Pouhala Marsh
Restoration Project

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AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
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FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT
WATER RESOURCE MANAGEMENT

July 31, 1998

Mr. Gary Gill, Director
Office of Environmental Quality Control
235 South Beretania Street, Suite 702
Honolulu, Hawaii 96813

Dear Mr. Gill:

Subject: Finding of No Significant Impact (FONSI) for Pouhala Marsh Environmental Assessment and Enhancement Plan, TMK 9-3-01 and portions of 9-3-02, Waipahu, Oahu, Hawaii.

The Hawaii Department of Land and Natural Resources has reviewed the comments received during the 30-day public comment period which began on August 8, 1997. The agency has determined that this project will not have significant environmental effects and has issued a FONSI. Please publish this notice in the August 23, 1998 OEQC Environmental Notice.

We have enclosed a completed OEQC Publication Form and four copies of the final EA. Please call Mr. Paul Conry at 587-4176 if you have any questions.

Sincerely yours,

Michael G. Buck
Administrator

cc: Andrew Engilis, DU
Paul Conry, DOFAW HNL
Dave Smith, DOFAW Oahu

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1998-08-23-OA-FEA-Pouhala Marsh Restoration Project

Environmental and Enhancement Plan for Pouhala Marsh, Oahu, Hawaii

Prepared for:
Hawaii Division of Forestry and Wildlife
U. S. Fish and Wildlife Service
City and County of Honolulu

Ducks Unlimited, Inc.

July 1998

Environmental and Enhancement Plan

for

Pouhala Marsh, Oahu, Hawaii

Prepared for:
Hawaii Division of Forestry and Wildlife
U. S. Fish and Wildlife Service
City and County of Honolulu

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Executive Summary

The Pouhala Marsh restoration project is a multi-cooperator effort that aims to secure and restore nearly 70 acres of wetlands in Pearl Harbor's West Loch. The project has been undertaken through a partnership of Ducks Unlimited, Inc., the State of Hawaii, the U. S. Fish and Wildlife Service, and the City and County of Honolulu. The planning for this project began in 1996. This document details the physical, natural and archaeological features of the marsh. What follows is a summary of the findings.

Pouhala Marsh Location, Ownership, and Zoning: Two parcels define the wetland: TMK West of Kapakahi Stream is 1-9-3-01 all parcels. East of Kapakahi Stream the TMK is 1-9-3-02 select parcels 9,27,2. Pouhala Marsh south of the railroad is classified P subzone in Conservation District.

Proposed Improvements

The data gathered under this EA have given the wetlands design team the tools to correctly develop habitat that will provide the necessary conditions to restore the wetland function of Pouhala Marsh. The primary goals of the project are as follows:

Enhance existing wetland basins so that they function under naturally occurring hydrologic conditions. Enhancement actions include 20 acres of vegetation clearing, sculpting basins, and removing obstructions (levees). Excavations will be to duplicate existing elevations that support stilts and migratory shorebirds (depths not to exceed 1.5 feet).

Clean the marsh of all human debris and trash.

Fence 70-acre marsh to exclude humans, vehicles, and large mammalian predators.

Restore eight acres of marsh through the removal of 66,000 cu. yds. of fill material.

Exclude fish from entering the managed 8-acre wetland through fish screens.

Create a hydrologic link from Kapakahi Stream to the 8-acre wetland. This site will be developed to provide habitat for native damselflies. An inoculation pond has been developed to provide for reintroduction of damselfly nyads.

Agency Determination

The proposing agency for the project will be the Department of Land and Natural Resources, Division of Forestry and Wildlife. Impacts to hydrology, water quality, soils, vegetation, wildlife, and cultural resources have been assessed. No long-term impacts are anticipated from the proposed project. Temporary construction impacts have been addressed in this Final Environmental Assessment and will be mitigated during project implementation. The proposed project is not expected to cause significant impacts to the environment, pursuant to the significance criteria established by the Environmental Council (Hawaii Administrative Rules, Section 11-200-12); therefore, the determination is to issue a Finding of No Significant Impact.

1. INTRODUCTION[1]

1-A. Project Overview

Pouhala Marsh is comprised of a remnant fishpond and coastal marsh in the western loch of Pearl Harbor, Oahu. The wetlands of Pearl Harbor have been degraded through several means including development, water pollution, and alien plant invasion (mangrove, Indian Fleabane, pickleweed). The Harbor's wetlands have declined to a few remaining basins and tidal flats. Pouhala, at 70 acres, is the largest of the remaining wetland habitats in Pearl Harbor. The Recovery Plan for Hawaiian Waterbirds (US Fish and Wildlife Service 1985) has identified Pouhala Marsh as a wetland of critical concern for protection and habitat enhancement.

The loss of wetlands in Pearl Harbor has been recently complicated with the decline of the sugar industry in Hawaii. The recent closure (April 1995) of the Oahu Sugar Company has resulted in the loss of over 100 acres of man-made ponds on Waipio Peninsula. These ponds were managed for effluent discharge from the sugar plant and were heavily used by all four species of Hawaii's endangered waterbirds as well as over 20 species of migratory waterbirds. Recent loss of the Waipio Peninsula Ponds has increased the pressure to restore and protect the remaining wetlands of Pearl Harbor. The wetlands of Pearl Harbor are the last remaining habitat of its type on Oahu's south coast.

Pouhala Marsh is a wetland of vital importance for the Hawaiian Stilt (Ae`o), a federally endangered species. During the non-breeding season, Hawaiian Stilt numbers on the marsh can exceed 150 birds (10% of the remaining world population). Hawaiian Stilt breed at the marsh, but successful nesting is limited due to predation by mongoose, rats, and feral cats and dogs. Restoration of the wetland and fencing of the restored habitat will greatly benefit Hawaiian Stilt. State waterbird surveys have documented two other endangered species at the marsh: Hawaiian Moorhen and Hawaiian Duck. In addition to native, endangered waterbirds, Pouhala Marsh is home to several species of migratory shorebirds.

During the past several decades, Pouhala Marsh has been degraded so that only 24 acres are

[1] Section Author: Andrew Engilis, Jr. Ducks Unlimited, Inc.

currently available and used by waterbirds. These acres have been degraded through siltation and waste disposal. The remaining acres have been filled (8 acres) or degraded and overgrown (38 acres). In addition, the wetland abuts a small residential community that uses the area as an illegal dumping site and promotes access by cats and dogs to waterbird nesting sites.

The Pouhala Marsh project is the first multi-cooperator, wetland restoration effort in Pearl Harbor. Several agencies view the project as instrumental in long-term efforts for the recovery of Pearl Harbor Estuary. Recently, the Environmental Protection Agency (EPA) has considered Pearl Harbor for inclusion into its National Estuary Program. The partners have banded together in hopes that through cooperative efforts Pearl Harbor Estuary will be restored in the future. These actions show that there is significant demand for habitat protection, restoration and water quality improvements in the Pearl Harbor area. Already, the Poūhala Marsh Project has spawned interest by the U.S. Navy (USN) in establishing additional wetlands habitat on Waipio Peninsula. To date, the project has drawn the attention of numerous cooperators and funding partners, including: Ducks Unlimited, Inc. (DU), Chevron Corporation, Hawaii Division of Forestry and Wildlife (DOFAW), Hawaii Department of Health, EPA, the City and County of Honolulu, and the U.S. Fish and Wildlife Service (USFWS).

The protection and restoration of Pouhala Marsh will be accomplished in four phases. Completion of multiple phases will create a wildlife area exceeding 70 acres, the largest in Pearl Harbor Estuary. Pouhala Marsh is especially valuable for the following reasons:

It is the largest remaining wetland in Pearl Harbor Estuary and its protection and restoration will provide significant gains in public awareness of endangered species, significance of estuaries and coastal wetlands, and increase wildlife appreciation.

It is fed by Waikele and Kapakahi streams and thus still has relatively intact surface hydrology, a rare situation on Oahu.

It is home to three federally-listed species of birds: the Hawaiian Stilt, the Hawaiian Moorhen, and the Hawaiian Duck. The Hawaiian Coot, also

endangered, may occur at Pouhala Marsh, and restoration will provide habitat benefits for this species.

It is critical as a wetland for migratory waterbirds. The candidate Bristle-thighed Curlew is known to use the area during its long-distance journeys to and from the South Pacific and Alaska. In addition, the wetland is winter home to four species of shorebirds, including the Pacific Golden-Plover, which winters exclusively on Pacific Islands.

It is consistent with the City and County of Honolulu's plan to develop a foot and bike path and interpretive program in Pearl Harbor. The County has already linked the Pearl Harbor National Wildlife Refuge to county parks in West Loch. The new extension will provide a final link to Pouhala Marsh, thus creating a secured open space parkway along Pearl Harbor's West Loch. Pouhala will provide the eastern anchor for the entire parkway.

Community involvement in wetland protection and restoration will be enhanced through outreach programs and community work groups such as local schools and conservation groups.

Coastal native plant communities are rare in the state of Hawaii. The restoration of this marsh will provide opportunities for revegetation with mixed native coastal wetland species.

The tidal flats of Pouhala are important nurseries for bait fish that are the building blocks of inshore fisheries. Protection of the tidal areas will improve and ensure that this area will remain secure from trespass and illegal contaminant dumping.

1-B. Location and setting

Pouhala Marsh is located on the island of Oahu, Hawaii in Pearl Harbor Estuary's West Loch. It is on the base of Waipio Peninsula, which separates Pearl Harbor into two lochs (**Figure 1-1**). The

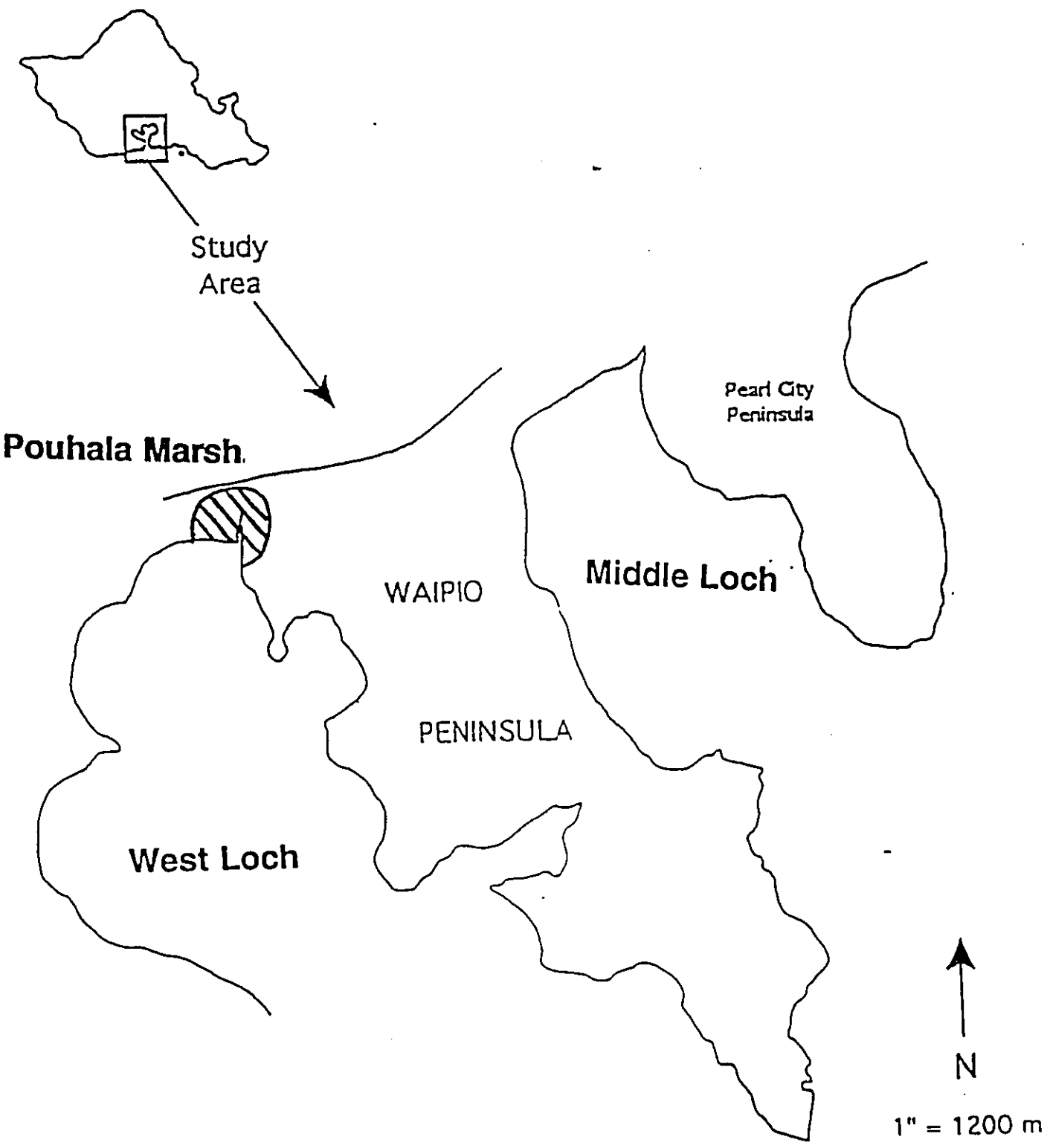
UTM Coordinates are: Zone 03; 602E; 2365N (TMK1-9-3-01). The wetland has three owners: The City and County of Honolulu (31 acres), the State of Hawaii (38 acres), and the U. S. Department of Defense (1 acre). The project will be carried out on lands owned by the City and County of Honolulu and the State. The area below the railroad grade is classified P subzone in Conservation District.

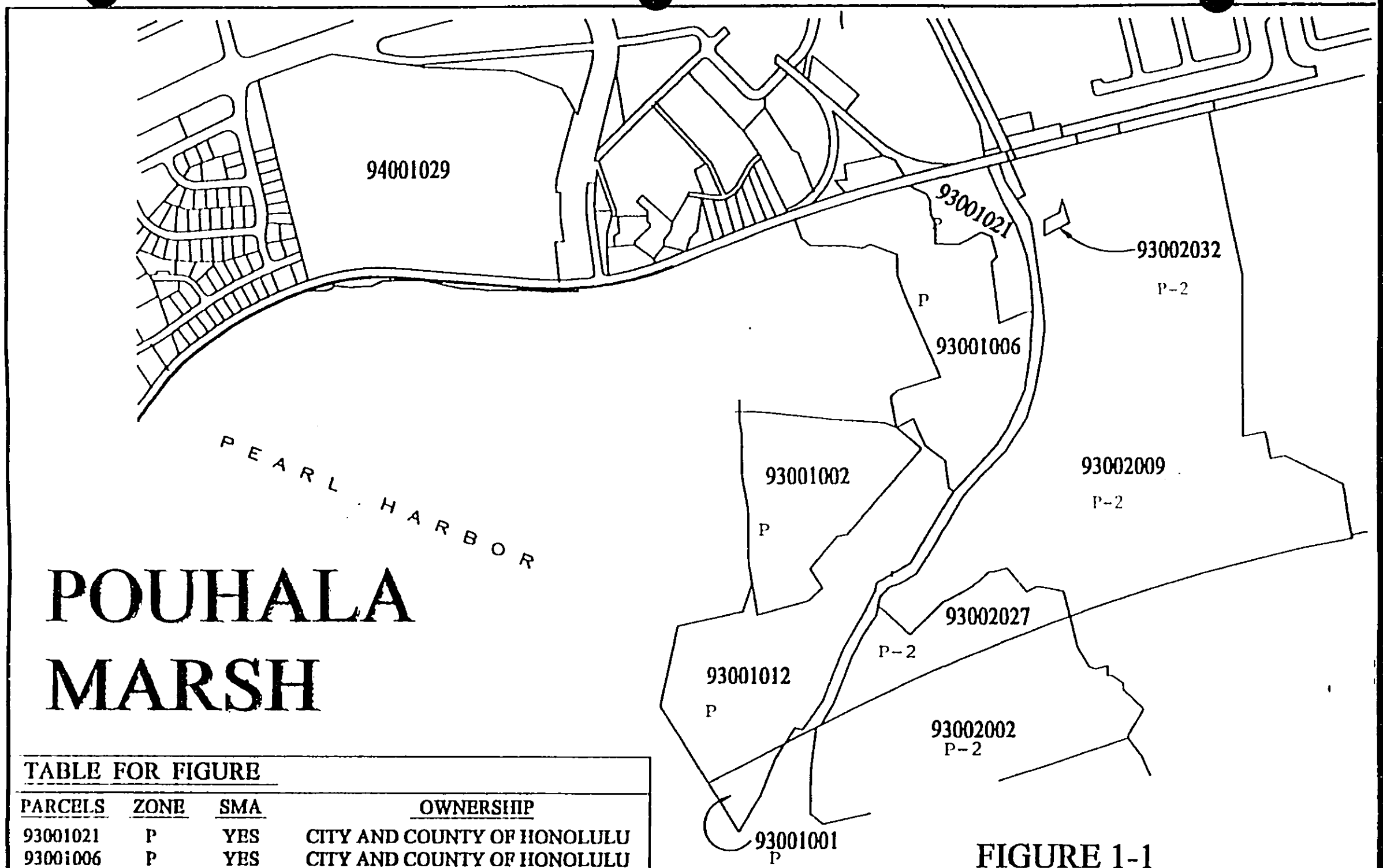
1-C. Partnerships

This project has developed a unique partnership and interest in the Hawaiian Islands. The project was initiated by an EPA grant obtained by the State of Hawaii to examine water quality of the marsh. The USFWS then matched these funds with a grant for planning and restoration. Ducks Unlimited, Inc. (DU), a non-profit, wetlands conservation organization, matched funds from these grants and has taken the lead in developing the site restoration plan for the marsh. Funds for restoration have been secured. The State of Hawaii secured a Coastal Wetlands Conservation Grant from the USFWS ($260,000), and DU secured $40,000. These funds will be used to implement the restoration plan presented in this environmental document.

Figure 1-1

Location of Pouhala Marsh, Oahu, Hawaii





POUHALA MARSH

TABLE FOR FIGURE			
PARCELS	ZONE	SMA	OWNERSHIP
93001021	P	YES	CITY AND COUNTY OF HONOLULU
93001006	P	YES	CITY AND COUNTY OF HONOLULU
93001002	P	YES	CITY AND COUNTY OF HONOLULU
93001012	P	YES	STATE OF HAWAII
93001001	P	YES	MILITARY
93002027	P-2	YES	CITY AND COUNTY OF HONOLULU
BALANCE OF PROJECT - TIDELANDS OWNED BY STATE OF HAWAII			

FIGURE 1-1
LOCATION, PARCELS AND ZONING
OF PROJECT AREA
POUHALA MARSH, OAHU, HAWAII

2. SITE CONDITIONS[2]

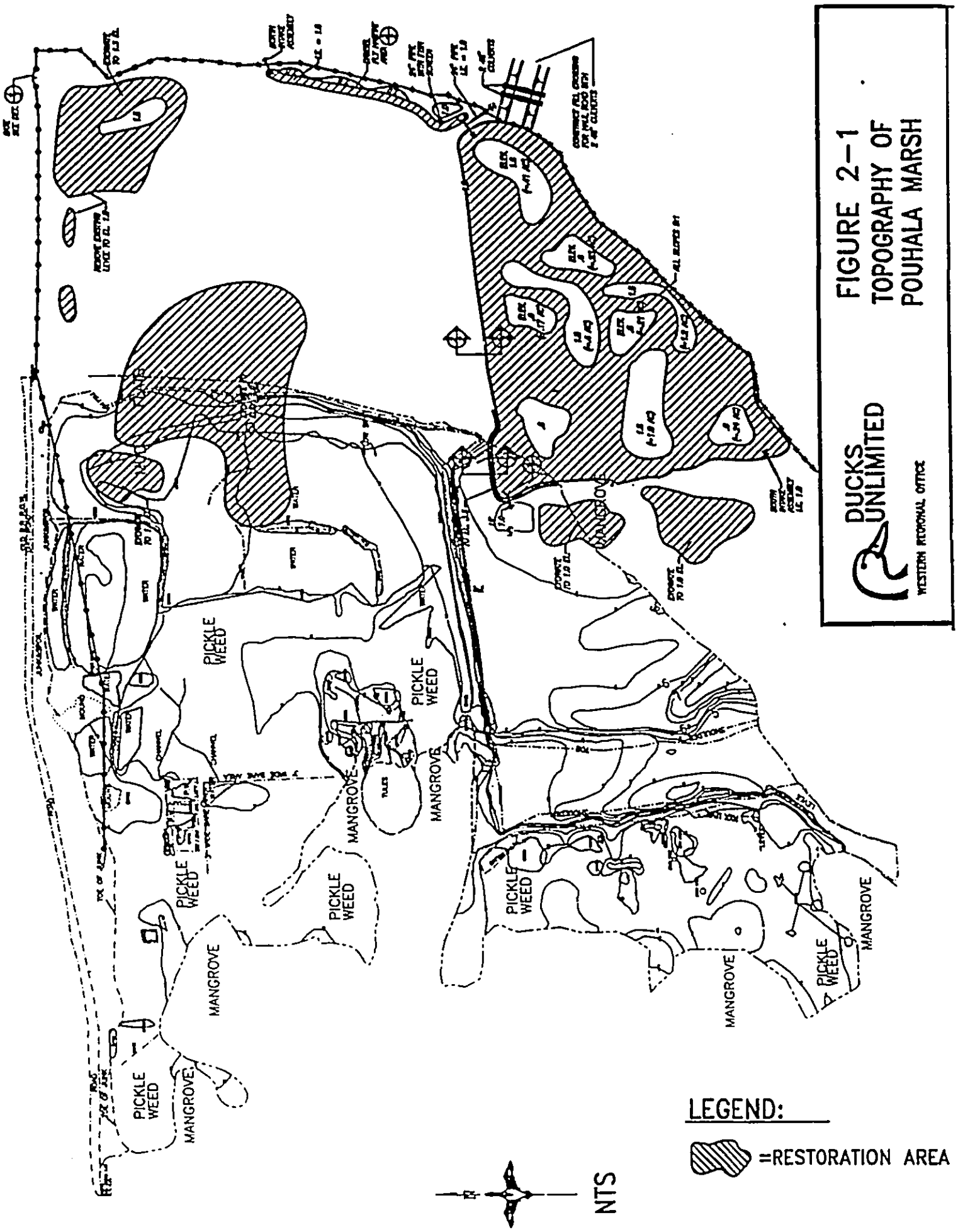
2- A. TOPOGRAPHY

Ducks Unlimited contracted the topographic survey to Robert Miller and Associates supervised by DU Project Engineer Paul Goebel. Due to the high degree of vegetation cover, aerial surveys were not used. Surveys were conducted in December 1995 and plotted using a CAD system. Several transects were set running the length of the wetland. Transects running makai to mauka bisected the first set of transects. Finally, the micro-topography of the open playa was more accurately surveyed. **Figure 2-1** and full scale drawings (attached) depict the surface elevations of the site. Areas in the mangrove community were not surveyed.

[2] Section Authors: Robert G. Armstrong, Brown and Caldwell Environmental Engineering and Consulting

Andrew Engilis, Jr. Ducks Unlimited, Inc.

Figure 2-1: Topography of Pouhala Marsh.



2-B. SOILS

Between December 7 and December 15, 1995, Brown and Caldwell conducted a limited soil study at Pouhala Marsh. The purpose of the study was to characterize the upper five feet of soil at the wetland. This information will help explain the nature of recharge for the wetland and the effects of the surface soil matrix on the movement of ground and surface water. **Figure 2-2** depicts the general locations of the 19 hand auger borings placed by Brown and Caldwell. Also shown are the relative locations of the four stainless steel well points installed at the wetland. These well points will be used to study variations in groundwater level and gradient.

As indicated on Figure 2-2, there are two discrete wetland areas of Pouhala Marsh that we identified as "makai wetland" and "mauka wetland." Following Figure 2-2 are brief summaries of the material encountered in each borehole (BH). Logs for all 19 hand auger borings are included as Appendix A of this report. Each BH was placed to a depth of 5 feet below grade (bg) using a hand auger extension and the appropriate clay or sand auger heads. **Figures 2-3, 2-4 and 2-5** are approximate cross-sections taken along various selected transects in the wetland. They show the relative variations in soil type at similar depth across these cross-sections and the changes encountered over seemingly short horizontal distances.

Figure 2-6 is derived from a 1971 aerial photograph that clearly shows some of the physical features described in the ensuing text. These include the former rice land, berms and channels; the deeper ponds on the mauka wetland; and the filled area along the southeastern portion of the marsh. Kapakahi Stream and a tributary stream from Waipio Peninsula can also be seen. Loko Ka`auku`u and Loko Mohoula are presumably remnants of historical fish ponds ("Loko" refers to a pond, lake, or pool).

Hand Auger Boring Results

Makai Wetland

A total of seven hand auger borings were placed in the makai wetland: BHs 1, 2, 3, 4, 5, 14, and 18.

BH-1. This boring was in the southern-most part of the makai wetland in an area vegetated with

pickleweed. The boring was placed where there was about one inch of standing water, which coincided, characteristically, with a section of sparse pickleweed growth. From grade to four feet below ground (bg) was easily penetrated peat material consisting of vegetable matter and dark reddish-brown fine silty sand. At the interval four to five bg, we encountered a definitive layer of more dense reddish-brown silty sand with oyster shell fragments.

BH-2. This boring was placed in the makai wetland approximately 150 feet north of BH-1, also in pickleweed. Approximately one to two inches of very clear water was standing at the boring location. The peat layer extended to only one foot bg. From one to four feet bg we encountered fine dark gray silty sand with occasional rounded basalt gravel or pebble and abundant oyster shell fragments. From four to five feet bg, there was a layer of very fine light brown to tan floury silty sand.

BH-3. This boring was placed in the makai wetland approximately 150 feet north of BH-2. Essentially the same lithology as found in BH-2 was encountered. In both BH-2 and -3, water appeared to be upwelling once the final five foot silty sand layer was penetrated. This water was cooler than that encountered at levels closer to grade.

BH-4. Located at the northeast corner of the makai wetland near the northwest corner of the landfilled area, this BH was placed adjacent to a pool of water over two feet deep. Unlike the preceding BHs, dark reddish brown clay was encountered right from the surface. This could have been due to erosion of the landfilled area. However, no peat was encountered in this BH. The moisture content of the clay appeared to diminish with depth as density increased. Clumps of weathered basalt and some reddish and olive mottling was encountered with increasing frequency with depth.

BH-5. This borehole was placed along the eastern edge of the makai wetland at the toe of the western edge of the landfilled area. Surface soil was dark reddish brown clay that appears to be slough from the landfill. From two feet bg, dark grayish brown silty clay with abundant (~40%) oyster shell fragments were encountered. Groundwater was first encountered at approximately one foot bg. Between three and four feet bg, medium stiff moist brown clay with continued presence of shell fragments were found. From four to five feet bg, we encountered a very dark gray stiff clay.

The water level in the boring appeared, at the time the borehole was placed, to be lower than standing water on the makai wetland about ten feet to the west.

BH-14. On December 13, this borehole was placed at the northeast corner of the makai wetland adjacent to and south of the mangrove in that area. There was about six inches of standing water at the borehole location. Like BH's 1, 2 and 3, a peat layer extended to about one foot bg. From one to four feet bg we encountered fine dark gray silty sand with occasional rounded and sub-rounded basalt gravel or pebble and abundant oyster shell fragments. From about one to three and a half feet bg, we encountered a dark reddish-brown clay with dry, chalky clumps of weathered basalt. The occurrence of oyster shell fragments increased with depth. Over the interval three and a half to five feet bg was dark gray sandy, silty, clay with some sub-rounded to rounded basalt and limestone gravel.

BH-18. This borehole was located at the southeast corner of the makai wetland, just south of the landfill. Like BH-5, the very thin surface soil layer appeared to have been sloughed from the landfill. The upper six inches was peat material. The interval six inches to two feet was moist dark reddish brown clay. From two to five feet was dark grayish brown silty clay with limited fragments of oyster shell and some quarter to half-inch basaltic pebbles. Monitoring well (MW) three was set in this boring.

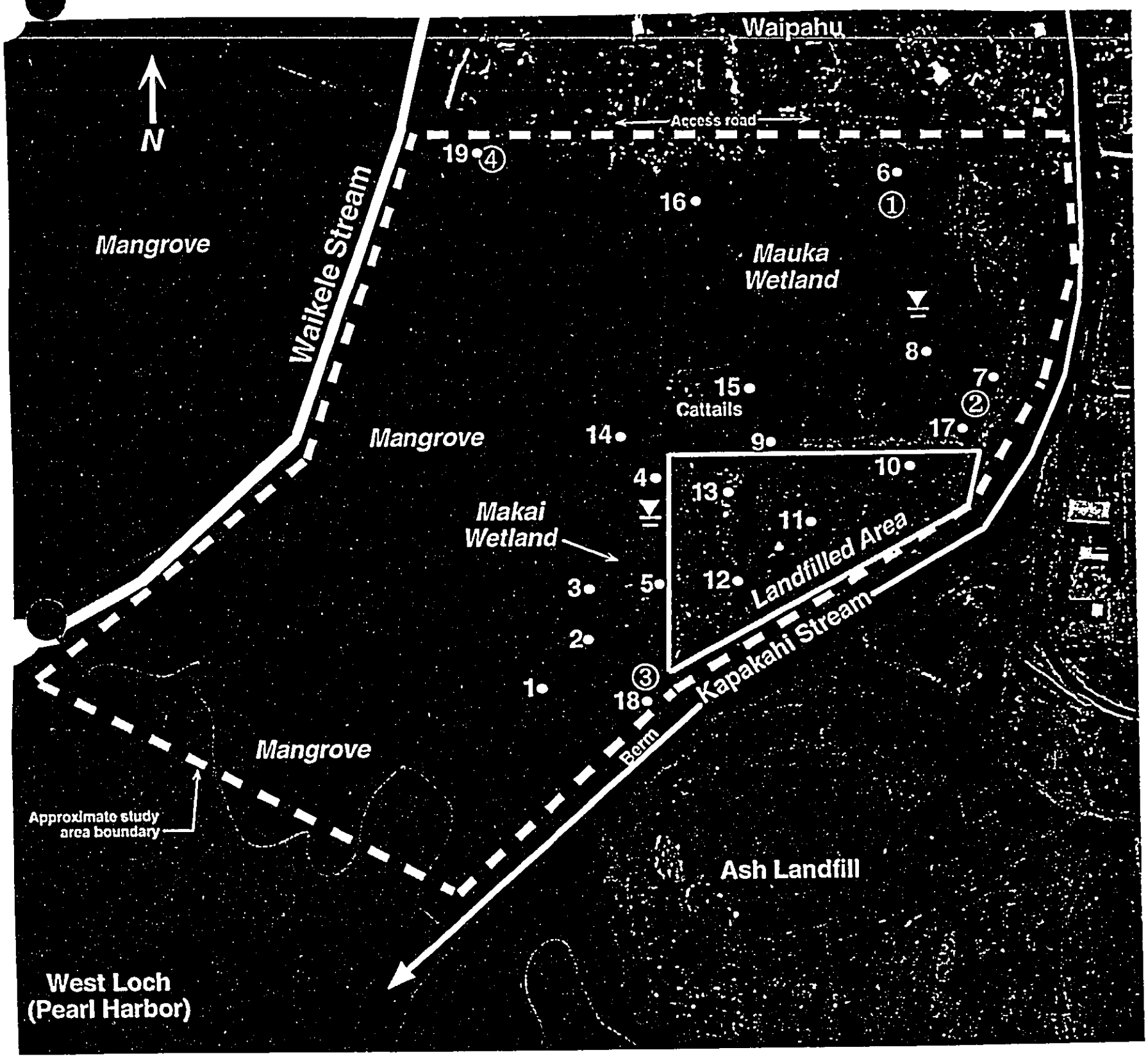
Mauka Wetland

Eight hand auger borings were placed in the mauka wetland: BHs 6, 7, 8, 9, 15, 16, 17, and 19. The mauka wetland, especially the northern portions along the east-west access road, the eastern edge, and, to a lesser extent, the southern edge at the toe of the north edge of the landfill contains a myriad of wastes and debris. This material can be found in piles, strewn over the ground surface, partially buried in mudflats or partially submerged in areas of standing water, or covered over by pickleweed.

