something she forgot, during that period the water had gone from street level up to 6 inches inside the garage like that.

So as Mr. Thompson stated, it looked like the water came over in a wave, one time. We need to get the water out more quickly before it has a chance to build up and then come over in a big wave. Thank you very much

LTC Wynn: Thank you Mr. Thompson.

Dr. Diane Drigot: May I ask you some questions?

LTC Wynn: Why certainly. Please come up and state your name.

Dr. Diane Drigot:

My name is Dr. Diane Drigot. I'm an author of a book on the marsh and also a resident and resource manager by profession, and I manage wetlands among the other things I do in my job. I have a couple of questions I have been working on marsh issues for a long time. I'm going to be submitting written testimony later, but I do have some questions all based mostly on this meeting and a cursory look at the EIS which I did get. First of all I would like to congratulate Margo for her herculean effort to get it done on recycled paper, and I do appreciate that at least in your written statement you said that you hadn't wedded yourself to any one particular alternative which is the way it should be if you read the law of EIS that requires that approach. The questions I have are, you were quick to point out in the beginning that you have financial constraints to $5M. Your money constraints have to be devoted to flood protection. I'd like to ask, since the Corps of Engineers also has permission for wetland protection and no doubt the process in which they can ask for more money, is it not unorthodox to ask that there be national funds made for wetland enhancement in parallel with flood protection? I don't see any rule why that can't be done in the same fiscal year.

LTC Wynn: Thank you for asking that question. There has been a recent program and unfortunately it is just recently that Congress enacted and its called Section 1135 of the Water Resources Development Act. What it essentially provides is a small amount of money for environmental enhancement associated with federal projects. We submitted the Kawainui Marsh as a project for this last year.

Dr. Drigot: What about the legacy program? It's run by the Department of Army.

LTC Wynn: I'm not familiar with that program.

Dr. Drigot: It's run by the Department of Army. It's something to look into and you can ask for money every year. The Marine Corps got over $200,000 for one project. It was announced in the papers *here, in fact* it was released from the press two weeks ago. A lot of community activity in Hawaii got money for projects under that program. I would just like to see the Corps a little bit more creative in financing instead of just saying these are our financial constraints.

LTC Wynn: I understand what you're saying but we are bound by the law.

Dr Drigot:

Right *but I'm pointing out* these are other options that you might look into for mixing money for both missions in one project. Another question I have is I am concerned that what I heard so far, vegetation is considered an imponderable, the floating mat is considered an imponderable, and I haven't seen anything in the document saying which wetland ecology experts you probably employed, people who are familiar with floating mats.

There are numerous wetlands in the United States that have this problem with floating mats and I'm going to be looking here carefully for your reference to experts. I think it was at your scoping meeting that I asked this question and somebody apologized and said that yes we had wetland expert fly in from Boston but he couldn't be here for the meeting tonight. I'm still wondering what that wetland expert said because the only reference I see in the document is Linda Smith's management thesis that was done over a decade ago. I don't see any updated, unless I haven't read it thoroughly enough. I really don't understand why vegetation is imponderable when you supposedly consulted vegetation experts.

LTC Wynn: Perhaps I didn't make myself clear. Vegetation isn't imponderable. The floating mat is not *imponderable.* We understand what goes into a floating mat. What we don't know is the reaction of a floating mat in a flood situation such as Kailua basin. That's what we don't have. We have gone out and searched for a similar condition. We even tried to look to see if we can equate the response of the floating mat to ice flows, and we did some of the modeling in that way, but that didn't work. So we have gone out and certainly if you have knowledge of a mat such as this that has been studied with engineering reaction to hydrology, we would certainly include that, take a look at that. But we have not been able to find that type of condition that anybody has studied or any similar type.

Dr. Drigot: I understand that there are a lot of people who are attending a science conference here right now. You might actively seek out some of the best ecologists in the Pacific are meeting right now, it is at Waikiki at the Sheraton Hotel.

LTC Wynn: Well, remember what we're looking for is engineering not necessarily the ecology of the mat but the engineering response, hydraulic response to the flood condition.

Dr. Drigot: Oh, I'm just saying that there are probably people who have pondered that under a different part of the world, other than Hawaii. I don't know. But I'm saying that it would be nice to see the Corps spend money looking for that expertise.

LTC Wynn: We definitely have sought expertise.

Dr. Drigot:

Okay, I'll be looking for it in the EIS.

Planning Horizon. I'm concerned about the planning horizon in your benefit-cost analysis. How long is the planning horizon for a solution? In fact, what seems to be the cheapest alternative is to raise the sides of the bath tub and ignore the fact that sediment and vegetation keeps building up in the bath tub and anybody that read the book Cadillac Desert knows that's the desert, dams in the west are getting filled up every day. What about the sediment and the marsh build up behind that large wall? Are there calculations as to how long that will last in your computer math? Is there a 25-year horizon?