Along the northern portion of the wetland, there are indications of active disposal and incineration (small open fires) of wastes. This includes agricultural and wood waters, old 55-gallon storage drums and containers, household wastes, concrete wastes, various metal wastes, soil fill, entire automobile engine blocks, and assorted glass, offal, and junk autos (parts and entire automobiles).

There were five junk cars closer to the railroad bridge at Waikele Stream, on the makai side of the east-west access road. There was a pile of asphalt concrete waste in the same vicinity.

Figure 2-2 Pouhala Marsh Boring and Piezometer Locations



1• Borehole Location (typ. of 18)

Standing water under normal conditions

③ Piezometer Location (typ. of 4)

Stream Flow

Figure 2-3 Approximate cross-section: BH's 1, 2, and 5

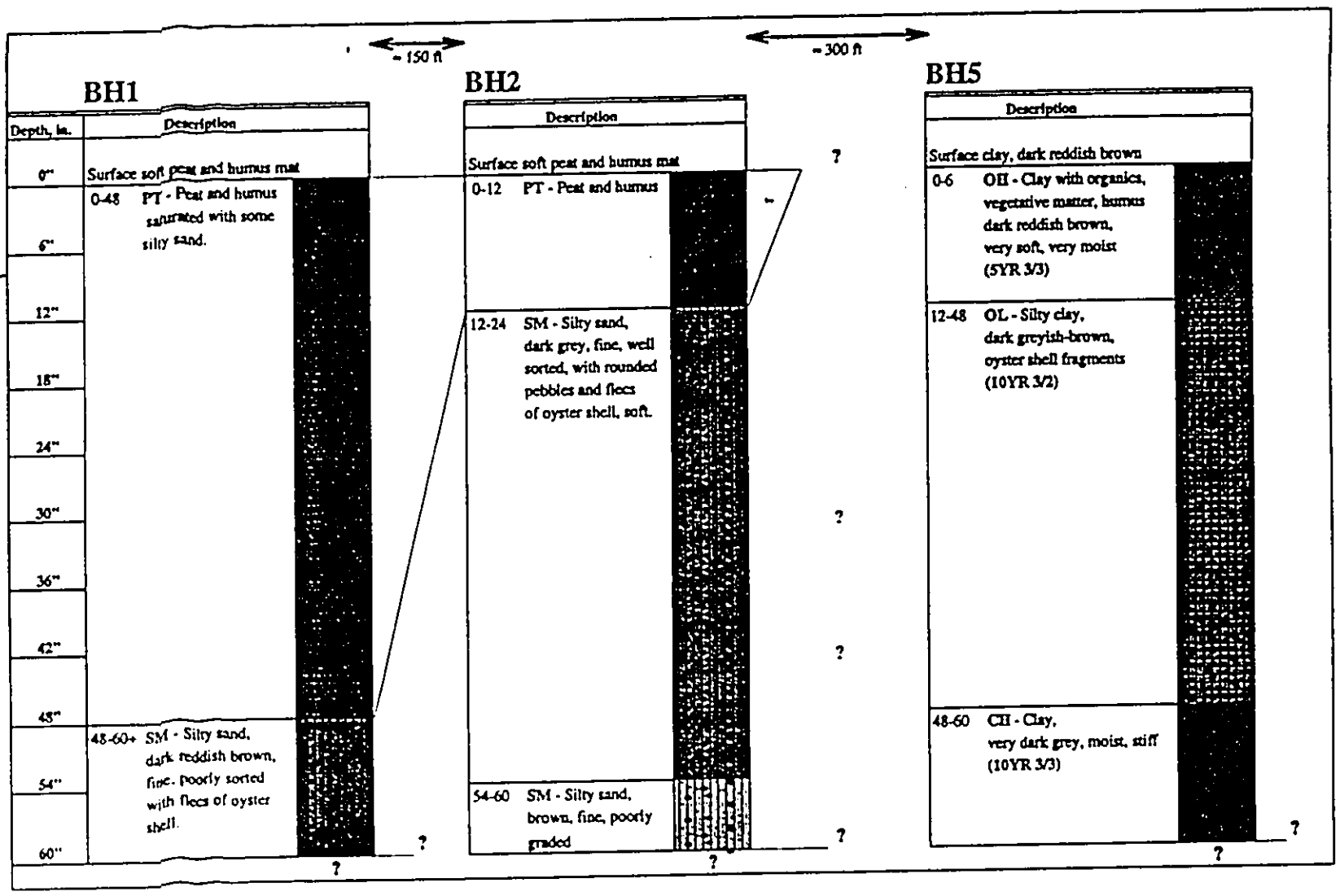


Figure 2-4 Approximate cross-section: BH's 2, 3, 4, 15, 6

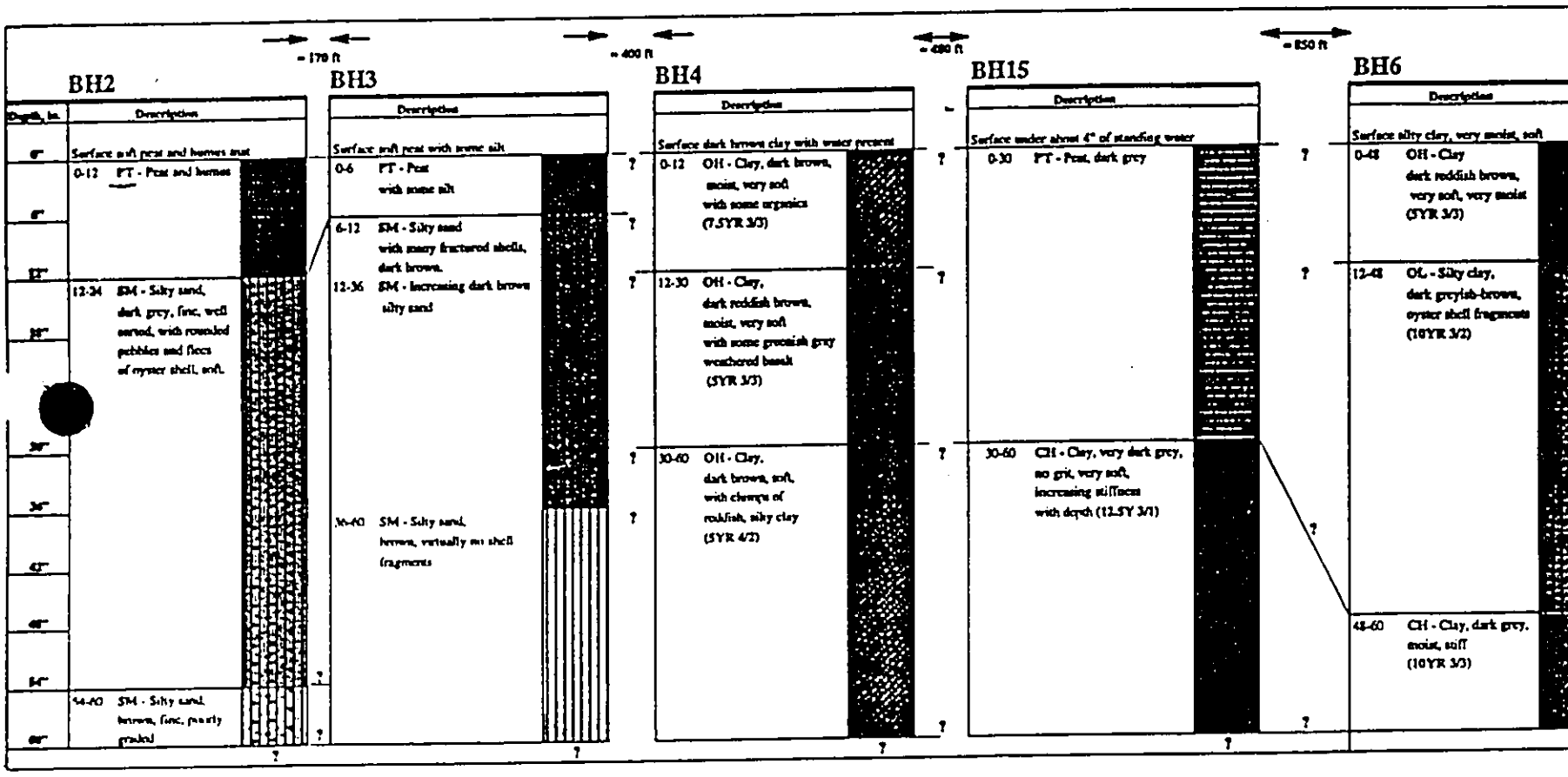


Figure 2-5 Approximate cross-section: BH's 9, 15, and 16

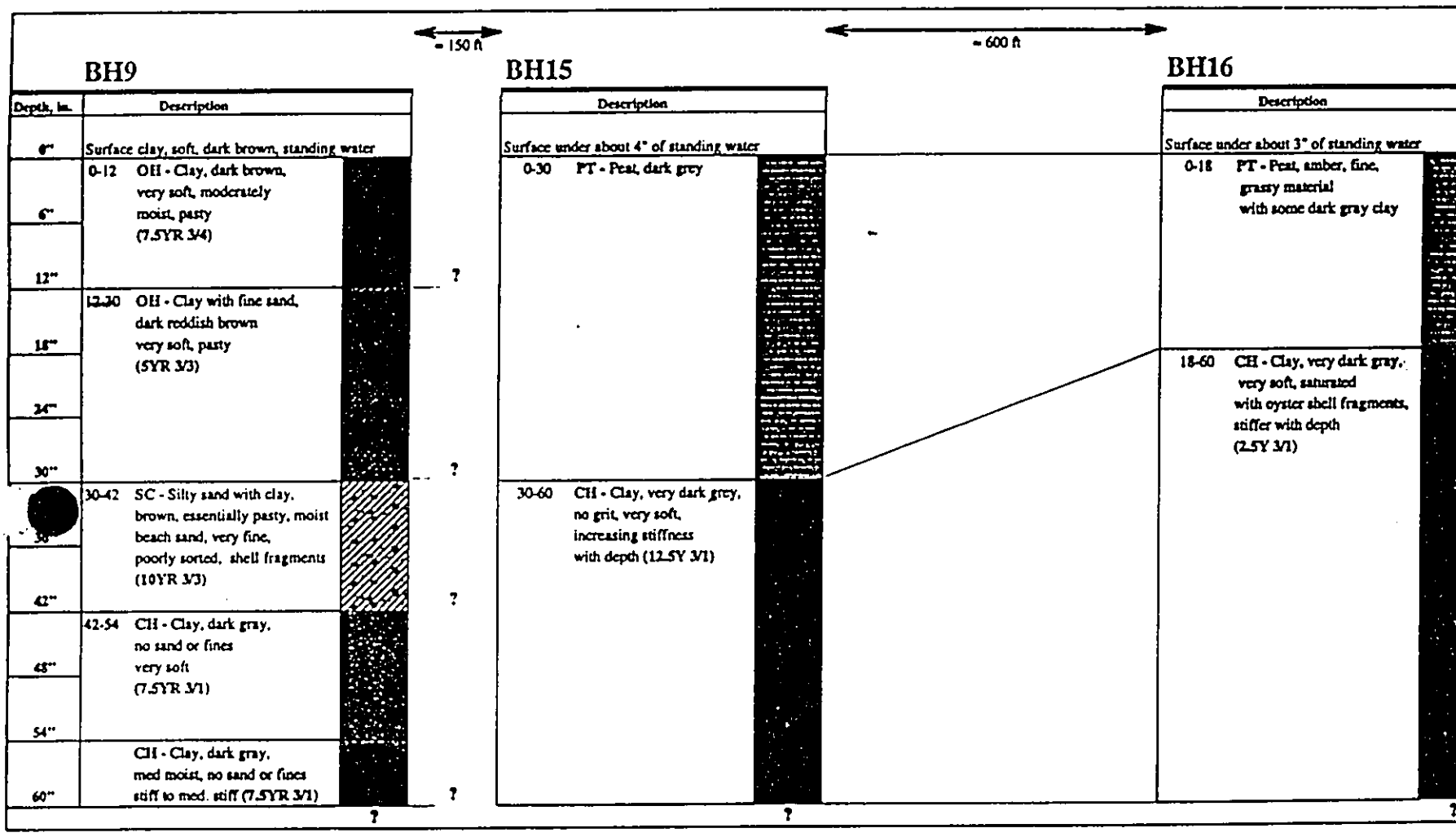
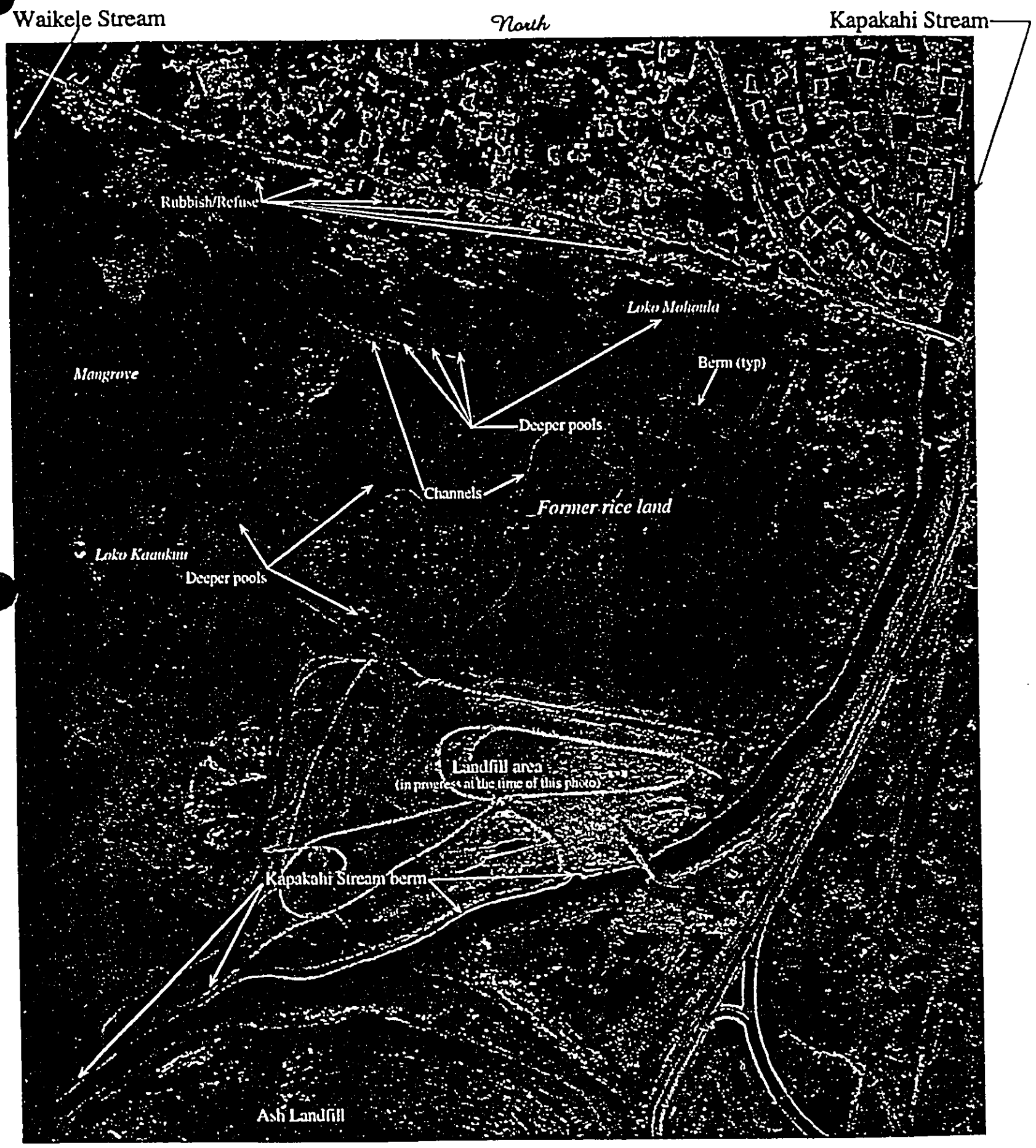


Figure 2-6 1971 Aerial Photograph of Pouhala Marsh showing existing features.



Photograph taken 1/3/71
Adapted from Air Survey Hawaii

The heaviest concentration of illegally dumped refuse is along the marsh side of the mauka east-west access road near the subdivision access road. Concrete and household wastes and used storage drums and containers are most prevalent here.

The mauka wetland area is crisscrossed and pocked with channels and deep ponds. Some of the east-west and north-south oriented channels are probably related to the rice fields that once occupied the Pouhala Marsh flats. Well-defined berms and vestiges of boundary fences are visible on these flats. Three deeper pools aligned in series east to west and located at the center of the mauka wetland area close to the mauka access road are geometrically similar and may also have been associated with the former rice fields.

BH-6. In mudflat adjacent to and at the southeast corner of the northeast rice pond, there are abundant wood wastes and assorted metal debris. From surface to four feet bg, the soil encountered was dark brown clay exhibiting increasing stiffness with depth. At the internal 4 to 5 feet bg, there was a soft, fine, silty, clayey, sand that was essentially beach sand. Once this sand layer was penetrated, the groundwater level in the borehole rose from roughly one foot bg to about one inch bg.

BH-7. This boring was placed along the east boundary of the makai wetland, near its southeast corner at the lone junk car at the side of the north-south access road, approximately 250 feet west of Kapakahi Stream. This is mainly a mudflat area with some dried pickleweed. The upper foot was dark brown silty clay with some peat/humus. From one to about four and a half feet bg was essentially brown clay with increasing beach sand and diminishing tightness with depth. At the bottom of the boring, approximately four and a half to five feet bg, there was a transition from the brown clay to a loose, dark gray, gritty sand (essentially beach sand). Groundwater was encountered at about four inches bg. Water level in the borehole did rise to grade once the gritty sand layer was reached. There was standing water in the mauka wetland approximately 15 feet from the boring.

BH-8. This boring was placed on a high spot or island in the southern one-third of the mauka wetland. The upper one foot was dark brown, very soft silty clay with humus. Over the interval one to three feet bg was a very tight dark brown organic clay. From three to three and a half feet

bg began a transition to a less tight, very moist dark gray clay that became softer from three and a half to four and a half bg and the loose, dark gray, gritty, beach sand between four and a half and five feet bg, as found in BHs 6 and 7.

BH-9. This borehole was located at the edge of the mauka wetland, at its southwest corner, near the eastern stand of cattails and the toe of the landfilled area. From grade to about one foot bg was a dark brown organic clay that was very moist, soft, and pasty. From one to two and a half feet bg the clay took on a more reddish color, remained soft, and contained increased amounts of sand with depth. From two and a half to three and a half feet bg there was increased fine beach sand mixed with the dark reddish-brown clay. There was also some shell fragments. From three and a half to five feet bg began a distinct layer of dark gray clay with no sand that became stiffer with depth.

BH-15. Located in the pickleweed just east of the eastern stand of cattails, this borehole revealed peat in most dark gray soft clay from grade to two and a half feet bg. There was very dark gray clay that went from very soft to increasingly stiff with depth.

BH-16. This borehole was located adjacent to the deep pools at the north central section of the mauka wetland in dense pickleweed where standing water covered the ground surface with about two inches of water. Essentially the same lithology and intervals encountered in BH-15 was found although oyster shell fragments were seen in increasing density with depth.

BH-17. Located at the southeast corner of the mauka wetland near BH-7 and the northeast corner of the landfill area. The upper two and a half feet bg was moist, soft, dark reddish brown clay. This was underlain for the remaining two and a half feet of the boring by a stiffer gray clay. At five feet bg, we encountered coarse granular sand.

BH-19. This boring was located at the northwest corner of Pouhala Marsh, near the Waikele Stream railroad bridge at the northwest corner of the mauka wetland. The borehole was set in moist soil in an open area densely vegetated with pickleweed. In the upper foot of the borehole, we encountered peat mixed first with a dark reddish brown silty clay and then a dark gray clay. Standing water was encountered at about four inches bg. From one foot to five feet bg, we encountered dark gray clay with diminishing moisture and increasing stiffness with depth. Some

oyster shell fragments were encountered at the deeper intervals. A Well Four Monitor was set in this borehole.

Landfilled Area

Four hand auger borings were placed in the prominent landfilled area: BHs 10, 11, 12, and 13. The fill material that comprises the above-grade cap of this area is primarily dark reddish brown clay and silty clay. It appears the fill is essentially homogeneous in this regard. We did not penetrate the soils beneath the cap. Our extensive walk-through and the limited borings into the landfill cap did not reveal buried or covered refuse. However, the landfill cap is littered with wood wastes, some discarded white goods (stoves. refrigerators, etc.), waste and asphalt concrete, car and truck parts, cinder blocks, bottle glass (broken), tin and aluminum cans, and other assorted metal wastes. There was no evidence of storage drums and containers or stained soils on the landfilled area.

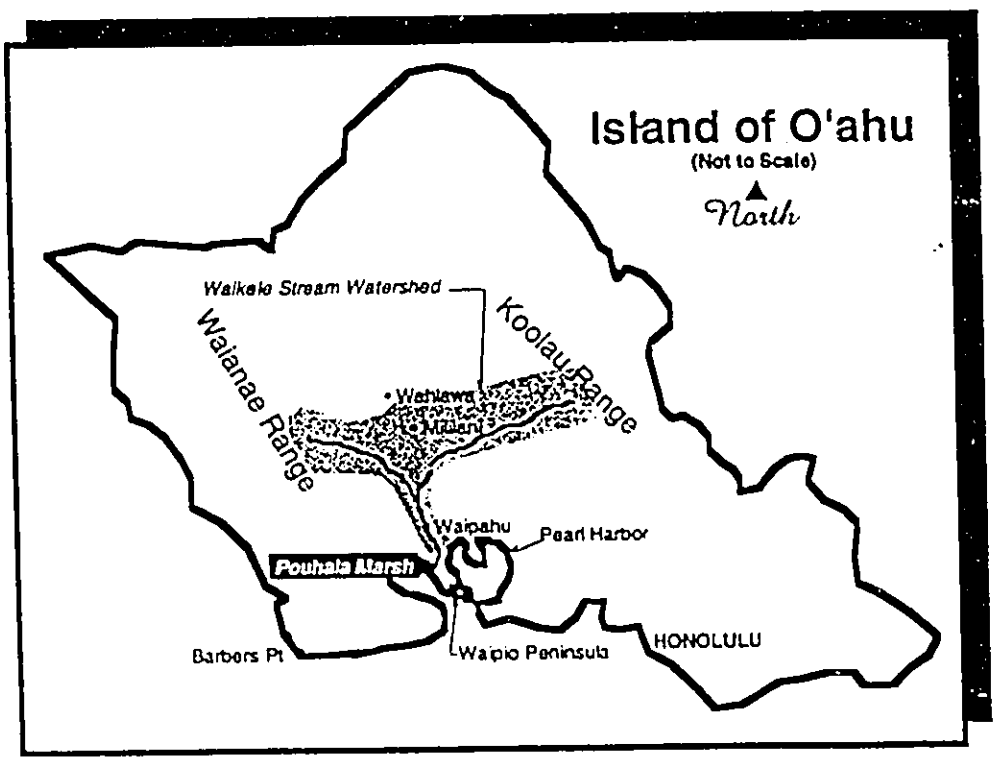
2-C. Regional Hydrology and Hydrogeology

Waikele Stream drains a major regional watershed with an area of approximately 36 square miles. This watershed extends between the Koolau and Waianae Ranges and includes Waipahu, Mililani, and parts of Wahiawa and Schofield Barracks. The watershed also includes Kipapa Stream, which is tributary to Waikele Stream, and has its source in the Koolau Range. The Kipapa-Waikele Stream confluence is approximately four miles north of the marsh, near Mililani. The watershed is extensive and includes a variety of land use classifications. Predominant areas are used for pineapple and sugarcane cultivation. More densely-populated areas east of Waipahu, including Pearl City, are not included in this watershed. The Waikele Watershed is shown in schematic form on **Figure 2-7**.

Briefly, the historical formation of Oahu involved the interbedded joining of flows from the older Waianae and newer Koolau domes. This was followed by periods where the island was successively submerged and exposed during ocean rising and recession. During these periods, the four largest streams that converge at Pearl Harbor formed major valleys and the present lochs. The cutting of these wide valleys was a result of the heavy precipitation on the steeper mauka areas and led to the vast deposition of calcareous and noncalcareous sediments in what is now Pearl Harbor. These long periods of sedimentation formed the cap rock of the aquifer that is recharged

by rainfall permeating through porous basalts in the mauka regions of the Koolau and Waianae ranges. As ocean encroachment and recession occurred, these sediments were eroded and then restored. Bedrock below Waipio Peninsula can be found as deep as 500 feet below sea level (Stearns, H. T. and Vaksvik, K. N., Geology and Groundwater Resources of the Island of Oahu, Hawaii, U.S. Geological Survey, 1935). The sedimentary caprock (mainly limestone formations derived from coral growth) and consolidated alluvial deposits at the deltas of the major streams, such as Waikele Stream, effectively confine the basal groundwater and can create artesian-like

Figure 2-7: Schematic of O`ahu showing location of Pouhala Marsh and tributary watershed.



conditions. Because of lowering sea levels over the last 10,000 years to the present level, stream grades were increased and erosion of sedimentary caprock and deposition of clays and silts have occurred. This has resulted in the thinning of caprock to the extent where artesian-like springs have developed.

To further complicate the geomorphology of the area around Waipio Peninsula, the succession of ocean encroachment and recession led to irregular reef growths on former stream divides and the ensuing deposition of noncalcareous sediments transported from the mauka areas through erosion (Stearns).

Ground water assessments

Four stainless-steel well point piezometers (wells) were placed in Pouhala Marsh at locations shown on Figures 2-2 and 2-8. Top of casing (TOC) elevations for each well were determined. On May 17, 1996, Brown and Caldwell measured depth to water at each well. On this date, the mauka wetland was essentially dry while the makai wetland contained as much or more water than observed during the December 1995 and January 1996 site visits. At the time of the May 17, 1996, site visit, the tide cycle was at its apex. As a probable consequence, standing water was observed at Well 3 for the first time. About 10 inches of water covered the ground surface.

As can be seen on **Figure 2-8**, the highest water elevations encountered were in Wells 3 and 4. These wells are closest to Pearl Harbor and are likely most affected by the tide. Wells 1 and 2 had significantly lower water level elevations. Both are situated in the mauka wetland, which is likely to be most influenced by groundwater recharge from up-gradient sources.

Follow-up water level readings will aide in characterizing the hydrogeology in the marsh as a whole.

Therefore, the hydrology and geohydrology of the area that is now Pouhala Marsh is extremely complex. The area is and has been essentially a vast delta region for Waikele Stream. The prominent cuts and gulches north of the wetlands are evidence of the powerful erosive forces that have existed. Ancient stream beds, sedimentary caprock of varying and diminishing thickness (resulting in springs), and irregular reef formations lay beneath the present alluvial cover. Oyster beds found by Brown and Caldwell beneath layers of clayey sediment provides evidence of more recent accretion.

2-D. Summary of Soils and Hydrology

Overall, in addition to the hydrological and geohydrological factors that differentiate what are referred in this report as the makai and mauka wetlands, the soils and associated layering in the two respective wetland areas also have distinguishing elements. In both areas, there was generally found a confining or semi-confining layer of clay or silty clay. The more makai borings, BHs 1, 2, and 3, did not contain any confining layers in the upper five feet. Instead, a peat layer overlaying a

silty, sand with heavy deposits of oyster shell fragments were encountered. This is not unusual considering that the area, historically, has been at the interface of the Waikele Stream Delta and the waters of Pearl Harbor proper. Older United States Geological Survey (USGS) maps show the area where BHs 1, 2, and 3 are located as part of Pearl Harbor. Presumably, through accretion possibly associated, in part, with other fill activities in the West Loch and Waipio Peninsula areas, as well as the establishment of mangrove, the wetland expanded to its current footprint.

The significance of the surficial soils is greater in the mauka wetland soils where the silts, clays, and silty clays act as confining or semi-confining layers for the upward movement of basal groundwater. BHs 6, 7, 8, 9, 15, 16, and 17 all show silts and clays of varying consistency over the upper five feet. The historical rice land and other delineated pools and ponds (*i.e.*, Loko Monuola) located at the northeast corner of the mauka wetland may have apparently penetrated these upper noncalcareous sedimentary layers.

The springs or artesian-like conditions briefly discussed at the beginning of this report may be a factor in the recharge of the mauka wetland. Based on the literature, the caprock, through which the springs emanate, is situated at depths greater than the five-foot borings placed for this study. These springs, for the most part, should be independent of the surficial and silty clays that were encountered. However, the surficial clays and silty clays encountered may impact recharge by acting as confining or semi-confining layers. This may become clearer once water level data is available from the four piezometers that have been placed at different points in the wetland.

No artesian conditions were observed by Brown and Caldwell. Based on our observations and the survey information provided by Robert S. Miller and Associates, the water levels in the most northern pools of the mauka wetland are greater than the water levels in the makai wetland pools. For the mauka wetland, this suggests recharge from groundwater from up-gradient sources or that it is tidal-affected, or both. This recharge may be a result of penetration of surficial confining layers and the effects of the pressure gradients induced by breaches or thinning of the deeper caprock. Readings from four piezometers placed throughout the marsh will help identify the existence of pressure gradients. This will be useful in predicting if further penetration or removal of the surface clays would result in overall flooding of the wetland other than in the immediate areas impacted by the grading.

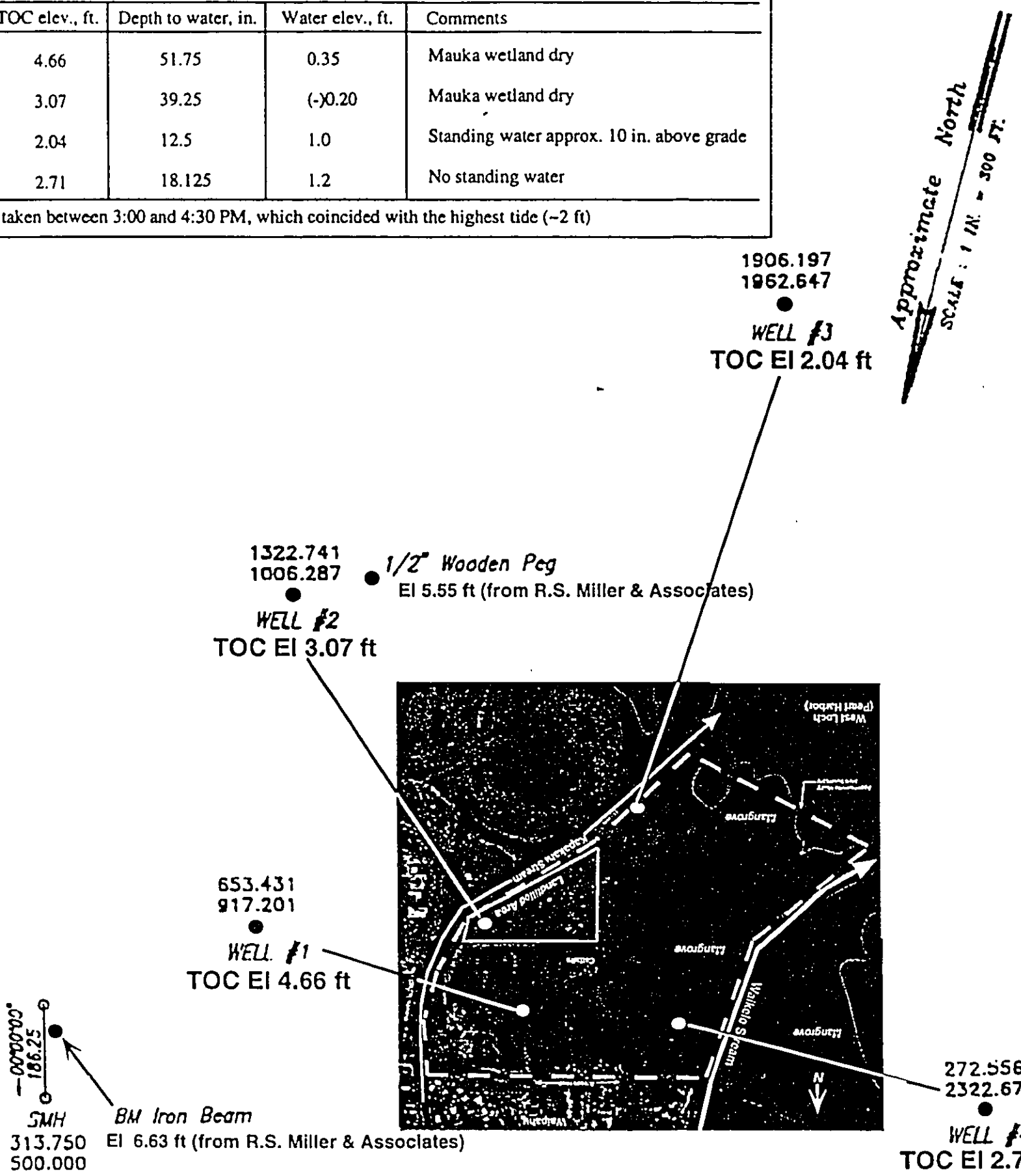
Figures 2-3, 2-4 and 2-5 are approximate cross-sections taken along various cross-sections in the wetland. They show the relative variations in soil type at similar depth across these cross-sections and the changes encountered over seemingly short horizontal distances.

Figure 2-8 Pouhala Marsh piezometer locations and May 17, 1996 water level readings.

17, 1996

Well	TOC elev., ft.	Depth to water, in.	Water elev., ft.	Comments
1	4.66	51.75	0.35	Mauka wetland dry
2	3.07	39.25	(-)0.20	Mauka wetland dry
3	2.04	12.5	1.0	Standing water approx. 10 in. above grade
4	2.71	18.125	1.2	No standing water

Readings taken between 3:00 and 4:30 PM, which coincided with the highest tide (~2 ft)



2-E. Water Quality Studies

During numerous site visits to Waipahu and Pouhala Marsh, we collected grab samples at various locations and performed field measurements for pH, temperature, and electrical conductivity (EC), an indicator of the quantity of total dissolved ionic constituents and one means of classifying water based on salinity. The associated readings and field observations were used to develop a water quality sampling plan that established sampling stations along the two tributary streams, Waikele and Kapakahi, and at two locations in the marsh itself. The two marsh locations, designated mauka and makai as discussed above, were established because they appeared to be two separate hydrological units. Sample collection equipment and protocols were designed to minimize contamination and generally conform to EPA guidelines for "clean" sampling methodologies. Dry weather sampling took place on December 13, 1995, after a period of at least five days with no significant precipitation (< 0.01 inches). Wet weather sampling was conducted on the morning of January 25, 1996, during a 24-hour period in which 1 to 1.5 inches of rainfall occurred in the Waipahu/Pearl Harbor area.

Field Screening.

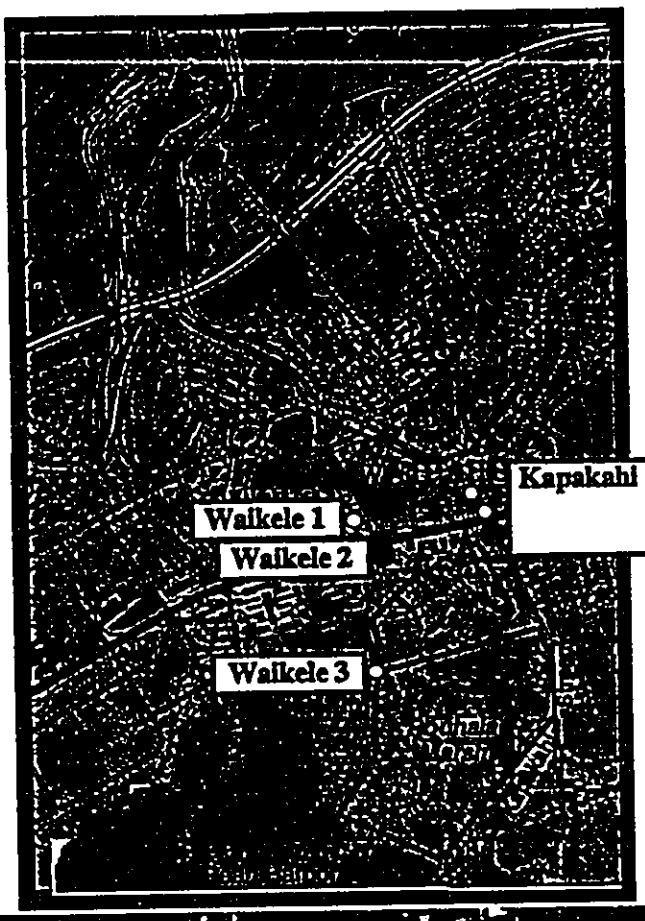
The locations of the field screening grab-sampling locations are shown on **Figure 2-9**. The results of the screening tests are listed on **Table 2-1**. The results indicate that, in general, the two discrete wetland units exhibit different water quality. The electrical conductivity (EC), pH, and temperature readings were consistently higher in the visibly more turbid and stagnant mauka wetland than in the makai wetland. Grab samples were taken at the two wetland locations and in the two streams during dry and wet weather.

During field screening activities, we explored much of the mangrove stands along Waikele and Kapakahi streams. The co-mingling of Pearl Harbor (West Loch) and stream waters and the resulting spread into the wetland zones occurs much closer to the east-west access road along the mauka edge of the wetland on Waikele Stream than along the smaller Kapakahi Stream. The principal reason for this is the location of Waikele Stream along (or even beyond) the western edge of Waipio Peninsula.

Figure 2-9 Waikele Stream, Kapakahi Stream and Pouhala Marsh Water Quality Screening Locations

The two maps on this page show approximate locations where grab water samples were field analyzed for electrical conductivity, pH, and temperature.

Results are listed on Table 1.



● Signify dry and wet weather sampling locations (typ of 4)

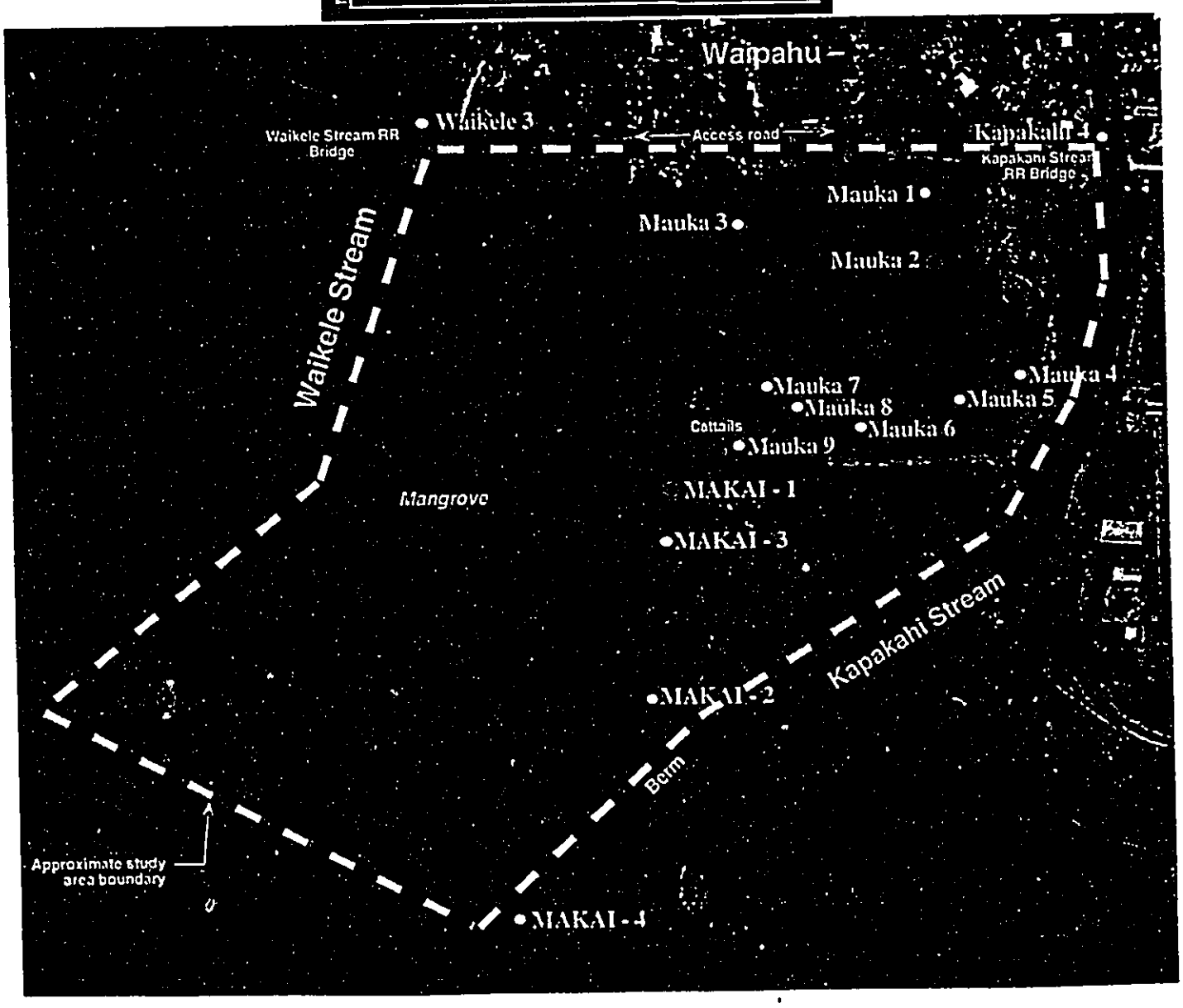


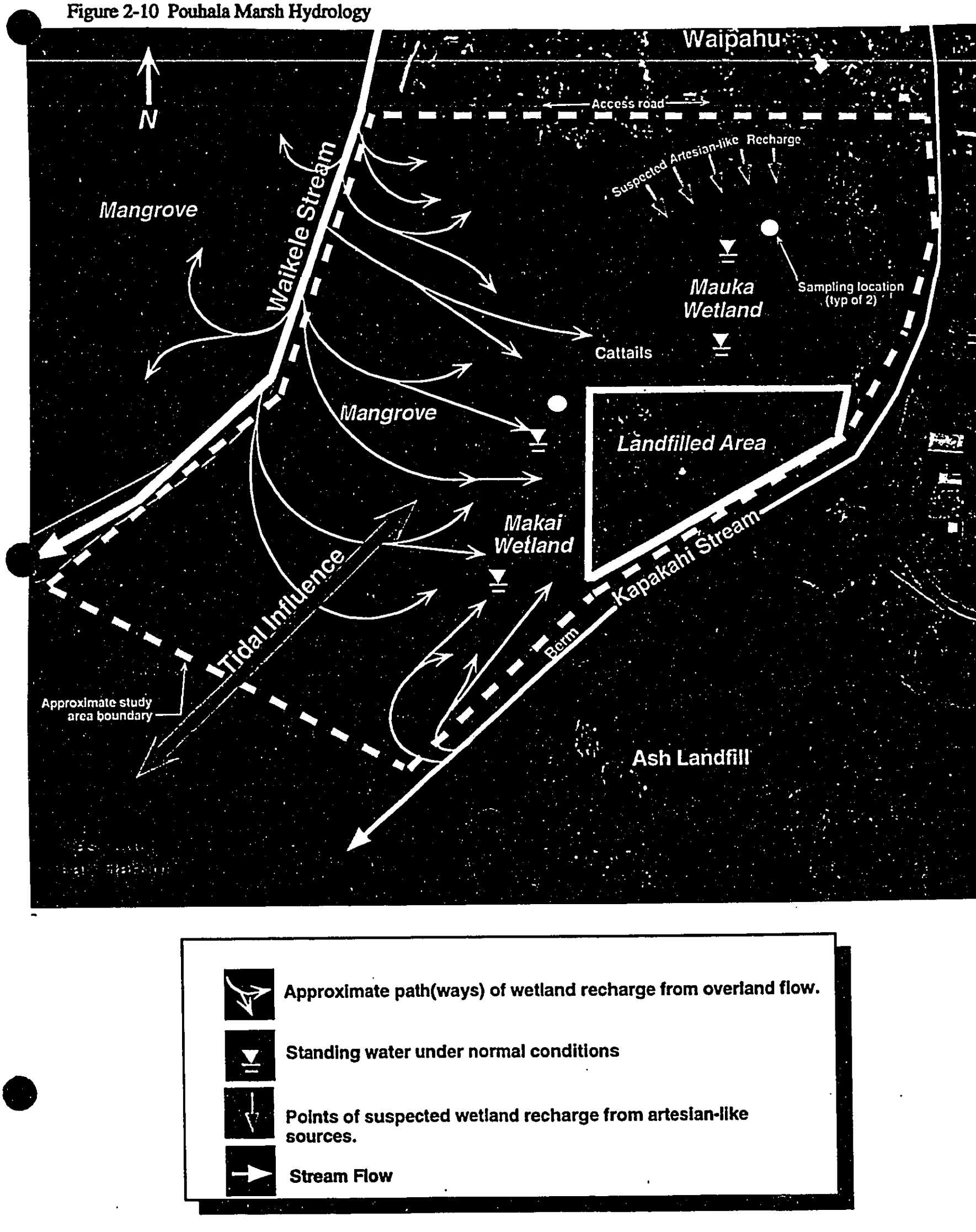
Table 2-1. Results of Waikele Stream, Kapakahi Stream and Pouhala Marsh Water Quality Screening

Sampling Location	Date Sampled	Electrical Conductivity, micromhos/cm	pH	Water Temp., Deg C	Comments
Mauka 1 (s)	12/08/95	31,500	8.34	27.5	Surface water (sw): brown, turbid
Mauka 1 (gw)	12/08/95	37,300	6.33	27.2	Ground water
Mauka 2 (1)	12/15/95	32,000	8.65	26.5	sw: brown, sl. turbid
Mauka 2 (2)	1/25/96	28,900	8.31	24.6	sw: brown, sl. turbid, wet weather sampling (wws)
Mauka 3	12/31/95	32,300	--	--	sw: brown, sl. turbid
Mauka 4	12/08/95	31,500	8.34	27.5	same as above
Mauka 5	12/08/95	30,700	8.49	27.5	same as above
Mauka 6	12/08/95	30,700	8.48	29.8	same as above
Mauka 7	12/13/95	30,600	7.80	27.0	same as above
Mauka 8	12/08/95	28,700	8.40	29.1	same as above
Mauka 9	12/08/95	26,900	7.10	27.1	sw: clear
Makai-1 (1)	12/08/95	23,800	7.00	25.7	same as above
Makai-1 (2)	1/25/96	16,600	7.40	24.4	sw: clear, wws
Makai-2	12/13/95	27,700	6.60	27.4	sw: clear
Makai-3	12/15/95	16,700	7.30	25.6	same as above
Makai-4	12/13/95	20,500	6.68	26.0	same as above
Kapakahi 1	12/13/95	625	6.78	22.6	same as above
Kapakahi 2	12/13/95	625	6.90	22.9	same as above
Kapakahi 3 (1)	12/13/95	625	6.90	22.9	same as above
Kapakahi 3 (2)	12/15/95	630	7.60	24.3	same as above, wws
Kapakahi 4	12/13/95	1,784	7.45	--	sw: clear
Waikele 1	12/15/95	392	--	--	same as above
Waikele 2 (1)	12/13/95	518	6.75	23.0	same as above
Waikele 2 (2)	12/15/95	50	8.17	20.0	wws: water brown, turbid
Waikele 3	12/13/95	6,000	6.88	25.2	sw: clear

Much of the western mangrove at the Waikele Stream Delta is shown on older topographic maps to be part of Pearl Harbor. Another reason is the extended channelization of Kapakahi Stream by the prominent berm along the west, or wetland, side of the stream. The berm can be seen on Figure 2-6. It extends to near the terminus of Kapakahi Stream at West Loch. We observed water on both sides of the berm at its terminus, with the Pouhala-side extending into the makai wetland. From the berm, the grade slopes to the west or makai areas except in the vicinity of the landfilled area where an artificial high area exists.

Overall, wetland recharge is probably due to a combination of complex and inter-related factors including tidal, stream flow, and groundwater (spring discharge and tidal-influenced) effects. Flow into the western mangrove bank occurs at the Waikele Stream/ Pearl Harbor confluence. This includes the deeper, permanent pools near the two cattail clusters at the northwest corner of the landfill area and the pools in the makai wetland. The deeper pools at the mauka edge of the mauka wetland, including the network of deeper channels and remnants of fishponds and rice fields, have penetrated the upper dense clay and silty clay layers and, for the most part, do not appear to be recharged via surface water from the Waikele Stream/Pearl Harbor confluence zone. Instead, the influence of groundwater, probably artesian-like releases from porous basalts extending from up-gradient, and the combined effects of tides contribute to the filling of the mauka wetland. This is supported by the field screening and wet and dry sampling event data, discussed below. Overall, the hydrology of Pouhala Marsh is affected by a variety of natural and anthropogenic factors that include artesian-like springs, channels and berms (including a low berm that runs along the wetland site of Waikele Stream from the railroad bridge, extending approximately 300 yards south, into the mangrove), land-filled areas, and the dense mangrove. **Figure 2-10** is a schematic of the suspected overall Pouhala Marsh hydrology.

Figure 2-10 Pouhala Marsh Hydrology



The sampling locations for the more detailed wet and dry weather studies were determined, through field screening, to be most suitable in that they best characterized the specific wetland area or stream. Both the Kapakahi and Waikele Stream locations were believed to experience minimal tidal influence, as represented by field EC readings and general observations. The Kapakahi Stream sampling location was on the makai side of the Farrington Highway bridge. The Waikele Stream sampling location selected was on the mauka side of the west-bound (mauka) Farrington Highway bridge near an old water pumping station and standpipe structure, just downstream of a spillway and gauging station. A more suitable location from a tidal-influence perspective may have been upstream of the spillway. However, we believed the slightly downstream location was safer since access upstream of the spillway was limited. These suspicions were confirmed by the high, swift-flowing river conditions encountered during wet weather sampling.

The mauka wetland location was in the former rice field near a deeper mauka-situated pool. The water was characteristically turbid, warm, and stagnant. The makai wetland location was in a deep pool amidst pickleweed, near the west to east extension of mangrove that terminates at the cattails. The water at this location was characteristically clear and cool.

Wet and dry weather sampling. Baseline, dry weather sampling was done on December 13, 1995, in conjunction with the soil survey. Non-stormwater flows were sampled at the four locations shown on Figure 2-8. This included standing water in the marsh, on the mauka and makai sections, and in Kapakahi and Waikele Streams, respectively. The purpose of the dry-weather sampling was to provide a baseline for the ensuing wet weather sampling. The sampling was designed to help assess the effects of runoff on the marsh from diffuse-source or non-point source pollution from urban and agricultural watersheds. All samples were handled and shipped according to established protocol and procedures. Laboratory analyses were performed by Brown and Caldwell Analytical (BCA) in Glendale, California.

Summary of field screening and wet and dry weather sampling analyses. Table 2-2 is a summary of the results of the dry and wet weather sampling and analyses. Complete analytical reports, QA/QC data, and chain of custody forms are included as Appendix B to this report.

Overall, metals, pesticides, and PCBs were either "none detected" or found in very low

concentrations in all sampling locations. The other water quality data for Pouhala Marsh from the wet and dry weather sampling are within reasonable levels expected for the conditions at a wetland. The data indicate possible differences due to varying amounts of recharge and dissolved oxygen levels in the wetland. For example, EC and water temperature are both generally higher for sampling locations in the mauka wetland where there is thought to be less recharge from adjacent water sources (see also Table 1). Evaporation rates are likely higher in this area, which may also be responsible for these results. Less recharge also favors lower dissolved oxygen levels, which may explain the relatively high levels of ammonia found in the mauka wetland since anaerobic conditions cause more of the nitrogen present to be in the reduced form. The data also suggest that there is more algae growth in the mauka wetland, as evidenced by more turbidity, higher total suspended solids, higher BOD_5 and TOC (from organic matter associated with the algae), and higher pH (samples were taken during daytime when algae respiration is high). This is supported by greater concentrations of nutrients found in the mauka wetland. The limited data on groundwater quality (mauka 1 (gw)) do not show elevated conductivity readings in groundwater.

Samples collected from both areas of the wetland during wet weather conditions (Table 2-2) generally had lower concentrations than dry weather samples, probably due to dilution. However, comparison to data from the two streams sampled suggests that the source of diluted water is not necessarily from the streams. For example, levels of barium, zinc, phosphorus, and total suspended solids all decreased during wet weather in the makai wetland while they increased and were above concentrations in either wetland in Waikele Stream, which presumably feeds the makai wetland. Similar results occurred for several parameters in the mauka wetland. Settling of stormwater from the streams prior to reaching the wetlands, or high amounts of relatively dilute groundwater flow during storms, may explain the results observed. The filtering capability of the mangrove may explain the clear water encountered in the makai wetland during wet weather sampling. Waikele Stream was experiencing high flows and was sediment-laden (flowing red) at this time. The metals detected in Waikele Stream during wet weather sampling can be attributed to high sediment content (TSS concentration of 1,400 ppm).

Kapakahi Stream water quality experienced little change between the sampling events. The limited urban setting of the stream, as well as Waikele Stream, precludes the presence of most toxic constituents often found in urban stormwater. BOD_5, TOC, and TSS were all low in Kapakahi

Stream in both rounds. Limited flows were observed entering the stream via small (<16-inch) storm drains terminating beneath the wide Farrington Highway bridge. A small shopping center and old Waipahu Town upstream of the Farrington Highway bridge provide the only semblance of an urban setting, which appeared to have little or no effect on stream water quality. The principal source of Kapakahi Stream appears to be the Waikele Springs just down-gradient of the Waipahu Sugar Mill, near Waikele Stream. This is a boggy area currently used for banana, taro and other food crops.

Table 2-2 Results of laboratory analysis--wet and dry weather sampling

All values except pH in mg/l

Analyte	Results by location, mg/l							
	Pouhala Marsh Mauka		Pouhala Marsh Makai		Kapakahi Stream		Waikele Stream	
	Dry (12/15/95)	Wet (1/25/96)	Dry (12/15/95)	Wet (1/25/96)	Dry (12/15/95)	Wet (1/25/96)	Dry (12/15/95)	Wet (1/25/96)
Pesticides (M608)[1]	ND	ND	ND	ND	ND	ND	ND	ND
PCBs (M608)[1]	ND < 1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1
Metals								
Arsenic (M7060)	ND < 0.002	ND < 0.002	*0.0039*	ND < 0.002	ND < 0.002	*0.0025*	*0.0022*	ND < 0.002
Antimony (M6010)	ND < 0.100	ND < 0.100	ND < 0.100	ND < 0.100	ND < 0.100	ND < 0.100	ND < 0.100	ND < 0.100
Barium (M6010)	*0.025*	*0.053*	*0.062*	ND < 0.002	*0.011*	*0.011*	*0.0097*	*0.20*
Beryllium (M6010)	ND < 0.001	ND < 0.001	ND < 0.001	ND < 0.001	ND < 0.001	ND < 0.001	ND < 0.001	*0.0019*
Cadmium (M6010)	ND < 0.005	ND < 0.005	ND < 0.005	ND < 0.005	ND < 0.005	ND < 0.005	ND < 0.005	ND < 0.005
Chromium (M6010)	ND < 0.010	ND < 0.010	ND < 0.010	ND < 0.010	ND < 0.010	ND < 0.010	ND < 0.010	*0.46*
Cobalt (M6010)	ND < 0.040	ND < 0.040	ND < 0.040	ND < 0.040	ND < 0.040	ND < 0.040	ND < 0.040	*0.077*
Copper (M6010)	ND < 0.020	ND < 0.020	ND < 0.020	ND < 0.020	ND < 0.020	ND < 0.020	ND < 0.020	*0.20*
Lead (M7421)	ND < 0.002	ND < 0.002	ND < 0.002	ND < 0.002	ND < 0.002	ND < 0.002	ND < 0.002	*0.0084*
Mercury (M7470)	ND < 0.0002	ND < 0.0002	ND < 0.0002	ND < 0.0002	ND < 0.0002	ND < 0.0002	ND < 0.0002	ND < 0.0002
Molybdenum (M6010)	ND < 0.010	ND < 0.010	ND < 0.010	ND < 0.010	ND < 0.010	ND < 0.010	ND < 0.010	ND < 0.010
Nickel (M6010)	ND < 0.040	ND < 0.040	ND < 0.040	ND < 0.040	ND < 0.040	ND < 0.040	ND < 0.040	*0.43*
Selenium (M7740)	ND < 0.004	ND < 0.004	ND < 0.004	ND < 0.004	ND < 0.004	ND < 0.004	ND < 0.004	ND < 0.004
Silver (M6010)	ND < 0.010	ND < 0.010	ND < 0.010	ND < 0.010	ND < 0.010	ND < 0.010	ND < 0.010	ND < 0.010
Thallium (M6010)	ND < 0.070	ND < 0.070	ND < 0.070	ND < 0.070	ND < 0.070	ND < 0.070	ND < 0.070	ND < 0.070
Vanadium (M6010)	ND < 0.040	ND < 0.040	ND < 0.040	ND < 0.040	ND < 0.040	ND < 0.040	ND < 0.040	*0.29*
Zinc (M6010)	*0.018*	ND < 0.010	*0.013*	ND < 0.010	*0.041*	*0.017*	*0.026*	*0.21*
Nutrients								
Ammonia (M350.1)	*2.4*	*0.14*	*0.79*	*0.20*	*1.6*	*0.16*	ND < 0.1	*0.40*
Nitrate (as N) (M353.2)	ND < 0.050	ND < 0.050	ND < 0.050	ND < 0.050	*1.2*	*0.65*	*1.0*	*0.14*
Nitrate (as NO_3) (M353.2)	ND < 0.200	ND < 0.200	ND < 0.200	ND < 0.200	*5.3*	*2.9*	*4.4*	*0.62*
Nitrite (as N) (M353.2)	ND < 0.050	ND < 0.050	ND < 0.050	ND < 0.050	ND < 0.050	ND < 0.050	ND < 0.050	ND < 0.050
Nitrite (as NO_2) (M353.2)	ND < 0.200	ND < 0.200	ND < 0.200	ND < 0.200	ND < 0.200	ND < 0.200	ND < 0.200	ND < 0.200
Phosphorus (as P) (M365.4)	*0.88*	*0.25*	*0.16*	*0.12*	*0.52*	*0.18*	*0.16*	*3.0*
Tot. Phos. (PO_4) (M365.4)	*2.7*	*0.77*	*0.49*	*0.36*	*1.6*	*0.55*	*0.50*	*9.3*
BOD_5 (M405.1)	*62*	*8.7*	<7	<7	*7.2*	<7	<7	<7
pH (M150.1)	*8.6*	*8.2*	*7.2*	*7.2*	*7.2*	*8.3*	*7.6*	*8.2*
TSS (M415.1)	*570*	*180*	*100*	*43*	*10*	<6	*10*	*1400*
TOC (M365.4)	*29*	*14*	*3.9*	*2.8*	*7.3*	*1.9*	*1.6*	*2.1*

1. Listed results based on a battery of constituents. See Appendix B for laboratory analytical reports.

2-F. Sampling and Analysis of Pouhala Marsh Landfill Soil

Background

In the June 1996 Pouhala Marsh Survey report (Survey), Brown and Caldwell identified three major physiographic areas of the marsh: the mauka wetland, the makai wetland, and the land-filled area (Landfill). These areas represent the non-mangrove, open space of the wetland. The Landfill is a soil wedge encompassing an approximate area of six-acres and an estimated in-place volume of 60,000 cubic yards. This wedge is bordered by the mauka wetland to the north, the makai wetland to the west, and by the berm along Kapakahi Stream to the east and south. For the Survey, Brown and Caldwell completed 19 hand auger borings throughout the marsh. The purpose of the borings were to classify the upper five feet of soil at the wetland. Borehole cross-sections and soil horizon descriptions are included in the Survey. Essentially, Landfill soils in the above-grade cap were found to be dark reddish brown clays and silty clays. The fill material appeared to be fairly homogeneous throughout the six-acre wedge.

Sampling Methods

On January 24, 1997, Brown and Caldwell conducted soil sampling activities at the Landfill. The weather on that day was warm, with clear skies and tradewinds. Portions of the Landfill had standing water, specifically in depressions and on portions of the unpaved access road that traverses the Landfill from north to south.

For the sampling, the Landfill was partitioned into 10 sections. In each section, sampling was conducted in two horizons. The upper-horizon soil samples were taken at the interval from surface to six inches bg. The lower horizon samples were taken at approximately four to five feet bg. As described in the Survey, the Landfill surface is littered with wood wastes (from demolition activities), organic wastes (coconut husks and other plant-derived or clearing and grubbing debris), discarded white goods (stoves and refrigerators), waste asphalt and concrete, pieces of cars and trucks, cinder blocks, broken glass, tin and aluminum cans, and other assorted metal wastes. The areas where obvious illegal dumping had taken place, and where there was standing water, were avoided during the

soil sampling.

Pouhala Marsh had received significant rainfall in the two to three months preceding the soil sampling. As a result, there were areas on which water was ponded and where obvious erosion and sediment transport (as a result of the rainfall and water accumulation and drainage) had taken place. This was most noticeable at the lower terrace at the south point of the Landfill wedge, near monitoring well (MW) 3. Here, and along the north face of the Landfill where the fill material is highest and slopes steeply to the mauka wetland, there were indications of significant sediment transport to the wetland. This was evident on the steeper banks by the multiple rills and larger, gulley-like cuts in the exposed soil and by the broad sediment fans where the slopes were shallow.