Jim Pennaz: We looked at a project with a 100-year time horizon. We assume the marsh would fill to about elevation 4 1/2 ft mean sea level. Right now the marsh is around 2 1/2 ft msl and has areas as deep as 30 ft that can store sediment. We anticipated this sediment storage can last at least for a 100-year time horizon if not longer.

Dr Drigot: And does your computer model have the vegetation factor built into it?

LTC Wynn: What kind of vegetation factor are you interested in?

Dr Drigot: I don't have *the information on* the model question up on the screen.

Jim Pennaz: That's called theRMA-2V model, Resource Management Associates Hydraulic model. The model separates the marsh into various grids. We looked at a map of vegetation and we assigned different roughness factors for each of those grids based on the vegetation contained within the grids. We also did a model study of an April 89 flood that had water surface recordings. We duplicated those results from the April 89 flood. We also duplicated the New Year's Eve flood that occurred in January 1, 1988. So we had two events that we were able to duplicate very closely using the hydraulic model. We felt we had very good results and very positive results. The study results are all in the report.

Dr Drigot:

Okay, two more quick ones. I went to a meeting where Dr. Athens, a consultant to you, announced that his report isn't officially released yet and I asked him if I could get a copy of that. I can't evaluate your archaeology contributions without seeing the report. Is Dr. Athen's report coming to us?

Margo Stahl: Yes. We received the draft version of that and according to the requirements we have to have it reviewed and it has to go through a certain approval process before we can go to the public. We've summarized the result of his work in the DEIS; there were no cultural deposits located along the corridors that they looked at, but the final report will be released shortly, it would be out before the final EIS goes out.

Dr. Drigot: Is it always the case where we need an either/or alternative? Why can't the cost analysis be more like a mixed plate, such as represented in the Kailua Neighborhood Board. How do you take into account the combination of factors, rather than just either/or?

LTC Wynn: I'm sorry I don't know what you mean by either/or. Do you mean clearing the marsh or levee raise?

Dr Drigot: Yes, things like that.

LTC Wynn: If you've read the report and looked at the channel clearing, back channel clearing or marsh clearing plan, both of those are associated with the levee raises also. So I guess you could say that's a combination either/or type of situation.

Dr Drigot: Then its a one shot deal. You have to submit the money the same fiscal year that you get it? You can't do like a savings plan, you can't ask for $5M each year?

LTC Wynn: No you can't do that. You can't ask for $5M year after year for the same project.

Dr Drigot: Thank you for answering my questions.

LTC Wynn: Is there anyone else?

Unknown #1: Yes, I'd like to say something. It seems very pointed and over emphasis on the loss of view of Kawainui Meadows if we have a larger levee. I live right at the edge. I moved there because I liked the view and you cannot see Kawainui unless you get up on either road. All you see is the flat. The view from the flat is the mountains. You see the whole Koolau Range, you see the Pali cut and so forth. The ground level view is not going to be affected by whatever height that you build on. because there is nothing to see. There are trees growing now where I live that are much taller than the highest possible berm, concrete wall or whatever we build. Thank you.

LTC Wynn: I think there is a gentleman in the back who hasn't spoken.

Unknown #2: I'm not a resident in that area. You might want to have those people who live there speak first.

Unknown #3: One question. A lot of people don't realize that the Kaneohe area across Kailua Road there's a height of 8 ft and as you drive and go down to where it is 3 ft in that area. Around the 300th block, approximately how many feet will that be above the present dike?

LTC Wynn: We can show an outline, but not give you a measurement right on the top of our heads. Sir you wanted to ask me some questions?

Andrew Yanoviak: My name is Andrew Yanoviak and I'm President of Save Mt. Olomana Association. One question I have Colonel Wynn which concerns me very much, I heard earlier this evening from Jim that this is the last presentation before construction, is that correct?

LTC Wynn: What it is is the last public hearing we're going to have prior to making a decision on which alternative we're going to use.

Andrew Yanoviak: That concerns me very much because there has been an awful amount of literature that has been published that in fact, the Corps of Engineers has not been all that good in handling wetlands. My concern is that the Kawainui Marsh is in fact the largest wetland in the entire State of Hawaii. I don't know if we have anyone here that is confident to handle that. particular marsh. Ducks Unlimited is going to have a major presentation in June, and hopefully the community and yourselves would participate in that presentation. I would hope to have that in the presentation, the community has a first chance for input.

LTC Wynn: Let me ask you a question. Which one of the alternatives don't you like?

Andrew Yanoviak: Well, as far as I understand talking to your folks, the marsh is very sick, it's ill. In fact the marsh may be dying and the concern that I have Colonel Wynn, is that the Kawainui Marsh behaves like a sponge and affects the water quality on top of Kailua Bay. So we need to look at the entire ecology, the full out watershed, including the Maunawili Streams. Your EIS does not take into consideration the Kapaa Stream and also the Kapaa Valley. You ignore that and that's a major ignorance because those waters are in fact flowing into the marsh which we've seen that just recently in 1991. I'm not going back to 1989. The water levels are increasing and the hydrology is increasing in the Kapaa Valley. It must be taken into consideration. The same for the Kalaheo watershed. Again your report ignores that. So I'm very very concern about looking at this big picture from the Koolau watershed as the citizens advisory going all the way into Kailua Bay. We don't want to see for example you folks kill Kawainui Marsh and in the process kill Kailua Bay.