Upper horizon samples were collected with a shovel, and a hand-auger sampling bucket was used for the lower horizon. Upon sampling, soil was stored in eight-oz pre-cleaned clear glass wide-mouth jars, with teflon-lined caps. Prior to sampling at each location, the shovel and hand-auger bucket were cleaned with a solution of dionized water and Liquinox. This was to mitigate potential cross-contamination. Soil sample jars were immediately sealed and stored in a cooler on blue ice. All 20 soil samples were priority-shipped to West Laboratory of Davis, California. At the lab, the ten samples representing each of the two horizons were composited into one homogenized sample. The remainder of each sample was stored at the lab and held in case additional analyses are needed for the individual sections (in the event composite sample analyses indicate the potential for a "hot spot."). These two composites were analyzed for the following:

Metals

A screen for semi-volatile organics, including for chlorinated hydrocarbons, such as chlorinated solvents, PCBs, and chlorinated pesticides by Method 8270

A screen for volatile organics by Method 8240

A screen for TCDD Dioxin

Analytical Results

The full analytical report is attached as an appendix to this report. Table 2-10 summarizes the key analyses performed on the two composite soil samples

Table 2-3 Results of Laboratory Soil Analysis, Pouhala Marsh
All values in mg/kg (ppm)

Table 2-3 continued

	Analyte(s)	Result(s), ppm	EPA PRG[a] Residential	Industrial
Upper horizon composite *Surface to 6-inches*	**EPA 8240 - Volatile organics**	all < MRL[b],	-	-
	Toluene	0.012	3,200	3,200
	P&M-Xylene	0.083	3,200	3,200
	EPA 8270 - Semi-volatile organics	all < MRL[b]		
	Metals			
	Antimony (M6010)	9.1	31	680
	Arsenic (M7060)	4.4	22[c]	-
	Beryllium (M6010)	0.47	0.14	1.1
	Cadmium (M6010)	0.68	38	850
	Chromium (M6010)	200	210	450
	Copper (M6010)	71	2,800	63,000
	Lead (M6010)	34	400	1,000
	Mercury (M7471)	0.065	-	-
	Nickel (M6010)	99	1,500	34,000
	Selenium (M7740)	2.3	380	8,500
	Silver (M6010)	<1.4	380	8,500
	Thallium (M7841)	<0.50	6.1 - 7.9	140 - 150
	Zinc (M6010)	97	23,000	100,000
	EPA 8280 - 2,3,7,8-TCDD	None Detected		

	Analyte(s)	Result(s), ppm	EPA PRG[a] Residential	Industrial
Lower horizon composite *4 to 5 feet below grade*	**EPA 8240 - Volatile organics**	all < MRL[b],	-	-
	Toluene	0.057	3,200	3,200
	EPA 8270 - Semi-volatile organics	all < MRL[b]		
	Metals			
	Antimony (M6010)	10	31	680
	Arsenic (M7060)	4	22	-
	Beryllium (M6010)	0.43	0.14	1.1
	Cadmium (M6010)	<0.40	38	850
	Chromium (M6010)	200	210	450
	Copper (M6010)	56	2,800	63,000
	Lead (M6010)	6	400	1,000
	Mercury (M7471)	0.06	-	-
	Nickel (M6010)	86	1,500	34,000
	Selenium (M7740)	<2.0	380	8,500
	Silver (M6010)	<1.4	380	8,500
	Thallium (M7841)	<0.50	6.1 - 7.9	140 - 150
	Zinc (M6010)	57	23,000	100,000
	EPA 8280 - 2,3,7,8-TCDD	None Detected		

a: US Environmental Protection Agency (EPA) Region IX Preliminary Remedial Goals PRG),
b: MRL B Method Reporting Limit

Summary

The results indicate the respective horizons are very similar or identical in nature. This is supported by field observations of soil texture and color made during sampling activities. From these results and observations, it can be concluded that the Landfill soils represent a well-homogenized fill material and do not require special handling, treatment, or disposal. The composite samples are identified on the analytical reports as PMLF-U, for the upper horizon, and PMLF-L, for the lower horizon. In the preceding table, the results for each horizon were listed with, where applicable, the associated US Environmental Protection Agency (EPA) Region IX preliminary remediation goals (PRGs), established August 1, 1996. The PRGs are planning guidelines useful in designating the ultimate use of the soil.

The volatile organics (EPA Method 8240) were all less than the method reporting limits (MRLs) with the exception of two constituents: Toluene, in both the upper and lower horizons; and P&M-Xylene, in the upper horizon. The results attained for these constituents are well below regulatory limits and are not significant.

The screen for semi-volatile organics, including for chlorinated hydrocarbons, such as chlorinated solvents, PCBs, and chlorinated pesticides by Method 8270, had no hits as all constituents fell below their respective MRL. The screen for 2,3,7,8-TCCD (Dioxin) was non-detected (ND) for both samples.

The results for the metals analyses for the two composite samples were virtually identical. The constituents that are typically of concern from a regulatory perspective, cadmium and lead, were found in concentrations well below their PRGs.

The 200 ppm total chromium concentration in each sample could, at first glance, raise concerns. However, chromium is generally present in Hawaiian volcanic soils, with naturally-occurring concentrations ranging from 200 ppm to 9,000 ppm, depending on the specific type of soil (Nakamura and Sherman, Technical Bulletin No. 37, *Chromium Distribution in Latosols of the Hawaiian Islands*, Hawaii Agricultural Experiment Station, University of Hawaii, February 1958). Generally, chromium concentration

increases with the degree of weathering, especially in soils derived from the weathering of pyroxene and olivine basaltic lava, both of which are very common to Hawaii. The PRG for chromium is 210 and 450 ppm, for residential and industrial locations, respectively.

The soil comprising the Landfill is non-native in that it is not a naturally-occurring wetland soil. Although the precise source of the fill material at the Landfill is unknown, aerial photographs from early 1971 show an ongoing soil placement and grading operation in its early stages (Air Survey Hawaii, Photo # 56-24, taken 1-3-71). Based on the lithology of the Landfill soil, its source is most likely up-gradient of Pearl Harbor and Waipahu. The Landfill soil shares similar physical characteristics as Lahaina silty clay; Molokai silty clay loam; or Wahiawa silty clay, all very common pineapple and sugarcane soils found mauka of Waipahu.

Conclusions and Recommendations

The screening of the Landfill soil yielded results that essentially classify the material, at the horizons sampled, as a non-hazardous homogeneous silty clay. The constituents for which the soil was analyzed were selected to provide an overall chemical and organic characterization. In this regard, based on the results presented above, the Landfill soils do not appear to present an environmental risk if properly utilized as a fill or cover material offsite. This applies to the Landfill soil from pre-existing grade to top of cover and does not include the various debris scattered throughout.

The observed ongoing erosion and sedimentation could present a physical risk to the mauka and makai wetland sections closest to the Landfill. Accordingly, the Landfill should be either removed or regraded, with appropriate slope stabilization measures incorporated to mitigate transport to the wetlands.

Based on Brown and Caldwell's activities associated with the Survey and follow-up soil sampling, the material currently littering the Landfill cap appears to be limited to the surface and is a product of random illegal dumping. Some stones and cobbles were encountered while boring into the soil, but these appeared to be native to the material and

were probably present within the soil when it was originally placed. Prior to removing or regrading the Landfill soil, the surficial material must be cleared and grubbed and removed to a suitable solid waste processing facility or municipal solid waste landfill. One particular pile of debris encountered appears to be a tan and gray fibrous demolition waste that could be an asbestos containing material (ACM). Prior to removal, this material should be classified and handled accordingly.

One potential receiving area for stockpiling the 60,000 cubic yards of soil is near the closed City and County of Honolulu (City) solid waste incinerator situated adjacent to Pouhala Marsh, on the Diamond Head side of Kapakahi Stream. The City could potentially use the soil as a cover for the existing ash landfill adjacent to Kapakahi Stream or as fill material for a prospective athletic complex or sludge composting facility, both of which may be situated on Waipio Peninsula near the inactive incinerator. This location would minimize transport costs and could provide a residual benefit from the relocation of the Landfill soils.

Brown and Caldwell believes that no other soil analyses are warranted for the 10 discrete samples taken at each horizon.

3. BIOLOGICAL RESOURCES[3]

3-A. Introduction

By 1990, over 30 percent of Hawaii's natural lowland wetlands have been filled or converted to other land uses such as agriculture and urban expansion (Dahl 1990, USFWS 1983). Despite the loss, many of Hawaii's wetland-adapted plants and animals have survived, yet several are endangered. Pearl Harbor's wetlands are unique on Oahu in that they are the last remaining tidal flats in Pearl Harbor. Most of these flats are overgrown by red mangrove and pickleweed, both non-native plants to the Hawaiian Islands. Pouhala wetlands exemplify what once occurred in Pearl Harbor but has been lost due to filling activities of humans and encroachment by red mangrove.

Pouhala Marsh was historically more expansive with a freshwater marsh adjacent to the site on its mauka edge. It was formed as a deposition delta of Kapakahi and Waikele streams. More extensive marshlands are noted on historic maps of the area. Today those freshwater wetlands have been filled and altered to support present-day Waipahu. Pouhala Marsh is now fed by runoff from rainfall and functions as a playa wetland (seasonally inundated alkalai flats). Portions of the marsh are fed by tidal waters as well.

Hawaiian Playas - An Important Waterbird Resource

The Hawaiian Islands are characterized by numerous types of wetlands. The most familiar are those associated with rivers and streams or lowland aquifers (Hanalei Valley, Kauai; Kawainui Marsh, Oahu; Kanaha Pond, Maui). Montane bogs make up another well known wetland resource (due in part to their high degree of endemic plants and forest birds).

The Hawaiian playas are characterized as seasonal wetlands, filling during winter rains and evaporating by summer. Only a few playa regions remain in the islands, the largest are: Niihau, where three basins comprise 1,900 acres; the Palaau-Ooia Playa comprising

[3] Section Authors: Andrew Engilis, Jr. Ducks Unlimited Inc., Gordon Nishida, B. P. Bishop Museum and Clyde Imada, B. P. Bishop Museum

2,000 acres on Molokai; and Kealia Pond on Maui comprising 600 acres. The later has been modified to remain flooded year-round, a condition that has increased silt loading in the pond.

These playas remain the most important seasonal wetland resource in the Hawaiian Islands. The shallow conditions provide optimal foraging habitat for Hawaiian Stilt, Hawaiian Duck, and Hawaiian Coot, particularly during periods of draw down when invertebrates are concentrated in shallows. DOFAW biannual waterbird surveys have documented large numbers of stilts and coots using playas (Engilis 1988). Seasonally, depending upon rainfall regimes, numerous stilts and coots use these wetlands (Engilis and Pratt 1993). The variable weather patterns found in the Hawaiian Islands as a result of Southern Oscillations and El Niño weather patterns make inundation of the playas somewhat unpredictable. However, the waterbirds seem to know when the playas are flooded and readily move (even between islands) to exploit them (Engilis and Pratt 1993).

Hawaiian lowland wetlands are characterized by their flora and avian components. These are discussed in detail below. The Pouhala Marsh Project is designed to provide for the needs of waterbirds, native plants, and rare damselflies through habitat enhancement and restoration.

The Recovery Plan for Hawaiian Waterbirds (USFWS third revision in press) has identified Pouhala Marsh as an area of importance for protection and restoration. Step-down Action 151 has recommended working with private and state landowners to protect and enhance (through removal of *Batis* and mangrove) this important resource. The restoration of Pouhala Marsh will fill critical habitat needs for all four species of endangered waterbirds.

3-B. Vegetation Communities - Written by Clyde T. Imada

Field Survey Methods

Basic survey methods were used for documenting vegetation communities of Pouhala Marsh. Plants were observed and noted in the field using the walk-through method, by

systematically traversing the area by foot and in some areas by using waders. Those plants that were not immediately recognized were collected and taken to the Bishop Museum for identification by using taxonomic keys and comparison to reference materials in the collections.

Results

Pouhala Marsh is characterized by five habitats (Figure 3-1). These are described as follows.

***Batis* Flats.** The Pickleweed Marsh shrub community is dominated by extensive low thickets of pickleweed *(Batis maritima)*, often with no other species present. This aggressive colonizer of coastal mud flats was occasionally associated with (especially on the pond margins) water hyssop *(Bacopa monnieri)*, a native ground cover herb; spikerush *(Eleocharis geniculata)*, a small bunching sedge; makai *(Bolboschoenus maritimus* subsp. *paludosus)*, a native sedge up to two feet tall; makaloa *(Cyperus laevigatus)*, a slender native sedge up to nine inches tall; common cattail *(Typha latifolia)*; and Indian fleabane *(Pluchea indica)*, an introduced woody shrub. On the mud flats adjacent to Pickleweed Marsh, facultative wetland species such as saltmarsh sand spurry *(Spergularia marina)* and sprangletop *(Leptochloa uninervia)* were noted.

Alkali Flats. Pouhala Marsh is dominated by a large, open flat that is impacted by high water table and long periods of inundation. There is no vegetation in this habitat. When dry (May - November) the tuff-like soils readily blow away with the tradewinds, thus maintaining a low sink. The large pond may represent the remnants of a Hawaiian fishpond. A modern dike separates the pond into several distinctive hydrologic units.

Kaluha Sedgeland. An example of a third community, Kaluha *(Schoenoplectus)* Sedgeland, was investigated. This single patch, perhaps 100 feet x 50 feet, consisted of a solid stand of closely packed, gray-green stems of kaluha *(Schoenoplectus californicus)*, up to 11 feet long, with a scattering of California grass *(Brachiaria mutica)* and Indian

fleabane mixed in. Kaluha is believed to be naturalized but is possibly indigenous (Wagner *et al.* 1990). The sedgeland is surrounded on all but the eastern end by a rim of Mangrove Swamp.

Red Mangrove (*Rhizophora mangle*). Mangroves are introduced to the Hawaiian Islands and have become invasive in tidal, silty and coralline habitats in Pearl Harbor. They have inundated valuable shoreline and fishpond habitat on the island and pose a threat to native waterbirds and the local humans dependent upon coastal fisheries. The mangroves have formed a wooded swamp habitat along the coast and inlets, intruding up the channels of Kapakahi and Waikele streams. These mangroves have obscured Pearl Harbor's shoreline, yet sea water extends well in, under the trees. Most mangroves attain a height of 20-40 feet. However, much larger trees can be found on the stream courses. Seedlings are not prevalent in Pouhala Marsh, and planning might provide a better environment for mangrove intrusion. Thus, care must be taken in wetland design. Mangrove may also present a small management concern for Pouhala Marsh. The mangrove community along Kapakahi Stream is festooned with the aggressive weedy cucurbit vine, ivy gourd *(Coccinia grandis)*.

Marginal Terrestrial Environments. The southeast section of the site consists of piled-up dredge material on dry ruderal land. The vegetation here is a weedy mix of grasses, herbs, shrubs, and trees commonly found in coastal and lowland settings. Representative grasses include swollen fingergrass *(Chloris barbata)*, Guinea grass *(Panicum maximum)*, buffelgrass *(Cenchrus ciliaris)*, sourgrass *(Digitaria insularis)*, and bristly foxtail *(Setaria verticillata)*. The herb layer includes Australian saltbush *(Atriplex semibaccata)*, sow thistle *(Sonchus oleraceus)*, spiny amaranth *(Amaranthus spinosus)*, and pigweed *(Portulaca oleracea)*. The shrub layer is dominated by Indian fleabane *(Pluchea indica)*, koa haole *(Leucaena leucocephala)*, and slender mimosa *(Desmanthus virgatus)*. Small kiawe *(Prosopis pallida)* trees are interspersed. A Kiawe *(Prosopis)* Forest community is on the northeast border of the site, dominated by 30-40 feet tall kiawe *(Prosopis pallida)*. Common understory elements included Guinea grass and buffelgrass.

Threatened and Endangered Plants

No federally-listed endangered or threatened plant species were noted during the assessment, nor were any native plant communities noted (with the possible exception of the Kaluha Sedgeland, explained above). That the site has apparently been much-modified in the past is reflected in the poor representation of native plant elements (seven indigenous species), both in the percentage of species noted and in total biomass. Table 3-1 lists the plant species documented by botanists.

DUCKS UNLIMITED
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FORESTRY AND WILDLIFE HAWAII

U.S. FISH & WILDLIFE SERVICE

POUHALA MARSH

(FLOODED CONDITIONS)

VEGETATION TYPES

- Pickleweed Marsh
- Mangrove Swamp
- Kaluha Sedgeland
- Ruderal Land
- Kiawe Forest
- Open Water
- Mud Flats

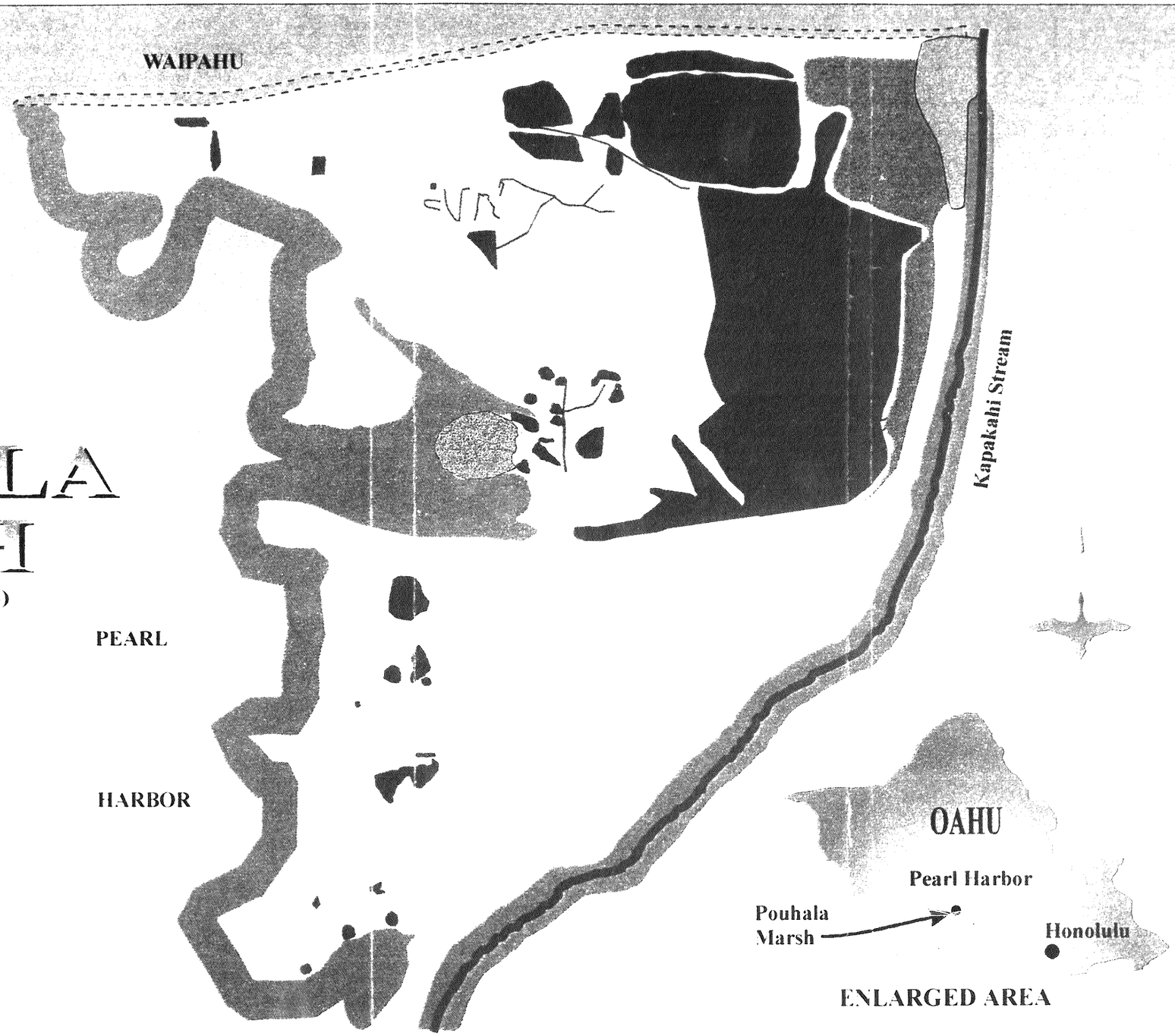

Table 3-1. Pouhala Marsh Plant Species

The following is a list of vascular plant species noted during the walk-through survey conducted December 18, 1996. Plants are divided into two main groups, monocots and dicots. Within these groups, taxa are arranged alphabetically by family, genus, and species. Each entry includes author citation, common name (if available), biogeographic status, and presence or absence in each of five vegetation communities on the site. Taxonomy, common names, and status are in accordance with Wagner *et al.* (1990). An explanation of abbreviations used in the list follows.

Biogeographic Status

end Endemic: native, occurring only in the Hawaiian Archipelago.

ind Indigenous: native, occurring naturally in the Archipelago but also outside of Hawaii.

nat Naturalized: introduced to the archipelago directly or indirectly by humans since Western contact and reproducing and spreading vegetatively or by seed.

pol Polynesian introduction: introduced by original Polynesian settlers, either intentionally or unintentionally, and now naturalized.

ind? Questionably indigenous: probably indigenous, possibly naturalized.

nat? Questionably naturalized: probably naturalized, possibly indigenous.

Cult: Cultivated.

Vegetation types

1 Pickleweed *(Batis)* Marsh

2 Mangrove *(Rhizophora)* Swamp

3 Kaluha *(Schoenoplectus)* Sedgeland

4 Ruderal Land

5 Kiawe *(Prosopis)* Forest

VEGETATION TYPES

SCIENTIFIC NAME	STATUS	COMMON NAME	1	2	3	4	5
Dicotyledons							
ACANTHACEAE							
Asystasia gangetica (L.) T. Anderson	nat	Chinese violet				X	
AIZOACEAE							
Trianthema portulacastrum L.	nat					X	
AMARANTHACEAE							
Achyranthes aspera L. var. aspera	nat					X	X
Amaranthus spinosus L.	nat	Spiny Amaranth				X	
Amaranthus viridis L.	nat	Slender amaranth				X	
ANACARDIACEAE							
Schinus terebinthifolius Raddi	nat	Christmas berry				X	
APOCYNACEAE							
Cascabela thevetia (L.) Lippold	nat	Be-still tree				X	
ASTERACEAE							
Bidens pilosa L.	nat	Spanish needle				X	
Emilia fosbergii Nicolson	nat					X	
Pluchea xfosbergii Cooperr. & Galang	nat					X	X
Pluchea indica (L.) Less.	nat	Indian fleabane	X		X	X	
Pluchea symphytifolia (Mill.) Gillis	nat	Sourbush				X	X
Sonchus oleraceus L.	nat	Pualele				X	
Verbesina encelioides (Cav.) Benth. & Hook.	nat	Golden Crown-beard				X	
BATACEAE							
Batis maritima L.	nat	Pickleweed	X				
CACTACEAE						X	
Opuntia ficus-indica (L.) Mill.	nat	Prickly pear, panini					
CAPPARACEAE							
Cleome gynandra L.	nat	Wild spider flower				X	
CARYOPHYLLACEAE		Saltmarsh sand	X				
Spergularia marina (L.) Griseb.	nat	spurry					
CHENOPODIACEAE							
Atriplex semibaccata R. Br.	nat	Aust. Saltbush				X	
Atriplex suberecta Verd.	nat	Saltbush				X	

SCIENTIFIC NAME	STATUS	COMMON NAME	1	2	3	4	5
Chenopodium murale L.	nat	Aheahea				X	
CUCURBITACEAE							
Coccinia grandis (L.) Voigt	nat	Ivy gourd	X			X	X
EUPHORBIACEAE							
Chamaesyce hirta (L.) Millsp.	nat	Hairy spurge				X	
Euphorbia antiquorum L.	cult					X	
Phyllanthus debilis Klein ex Willd.	nat	Niruri				X	
Ricinus communis L.	nat	Castor bean				X	
FABACEAE							
Chamaecrista nictitans (L.) Moench subsp. *patellaria* (DC ex Collad.)H. Irwin & Barneby var. *glabrata* (Vogel) H. Irwin & Barneby	nat	Patridge pea				X	
Desmanthus virgatus (L.) Willd.	nat	Slender mimosa				X	X
Leucaena leucocephala (Lam.) de Wit	nat	Koa Haole				X	
Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	nat	Kiawe, algaroba				X	X
Senna surattensis (N.L. Burm.) H. Irwin & Barneby	nat	Kolomona				X	
LAMIACEAE							
Hyptis pectinata (L.) Poit.	nat	Comb hyptis				X	
Leonotis nepetifolia (L.) R. Br.	nat	Lion's ear				X	
MALVACEAE							
Abutilon grandifolium (Willd.) Sweet	nat	Hairy abutilon				X	
Abutilon incanum (Link) Sweet	ind?	Ma'o, hoary abutilon				X	
Malvastrum coromandelianum (L.) Garcke	nat	False mallow				X	
Sida fallax Walp.	ind	>Ilima				X	
Sida spinosa L.	nat	Prickly sida				X	
POLYGONACEAE							
Antigonon leptopus Hook. & Arnott	nat	Mexican creeper				X	
PORTULACACEAE							
Portulaca oleracea L.	nat	Pigweed				X	X
Portulaca pilosa L.	nat					X	
RHIZOPHORACEAE		Red mangrove	X	X			
Rhizophora mangle L.	nat						
SCROPHULARIACEAE							
Bacopa monnieri (L.) Wettst.	ind	Water hyssop	X				
SOLANACEAE							

Scientific Name	Status	Common Name	1	2	3	4	5
Nicandra physalodes (L.) Gaertn.							
Solanum americanum Mill.	nat	Apple of Peru				X	
	ind?	Popolo, glossy nightshade	X				
STERCULIACEAE							
Waltheria indica L.	ind?	>Uhaloa, hi'aloa				X	
VERBENACEAE							
Stachytarpheta jamaicensis (L.) Vahl	nat	Jamaica vervain				X	
Verbena litoralis Kunth	nat	Owi, oi				X	
Monocotyledons							
AGAVACEAE							
Furcraea foetida (L.) Haw.	nat	Mauritius hemp				X	
CYPERACEAE							
Bolboschoenus maritimus (L.) Palla subsp. paludosus (A. Nels.) T. Koyama	ind	Kaluha, makai	X				
Cyperus laevigatus L.	ind	Makaloa	X				
Cyperus rotundus L.	nat	Nut sedge				X	
Eleocharis geniculata (L.) Roem. & Schult.	nat	Spikerush	X				
Schoenoplectus californicus (C.A. Mey.) Palla	nat?	Kaluha			X		
POACEAE							
Brachiaria mutica (Forssk.) Stapf	nat	California grass			X		
Cenchrus ciliaris L.	nat	Buffelgrass				X	X
Chloris barbata (L.) Sw.	nat	Swollen fingergrass				X	X
Digitaria insularis (L.) Mez ex Ekman	nat	Sourgrass				X	
Leptochloa uninervia (K. Presl) Hitchc. & Chase	nat	Sprangletop	X				
Panicum maximum Jacq.	nat	Guinea grass				X	X
Setaria verticillata (L.) P. Beauv.	nat	Bristly foxtail				X	
Sporobolus sp.	nat	Dropseed				X	
TYPHACEAE							
Typha latifolia L.	nat	Common cattail	X				

3-C. Arthropods - Written by Gordon M. Nishida

Study Methods

Basic survey methods were used for documenting arthropods with an emphasis at identifying the presence of threatened or sensitive species. Identifications were undertaken in the field where possible. Those that were not immediately recognized were collected and taken to the Bishop Museum for identification by using taxonomic keys and comparison to reference materials in the collections. Arthropods were collected by hand or by the use of an aerial net. The techniques of beating and sweeping of plants and sifting of litter were also applied. Mass collecting techniques were not employed, the limitation being the amount of time available.

Results

The inventory of arthropods is far from complete as a number of other factors such as the nocturnal fauna and differences in seasonality were obviously not addressed. However, enough information was gathered to establish that the composition of the arthropod fauna suggests that the area is heavily disturbed. Nearly 90% of the species collected or observed are non-native alien species (Table 3-2). The native species that do occur at Pouhala Marsh are either relatively widespread in distribution and/or predators or generalists that do not depend on other native elements (such as plants) to survive. Similar to the native plants, the native species of insects are also found mostly associated with wetlands and either aquatic or semi-aquatic in habit. The species representation is undoubtedly influenced by the high numbers of non-native plants and by the large numbers of fish that occupy the marsh (which prey on larval and adult stages of insects).

Threatened and Endangered Arthropods

No threatened or endangered arthropods nor candidates were collected during this survey. In fact, no sensitive species were collected or noted (the U.S. Fish & Wildlife Service currently considers species previously listed as C2 or C3 candidate species as "sensitive" species and not candidates). A significant portion of the time was spent searching for the candidate species of damselfly, *Megalagrion xanthomelas*, the Orangeblack Hawaiian damselfly. This endemic lowland species historically occurred in this area but presently is known on Oahu from a single

population located in a higher elevation isolated stream on Federal property. The Orangeblack damselfly is likely extirpated from the Waikele-Kipapa drainages as it has not been collected in this area since the 1920s, and neither this survey nor one earlier (Englund 1993) discovered any individuals.

Recommendations

The result of the arthropod survey reflects the general condition of the site from a botanical standpoint. The botanical survey shows the area is highly disturbed with a very high percentage (87.5%) of non-natives occupying the area, particularly in the drier sections. The few natives that remain are mostly wetland elements. Nearly 90% of the arthropods collected were non-native species. The few arthropods that are considered native are mostly aquatic or semi-aquatic species, again mirroring the plant situation. Based on the results of this survey, we conclude that no botanical or arthropod elements exist at Pouhala Marsh that would be threatened by the physical restructuring and restoration of the area.

Despite the heavy perturbation, the site does have a number of attractive qualities for conservation of native arthropods. The wetlands do retain a native species presence that likely can be enhanced by management of the site. The relatively abundant avifauna and ichthyofauna attests to the bioproductivity of the marsh system. The site appears ideal for the potential reintroduction of *Megalagrion xanthomelas*. Fish appear to be the major factor for the extirpation of the Orangeblack damselfly on most of Oahu, so the removal of the introduced species of fish would be a first step along with management of weedy plant species such as mangrove and pickleweed. The basal springs should be left intact as they provide greater opportunities for microclines and microhabitats that would increase the chances for native species obtaining a foothold and eventually becoming established. DU and the Bishop Museum will work to develop a plan for re-establishing *Megalagrion* to the site. The re-establishment report will be developed separate from this environmental document.

TABLE 3-2. POUHALA MARSH LIST OF ARTHROPOD SPECIES

This list is organized by class with the order and family nested below. The scientific names follow the latest version of the Hawaiian Terrestrial Arthropod Checklist. Common names are added where known. The entries under status are explained below.

Biogeographic Status

endemic	Native, restricted to the Hawaiian Archipelago
indigenous	Native, occurring in a restricted area that includes Hawaii
adventive	Non-native, accidental immigrant
introduced	Non-native, purposefully introduced usually for biological control
NSR	Non-native, accidental immigrant, new state record

SCIENTIFIC NAME	COMMON NAME	STATUS
MALACOSTRACA		
Order ISOPODA	Snowbugs	
Family **Ligiidae**		
Ligia hawaiensis (Dana)		endemic
ARACHNIDA	**Spiders**	
Order ARANEAE	Spiders	
Family **Clubionidae**	Two-clawed hunting spiders	
Cheiracanthium mordax L. Koch		adventive
Family **Heteropodidae**	Giant crab spiders	
Heteropoda venatoria (Linnaeus)	Large brown spider	adventive
CHILOPODA	**Centipedes**	
Family **Scolopendridae**		
Scolopendra subspinipes Leach	Large centipede	adventive
INSECTA	**Insects**	
Order DICTYOPTERA	Roaches & Mantids	
Family **Blaberidae**		

SCIENTIFIC NAME	COMMON NAME	STATUS
Diploptera punctata (Eschscholtz)	Pacific beetle cockroach	adventive
Family **Blattellidae**		
Balta notulata (Stål)		adventive
Family **Blattidae**		
Periplaneta americana (Linnaeus)	American cockroach	adventive
Family **Mantidae**	Mantids	
Hierodula patellifera (Serville) [nymph]		adventive
Order ODONATA	Dragonflies & Damselflies	
Family **Aeschnidae**		
Anax junius (Drury)	Common green darner	indigenous
Family **Coenagrionidae**		
Ischnura ramburii (Selys-Longchamps)		adventive
Family **Libellulidae**		
Pantala flavescens (Fabricius)	Globe skimmer	indigenous
Crocothemis servilia Drury	Chinese dragonfly	adventive
Order ORTHOPTERA	Grasshoppers & Allies	
Family **Acrididae**	Shorthorned grasshoppers	
Oedaleus abruptus (Thunberg)	Small bandedwing grasshopper	adventive
Schistocerca nitens (Thunberg)	Vagrant grasshopper	adventive
Family **Tettigoniidae**	Longhorned grasshoppers	
Conocephalus saltator (Saussure)	Longhorned grasshopper	adventive
Xiphidiopsis lita Hebard		adventive
Order HETEROPTERA	True Bugs	
Family **Mesoveliidae**	Water treaders	adventive

Scientific Name	Common Name	Status
Mesovelia amoena Uhler		
Family **Miridae**	Plant bugs	
Orthotylus sp.		endemic?
Order HOMOPTERA	Planthoppers & Allies	
Family **Delphacidae**	Delphacid planthoppers	
Tarophagus colocasiae (Matsumura)	Taro delphacid	adventive
Family **Flatidae**		
Melormenis basalis (Walker)	Flatid planthoppers	
	West Indian flatid	adventive
Family **Psyllidae**	Jumping plantlice	
Heteropsylla cubana Crawford	Leucaena psyllid	adventive
Family **Tropiduchidae**	Tropiduchid planthoppers	
Kalitaxila sp. nr. *sinica* (Walker)		NSR
Order LEPIDOPTERA	Butterflies & Moths	
Family **Crambidae**	Grass moths	
Spoladea recurvalis (Fabricus)	Hawaiian beet webworm	adventive
Family **Geometridae**	Measuringworms	
Macaria abydata Guenée		adventive
Family **Lycaenidae**	Blues	
Brephidium exilis (Boisduval)	Western pygmy blue	adventive
Family **Nymphalidae**	Brushfooted butterflies	
Agraulis vanillae (Linnaeus)	Passion vine butterfly	adventive
Danaus plexippus (Linnaeus)	Monarch butterfly	adventive
Order COLEOPTERA	Beetles	
Family **Anthribidae**	Fungus weevils	
Araecerus fasciculatus (DeGreer)	Coffee bean weevil	adventive

SCIENTIFIC NAME	COMMON NAME	STATUS
Family **Bruchidae**	Seed beetles	
Stator pruininus (Horn)	Pruinose bean weevil	adventive
Family **Coccinellidae**	Ladybird beetles	
Coccinella septempunctata Linnaeus	Seven spotted lady beetle	introduced
Coelophora inaequalis (Fabricus)	Common Australian lady beetle	introduced
Curinus coeruleus (Mulsant)	Dark blue lady beetle	introduced
Olla v-nigrum (Mulsant)		introduced?
Family **Curculionidae**	Weevils	
Myllocerus sp.		adventive
Family **Limnichidae**		
genus? species?	Minute marshloving beetles	NSR?
Order DIPTERA	Flies	
Family **Agromyzidae**	Leafminer flies	
Liriomyza sativae Blanchard	Vegetable leafminer	adventive
Family **Ceratopogonidae**	Biting midges	
Forcypomyia sp. nr. *hardyi* Wirth & Howarth		endemic
Family **Chironomidae**	Midges	
Chironomus sp.		endemic?
Family **Culicidae**	Mosquitoes	
Aedes albopictus (Skuse)	Forest day mosquito	adventive
Family **Dolichopodidae**	Longlegged flies	
Chrysosoma globiferum (Wiedemann)		adventive
Syntormon flexible Becker		adventive
Family **Ephydridae**	Shore flies	
Scatella spp.		endemic?

Scientific Name	Common Name	Status
Family **Otitidae**	Picturewinged flies	
Euxesta annonae (Fabricius)		adventive
Family **Syrphidae**	Flower flies	
Allograpta exotica (Wiedemann)		adventive
Syritta orientalis Macquart		adventive
Family **Tachinidae**	Tachinid flies	
Archytas cirphis Curran	Mexican cutworm tachinid	
Lespesia archippivora (Riley)	Lesser armyworm parasite fly	introduced
Lixophaga sphenophori (Villeneuve)	Cane weevil tachinid	introduced
		introduced
Order HYMENOPTERA	Bees, Wasps & Ants	
Family **Anthophoridae**	Digger bees, Carpenter bees	
Xylocopa sonorina F. Smith	Sonoran carpenter bee	adventive
Family **Apidae**		
Apis mellifera Linnaeus	Honey bees & relatives	
	Honey bee	introduced
Family **Formicidae**	Ants	
Cardiocondyla sp. nr. *nuda (Mayr)*		adventive
Family **Sphecidae**	Sphecid wasps	
Sceliphron caementarium (Drury)	Muddauber	adventive
Trypoxylon sp. nr. *philippinense* Ashmead		adventive
Family **Vespidae**	Paper wasps & relatives	
Polistes aurifer Saussure	Golden paper wasp	adventive

3-D. Fisheries

No studies of the fisheries in Pouhala Marsh were undertaken in the scope of this study. Work will be conducted when the marsh is dry and should not have an impact on fisheries. Non-native fishes may prove to be a limiting factor on native arthropod and avifauna reproduction as noted below.

The Kapakahi Stream estuary, which includes Pouhala Marsh, provides critical habitat for many saltwater and estuarine species such as: aholehole, papio, awa, awaawa, kaku, and amaama. The Samoan crab, blue-pincer crab, and red crab are also found in the estuary. All of these species are important to local inshore fisheries. Nehu and gold-spotted herring, two very important bait fish used by local fishing fleets, are found in West Loch and depend on nutrient discharge from Waikele and Kapakahi streams.

The Pearl Harbor Estuary is also a critical link between the upper watershed of Waikele Stream and the ocean. All of Hawaii's native freshwater fishes and macro-invertebrates spend the initial stages of their lives in the estuary. When the larvae are ready to metamorphose into post-larvae, they seek freshwater inflows into Pearl Harbor. An intact delta, including Pouhala, is therefore critical for the successful recruitment of native, freshwater fauna into Kapakahi Stream. The project will have a neutral effect on fisheries but will serve to enhance wetland conditions at the marsh, which will maintain water quality that supports nearshore fisheries.

Tilapia are prevalent in Pouhala Marsh and have been attributed to the absence of native aquatic arthropods. Tilapia have also been implicated in the lower productivity of native waterbirds due to competition. Large densities of Tilapia can affect water quality by increasing turbidity, reducing vegetative diversity, and impacting arthropod food items shared with native waterbirds.

3-E. Avifauna - Written by Andrew Engilis, Jr.

Study Methods

To determine the relative abundance of birds and document overall bird species diversity, DU

instituted a monthly survey of the birdlife at Pouhala Marsh. Surveys were conducted by Anthony J. McCafferty and Andrew Engilis, Jr. Incidental observations were provided by Peter Donaldson. Pouhala Marsh was surveyed using a transect method that was walked each count period. Surveys were usually conducted before noon or late in the afternoon. Waterbirds were counted to the individuals and recorded on field forms. Terrestrial birds were documented using a scale of 1-5 that relates to relative abundance. Weather, tide, and other site conditions were documented on each count. To review historic occurrences, we summarized biannual waterbird survey records provided by the Hawaii Division of Forestry and Wildlife (DOFAW).

Results - Weather

These results summarize monthly bird observations from 4/16/96 through 1/30/96. DU is continuing these monthly surveys for another year. From **Table 3-3** Pouhala Marsh remained flooded throughout the winter of 1996.

Results - Terrestrial Birds

Pouhala Marsh supports 16 non-native landbird species. Table 3-4 lists the species using relative abundance codes developed by the survey team members. Species names follow Pyle, (1993). Non-native species were characterized using a sliding scale of abundance.

Table 3-3 Pouhala Marsh - Wetland and Weather Conditions during bird surveys.

Survey Date	*% Water Coverage*	*Temp Deg F*	*Wind Direc.*	*% Cloud Cover*	*Wind Speed Beaufort*	*Tide*
4/16/96	5	85	NE	50	1	Low
5/22/96	20	86	NE	70	1	Low
6/11/96	15	89	S	70	0	High
7/24/96	100	88	S	95	0	Low
8/20/96	80	86	NE	5	1	High
9/18/96	85	84	S	70	0	High
10/29/96	90	86	S	90	1	Low
11/18/96	85	82	S	75	1	High
12/27/96	100	84	S	100	1	Low
1/30/97	95	82	NE	90	2	High

Table 3-4. List of non-native bird species documented at Pouhala Marsh

Species	Scientific Name	Status
Cattle Egret	*Bubulcus ibis*	3
Rock Dove	*Columba livia*	1
Zebra Dove	*Geopelia striata*	4
Spotted Dove	*Streptopelia chinensis*	4
Barn Owl	*Tyto alba*	1
Red-vented Bulbul	*Pycnonotus cafer*	2
White-rumped Shama	*Copsychus malabaricus*	1
Common Myna	*Acridotheres tristis*	4
Japanese White-eye	*Zosterops japonicus*	2
Northern Cardinal	*Cardinalis cardinalis*	1
Red-crested Cardinal	*Paroaria coronata*	2
House Finch	*Carpodacus mexicanus*	1
House Sparrow	*Passer domesticus*	2
Common Waxbill	*Estrilda astrild*	3
Red Avadavat	*Amandava amandava*	2
Nutmeg Mannikin	*Lonchura punctulata*	3
Chestnut Mannikin	*Lonchura malacca*	1

1 = < 5 individuals, 2 = 6 - 10 individuals, 3 = 10 - 20 individuals, 4 = >20 individuals

Waterbirds

Historical records and current surveys have documented 22 species of waterbirds using Pouhala Marsh. **Table 3-5** summarizes the current status of these species.

Native Waterbirds

Surveys documented two species of native, endangered waterbirds at Pouhala Marsh. **Table 3-6** depicts the survey results for birds recorded in 1996-97. Hawaiian Stilt (*Himanotopus mexicanus knudseni*) was the most abundant native waterbird in the marsh (when flooded). Banded individuals have been observed on numerous occasions; the majority were banded at Rowland's Pond within Chevron Incorporated's Hawaiian Refinery (Ewa Plain). There is at least one pair of Hawaiian Moorhen (*Gallinula chloropus sandwicensis*) present. The pair survives in the Kaluha Sedge habitat and mangrove channels. More moorhen may be present in the mangrove habitats (not surveyed). They have been observed nesting within the past five years (D. Smith - DOFAW, person. comm.). There remains a single pair of Hawaiian x mallard ducks in the Kaluha Sedgeland as well. Although these birds are apparent hybrids,

other ducks have been noted in the past, some of which might have been pure Hawaiian Ducks (*Anas wyvilliana*). Pouhala Marsh can certainly support re-established, pure Hawaiian Ducks in the future. The fourth native, endangered waterbird, Hawaiian Coot (*Fulica alai*) has not been documented at Pouhala Marsh. It has been seen in other wetlands of Waipio Peninsula and on units of the Pearl Harbor National Wildlife Refuge. It is suspected that the species will use Pouhala Marsh once the marsh is restored.

The native, but not endangered, Black-crowned Night-Heron (*Nycticorax nycticorax*) is a common species, both foraging and loafing in the wetland.

Migratory waterbirds

Historical records and current surveys have documented 15 species of migratory waterbirds in Pouhala Marsh (Table 3-5). The marsh is of importance for Pacific Golden-Plover (*Pluvialis fulva*) that use the marsh for foraging, loafing and as a staging wetland prior to migration. Wandering Tattler (*Heteroscelus incanus*) and Ruddy Turnstone (*Arenaria interpres*) are regular in small numbers. The wetland has also supported Bristle-thighed Curlew (*Numenius tahitiensis*), a Federal sensitive species, during fall migration. Other species are of sporadic occurrence.

Recommendations

Pouhala Marsh, in its current degraded state, still provides critical wetland habitat for shorebirds in the Hawaiian Islands. The current population of Hawaiian Stilt remains between 1,500 and 1,800 birds statewide (Engilis and Pratt 1993). The numbers documented at Pouhala Marsh show that the marsh can support over 10% of the entire world population of Hawaiian Stilt. Low numbers (1-5) of stilt nests have been observed at the marsh annually between 1992 and 1997 (K. Evans - USFWS, pers. comm.). However, because of the proximity of Pouhala Marsh to Waipahu, successful stilt nesting (fledged birds) is rare due to the high level of human disturbance and high numbers of dogs, cats, rats and mongoose. The level of predation management and protected nesting habitats needs to be increased and managed. Only through these measures can stilt begin to nest successfully, in larger numbers, at Pouhala.

Table 3.5. Known waterbird species of Pouhala Marsh

Species	Occurrence in Hawaii	Status on Pouhala Marsh
Ardeidae		
Black-crowned Night-Heron	Indigenous Resident	Common
Cattle Egret	Introduced Resident	Common
Little Blue Heron	Accidental	Three records
Anatidae		
Hawaiian Duck (Koloa)	Endemic Endangered	Very Rare - hybrids pose problem
Mallard x Koloa	Hybrid Species	Rare
Northern Shoveler	Migratory	Uncommon Winter Visitor
Northern Pintail	Migratory	Uncommon Winter Visitor
Rallidae		
Hawaiian Coot	Endemic Endangered	Hypothetical Occurrence
Hawaiian Moorhen	Endemic Endangered	Rare breeder
Recurvirostridae		
Hawaiian Stilt	Endemic Endangered	Common resident, rare breeder
Charadriidae		
Pacific Golden-Plover	Migratory	Common Winter Visitor
Black-bellied Plover	Migratory	Rare Winter Visitor
Semipalmated Plover	Migratory	<5 records
Scolopacidae		
Bristle-thighed Curlew	Migratory Sensitive	Rare Fall Transient
Greater Yellowlegs	Migratory	1 record
Wandering Tattler	Migratory	Uncommon Winter Visitor
Ruddy Turnstone	Migratory	Uncommon Winter Visitor
Sanderling	Migratory	Rare Winter Visitor
Western Sandpiper	Migratory	1 record
Least Sandpiper	Migratory	2 records
Ruff	Migratory	2 records
Long-billed Dowitcher	Migratory	< 5 records
Wilson's Phalarope	Migratory	1 record

Table assembled from following sources: Rare Birds DataBase (Bishop Museum). DOFAW biannual waterbird survey results 1940 - 1996, A. Engilis, Jr. (1988), A. J. McCafferty pers obs., P. Donaldson (pers obs.).

Table 3.6 - Waterbird Survey Results April 1996 - January 1997, Pouhala Marsh

	1996									1997
	4/16	5/22	6/11	7/24	8/20	9/18	10/29	11/18	12/27	1/30
Mallard x Koloa	4		4	3	1	2		2		
Cattle Egret	50	17	23	10	10	13	21	18	23	12
B. c. Night-Heron	13	7	5	14	11	12	9	7	14	8
Hawaiian Moorhen			2		2	1		1	2	
Hawaiian Stilt	50	65	7	55	151	108	76	87	37	23
P. Golden-Plover	178			3	133	109	95	135	86	110
Wand. Tattler	3	1	1	3	5	1		2		1
Gr. Yellowlegs									1	
Ruddy Turnstone				1		1		2		1
Total Birds	298	90	42	89	313	237	201	254	163	155
Total Species	6	4	6	7	7	8	4	8	6	6

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4.0 ARCHAEOLOGICAL RECONNAISSANCE[4]

4-A. Introduction

This section concerns the archaeological reconnaissance of the Pouhala Marsh area on the West Loch of Pearl Harbor. It was undertaken for Ducks Unlimited, Inc., by Bishop Museum. The archaeological study focused on the northeastern portion (approximately 0.1 km^2) of the delta between Waikele and Kapakahi Stream (**Figure 4.1**).

The substrate in the area is limestone reef (Hazlett and Hyndman 1996) and the sediment covering most of the area south of the old Oahu Railway & Land Railroad (Site 9714) is largely fill (Foote *et al.* 1972: Sheet 53). The southernmost half to third of the research area was covered with several feet of fill in the early 1970s. Soils just north of the old railroad grade are silty clays of the Waipahu series and Tropaquets (Foote *et al.* 1972: 121, 134-135). The former are well drained soils derived from old alluvium and the latter are poorly drained soils that are regularly flooded for taro and/or rice production.

4-B. Scope of Work

The archaeological resources in the defined study area were investigated concentrating on the locations that are to be graded. The target areas will have 0.5 to 5 ft. [15-152 cms] of sediments removed in order to restore habitat for wildlife such as the Hawaiian stilt (*ae`o*, *Himantopus mexicanus knudseni*) and damselflies (*pinao`ula*, *Megalagrion* spp.). As noted in **Figure 4.2**, the specific locations to be impacted are limited. In addition, much of the southeastern area to be graded is currently under 6 ft. [1.8 m] of fill and was not tested at this time. In order to assess the potential for encountering archaeological remains, the following steps were taken:

Relevant historical documents (including maps, land surveys, grant and land court records, and written descriptions) were searched for information which would indicate the types of activities that took place in the area to predict the types of archaeological remains that could be encountered and their potential locations. In addition, these sources were consulted to help

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determine the possible archaeological significance of the area.

A review of previous archaeological work conducted around the West Loch of Pearl Harbor was conducted to determine the types of sites, sediments, and cultural materials that have been recorded in the vicinity of the study region.

A pedestrian survey of the portions of the area currently above water was made and subsurface testing was conducted to assess the potential for *in situ* materials related to possible pre- and post-Contact use of the area.

If archaeological materials were encountered, their significance was assessed, based on the current draft regulations issued by the Hawaii State Historic Preservation. The significance of the cultural materials was the basis for recommendations made for mitigation, avoidance or preservation of these finds during the preparation of part of the study area for wildlife habitats.

4-C. Historical Background

The project area is in Waikele, a traditional Native Hawaiian land segment, or *ahupua`a*, in Ewa District, Oahu. Waikele was once an important center for Native Hawaiian chiefs. Waikele, containing the sugar mill community of Waipahu, was the home of paramount chiefs such as Hao, who ruled Ewa in the mid-seventeenth century (see Klieger 1995). With such an important political center, there are many myths, legends, and ancient sites in Waikele that have been remembered. A few of the more important ancient features are presented here.

Two *heiau*, or Hawaiian temples, were located in Waikele, about a kilometer *mauka* (toward the mountains) of the project area. Mokoula Heiau was located on a bluff above Waikele Stream, near the point where the stream makes a sharp bend to the east on its course to the sea. According to McAllister (1933:106), this temple was completely destroyed for modern neighborhood construction. Hapupu Heiau was apparently a *heiau luakini*, or chiefly temple where human sacrifice was performed. This temple was associated with the powerful chief Hao and appears to have been located just *mauka* of Waipahu Elementary School, across Waipahu Street (McAllister 1933:106). The area of lower Waikele is noted for its springs (see Sterling and Summers 1978:25).

The two main historic features of the project area were Ka`auku`u and Pouhala fishponds (*loko*), which extended into the Sea of Kaihuopalaai, now known as the West Loch of Pearl Harbor. Loko Ka`auku`u, according to Cobb (1905:23), was once 41 acres in extent, and Pouhala was 22 acres. A smaller fishpond, Mokuola, was 23 acres at one point, and Loko Ma`aha was 48 acres. Many of the ponds were subsequently subdivided and converted to rice paddies in the late nineteenth to early twentieth centuries. Some of the changes to this region can be seen in the sequence of maps of the area from 1825 to modern times (**Figures 4.3- 4.6**). After the end of rice production in the early twentieth century, most of the remaining fishponds were filled in by trash, incinerator ash, and mangroves. The lack of documentation of some of these fishpond walls presents difficulties in predicting their exact location at the project area.

The area around the impact zones of the project area is basically a riverine delta that has been modified extensively by human activity. The stream flowing into this region is Waikele Stream, but the effluent is presently divided. A western branch of the stream empties into the west loch through a modern drainage canal. Another branch extends farther to the east and forms a wide curve to the south, creating an eastern and southern boundary for the project area. Along this eastern course, the channel is currently known as Kapakahi Stream.

Most of the former fishponds on or adjacent to the present project area were discontiguous components, or *lele*, of the *`ili* subdivisions of Waikele Ahupua`a. An *ahupua`a*, one of the major political land units of traditional Hawai`i, would normally consist of several *`ili*. These *`ili* were usually fragmented into sections throughout the *ahupua`a* and were designed to take advantage of several environmental resource zones. There were *lele* of at least eight *`ili* in the project area and immediate surroundings. Each has a different history but similar land use.

Pouhala

After use by some favorites of the royal court in the early nineteenth century, the fishpond and lands of Pouhala `Ili seem to have reverted to the government around the time of the Great Mahele (1848-1854). Pouhala was a clearly defined tripartite *`ili*, with a large fishpond, taro *lo`i*, and open upland and forested areas (*kula* and *wao*). Tales of its more recent past were remembered by Mary Kawena Pukui:

> After resting, we decided to go down to Lahilahi's (Webb) old house near Pouhala, an important fish pond in olden days. The name Pouhala is now given also to the homestead lands, one of which is occupied by Kapeka Baker's pretty cottage [this land is immediately north of Pouhala fishpond]. The railroad [OR & L] crosses the pond, cutting it in two, but the old opening for the sluice gate that occupied the space in ancient times, there is now an ordinary wire screen held in by a wooden frame. The water is no longer as clean as it was and long yellow mosses sway to and from. Lahilahi pointed out the lands that were once a series of small taro patches. One has some very thrifty taro growing, another is only a small pond, but the rest hold only tall green grasses that swayed to and fro in the wind. The taro patch land was called Kapalaha. What a wonderful place it must have been with a fish pond and the sea in front and taro patches at the back door. "A fine place for crabbing," said Lahilahi, and when it was the season for oama, plenty! Sometimes we would take our cooked ka-i taro down to the shore and eat them, with shell fish as we caught them. Delicious, Oh! (HEN I:1258, cited in Sterling and Summers)

This description seems to capture the nature of the *`ili lele* system of resource extraction in general, as well as specifically for Pouhala.

Ohua

The *`ili* of Ohua in the *ahupua`a* of Waikele, `Ewa, O`ahu (LCA 6545) is perhaps the least documented land section on the project area. It was awarded to Hana Hooper Ha`alilio as a gift from King Kamehameha III in 1854. It had been the king's property before this time; thus, there are few records of its more distant past in the Native Register and Testimonies of the Great Mahele. Hanna Hooper was the widow of Timothy Ha`alilio, brother of Levi Ha`alelea. Levi had been married to Kekau`onohi, a granddaughter of King Kamehameha I. Timothy Ha`alilio was a chief of middle rank who was a close associate of King Kamehameha III. Timothy Ha`alilio traveled to Europe with William Richards in 1842 to lobby the European powers for recognition of Hawaiian sovereignty. Timothy died en route on the trip back to Hawaii (3 December, 1844 Kuykendall 1947:226), and Hana was his heir. Upon her death, Hanna Ha`alilio

devised her property back to Kamehameha III. There is no indication that anyone resided on this claim.

This parcel of land was awarded in at least three parcels, or *`āpana*. The first parcel (LCA 6545) was located next to the roadbed of the O.R. & L. RR, between Pouhala and Mokuola fishponds. What appears to be another portion of this parcel existed *mauka* along Kapakahi Stream (TMK 9-4-13) and was perhaps used for growing pondfield taro. LCA 6545.2 is a ten-acre parcel located between Pouhala, Ka`auka`a, and Ulumoku fishponds. It appears to have been solid land or marsh as opposed to a walled fishpond. The parcel was bounded on the north, however, by the wall of the Pouhala fishpond and to the west by an *`auwai*, or drainage channel. A major portion of LCA 6545.2 is represented at the project area. The third section of LCA 6545 was immediately adjacent to 6545.2 on the northeast. It probably was a marsh as well.

Not much more is known about the Ohua `Ili until 10 September 1897, when Kale sold half of *`āpana* 2 to C.K. Maieha and his heir for $50.00 (BC Liber 172:229). On 20 May 1922, Edward Pulawa Maieha and his wife sold the parcel to Henry Holmes for $600.00 (BC Liber 635:399). On 10 November 1934, Holmes sold this parcel to Tatsuichi Ota for $100.00 (BC Liber 1249:499). Ota acquired the other half of LCA 6545.2 from Dinah K. Kalua for $75.00 on 31 December 1934 (BC Liber 1269:404). By 1937, Ota had also acquired LCA 6545.1 (Field Book 1414 Tax Office) and LCA 6545.3 (tax maps). Ota had many other lands in Waikele. Eventually, Ohua `Ili was owned by the City and County of Honolulu and used for the development of a sewage treatment plant and incinerator ash disposal site.

Kahapu`upu`u

Only one small segment of the *`ili* of Kahapu`upu`u is represented in the vicinity of the project area. In 1849, Frank Manini, a son of Don F. De Paulo de Marín, aide to King Kamehameha I, was awarded Grant 126 (Grant 1:258-260). It consisted of 10.75 acres of land and the 1.75-acre fishpond, Loko Kuhewa, which was adjacent to the tiny Loko Lilio and Loko Pahao.

Paiwa

*The `ili* of Paiwa, Waikele, `Ewa, O`ahu (LCA 1613B) consisted of two segments, or

`äpana/lele.* The current plans for Ducks Unlimited excavation activities include all of this parcel's *`äpana 2, which was described during the time of the Mahele as a sand-banked fishpond (*pu`uone*) named Hananu (LCA 1613 B, 7:262). *`Äpana* 1 of LCA 161B was a cultivated strip of land (*mo`o`äina*) of nearly 2 acres, located *mauka* of the fishpond and along Waikele Stream (TMK 9-4-25).

The *`ili* was awarded to Huailua during the Mahele on the basis of having received the parcels from probable *konohiki* (landlord) Kalaipaihala at the time Boki was governor of O`ahu, ca. 1819-1829 (NT 9:246). In time, the parcel became Grant 150.3, awarded to S.P. Kalama, secretary to the Board of Commissioners to Quiet Titles of the Mahele (Kame`eleihiwa 1992:222). This parcel was a small component of a total of ca. 24 acres.

Pahao

Another part of the S.P. Kalama grant was an adjacent fishpond known as Loko Puhau (Pahao). Kalama paid only $1.00 for this property (Grant 150, 1:370-372). A small section of adjacent Pahao `Ili land was awarded during the Great Mahele to Kahonu as LCA 5663.1 (LCA 10:640). Kahonu died on 24 November 1851 and left his land to cousin Abner Päkï, father of Bernice Pauahi Bishop (Barrère n.d.:138-139). Thus, this land eventually passed into the Bishop Estate. It appears that both Oahu Sugar Company and the Sing Chong Company (rice) leased this land, as well as the strip of marsh between LCA 5663.1 and Kapakahi Stream (Land Court Application 779).

Hanohano

The *`ili* of Hanohano in Waikele was located on the west bank of Waikele Stream at the mouth of the western channel. This region is now called the Waipahu Flood Control canal. In ancient times the natural bayou that had formed here was known as the Kaalahina River (NT 224.10).

From the mouth of the stream to the west, the fishery of Apoka`a (Apoka) extended into the west loch. The fishpond Loko Ka`auku`u, adjacent to the project area on the west, was part of this fishery as well as the *`ili* of Hanohano. The land segment (probably LCA 5930:1) and the fishpond (LCA 5930:2) were awarded to Puhalahua during the Great Mahele. The land portion of the *`ili* , composed of *lo`i*, is described as having been at the mouth of the stream (NT 224:10).

This would have placed it directly northwest of the Pouhala fishpond. Pukui et *al.* (1974:41) mention that Hanohano is the site of the present Waipahu "High" [Intermediate] School, which is located immediately west of the mouth of the Waikele Stream Flood Control channel. This particular land parcel and associated fishpond have an important history that warrants a detail examination:

Kahaekana, a Mahele witness for the claimant Puhalahua, stated that his/her mother, Naulu, was the overseer of Hanohano while she lived at this place. Naulu reportedly resided here during the time of King Kahanana of O`ahu and Moloka`i, which would place the occupation at the last quarter of the eighteenth century (A.D. 1773, Kamakau 1992:130). Kahekili of Maui invaded O`ahu during the reign of Kahanana. After several skirmishes and battles, Kahanana hid in the back country. His last residence was near Wailele at Waikele, and, thus, he was in the neighborhood of the project area. Kahekili learned about Kahanana's whereabouts and promptly sent canoes to Waikele. There the last native O`ahu king was killed, and Kahekili established his rule over O`ahu. Not long after, however, many of the old chiefs of O`ahu met at Waipi`o Peninsula (directly south of the project area), plotted, and rose up against the Maui usurper. They were soundly defeated and it was the end of native rule of O`ahu.

It is quite surprising that Naulu, a native O`ahu *konohiki,* retained control over Hanohano throughout the reign of Kahekili. Normally, she would have been dispossessed by the conquering chief. King Kahekili was succeeded by his son, Kalaniküpule, who kept the land of Hanohano but confirmed Naulu's control over the sea resources of the *`ili.* Kalaniküpule was defeated at the famous Battle of Nu`uanu by Kamehameha of Hawai`i. Remarkably, Naulu still retained control over the Hanohano fisheries in Waikele despite the latest conquest.

Kamehameha I gained O`ahu in 1795 and promptly redistributed the land and fisheries of this island. Puhi was given the adjacent Pouhala by Kamehameha I, and because he was a favorite of the king, he was also given the fishery of Apoka`a during the reign of Liholiho (1819-1824). After the ascension of Kauikeaouli (Kamehameha III) in 1825, the fishery of Apoka`a was returned to the holders of Hanohano. Perhaps to accommodate the needs of tenants and overseers of both Hanohano and Pouhala, the fishpond Pouhala was most likely split to form Loko Ka`auka`a for the

`ili of Hanohano.