LTC Wynn: I'm awfully confused. How then will we be killing Kawainui Marsh?

Andrew Yanoviak: The way that works Colonel as you folks know, the Kawainui Marsh must in fact act as a sponge. It must be a sponge. It must be able to absorb water. We've done things to the marsh over the years and the one major disagreement that I have this evening is that it is not just what you perceived to be problem, you jumped to alternative solutions. You expect the people here who are not airline mechanics or naval mechanics to jump in and solve these ecological problems and vote on alternatives when in fact no evaluation maintenance was presented?

That's fundamental and I'm concerned that the community has not considered in the future and the near future to look at an evaluation maintenance on a slide screen and vote on that basis. Thank you.

LTC Wynn: Okay. I appreciate your comments. Anyone else? Okay, then we'll close this meeting.

PATSY T. MINK
SECOND DISTRICT, HAWAII

WASHINGTON OFFICE
2135 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515-1102
(202) 225-4906
FAX (202) 225-4987

Congress of the United States
House of Representatives
Washington, DC 20515-1102

DISTRICT OFFICE
HONOLULU
5104 PRINCE KUHIO FEDERAL BUILDING
P O BOX 50124
HONOLULU, HAWAII 96850-4977
(808) 541-1986
FAX (808) 538-0233

U.S. REPRESENTATIVE PATSY T. MINK
STATEMENT TO THE
ARMY CORPS OF ENGINEERS
AND THE CITY AND COUNTY OF HONOLULU
ON THE KAWAINUI MARSH FLOOD CONTROL PROJECT

Kailua, Oahu, Hawaii
May 29, 1991

I want to thank the Army Corps of Engineers and the City and County of Honolulu for this opportunity to submit my statement for the record on the flood control alternatives for Kawainui Marsh as discussed and assessed in the April, 1991 Draft Detailed Project Report and Draft Environmental Impact Statement.

I believe the draft report and EIS document represent a thorough study of the avenues available to protect Coconut Grove and the wider Kailua community from any further damage and flooding as occurred during New Year's, 1988.

Coconut Grove has been subject to a number of floods in the last century, and the flood control measures of the Territory of Hawaii, the Army Corps of Engineers and the City and County of Honolulu through the years have been only partially, and temporarily, effective in the face of changing conditions in the surrounding community and the marsh itself.

4. The destruction of about 3 acres of vegetation by the fill on the Coconut Grove side of the existing levee will be insignificant because this growth is non-native to the marsh and not considered prime habitat for wetfowl;

5. Endangered coots, stilts, moorhens and ducks known to inhabit the marsh are expected to return to the immediate area of the levee raise once construction has ceased and activity returns to normal;

6. No fish or other aquatic species habitat will be permanently destroyed through water quality degradation;

7. No significant impact is anticipated on the waters of Kailua Bay because of sediment runoff during construction or after completion of the project;

8. No historical sites or properties will be affected by the levee raise in the area of Coconut Grove. An archeological survey for the entire marsh is strongly recommended, however, to assure that no sites are inadvertently damaged or destroyed under any circumstances;

The need for a durable and truly effective plan of flood control for Kawainui Marsh is critical to the safety of the homes and residents of Coconut Grove, and to the long-term ecology of this uncommon natural and cultural resource.

By all relevant measures of consequences and mitigations, the Earthen Levee Raise should be the recommended course of action for Kawainui Marsh. This alternative appears to offer the least environmental impacts and adverse social effects to the area because:

1. The impact of construction activities will be minimal through the observation of proper precautions.

2. The required 3 acres of wetland fill created by the levee raise will be located on less valuable wetbird habitat than other areas of the marsh.

3. Water quality should not be affected by the 3 acres of wetland fill, provided the fill material is free of contaminants;

9. The expanded earthen raise will not affect access or recreational use of the levee once construction activity has ceased. Better control of such use within the marsh, such as jogging, walking and sightseeing, is recommended through vigilant, park-type security;

The earthen levee raise alternative is not without some negative impacts, such as the blocking of viewplanes for certain homes in Coconut Grove, disturbance to native waterbird populations and the alteration of some environmental regimes in the marsh, and the cost of construction of the new levee structure.

The social and economic effects of the raised levee alternative to Coconut Grove and greater Kailua, however, far outweighs these impacts. The need for action is undeniable, and the choices before you range from relatively insignificant, though hardly inexpensive, to unmitigable.

The citizens of this community deserve no less than their government's best effort to relieve them of the potential for great loss and harm from another massive rainstorm such as they experienced just two-and-a-half years ago. Delay is unthinkable, and I urge you to proceed in all due consideration and dispatch.

My sincere appreciation again to you all for allowing me to testify through my representative Mr. Earl Arruda of my Honolulu District Office. Aloha and mahalo.