Kahaehana succeeded to his mother's holdings (*kuleana*) in Hanohano at the death of Naulu. Meanwhile, Luluhiwalani was *konohiki* over Pouhala. Kahaehana's own *konohiki* was identified as Puhalahua. This may indicate a demotion in the family since the time that Naulu was *konohiki* of Hanohano. It is also possible, however, that Naulu was simply *luna*, or a subordinate under some other *konohiki*.

In 1846, M. Keküana`oa, Governor of O`ahu, adjusted the land boundaries in the area. According to Kahaehana, he restored everything in favor of Hanohano. This does not seem to have been completely accepted by the government through the subsequent Mahele proceedings. The dispute apparently was resolved in 1854 with the award of LCA 5930 to Puhalahua. There does not seem to be compensation to Kahaekana as heir to Naulu. However, a certain Kahaekaua was awarded LCA 6025, a small taro plot in Ulumanu `Ili in Waikele.

Ulumoku

The fishpond at Ulumoku, located directly south of Loko Ka`auku`u at the mouth of Kapakahi Stream, appears to have consisted of several enclosed ponds on either side of the estuary by the early twentieth century (tax map). Some sections of this fishpond will be impacted by proposed excavations. One of the enclosures of Loko Ulumoku is known as Loko Paukamumu. Its specific title history is unknown. Loko Ulumoku was reserved by the government during the Great Mahele (BCQLT 1929:43) and remained as such through to American annexation. The Territory of Hawaii leased this property to J. Lawrence P. and Mark A. Robinson for $45.00 in 1930 (Lease 2306). In 1942, the Robinsons leased the fishpond back to the Territory (Lease 2711). A series of executive orders from 1943 to 1964 tossed the fishpond from City and County, to territorial, state, and federal jurisdictions. The United States Navy had condemned most of the parcels in the project area to create a security strip around the Pearl Harbor base facilities (BC Liber 2002:157). On 27 September 1962, the Federal government decided to return surplus lands to the State of Hawaii (BC Liber 4486:10). Finally in 1964, the City and County of Honolulu acquired a 65-year lease to the pond for use as a sewage treatment plant and incinerator ash disposal site (BC Libers 4782:1; 4774:439).

Waipahu

On 17 August 1850, William Jarrett purchased Kalama's Grant 150 (BC Liber 14:239). Jarrett also purchased adjacent property under Grant 122. This consisted of a total of about 76 acres, mostly from the former *`ili* of Waipahu. The grant was purchased for $152.00 in 1849. Grant 122 included a portion of Loko Hananu and Loko Lilio, the latter being directly north of Loko Puhau. Lilio and half of Hananu may have been parts of Waipahu `Ili. These were probably all sand-banked ponds fed from the fresh water of nearby Kapakahi Stream. During the late 1930s or early 1940s, J.L.P. Robinson purchased parcels 2 and 3 of Grant 122. The Roman Catholic Church bought parcel 2 of Grant 150 (Loko Puhau) during this time. All these watery parcels became a part of the City and County sewage and ash disposal site.

4-D. Discussion

Documents were examined primarily for evidence of various architectural features that could relate to historical patterns of land use in the Pouhala marsh region. Evidence for habitation of the area is scant, with the 1825 map indicating that there were some houses along the west side of a stream, assumed to be Kapahaki (Figure 4.3). No other evidence of direct human habitation in the project area has been found, including house sites and cemeteries. However, fishpond walls, *`auwai*, and possibly other features related to aquaculture are indicated for this site.

Although most of the fishponds have been filled in the twentieth century, one cannot presume that the walls of the fishponds, especially if they were of coral or basalt construction, were destroyed in the process of filling. It is well documented that many of the Hawaiian fishponds were simply filled in with the walls intact (see Klieger *et al.* 1995; Devaney *et al.* 1976). It would take considerable effort to remove these usually massive walls, and there would normally not be a need to do so.

Previous Archaeological Research

The study area between lower Waikele and Kapakahi streams has not been the site of specific archaeological investigations, but there are a number of complementary projects in the Pearl Harbor area. In addition, there are numerous studies focusing on Hawaiian fishponds from O`ahu

and other islands (*e.g.*, Apple and Kikuchi 1975; Costa-Pierce 1987; Kikuchi 1973, 1976; Summers 1964). These and other studies in conjunction with ethnographic work have defined four types of fishpond. Two are inland freshwater systems, termed *loko i`a kalo* and *loko wai*. *Loko pu`uone* are often filled with brackish water and usually separated from the sea by a ridge of sand; *loko kuapä* are built in the saltwater regions along the shoreline, with walls of coral and stone (Costa-Pierce 1987). Kikuchi (1973: 24, 245, 246) identifies four of the named fishponds in the study area as *loko kuapä* (Ka`auku`u, Ulumoku, Mokuola, and Ma`aha) and one (Pouhala) as a *loko pu`uone*.

One of the closest, recent archaeological studies in the West Loch area was conducted just northwest of the Ducks Unlimited area by Nagota and Davis (1989). Their investigation centered on a small plot of land slated for the development of Pupu`ole Street Park, on the *mauka* side of the O. R. & L. RR. Their excavations encountered post-Contact artifacts, mollusk shells, and charcoal. They noted a heavy deposition of sediments washed down from inland sources, sometimes covering a gleyed horizon, interpreted as Alagoonal muck. @ No mention is made that the gleyed horizon might represent a fishpond (none is known historically from this location) or a *lo`i*.

Another neighboring archaeological project was conducted south of the study area on the Waipi`o Peninsula, Laulaunui Island, and the Honouliuli Naval Reservation (Jensen and Head 1995). On these properties 281 archaeological sites were recorded and, of these, 108 are believed to represent traditional Hawaiian activities. The types of traditional Hawaiian sites encountered include temporary and permanent habitation, agriculture, storage, possible burials, and aquaculture. Post-Contact sites encompass a wide variety of military installations, as well as some plantation features. The methods used to investigate these areas included pedestrian survey but no excavation. Additional information was gathered from historical documents, maps, and photographs. A number of fishponds were investigated in the area. Oki`okilepe fishpond (50-80-13-143), located on the western bank of the West Loch was visible and deemed to be in good condition. The area where the Kapmuku fishpond (Pamoku) was recorded by McAllister (1933:108) was searched, but no trace of it was to be found. Remnants of the Laulaunui fishpond site (50-80-13-140) were visible on the surface, although extensive vegetation and recent

modifications appear to have damaged its integrity. Examination of aerial photographs in conjunction with ground checks suggested that Loko Hanaloa (in the center of Waipi`o Peninsula) has been filled and the land used for sugarcane cultivation. Loko Eo, also on the Waipi`o Peninsula, appears to have been destroyed. Based on the results of their work, Jensen and Head deemed Oki`okilepe and Laulaunui fishponds to be significant under criterion "c" and "d" of the SHPD draft guidelines; these reflect the sites' status as excellent examples of site types and that they are important for their informational content. The authors recommend further data collection, including subsurface excavations, and possibly data recovery/mitigation.

Extensive research has also been conducted in conjunction with the construction of the West Loch Estates, Golf Course, and Shoreline Park along the western shore of the west loch (e.g., Dicks et al. 1987; Goodfellow and Dunn 1995). Pedestrian survey and subsurface testing encountered seven sites which are interpreted as remains of habitation/burial (Sites 3321 and 3319), habitation (Sites 3318 and 3320), agriculture (Site 3324), and aquaculture (Sites 3322 and 3323). Research suggests that Site 3322 is a pre-Contact fishpond dating to the mid-twelfth to mid-seventeenth centuries. Site 3323 is a post-Contact fishpond created in the 1890s by the construction of the O. R. & L. RR. Site 3322 was easily discernible on aerial photographs, and inventory survey trenches revealed heavily gleyed sediments buried under reddish brown clays, between 60 and 120 cmbs (Dicks et al. 1987:55). Layers of gastropods within the gleyed sediments suggest that the fishpond might have dried out at some time. Data recovery work describes the layer presumed to be fishpond deposits as a black silty clay loam (Goodfellow and Dunn 1995: 52). Site 3323, located just north of Site 3322, was not entirely silted in during fieldwork in 1987 and contained some standing water; no subsurface testing was done.

There are numerous other research projects in the other portions of Pearl Harbor, many of which also encountered fishponds and other types of archaeological and paleoenvironmental deposits (e.g., Anderson 1995; Avery et al. 1994; Cluff 1970; Hammatt et al. 1986; Sinoto 1989). Research is currently underway by Athens and Dye, who have cored a large number of fishponds from the Pearl Harbor region, including the west loch, in an effort to get a more regional perspective on these unique archaeological features (Steve Athens, personal communication 2/19/97). The most relevant information in these other studies (for our work) is the

acknowledgment by researchers that dark, grey, gleyed, or clay horizons do not necessarily derive from fishponds. These deposits may also form in *lo`i*, lagoons, or estuaries (e.g., Avery et al. 1994:34-35) . Instead, sedimentary data, in concert with architectural elements and historical documents, are suggested as the best evidence for the existence of fishponds. In addition, it of importance to note that there are a wide variety of pre- and post-Contact archaeological deposits in and around the Pearl Harbor region.

Research Methods

The methods used to assess the archaeological potential of the area were tailored to the plans of the Ducks Unlimited project. Historical documents, maps, and aerial photographs were first consulted and combined with the map of the changes proposed for the habitat restoration (Figures 4-6). Areas that potentially contained subsurface features and deposits were targeted for investigation.

On 21 February 1997, three Bishop Museum archaeologists conducted the reconnaissance of the study area. Limited subsurface testing was done in areas that were earmarked for disturbance but not covered with several feet of fill. This meant that subsurface work was concentrated in the northeastern area of the site where cuts are planned. The southern fill area was not tested. Additionally, walls of fishponds visible on the surface were searched out and plotted (Figure 4.7).

Nine subsurface bores were made using a 5-HP, 6-inch [15 cm] gas-powered auger. These were normally 60-80 cms deep and augered in two sections. Soils and sediments were examined and classed using a Munsell soil color chart and the materials were screened (when feasible) though a 1/4-inch [6-mm] mesh sieve.

Auger bores, cement slabs, and a historic-period fire feature (oven?) were mapped using a total station. Data were downloaded in the field computer. These data were later transferred into AutoCAD 13c. The base map used was scaled to metric units and located on the Universal Transverse Mercator (UTM) grid 4 North, with the North American 1927 datum (NAD27) and the 1866 Clarke Spheroid.

Results

Surface Recoveries

The surface of the area is currently littered with a wide variety of materials that have been dumped as refuse. These include household garbage, tires, glass, ceramics, metals, appliances, and automobiles. Interestingly, many of these materials are concentrated groups that are material-specific, especially two to three surface concentrations of broken glass bottles. These materials also appear to be most prevalent along the north and east parts of the area.

Post-Contact Artifacts

The small ceramic and bottle glass assemblage found on the surface contains food and beverage vessels from China, Japan, and the U.S. mainland. Two Chinese porcellaneous stoneware ceramic sherds were found subsurface. Japanese porcelain and porcellaneous stonewares dominate the assemblage. Chinese porcellaneous stonewares are common, but stoneware examples are poorly represented. American whitewares and stonewares are rare. The Japanese ceramics are straight-sided cups, rice and rice-serving bowls, and shallow dishes with transfer print, decalcomania, or handpainted geometric, floral, and anthropomorphic motifs. The Chinese porcellaneous stonewares are primarily rice or rice-soup bowls with handpainted cobalt blue motifs (e.g., Double Happiness) and large shallow dishes, cups, and rice bowls with an overglaze handpainted polychrome Four Seasons motif. Several brown stoneware sherds from soy sauce or food jars were found. The American vessels include several ironstone whiteware cups and bowls and a bristol-glazed stoneware crock. The bottle glass is represented by aqua, olive green, clear, and manganese-decolorized sherds from soda, beer, wine, ale or wine/champagne bottles.

The ceramic and bottle glass assemblage dates from the late nineteenth to early twentieth century. Japanese porcelain and porcellaneous stoneware vessels largely replaced their Chinese counterparts in Hawai'i by the end of the nineteenth century. Several of the vessels have stenciled marks on the base, all of which date after 1890 when the U.S. government required vessels to be marked as to the country of origin. The American ironstone vessels, often called hotel or restaurant wares, were commonly manufactured after 1880 and one marked piece dates to the 1920s. The bristol-glazed crock dates after 1890, and the bottle glass appears to primarily reflect machine-made bottles common after 1910.

It is unlikely that all of these materials are in situ, but their presence may indicate habitation in the vicinity during the nineteenth and twentieth centuries. As noted in the 1825 map of the area, a series of dwellings may have been located in the study area alongside the west bank of Kapakahi Stream.

Surface Architecture

In general there appear to be very few surface remains related to the historically documented fishponds. Inspection of aerial photographs and the current surface of the area suggests that there are some remnant walls that can be detected. These appear on the surface as large basalt boulders. One segment that most clearly resembles an intact wall is seen along the north-central section of the 1970s land fill, which may represent the boundaries of the Ohua `Ili (compare Figures 4-6 and 4-7). In addition, north of this location is an area of higher ground oriented north-south that coincides with another of the land boundaries noted in Figure 4-6. Other boulders scattered along the northwestern edge of the 1970s landfill may not represent intact walls but may simply be the result of the landfilling activities. Yet it is unlikely that these boulders were brought in as part of the fill (as it is a fairly homogeneous silty clay) or that they are part of the natural alluvial or sedimentation of the area. Instead, they may be remnants of fishpond walls that were disturbed by fill activities.

Subsurface Recovery

Below are listed the results of the auger bore tests. These were spread across the area most likely to be impacted by the habitat reconstruction and most likely to contain the remains of habitation, as indicated by surface scatters of artifacts and the 1825 map. Each auger bore is listed below, along with the sediments and cultural materials encountered.

Auger Bore 1

AB 1 Layer Descriptions

Layer I (0-60 cmbs/ 0-24" bs)

Dark reddish brown (5YR 3/4, w.) clay with thin (<1 cm) lamina of black organic matter, salt residue indicating recent inundation.

Layer II (60-80 cmbs/ 24-32" bs)

Dark yellowish brown (10YR 3/4, w.) silty clay, 20-30% well rounded granules.

AB 1 Cultural Materials

Layer I bottle glass

Layer II no cultural materials

Auger Bore 2

AB 2 Layer Descriptions

Layer I (0-47 cmbs/ 0-19" bs)

Dark reddish brown (5YR 3/4, w.) silty clay, encountered water at 42 cmbs.

AB 2 Cultural Materials

Layer I shell, two ceramic sherds (one @ 14 cmbs)

Auger Bore 3

AB 3 Layer Descriptions

Layer I (0-50 cmbs/ 0-20" bs)

Dark reddish brown (5YR 3/4, w.) loam with 1 cm rounded, yellowish brown (10YR 5/4) clay nodules.

Layer II (50-72 cmbs/ 20-28" bs)

Dark reddish brown (5YR 3/4, w.) loam with 1 cm rounded, yellowish brown (10YR 5/4) clay nodules, increasing sand and 2-4 mm granules toward base.

AB 3 Cultural Materials

Layer I charcoal, shell

Layer II charcoal

Auger Bore 4

AB 4 Layer Descriptions

Layer I (0-70 cmbs/ 0-28" bs)

Dark reddish brown (5YR 3/4, w.) silty clay. Similar to AB 3, Layer I.

Layer II (70-80 cmbs/ 28-32" bs)

Dark yellowish brown (10YR 3/4, w.) silty clay, 10-20% rounded granules, water

encountered.

AB 4 Cultural Materials

Layer I charcoal, shell

Layer II no cultural materials

Auger Bore 5

AB 5 Layer Descriptions

Layer I (0-43 cmbs/ 0-17" bs)

Dark reddish brown (5YR 3/4, w.) clay loam, soft.

Layer II (43-62 cmbs/ 17-24" bs)

Dark reddish brown (5YR 3/4, w.) grades to loam.

AB 5 Cultural Materials

Layer I bottle glass, metal, possible wire nail, charcoal

Layer II charcoal

Auger Bore 6

AB 6 Layer Descriptions

Layer I (0-80 cmbs/ 0-32" bs)

Dark brown/brown (7.5YR 4/3, w.) clay loam to silty clay, mostly soft and homogeneous, 2-2 cm rounded nodules of redder clay, water encountered at 73 cmbs.

AB 6 Cultural Materials

Layer charcoal (hand made bricks found about 4-5 m south of AB 6)

Auger Bore 7

AB 7 Layer Descriptions

Layer I (0-33 cmbs/ 0-13" bs)

Dark brown (7.5YR 3/3, w.) clay loam; organics included. Same as AB 8, Layer I.

Layer II (33-62 cmbs/ 13-24" bs)

Similar to Layer I, above, slightly redder, slightly clayier.

AB 7 Cultural Materials

Layer I broken basalt flake, shell, clear glass, bottle glass, styrofoam, metal, plastic

Layer II glass, charcoal, shell, plastic

Auger Bore 8

AB 8 Layer Descriptions

Layer I (0-17 cmbs/ 0-7" bs)

Dark brown (7.5YR 3/3, w.) clay loam; organics included.

Layer II (17-75 cmbs/ 7-30" bs)

Dark reddish brown (5YR 3/4, w.) silty clay, saprolitic rock; coral.

AB 8 Cultural Materials

Layer I glass, shell, charcoal

Layer II clear glass, *kukui*, charcoal, shell

Auger Bore 9

AB 9 Layer Descriptions

Layer I (0-ca. 40 cmbs/ 0-ca. 16" bs)

Very dark grayish brown (10YR 3/2, w.) silty clay. May be related to Layer I of ABs 7 and 8.

Layer II ca. 40 cmbs-64 cmbs/ ca. 16-25" bs)

Dark grayish brown (10YR 4/2, w.) clay (possibly gleyed clay).

AB 9 Cultural Materials

Layer I brown bottle glass, melted clear glass, charcoal, plastic, inner tube

Layer II no cultural materials

Interpretation of Auger Bores Contents

Sediments and cultural materials encountered in the nine auger bores demonstrate some patterning that suggests some similarities and differences of depositional histories across the study area. The most recent layer encountered in all auger bores appears to have been laid down during the historic period. In ABs 1-5 this consists of dark reddish brown silty clays to loams which contain increasing proportions of sand and granules with depth. In ABs 6-9 the uppermost layers are characterized as dark brown to brown and contain more organic materials than the ABs to the south, but it appears that they are contemporaneous. These differences are probably a function of

the modern vegetation at the site, which is more substantial, especially over ABs 7 and 8. Sedimentary evidence includes facies of stagnant, brackish pond silts and clays, which appear to interfinger with alluvial and colluvial materials. The alluvium likely derives from the lateral streams and the colluvium from Kapakahi Stream and the O. R. & L. railroad bed.

Most of artifacts in the deposits were encountered in the top layer. These were mainly post-Contact materials, including two sherds found in situ in the upper part of AB 2. These were fragments of a Double Happiness rice-soup bowl, manufactured in China. The sherds cross-mend and therefore represent a single vessel. This type of ceramic ware was manufactured in the nineteenth century and was used in Hawai`i during the mid- to late-1800s. Surface finds in the area surrounding ABs 1-6 included other nineteenth-century ceramic sherds and handmade bricks, which were widely used in the mid- to late 1800s. It is possible that these materials date to the period of rice growing in the area. It was not possible to determine if these sherds represent actual in situ habitation deposits or whether they were dumped or redeposited in this location. The ABs closest to the access road (old railroad grade) appear to contain the highest proportion of very recent trash, including a rubber inner tube, most of the plastic, and styrofoam. This probably relates to their easy-access locations.

In the lower levels of ABs 1-3 there is evidence of increased sandiness at depth. Cultural materials are limited to sparse charcoal. Together these elements suggest that these deposits are the result of human use of the area plus stagnant, brackish pond sedimentation mixed with some eolian sands. To the north, the lower deposits in ABs 7 and 8 (farthest from the water and on higher ground) appear to be deposited at the same time, although more historic materials were encountered in lower parts of ABs 7 and 8. The sediments in these lower portions of ABs 7 and 8 are interpreted as the result of heavier alluviation, probably derived from Kapakahi Stream; deposits of stagnant, brackish pond silts and clays are less common. These differences are likely a function of the spatial differences, with ABs 7 and 8 farther from the standing water and closer to the active stream bed. It is suggested that these deposits date to the late pre-Contact to the post-Contact period.

Auger Bore 9 differs most from the others in that its lower layer is composed of dark grayish

brown clay (possibly gleyed) which lacks cultural materials. It is possible that this sediment was deposited in very still water, possibly a fishpond, *lo`i*, rice paddy, or natural standing water.

Comparison of our 1997 auger bore data set to that described in the 1996 Brown and Caldwell report confirms their assertion that there is a considerable amount of sedimentary variability across fairly short distances within the study area, although there are a number of similarities. Of most interest are their BHs 6, 7, 8, 16, and 17, which were placed closest to our ABs. It appears that there may be some correlation between lower deposits of dark grayish clay and silty clay deposits is BHs 6 and 16 and AB 9, which are all located along northern edge of the study area. Also, BHs 6 and 17 display similar dark reddish brown sediments in their upper layers, as seen in our ABs 1-5. The Brown and Caldwell bores appear to have encountered more dark grey clays in their lower reaches which may represent ponded sediments. It is likely that they uncovered more of these types of deposit, since their bores extended to a uniform 152 cmbs and some were placed in lower areas in standing water. If these deposits do indeed represent intact fishpond deposits, it appears that they are generally more than 0.3 m below surface and may not be affected by shallow grading.

4-E. Interpretations and Conclusions

Together, the documentary evidence and field observations indicate that there were a number of fishponds in the study area. These appear to have changed their boundaries over the course of the historic period, and most are no longer readily discernible on the ground. There are a number of possible reasons that fishponds and other possible archaeological remains were not encountered. First, this area remains geomorphologically active, and inwashed sediments from the surrounding countryside may simply have buried walls completely. Such inundation of the area could also bury any gleyed soil horizon associated with fishponds far below the 0.4-0.8 m auger bores made during archaeological reconnaissance. In addition thick deposits of recent, artificial fill may have helped to obscure archaeological materials. A less likely explanation is that most of the fishponds have been destroyed by modern activities.

Results from the auger bores suggest that the materials in the top 0.8 m of the deposits in the area date mostly to the post-Contact era, as glass, ceramics, plastic, and metal were commonly

encountered below the surface; only one traditional-style basalt artifact was recovered. Yet these materials are not consistently from the most modern era, and many of the ceramics on the surface and a few within the sediments, date to the mid- to-late 1800s. It is possible that these older finds are associated with nineteenth-century habitation or agriculture.

Recommendations

The findings of the archaeological reconnaissance did not recover significant intact deposits related to the past land use of the area. Regarding the possible significance of individuals associated with land at the present site, none of the historical records reviewed present a truly significant and important historical signature in the broad scope of Hawaiian history. In addition, it is possible that archaeological materials are deeply buried by alluvium and modern fill activities and may not be encountered by land clearance associated with the wetland habitat reconstruction. This is especially true since most of the cuts will be removing less than 2 ft. [0.6 m] of sediment.

Yet surface and subsurface findings suggest the possibility of archaeological deposits. The data encountered suggest that there may be mid- to late-nineteenth-century debris related to habitation documented along the eastern and northeastern parts of the site, in the vicinity of ABs 1-8. In addition, there appear to be intact fishpond deposits. It is therefore recommended that all areas to be altered during the construction of the wildlife habitats be monitored by an archaeologist with experience in historic-period artifacts and architecture. This will ensure that any significant archaeological materials can be documented in situ. In addition, we recommend that any intact archaeological deposits be avoided if possible.

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Figure 4-1 Study area.

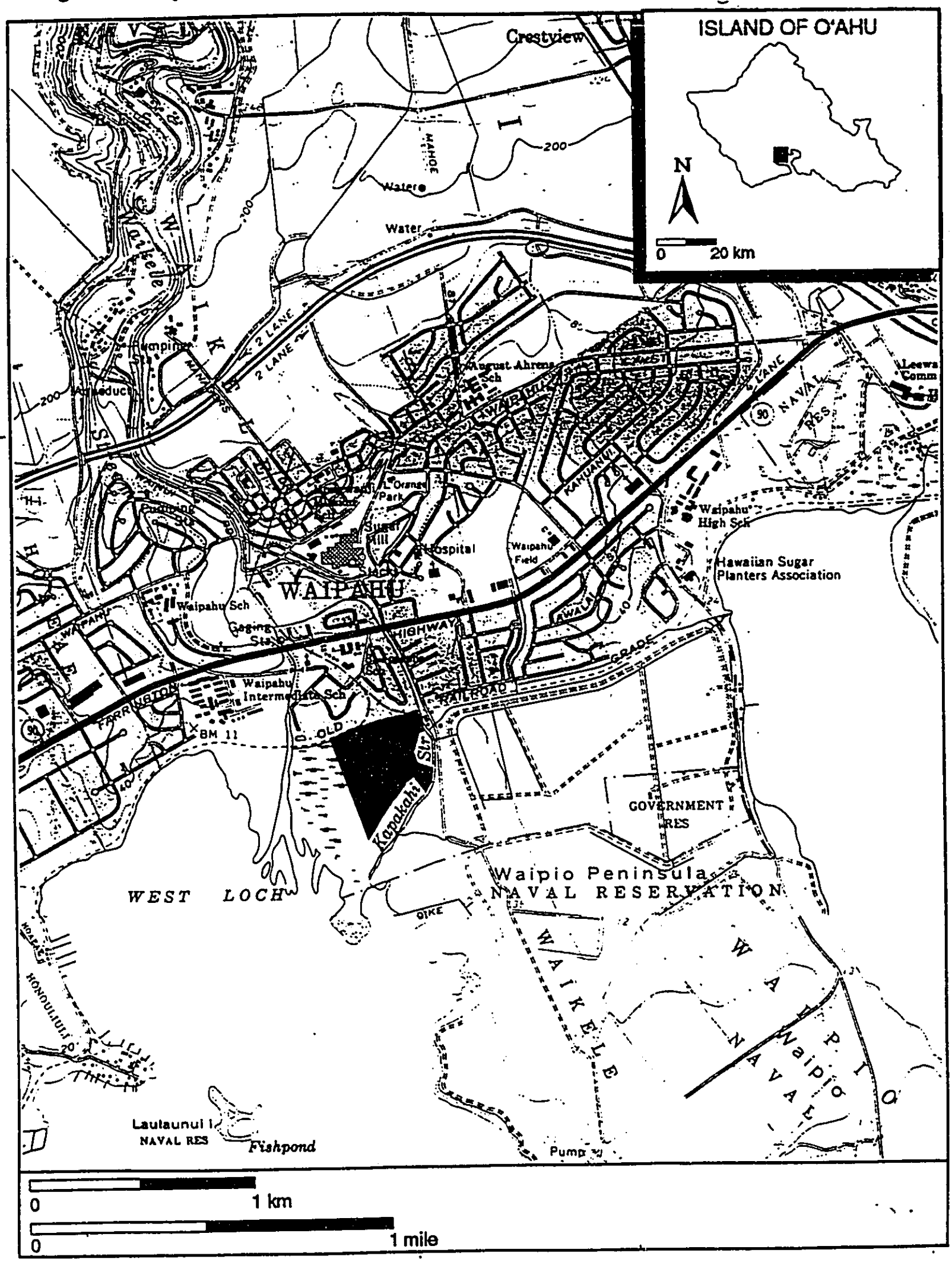


Figure 4-2 Areas of Potential Effect.

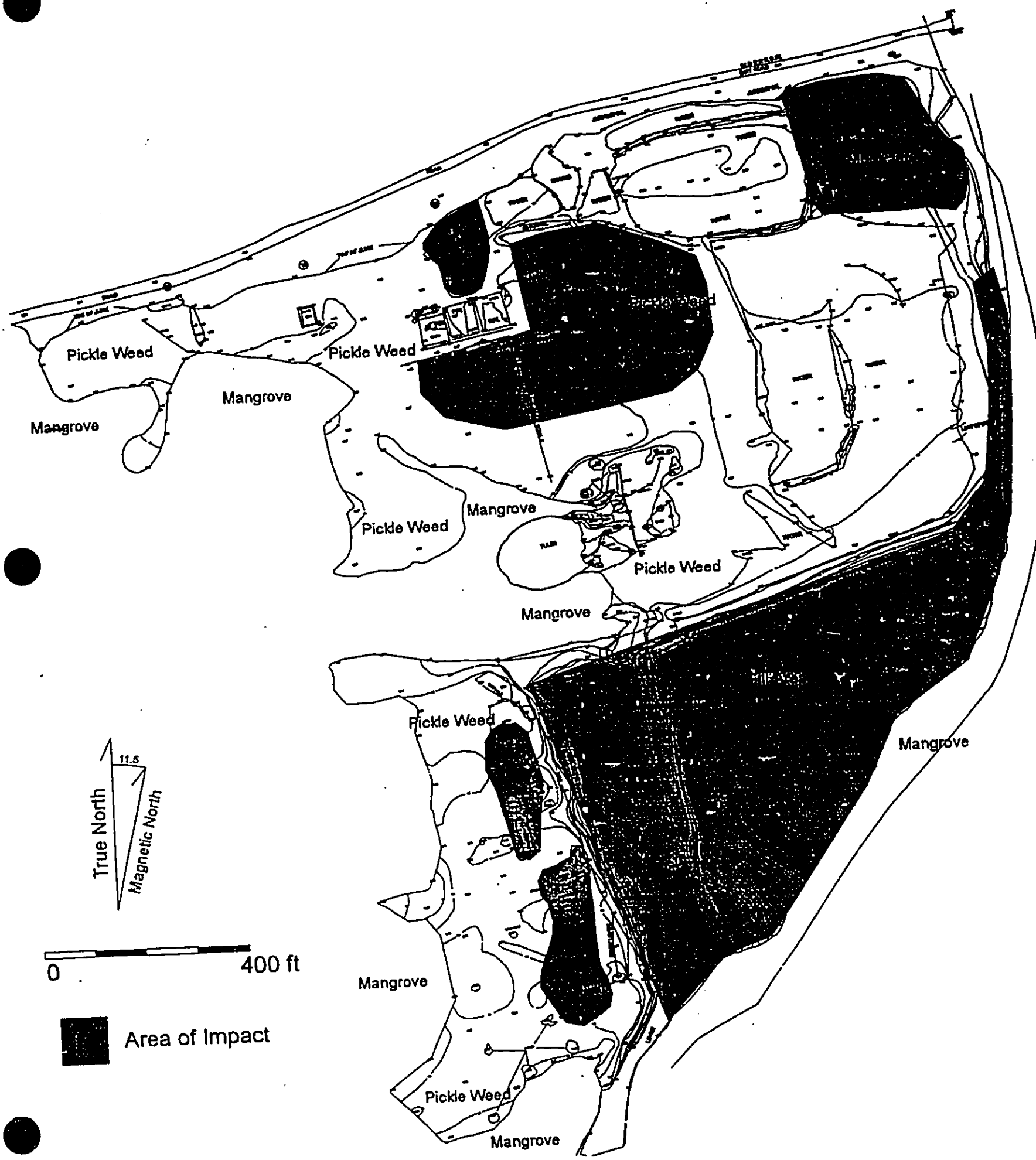


Figure 4-3 Malden map of Pearl Harbor, 1825.

(No scale; approximate north at top of page. No fishponds were described at Pouhala at this time, but they may have existed nevertheless).

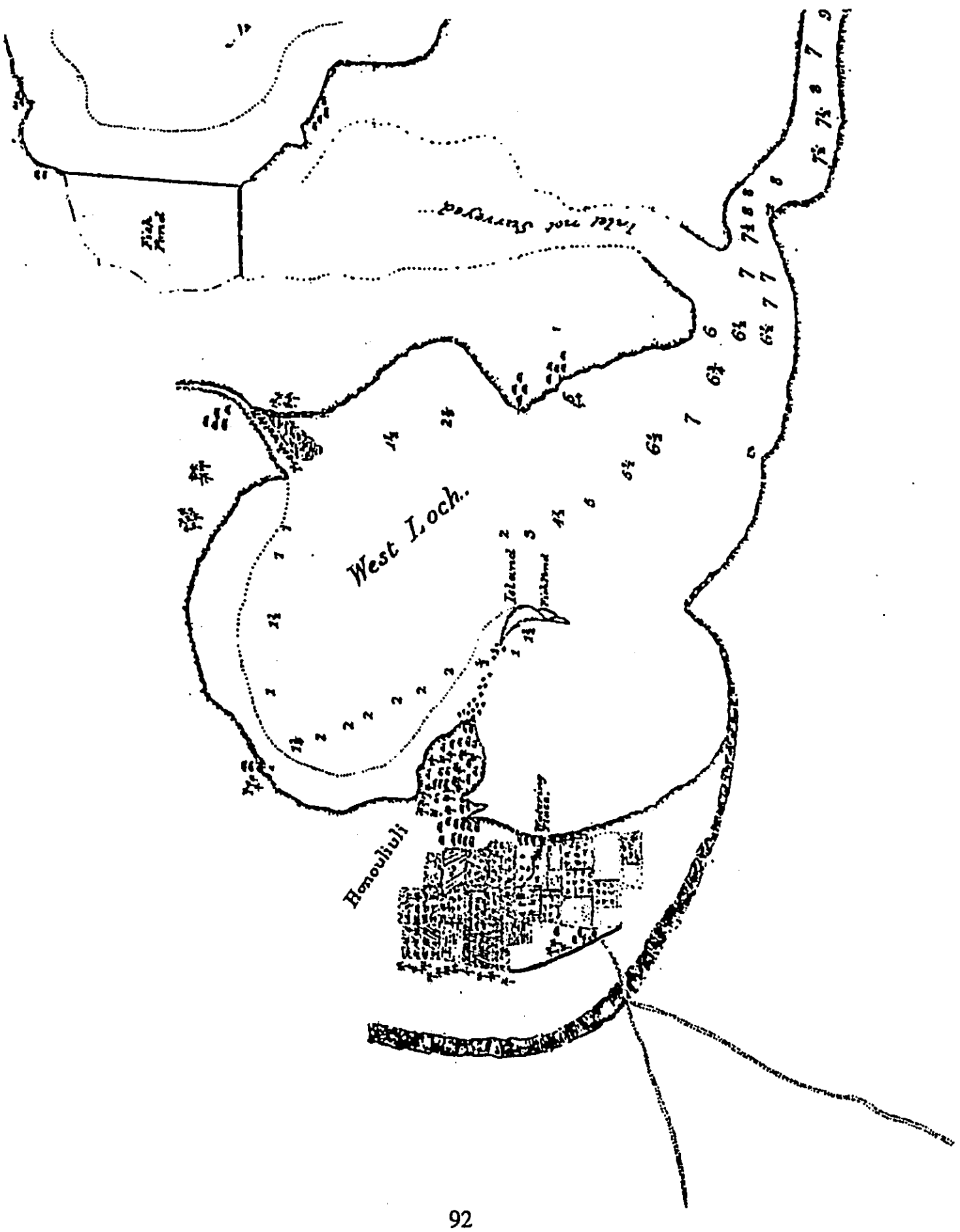


Figure 4-4 Fire control map of Pouhala Marsh (1908-1913).

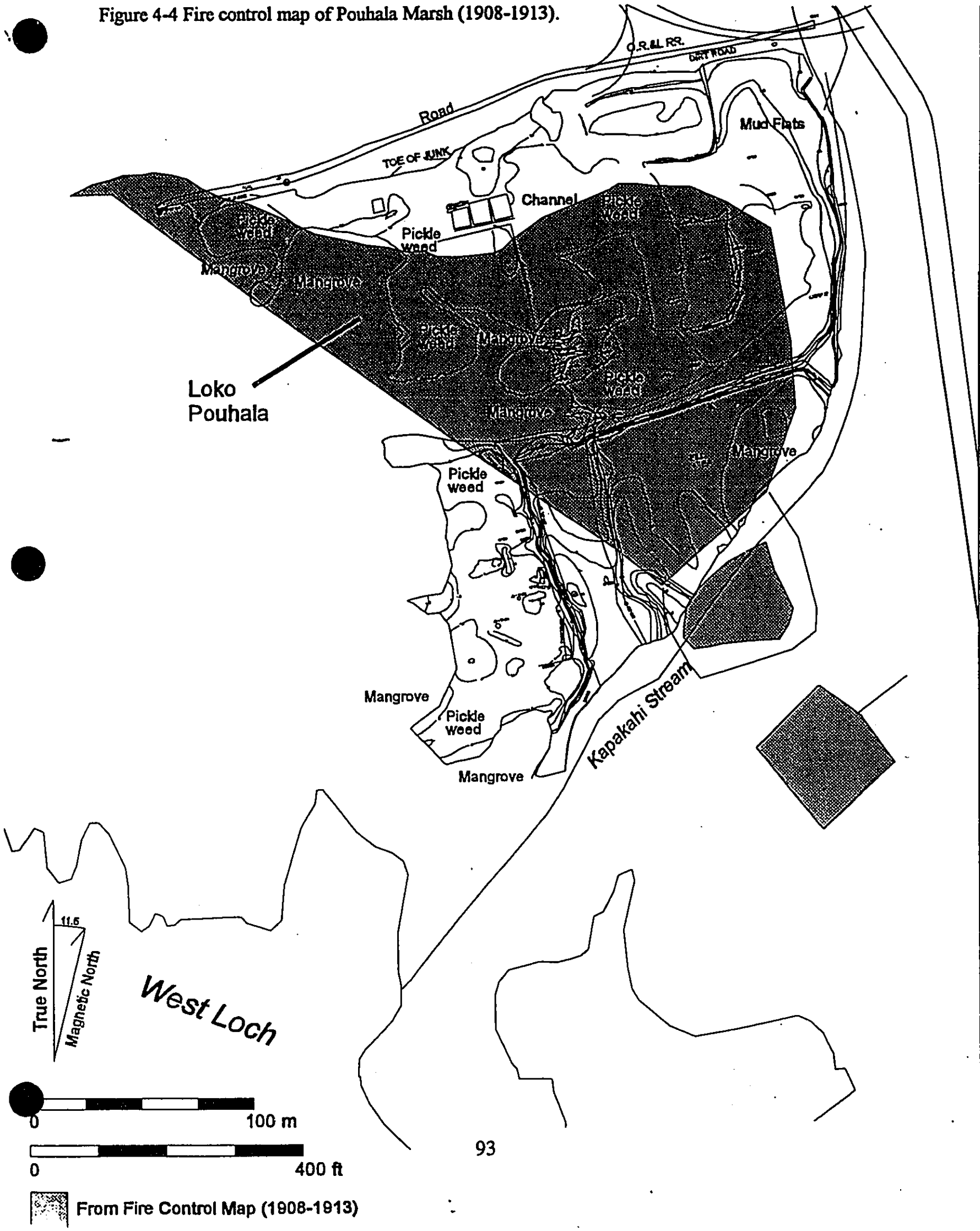


Figure 4-5 M.D. Monsarrat map of Pouhala Marsh (n.d., Probably early twentieth century).

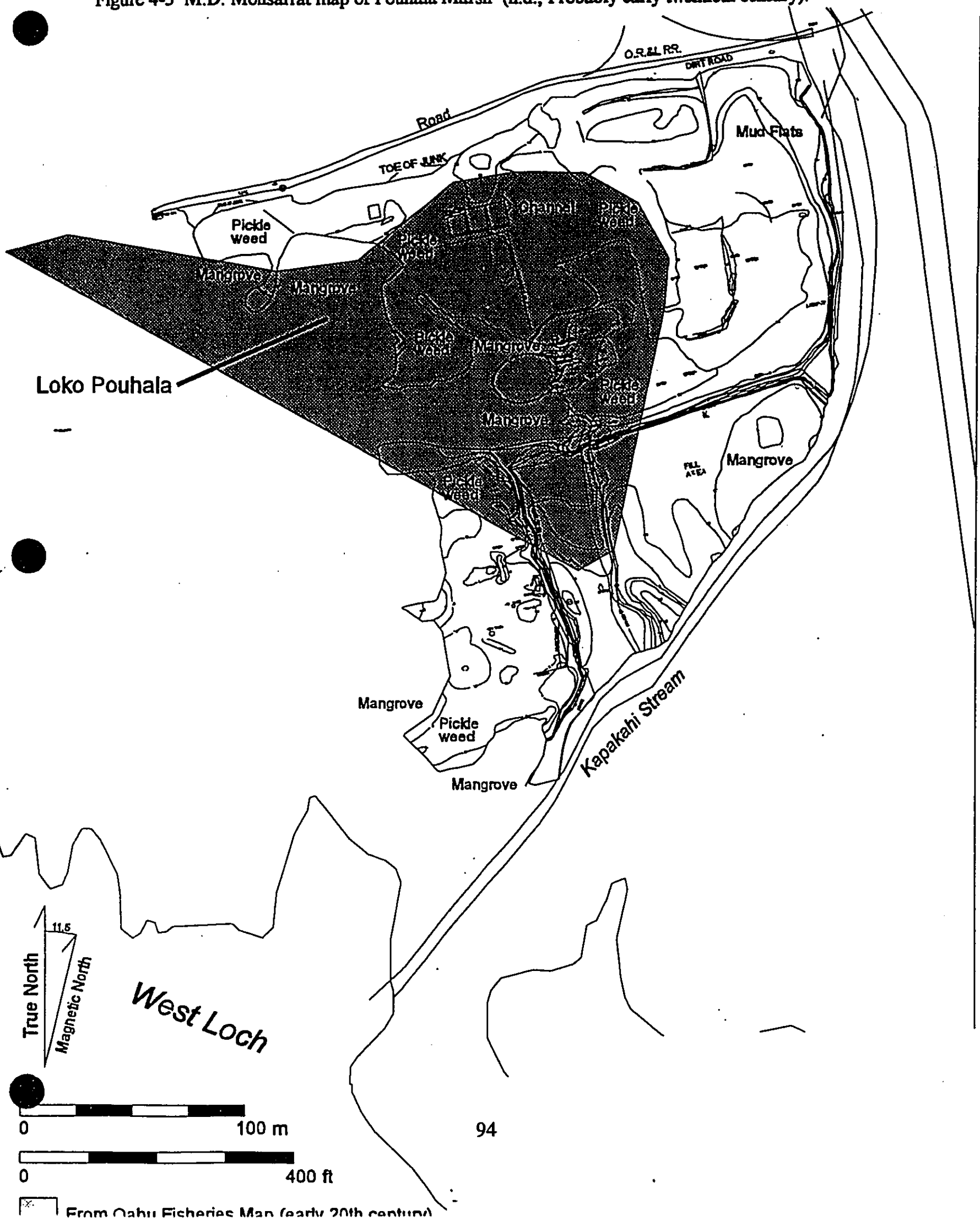


Figure 4-6 1939 tax map (This figure shows the fishponds at their greatest known subdivision).

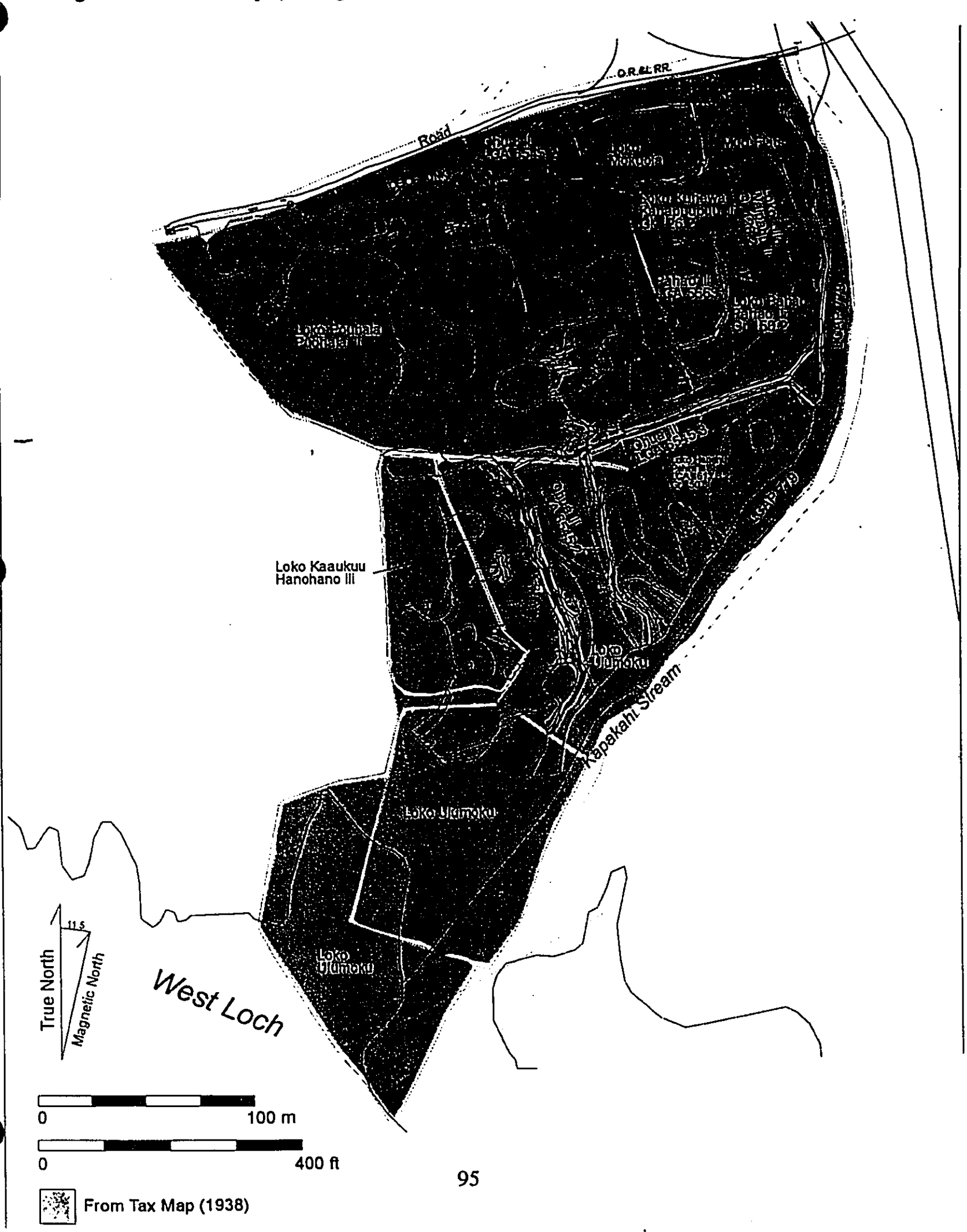
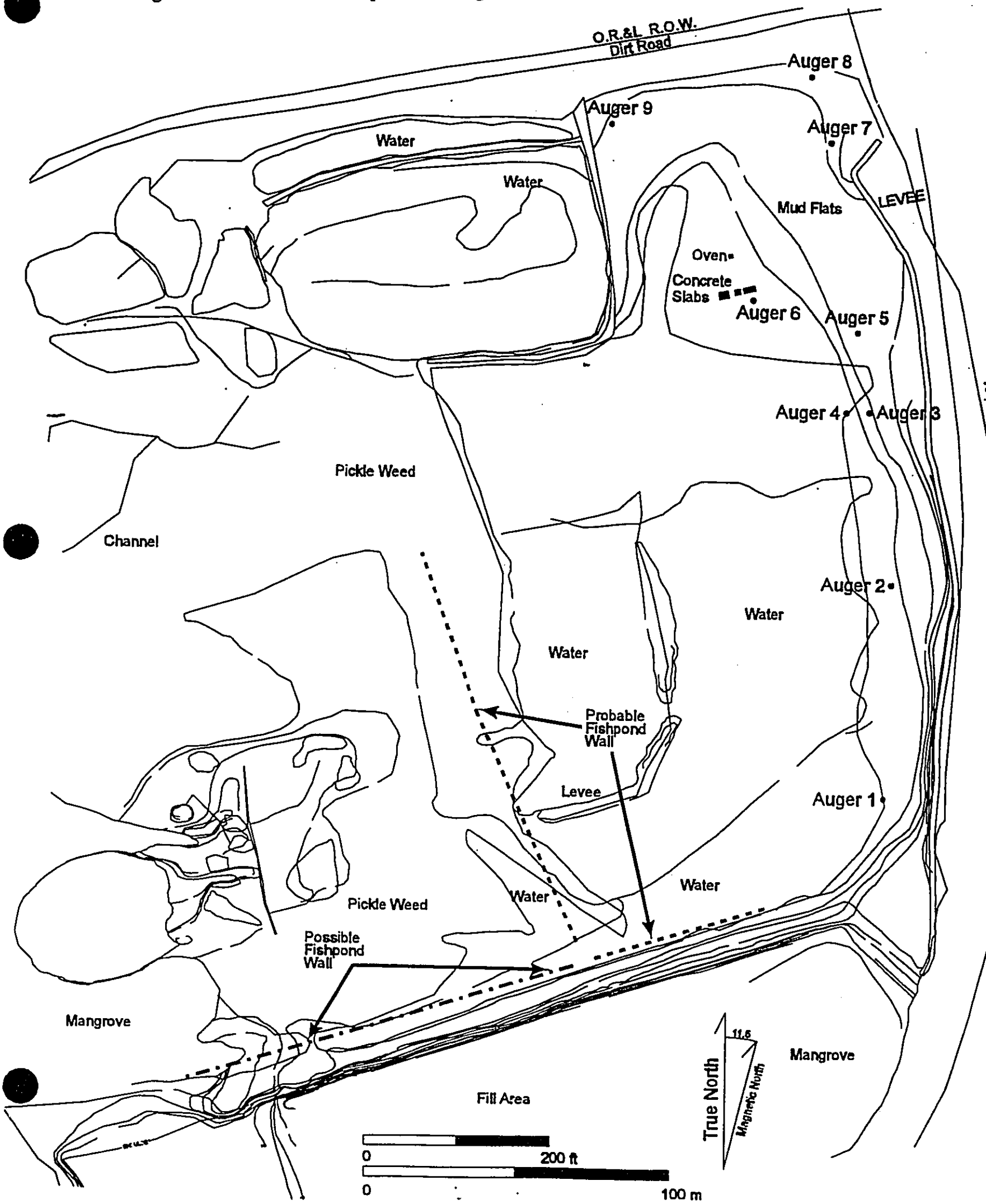


Figure 4-7 Location of Bishop Museum auger bores and surface features.



5. ENHANCEMENT ACTIONS[5]

5-A. PROPOSED ENHANCEMENT SITE

The data gathered under this EA have given the wetlands design team tools to correctly develop habitat that will provide the necessary conditions to restore the wetland function of Pouhala Marsh. (Refer to design plans attached.) The primary goals of the project are as follows:

Enhance existing wetland basins so that they function under naturally occurring hydrologic conditions. Enhancement actions include 20 acres of vegetation clearing, sculpting basins, removing obstructions (levees). Excavations will be to duplicate existing elevations that support stilts and migratory shorebirds (depths not to exceed 1.5 feet).

Clean the marsh of all human debris and trash.

Fence 70-acre marsh to exclude humans, vehicles, and large mammalian predators.

Restore eight acres of marsh through the removal of 66,000 cu. yds. of fill material.

Exclude fish from entering the managed 8-acre wetland through fish screens.

Create a hydrologic link from Kapakahi Stream to the 8-acre wetland. This site will be developed to provide habitat for native damselflies. An inoculation pond has been developed to provide for reintroduction of damselfly nyads.

5-B. OVERVIEW OF WETLAND ENHANCEMENT COMPONENTS

This wetland restoration and enhancement project has been designed to function as it always has, as a seasonal and semi-permanent marsh. As such, this plan does not call for altering hydrology to the bulk of the wetland. The 8-acre managed wetland will provide for both natural hydrologic function, but water levels can also be managed to minimize fluctuations that can

[5] Authors: Paul Goebel and Robert Charney Ducks Unlimited, Inc.

inundate stilt nests. Water levels in the marsh have been planned to mimic the naturally occurring basin (open mudflat). The water depths in each basin will not exceed 1.5 feet and will average 1.0 foot. The basins will fill from rain events and high, seasonal tides. The only way for water to leave will be through evapotranspiration. This seasonal drying will concentrate salts thus providing vegetation free foraging habitats. The borders of these basins will be lined with makai sedge and pickleweed. The associated invertebrates (particularly midges and sand flies) should respond in each of the wetland basins. The benefits to waterbirds are summarized in Table 5.1. Fish will be excluded from the 8 acre wetland to allow for minimal competition for food items (invertebrates) used by stilt adults and chicks.

Table 5.1. Project benefits for endangered waterbirds occurring at Pouhala Marsh.

Species	Status	Project Benefits
Hawaiian Stilt	Federal Endangered	foraging and loafing habitat restored and protected; nesting habitat created
Hawaiian Coot	Federal Endangered	nesting, foraging, and loafing habitat created and protected
Hawaiian Moorhen	Federal Endangered	nesting, foraging and loafing habitat restored and protected
Hawaiian Duck	Federal Endangered	foraging and loafing habitat restored and protected, minimize disturbance
Bristle-thighed Curlew	Federal Sensitive	foraging and loafing habitat restored and protected.
Migratory Shorebirds		increase foraging habitat and secure loafing habitat
Migratory Waterfowl		increase foraging habitat, minimize disturbance

Biological guidelines to construction.

Timing of Construction

The project restoration will be conducted to provide for a minimal impact on native waterbirds. Preferably the site will be dry during construction. If not, a biologist will be consulted to assess risk prior to beginning construction of elements identified in the technical section. The fill removal (8-acre site) can be undertaken at any time as long as a biologist has cleared the work. The planned construction window for Pouhala Marsh will coincide with the dry season. We

project that the wetland will be dry from June through October of each year. This date will vary according to rainfall patterns.

Vegetation Removal, Seasonal Marsh Enhancement

Vegetation removal is the most important habitat **enhancement** action in Pouhala Marsh. Removal of pickleweed and other invasive plants will create open basins in the wetland. This will create the desired interspersion (amount of open water to water covered in vegetation) that maximizes habitat for native waterbirds. Once the wetland is opened and enhanced, desired emergent growth currently suppressed by *Batis* are expected to return. Removal will require heavy equipment. Vegetation removed will be placed on upland habitat, identified by the State of Hawaii. A biologist will survey the sites for vegetation removal to ensure no waterbirds are nesting prior to work.

Fill Removal, Semi-Permanent Wetland Restoration

The goal of this phase is to remove fill that currently covers eight acres of historic marsh. This phase is a true restoration of wetland habitat. The goal is to lengthen the duration and allow for management of water levels, thus supporting nesting conditions for Hawaiian Stilt. Excavations will create a variable landscape with elevations ranging from 0.6 to 1.5 feet. The internal nesting areas (1.5 feet) will behave as semi-vegetated flats. They can be inundated and dried through water level management. These flats will be inundated in winter and, through evaporation, will become exposed. Once the fill removal reaches a base elevation of 2.0 feet, the finished wetland elevations will be surveyed and staked by an experienced crew. No fill will be placed in the wetland.

Fencing

A predator-proof fence will be installed encircling the marsh restoration site on three sides. The fourth side is bounded by Pearl Harbor and is impractical to fence. The fence will be suitable in restricting dogs. It will be high enough to deter human disturbance. A gate will be placed to allow equipment access into the marsh.

Predator Removal

Predator removal will be necessary once the restoration is completed. With the use of EPA approved chemicals and trapping methods, mongoose and rodents can be initially removed from inside the fenced wetland. The area will be surveyed for the removal of cats, if necessary. Periodic predator monitoring and removal will be a long-term management need for the wetland and will be undertaken by DOFAW.

Trash Removal

Trash removal is necessary as small quantities have accumulated over the years. Trash removal could be accomplished at the same time as the vegetation removal process.

6. TECHNICAL SPECIFICATIONS FOR ENHANCEMENT ACTIONS

The sections that follow provide the specifications and materials required to complete the planned restoration and enhancement of Pouhala Marsh (refer to design plans attached). This section has a different numbering system as a result of the standard bid specifications provided by DU.

6-A General Description

The work involves construction of fencing, levees and water control structures to improve wetland habitat conditions.

1. Project Access

The Contractor shall be expected to maintain all access roads open and accessible. Access to the construction site will be designed to have minimal impact on human or wildlife resources in the area.

2. Elements and Tasks

There are three elements to the project, each are described below:

Earthwork

Build new levees, and uplands and configure the ground as shown on the plans.

Demolition and additional site work may also be required.

Supply and install water control structures

Supply and install water control structures as shown on the plans.

Fencing

Install fencing as shown on the plans and specifications.

6-B Mobilization

The work shall include the supply and transport of all labor, material and equipment to successfully complete that project as shown on the plans or described by the Engineer. Mobilization shall also include securing all permits for moving equipment on public roadways, construction permits, and other applicable permits.

1. Execution

The Contractor shall conduct all mobilization operations in a timely, orderly manner. Unless otherwise approved by the Engineer, mobilization operations shall commence no later than one week after the notice to proceed. Demobilization shall be finished within two weeks after substantial project completion.

During all operations, the Contractor is responsible for maintaining public and private property in original condition. Damage to existing roadways and roadway shoulders shall be repaired to the satisfaction of the Engineer at the Contractors expense.

Measurement and Payment-Mobilization (Section 6.2)

Mobilization shall be measured and paid on a lump sum basis (L.S.) for the entire project. 50% of contract unit price shall be paid at the first billing. The remaining 50% of the contract unit price shall be paid at project completion.

A Contractor is eligible for a separate mobilization payment when the Contractor is required to discontinue work by the Corporation for reasons other than seasonal termination of work. The payment shall be payment in full for supply of all necessary labor, equipment, and materials to perform mobilization operations herein described and all work in this specification. The payment shall be commensurate to the amount of equipment and materials that are required to be removed from the project site and that payment shall not exceed the original unit price specified for mobilization.

6-C Site Preparation Description

This specification shall cover the supply of all labor, materials, and equipment required for clearing and grubbing the site as well as topsoil excavation, stockpiling and replacement.

Scope of Work

Clearing, grubbing, and stripping for levee base, and excavation areas.
Demolition.

2. Clearing

Clearing shall consist removing, and disposal of all trees, logs, stumps, rocks, stones larger than 12 inches in any dimension, broken concrete or other pavement, abandoned cars and parts, and rubbish within designated earthwork areas.

Items and rubbish shall become the property of the Contractor and be removed from the project site.

3. **Grubbing**

Grubbing shall consist of the complete removal of stumps including all roots 1.5 inches or greater in diameter, brush, grass, or weeds. Stumps shall be grubbed to a depth of 3 ft below natural ground. Brush, grass, weeds, and similar materials shall be grubbed to a minimum depth of 12 inches below natural ground. Grubbed material shall be disposed adjacent to the excavation as directed by the Engineer.

4. **Demolition**

Demolition and removal consists of removal of abandoned footings, slabs, and other structures found on Job site. All materials removed shall be buried at least three feet deep at a location designated by the Engineer. All Excavations caused by removal of existing material shall be backfilled in accordance with Section 2200, Earthwork.

5. **Stripping**

Stripping shall consist of the complete removal of all earth materials contaminated by organics. The Contractor shall strip all such materials regardless of the depth of material encountered to the satisfaction of the Engineer.

Stripping shall be done below each levee footprint . The intent of stripping is to eliminate organic materials from borrow materials for subsequent levee fill and to secure topsoil for respreading throughout the project site. Stripping containing large amounts of pickleweed shall not be respread on levee side slopes, or pond bottoms. This material may be deposited on the adjacent landfill area, as shown on the plans.

All stripped materials shall be stockpiled and respread in 4-6 inch lifts as directed by the Engineer. The contractor shall coordinate stockpiles and respreading activities on nearby and more distant areas of the project site as directed by the Engineer. Priorities for respreading of stripping materials are as follows:

1. Levee side slopes
2. Pond bottoms.

Stripping to a depth of six inches is assumed for payment purposes for all work regardless of the depth actually stripped.

6. **Protection**

The Contractor shall provide protection devices including barricades, fencing, warning signs, lights, and other devices necessary to ensure the security of and safety within the project site during all aspects of the work.

7. **Temporary Roads/Stream Crossings**

Temporary roads shall be removed and left in a condition satisfactory to the Engineer upon completion of the project. Stream crossings shall conform to state and local codes.

8. **Control of surface/subsurface water**

The Contractor is responsible for control of surface water, subsurface water and drainage during the construction period. All temporary fills, crossings, or culverts necessary to promote drainage will be installed and removed at the Contractor's expense prior to acceptance of the work. Any claims arising from upstream or downstream damages as a result of the construction or failure of these temporary works will be the Contractors responsibility. The discharge from dewatering operations shall be approved by the engineer before dewatering operations begin.

Measurement and Payment-Stripping, Grubbing, And Clearing (Section 6.3)

Bid and payment quantities for stripping shall be paid on a cubic yard (CY) basis for as determined from the plans. Stripping to a depth of 6 inches is assumed and no separate measurement for stripping shall be done in the field. Clearing and grubbing operations are paid on a lump sum (LS) basis. Temporary roads and crossings are to be considered incidental to the construction operation

6-D

Earthwork

The work shall include the supply of all labor, material and equipment required to complete the construction of pads, levees, and berms, as shown on the plans and as staked in the field.

Scope of Work

Construction of pad for water control structures.

Borrow area excavation.

Compacted embankment fill.

2. Inspection

The Contractor shall stop work and call for inspection at the following points of construction:

Upon discovery of major changes in soil composition during borrow and excavation operations.

After clear, grub, and stripping under levees.

After placement and compaction of water control structure aggregate base.

Prior to spreading topsoil over completed embankments.

3. Select Import Materials

The following select import materials are required where shown on the plans or specified:

Erosion protection rock

Erosion protection rock may be cobbles, river rock, or crushed rock and shall conform to the following:

Weight of Stone Percent	Smaller by Weight
50 lb	100
20	80-100
10	20-80
5	5-20
1	0-5

or as approved by the Engineer. All erosion protection rock shall be composed of hard, durable, sound pieces.

4. Executions

Clear, Grubbing, and Stripping

All excavation areas, levee sites, and facility areas as staked shall be cleared, grubbed, and stripped in accordance with Section 2100, Site Preparation.

Compacted Levee and Embankment Fills

Unless otherwise specified, all material shall be placed in loose lifts of not more than eight inch thickness and shall be compacted by suitable compaction equipment to a minimum of 90% of maximum density as determined by the Standard Proctor Method.

Embankment material excavated from ditches/borrows with tractor-scraper units shall be placed in successive layers across the entire width of the embankment. Each layer must be spread as deposited longitudinally along the embankment with each layer not exceeding eight inches in thickness. With the Engineer's approval the initial layer may be increased in thickness in wet areas to provide a working pad capable of supporting the hauling equipment. The embankment at all times must be maintained in a reasonably level condition and hauling equipment shall be directed over the full width of each layer to facilitate uniform compaction.

Where embankment material is excavated with bucket equipment, it shall be deposited into the embankment within reach of the equipment or hauled directly to the embankment site. To prevent levee failure, stockpiling on levees or berms will not be permitted. Materials shall be placed and

spread in layers with each layer after spreading not to exceed eight inches in thickness.

All embankment construction must be as continuous as possible and the fill maintained such that drainage is assured at all times.

Should fill settlement occur during the construction of the embankment and within seven days of substantial completion, and prior to acceptance of the work, additional material shall be placed and trimmed to achieve final grade by the Contractor at his own expense. After embankments have been constructed to grade, they shall be leveled and trimmed to conform with the lines, grades and cross-sections shown on the plans and/or as staked.

Whether shown on the plans or not, all embankments shall be constructed with a minimum 2% crown to facilitate drainage.

5. Trimming

The crest, side slopes and berms of fills and excavations shall be trimmed to conform to the lines and grades shown on the drawings. The crest shall be constructed within 0.1 foot of the elevation specified prior to acceptance of the work. Placement of stockpiled topsoil, erosion protection devices or materials, etc. shall be interpreted to occur above the stated design elevation on the plans unless otherwise indicated.

Measurement and Payment - Earthwork (Section 6.4)

Excavation from identified areas shall be measured and paid on a staked quantity basis (CY) by superimposing the staking notes on the original ground elevations and using the average end method of volume calculation. Large excavated areas shall be grid staked by the Engineer at 200' or smaller intervals. No separate measurement of excavation will be made where stated quantities are not available, payment will be made on plan quantities as reported on the bid sheets.

Compacted embankment fill shall be measured on a staked quantity basis (CY). The quantities shall be measured by superimposing the construction staking notes on the original ground elevations and using the average end method of volume calculation. No separate measurement of

placed embankment or excavation quantities shall be made. Where staked quantities are not available, payment shall be made based on plan quantities as reported on the bid sheets or as modified by change order. Quantity estimates based on staking shall only be done by the Engineer.

Excavation and backfill of control structures and culverts shall be considered incidental to the cost of those structures. Supply and placement of erosion control rock shall be measured and paid on a quantity installed basis (CY).

6-E Water Control Structures

The work of this section shall include the supply of all labor, materials, and equipment required to complete the installation of the water control structures as called for on the drawings and/or specified herein.

1. Inspection

The Contractor shall stop work and request inspection prior to placement of risers, gates, or pipe to allow inspection of the excavation and foundation material.

2. Quality Control

All workmanship and materials furnished and supplied under this specification are subject to close and systematic inspection and testing by the Engineer including all operations from the selection and production of materials through to final acceptance of the specified work. The Contractor shall be wholly responsible for the control of all operations incidental thereto notwithstanding any inspection or approval that may have been previously given. The Engineer reserves the right to reject any materials or works which are not in accordance with the requirements of this specification.

The Engineer shall be afforded full access for the inspection and control testing of materials, both at the site of work and at any plant or borrow pit used for the supply of the materials, to determine whether the materials are being supplied in accordance with this specification.

3. Materials

Half round flashboard riser

Water control structures shall be manufactured using 12 gauge aluminum corragagated pipe, conforming specification 2.04, CULVERT PIPE. Each riser shall have an enclosed 1 foot extension below the culvert invert which will be filled with concrete to add weight to counteract floatation. Concrete ballast shall be considered incidental to riser installation and no separate payment shall be made for the concrete.

An aluminum brace shall be placed across the top of the half round riser in such a position that it will not interfere with placing or removing the flashboards. A 3/16 plate or molded plate channel shall two inches by two inches (2@x2@) in dimension shall be attached to each side of the riser for the entire length above the one foot extension. The channel will be placed so that 2x4 or 2x6 flashboards will slide down the channels so that the bottom of the lowest board will be 2 inches lower than the invert of the outlet pipe. A bottom channel will be aligned with the upright channels to provide a relatively watertight seal and provide a base for the bottom flashboard to rest upon. All channels shall be shop fabricated and welded to the half round riser. All welds between the channels and the riser and between the riser and the stub shall be continuous and watertight.

Full round riser

Water control structures shall be manufactured using 12 gauge aluminum corragagated pipe, conforming specification 2.03, CULVERT PIPE. Riser shall be fabricated according to the plans, using welding methods and channels as specified in 2.01 HALF ROUND FLASHBOARD RISER.

Appurtenances

The Contractor shall supply all couplers, nuts, bolts, stoplog channels, sealants, and all accessories recommended by the material manufacturer or necessary for a complete installation. All pipe and materials shall be new (not used) except where salvaged materials are specified on the plans. Materials supplied may be subject to inspection and tests by the Engineer or his representative.

Culvert Pipe

The pipe shall meet the composition requirements of ASTM B745 and shall be of the length shown on the plans or determined in the field. All pipe shall be made of 12 gauge aluminum. All

corrugated aluminum pipe shall be close riveted (annular) or of a "lock seam" (helical) construction. Unless otherwise specified all corrugated metal pipe shall be supplied with 2-2/3 in by 1/2 in corrugations .

If annular pipe is used then connections of the same gauge as the pipe shall be made using a minimum one foot wide annular watertight overlapping connection band. If helical pipe is used then a minimum of four corrugations shall be reformed into annular corrugations to allow the use of wide watertight annular overlapping connecting bands of the same gauge and material as the pipe.

Wood Stoplogs

Wooden stoplogs shall be kiln dried redwood or Douglas Fir 2x6's without knots or knotholes. Each board will be cut to fit individual structures allowing a 3/8 inch clearance on each end for swelling when wet. A complete set of boards shall be supplied for each structure.

Slide Gate Valves

Gate valves shall be aluminum spigot backed units, with short stems, as manufactured by Waterman industries, model AC-9. All fasteners associated with the slide gates shall be stainless steel.

Flap Gate Valves

Aluminum flap gate shall be spigot back type AF-41 as supplied by Waterman industries, or approved equivalent. The gate shall be sized to fit pipe specified, and have a latching mechanism to hold the gate in the closed position. All fasteners associated with the Flap Gate valve shall be made of stainless steel.

Fish Screens

Stainless steel fish screens shall be installed according to the plans, and will be supplied by DU.

Sacrificial Anode

A 10 lb block of zinc shall be connected to each water control structure. The block shall be buried

at least 1 foot to maximize contact with soil/water. A connection between the block and the structure shall be made by means of a 1/4 inch steel cable and steel bolts. The connections shall be made so that the cable is above ground, and can be inspected visually, and will not interfere with operation of the flap gate, flashboard riser, or slide gate valve. The connection shall not be made through the wall of culvert pipe, or in a manner that may cause water leakage.

Coatings

No coatings are specified for water control structures.

4. Execution

Handling and Storage of Materials

All materials shall be handled and stored in careful and workmanlike manner to the satisfaction of the Engineer.

Any damage from storage or handling during transportation or installation shall not be allowed. The Contractor shall be responsible for replacement and reinstallation of the damaged materials at own expense.

Welding, drilling, bolting or otherwise attaching devises (temporary or permanent) to the structure to assist in structure installation is prohibited without prior approval from the Engineer.

Unsuitable Material

If in the opinion of the Engineer, the site excavated material is unsuitable for backfill, the Contractor shall supply, from an assigned borrow area, suitable impervious backfill material. The payment for supplying this impervious fill shall be considered incidental to the water control structure installation.

Excavation

Base excavation shall extend three feet beyond the ends and one foot beyond the sides of the pipe, or pipes, and the excavation shall be transitioned to meet the existing channel slopes. If necessary, the excavation shall be dewatered in order to prevent disturbing the natural soil conditions at the base of the excavation and to allow the placing and compacting of the backfill material.

The Contractor will be required to excavate the base to the lines of excavation and to a depth of approximately the spring line of the pipe. The Contractor shall compact the in-situ material at the bottom of the excavation to 90% of Standard Proctor prior to excavation of the support trench. The resulting bed shall be fully leveled and compacted throughout the full width and length of the trench and to the exact grade as specified. The contractor shall then excavate a support trench to conform with the bottom 1/3 to 1/2 of the pipe shape to the depth of the pipe invert. The support trench shall be excavated so that at least the lower 1/3 of the barrel of the pipe shall be uniformly and evenly supported throughout its entire length on compacted or undisturbed fill. The installation shall only be accepted if at least the bottom 1/3 of the pipe is placed on compacted or undisturbed soil.

The Contractor shall not over-excavate below specified lines and grades. If, in the opinion of the Engineer, the Contractor over-excavates material in an area, he shall replace at his expense the over-excavated material with suitable site material and compact that material to a density equal to the surrounding in-situ material, or to 90% of standard Proctor whichever is greater.

Assembly of Pipe

The Contractor, after preparation of the bed, shall assemble the pipe in strict accordance with the manufacturer's instructions. All pipe supplied to site shall be inspected prior to assembly for chipping or damage in handling and shall be repaired as directed by the Engineer. All materials damaged, distorted by more than 5 percent of nominal dimensions, lost, broken or deemed unsuitable due to the Contractor's method of installation, handling or from neglect shall be replaced by the Contractor at his expense.

Initial Backfill

Initial backfill shall be deposited in horizontal, uniform layers not exceeding 6 inches in thickness before compaction, and each layer shall be thoroughly compacted throughout to ensure thorough tamping of backfill under the haunches and around the pipe. This is to be achieved by hand and mechanical compaction, to a density of at least 90% of standard proctor. Compacted backfill shall be placed in this manner and shall extend to a depth of 1-1/2 feet above the top of the pipe for the entire width of the trench. Vehicles shall not be permitted to cross the pipe until initial backfill is completed.

No boulders, rock, organic material, or debris shall be permitted in the trench. This material will be classified as unsuitable material and treated as such. Compaction equipment or methods that produce horizontal or vertical earth pressures which may cause excessive displacements or which may damage the installation shall not be used.

Final Backfill

After initial backfilling has been completed, the remaining backfill, consisting of suitable site material, shall be placed in layers not exceeding 8 inches before compaction. Each layer shall be compacted by mechanical means to a density equivalent to that of the surrounding unexcavated material.

No boulders, rock, organic material, or debris shall be permitted in the trench. This material will be classified as unsuitable material and treated as such. Compaction equipment or methods that produce horizontal or vertical earth pressures which may cause excessive displacements or which may damage the installation, shall not be used.

Backfill shall be executed to the lines and grades shown on the plans and as specified herein.

Placement of Erosion Rock

One ton of erosion rock shall be evenly spread at the outlet end of each water control structure and flap gate valve. The erosion rock shall not interfere with the operation of the structures.

Measurement and Payment - Materials (Section 6.5)

Flashboard riser and flap gate installation shall be measured and paid on an individual basis (EA). Poly pipe will be paid on a per foot basis (LF) for attached culvert pipe (excluding the 4' stub for the riser structure).

6-F Fence Construction

Fence construction will consist of furnishing all labor, equipment, and materials needed for the installation of two types of fencing on the wetland boundary as designated by DU personnel.

Fence shall consist of woven wire field fence with two strands of barbwire, spaced on 6 inchcenters above field fence top strand. Fence ends and corners of steel posts as specified below; galvanized steel posts, fence securely anchored to posts with 9-gauge fence clips; wire must be stretched taunt.

1. Execution

The fence shall consist of the following materials:

TYPE 1 FENCING

One-half foot (1/2') minimum T-posts, hot-dipped galvanized, heavy duty anchor plates securely fastened to posts. Posts should be long enough to maintain a minimum of 60 inches above ground maximum spacing of 10 feet, while being anchored securely enough to exclude dogs, predators, and trespassers.

Corner posts shall require 4 inch dia. galvanized steel pipe, Schedule 40 posts spaced not more than 8 feet apart. Posts shall be 8 feet long with 6 feet above ground, set in concrete. Post holes shall be bored at least 12 inches in diameter, and 36 inches deep before setting the posts in 3000 psi concrete.

Steel pipe shall be securely capped on top with galvanized steel pipe caps.

Braces will be 1 1/2 inch galvanized steel pipe, Schedule 40, and shall be long enough to maintain

a 45 degree angle while securely anchored in concrete. A corner post and two braces will be installed wherever the fence deviates more than 30 degrees from its previous alignment, both horizontally and vertically.

Braces will be attached to corner post with rail end brace band of galvanized steel.

High quality, galvanized, woven wire graduated hinge joint field fence, Manufactured by National Wholesale # FT14548, *or equivalent, 48 inches height.*

Two twisted strands of galvanized 12 1/2-gauge steel wire with four-point round barbs of 14-gauge galvanized steel wire no more than 5 inches apart.

TYPE 2 FENCING

Type 2 fence areas indicated on the plans shall require 4 inch dia. galvanized steel pipe, Schedule 40 posts spaced not more than 8 feet apart. Posts shall be 9 feet long with sex foot ground, set in concrete. Post holes shall be bored at least 12 inches in diameter, and 36 inches deep before setting the posts in 3000 psi concrete.

Braces will be 1 1/2 inch galvanized steel pipe, Schedule 40, and shall be long enough to maintain a 45 degree angle while securely anchored in concrete. Two braces will be installed wherever the fence deviates more than 30 degrees from its previous alignment, both horizontally and vertically.

Corner posts shall be identical to other 4 inch dia. Type 2 posts mentioned above.

Woven wire shall be same type as used on Type 1 fence, except it shall be 60 inches high.

Barb wire shall be same as for Type 1 fence, and must be attached to the top oft the posts by drilling or other means to prevent vertical slipping on post.

A 1/2 inch steel cable shall be run through holes in the 4 inch fence posts, 24 inch above the

ground, to prevent vehicles from forcing through the fence wire. The cable shall be spliced with suitable cable clamps where necessary, and clamped or crimped at every other post. The cable shall be anchored to the ground at corner post locations with a suitable tension anchor, set in at least 2 CF of 3000 psi concrete.

2. Gate

Gate shall be constructed according to the plans, using galvanized schedule 40 pipe, with all welds and cuts treated with cold-galvanizing agent. Fencing fabric and barbed-wire identical to Type 2 fencing shall be used. A chain lock shall be provided for the gate. In addition to the gate, the 1/2@ galvanized steel cable used on the Type 2 fence shall continue in front of the gate, and have suitable fasteners provided for a lock at one end of the gate opening.

Measurement and Payment (Section 6.6)

Fence construction shall be measured on a linear foot (LF) basis for the entire project. Gate shall be paid for on a Lump Sum (LS) basis. Fence and gate shall be paid for at the unit price, for supplying all materials, equipment, labor and any incidental items necessary for performing all operations specified.

7. SUMMARY OF IMPACTS AND MITIGATION MEASURES

7-A. Hydrology

Pouhala Marsh is a remnant wetland of a much larger site that was created as a delta of Waikele and Kapakahi streams. Today Waikele Stream continues to supply the marsh with freshwater. Kapakahi Stream is cut off from the wetland by a dike. Daily tidal waters affect surface water of Pouhala Marsh. Ground water is complex. It appears there are no artesian springs and that ground water is fairly stable through time. The project will use the existing hydrology as a means to manage the site. Existing hydrologic processes will be re-established to 8 acres of filled wetland. Re-establishing a hydrologic connection between Kapakahi Stream and the wetland is being sought under this project. No other impacts to hydrology will occur.

7-B. Water Quality

We found no evidence of polluted waters in the project area. Kapakahi Stream was sampled to determine if diverting water would be feasible from a water quality stand-point. Our findings show that there are no contaminants in the system, and despite illegally dumped trash, Kapakahi Stream's water remains unpolluted. There should be no impact of bringing water from the stream into the marsh on a limited basis. Water quality will not be impacted from excavation procedures. A silt barrier will be erected to eliminate silt from the temporary fill needed to bridge Kapakahi Stream. The fill will be removed upon completion of the project. Best management practices to prevent erosion of sediment into the stream and to prevent construction materials and debris from entering the stream will be implemented. The restoration will take place during periods of minimal rainfall [summer and early fall months (June -October)] to further minimize impacts to the aquatic environment. No long-term impacts to Kapakahi Stream or its fauna are anticipated from these actions.

7-C. Soils

The marsh has classic coastal wetland soil characteristics combining silty-clay material with organic soils, the latter a result of deposition through time. The soil of the land fill area (fill proposed for removal) was classified as non-hazardous homogeneous silty clay. It has been determined that the fill could be used as clean fill or cover material offsite. Numerous waste sites persist in the marsh from illegal dumping activities. The removal of all debris will be undertaken, and the material will be properly disposed. Fencing will limit future illegal dumping in the wetland.

7-D. Vegetation

Wetland communities were mapped based on dominant species. The site is typically overgrown with pickleweed and mangrove. Some open salt flats occur that are free of vegetation. Small patches of Kaluha Sedgeland (native wetland associates) occur where water is less brackish. These sites will be avoided during restoration activities. Upland plant associations at the project site are typical of lowland sites on Oahu. There are no state or federally listed endangered, threatened or rare plant species in the wetland. Furthermore, restoration activities will not impact native ecosystems.

7-E. Wildlife

The wetland is home to three federally listed endangered bird species, Hawaiian Stilt, Hawaiian Moorhen, and Hawaiian Duck. Hawaiian Stilt and Hawaiian Duck have nested at the site. The wetland enhancements are intended to improve situations for all three species. The Hawaiian Moorhen inhabits Kaluha Sedgelands that will not be impacted from the restoration activities; thus, no impacts to moorhen will occur. Removal of fill material will be undertaken when the marsh is mostly dry to minimize disturbance to stilts. Field crews will be under the direction of a biologist who will monitor endangered bird use and disturbance throughout the restoration phase of this project. The biologist will work with the site manager to make recommendations for halting work if required to minimize impacts to waterbirds. No endangered, threatened or sensitive species of arthropods or fish were

encountered in the wetland.

7-F. Archaeological Resources

A site assessment of the marsh shows that it was historically used as a series of fish ponds. Most or all fish pond walls are covered in silt or are farther west of the site. One wall is suspected and mapped as per this document. Removal of fill from a portion of the landfill area will require monitoring by an archaeologist. Once excavation reaches existing ground level, an archaeologist will attempt to locate the wall and direct field equipment to avoid excavation or driving over the wall. No other areas of concern were found, and other planned improvements are not anticipated to impact the area's archaeological resources. Nevertheless, an archaeologist with experience in identifying and documenting historic-period artifacts and architecture will monitor the project components that include shallow excavation of soils and removal of vegetation cover. In the unlikely event that historic sites are uncovered, we will halt construction temporarily at that site so that any significant archaeological materials can be documented in situ and any intact archaeological deposits can be avoided.

8. PERMIT REQUIREMENTS

The applicant for the project will be the Department of Land and Natural Resources, Division of Forestry and Wildlife. Federal, State, and City and County permits that are required prior to project initiation include:

Federal

Clean Water Act Section 404 Permit;

Section 401 Water Quality Certification (administered through the Hawaii Department of Health, Clean Water Branch); and

Coastal Zone Management Consistency Determination.

State

Special Management Area Use Permit;

Conservation District Use Permit; and

Stream Channel Alteration Permit and Stream Diversion Work Permit (Authorized by the Commission on Water Resource Management).

City and County of Honolulu

Clearing and Grading Permit.

9. ANTICIPATED DETERMINATION WITH SUPPORTING FINDINGS AND REASONS

The proposed project is not expected to cause significant impacts to the environment, pursuant to the significance criteria established by the Environmental Council (Hawaii Administrative Rules, Section 11-200-12) and discussed below; therefore, the determination is to issue a Finding of No Significant Impact.

The proposed project will not involve an irrevocable commitment to loss or destruction to any natural or cultural resources. The project site at Pouhala Marsh is characteristic of disturbed coastal wetlands in Hawaii with a high percentage of the site dominated by non-native species. Historic fish pond walls that may be buried at the site will be avoided during project construction.

The proposed project will not curtail the range of beneficial uses of the environment. The project will enhance the site for use by endangered Hawaiian waterbirds and migratory shorebirds.

The proposed project will not conflict with the State's long-term environmental policies. The proposed project will not conflict with the environmental policies set forth in the State Plan and Chapter 344, Hawaii Revised Statutes in that the project will not damage sensitive natural resources nor emit excessive noise or contaminants.

The proposed project will not substantially adversely affect the economic welfare, social welfare, or public health of the community. The proposed project is in accordance with the Waipahu Town Plan that shows Pouhala Marsh as a proposed wildlife sanctuary.

The proposed project will not involve substantial secondary impacts, such as population changes or

effects on public facilities. The project will not affect any existing public recreation facilities. Once restored, the project area may provide for educational viewing of wildlife resources. The project will not induce population growth.

The proposed project will not involve a substantial degradation of environmental quality. Construction impacts to air, water, or noise quality will be temporary and minimized by implementing best management practices. There will be no significant or long-term degradation of air, water, or noise quality.

The proposed project will not have cumulative impacts or involve a commitment for larger actions. All phases of the project have been described and assessed in this EA. In a regional context, the project will not have cumulative impacts.

The proposed project will not substantially affect any rate, threatened, or endangered species of flora or fauna or habitat. No protected species of flora are known from the project site. The project site is home to three endangered species of Hawaiian waterbirds that will benefit from project implementation.

The proposed project will not substantially affect air or water quality or ambient noise levels. The proposed project will not produce any air emissions. Site work will be in accordance with grading permit conditions to minimize erosion, non-point source pollution, and dust. Noise during construction will be mitigated to acceptable levels through compliance with the Department of Health noise regulations.

The proposed project is not located in an environmentally sensitive area (e.g., flood plain, tsunami zone, coastal area). Although the site is located in a Special Management Area, the proposed project for restoration of the marsh is in accordance with the special area plan developed for Waipahu Town. The restoration project is also in accordance with the zoning of the area as preservation lands.

The proposed project will not substantially affect scenic vistas and view planes identified in county or state plans or studies. The project will not affect any of the listed sites or vistas for Oahu.

The proposed project will not require substantial energy consumption. Energy consumption will be limited to project construction and occasional land management activities required to maintain the restored marsh.

10. LIST OF CONTACTS

10-A. Agencies and Organizations Contacted

U.S. Fish and Wildlife Service, USDI
U.S. Navy
Hawaii Department of Land and Natural Resources
Hawaii Division of Forestry and Wildlife
Hawaii Division of Aquatic Resources
Hawaii Division of Historic Preservation
Hawaii Division of Lands
City and County of Honolulu Planning Department
Ducks Unlimited, Inc.
Bishop Museum
Chevron Inc.
Waipahu Public Library
Office of Environmental Quality Control
Hawaii Commission on Water Resource Management
Hawaii Community Planning Branch
Pat Tummons
Hawaii Department of Transportation Airports
Hawaii Department of Land Utilization

10-B. Landowners Contacted

Victorino S. and Josefina D. Abel
John G. and Leilani N. Acain
Isabelo and Irene Acosta Sr.
Pedro M. Agcanas II
Avelino O. Almogela
Ernesto O. and Priscilla Almogela
Marie J. Alavardo
Kapeka K. Baker Estate
Fedaldo M. Banda
Beneficial Hawaii Inc.
Gaudencio R. and Norma C. Betiong
Mateo L. and Lina Binabise
William P. and Venetia Birgado Jr.
Felix G. and Matilde P. Bonilla
William D. and Amelia C. Bulosan
Dionisio and Rosenda Casintahan
David J. and Narcisa A. Caspie Sr.
Lourdes B. Castillo
Alvin K. H. Chee
Julien A. Cooper
Romeo B. and Malou Dadiz

Johnny D. Dahilig
Irineo D. C. and Belen D. C. Deuz
German A. and Floral Domingo
Jimmy A. and Meriann I. Domingo
Mefflin M. Dumlao
First Samoan Congregational
Kathy N. Fukumoto
GE Capital Hawaii Inc.
Crispulo A. and Marletta Geronimo
Charles Herring
Penisimani Holakeituai
Duane F. and Mae K. Hong
Isobe Enterprises Inc.
JLP Robinson Ltd. Partnership
Sarah Kaaiahua
Lopeti and Meleseini Kasell
Viliami and Ema Kauvaka
Samuel A, and Feledelfa Labajo
Pedro and Linda Languita
Pedro A. and Lydia A. Macadangdang
Felix A. Mencenido
Sione Manupule
Simeon J. and Laura A. Mariano
Mark A. Robinson Trusts
Kauasi V. and Mele F. Mataele
Opetaia T. and Tausaga Matavao
Crispin M. and Lilia T. Montalla
Kuiee Napahuela Estate
Helen E. Napoleon
Antonio C. and Clarita Navarrete
Tuione and Fotui Ngata
George P. Norva
Benedict N. and Rosalinda I. Opaon
Rodolfo A. and Erlinda C. Pacariem
George M. Pacheco
Balbino M. and Mercedita Padilla
Caesar and Noelani A. Paet
Rudy V. and Clarita B. Pagulayan
Noel C. and Benita Paudan-Mencias
Mikaele and Akanesi Petelo
Melecio B. and Florence M. Plan
Soane Poso'a
Gregoria A. Powers
Orlando and Deodina Ramos
Maxie M. and Josephine B. Raquedan

Avelino A. and Pacita B. Raymondo
Victor A. and Annabelle B. Riel
Susan J. Sahara
Tahi and Avefua Siale
Konokono Soakai
Alfonso P. and Adela M. Sonson
Pabliot and Elina T. Sumaoang
Fermina Tiqui
Mauro T. Tivera
Crispin L. and Maria T. Tomas
Samuel L. and I. Tuikolongahau
Guillermo B. and Fe T. Tumaneng
Jack H. Ujimori Trust
Elipidio D. and Buena G. Viado
Felix T. and Leonida Yagin
Kim Ping Yee
Rolando V. and Trinidad G. Zamora
Priscila C. Zampaga

11. Appendix

11-A: Comment Letters and Responses

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STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

September 5, 1997

MEMORANDUM

LOG NO: 20003 ✓
DOC NO: 9709RC01

TO: Paul Conry, Acting Administrator
Division of Forestry and Wildlife

FROM: Don Hibbard, Administrator
State Historic Preservation Division

SUBJECT: **Enhancement Plan for Pouhala Marsh, O'ahu (DLNR, U.S. Fish & Wildlife, Ducks Unlimited, City & County of Honolulu)**
Waikele, 'Ewa, O'ahu

We do have concerns with this project as it is planned at present. We do believe that it is likely that significant historic sites are present, and we do not agree with the proposed mitigation. We suggest an alternative approach that will protect and restore the significant historic sites as well as create wildlife habitat for birds.

Because this is partly a State undertaking, compliance with Chapter 6E-8, HRS, is required, essentially obtaining our approval of the project. Additionally, because there is federal involvement -- the U.S. Fish & Wildlife Service -- compliance with the National Historic Preservation Act is required. Similar processes of review and compliance are required for both laws.

First, we urge caution of this project being thought of as a restoration of wetlands, if wetlands are being thought of in the context of restoring a marsh. Probably for the better part of 1,000 years -- from the A.D. 900s or so until the 1800s -- the project area was not a marsh. It included fishponds, shallow shore fisheries, and the edges of the tarolands of Waikele. It was not a marsh. It may have been a marsh before the 900s and gone back to a marsh after the fishponds and tarolands were abandoned.

Second, a study of the Mahele period land records identifying tarolands and fishponds was done a number of years ago, and we have a report of this study in our library, as well as

have the information on our GIS system. The reconnaissance study in the Draft EA does not clearly show what land uses were within your project area, based on historic records. Much of that report contains information on which chiefs the 'ili lands were awarded to, which is largely irrelevant to land use. There is no map showing clearly the 1889 map with the project overlay or a review of the commoner LCA's along the north fringe which identify this fringe as tarolands. The historic information in the EA's report could be vastly reduced and should focus on land use, with readable maps and a clear analysis of the records on the fringe area. (A key map, Fig. 4-6, fails to clearly show the fishpond borders which are quite legible on the 1889 map.) The Mahele records and the 1889 monarchy period map clearly show that much of your project area west of the stream labelled "mauka wetland" contained fishponds (with names given on the 1889 map and in the records -- many of them shown, not clearly, on Fig. 4-6 of the Draft EA), with its northern fringe containing some taro lo'i. The "makai wetland" was mostly nearshore waters.

These findings indicate to us that archaeological remains (walls, 'auwai, and field and pond soils/sediments) of the tarolands and fishponds should be present, unless there has been extensive land alteration that would have altered or destroyed their associated deposits. The Draft EA tends to suggest that while filling occurred in some areas, in general massive grading of the project area which would have removed archaeological soils/sediments has not occurred.

Additionally, the soil corings suggest deposits associated with fishponds and pre-fishpond deposits (silty sands with shell) in the fish pond areas and soils associated with irrigated taro cultivation (dark gray clays) near the former tarolands. There is no title page to the archaeological report, nor is there an evaluation of methods and we are uncertain who did the soils analyses. Nor were pollen analyses run on the soils to evaluate their archaeological nature. It appears that the conclusion that "no significant intact deposits" are present may be open to question. The soils collected need analysis by experts , or additional trenches or corings should be taken and the soils analyzed to accurately evaluate whether archaeological deposits are present. It seems highly likely to us that archaeological deposits associated with both fishponds and some taro fields are present, given the limited information presented in the Draft EA. We would appreciate clarification on how, and by whom, the soils were analyzed.

Also, the Draft EA report indicates that some fishpond walls may be present. Unfortunately, the study did not attempt to match known wall locations from the 1889 map to areas on the ground. We would suspect that many fishpond walls remain. The same may well be true of taro field walls and canals.

In sum, it appears to us that historic sites are likely to cover much of your project area --

mostly fishponds (with archaeological ruins in the form of walls and associated sediments) and tarolands on the northern fringe (with archaeological ruins in the form of soils and quite probably walls and canals). We believe that further analysis is needed to document the current status of these sites. Soils (those collected or new samples) need analysis by experts and pollen study. Better attempts to identify fishpond walls are needed (using old maps and trenches). This work would better establish the depth of deposits and the locations of walls. Dating is needed to establish the age of the deposits.

Nonetheless, it appears to us that, assuming these sites are present (which seems likely given current evidence), they are clearly eligible for inclusion on the National and Hawaii Registers of Historic Places -- or, in other words, they are significant. Waikele ahupua'a had one of the largest populations in 'Ewa, was a political residential area for some high chiefs, and had one of the largest taro floodplains, and plenty of fishponds. Very little is known about pre-European contact times for Waikele -- in contrast to Honouliuli to the west. Next to the Waiawa-Manana floodplain, the Waikele floodplain (including former fishpond areas) may be the largest remaining in 'Ewa. Its tarolands and fishponds are, thus, extremely important for their information content on the past (Criterion D of the registers) and for the information they contain on broad patterns of prehistory (Criterion A of the registers -- related to the permanent settlement of 'Ewa, the development of taro systems, the development of fishponds). Some of these fishponds, even if buried, may be excellent examples of their types (criterion C of the registers). And the fishponds collectively may have cultural significance to native Hawaiians (Criterion E of the Hawaii Register and a part of Criterion A of the National Register). In brief, it appears that these sites are likely to be significant for multiple criteria of the National and Hawaii Registers of Historic Places.

Your project clearly may have an adverse effect on these sites. It may well disturb and destroy deposits and walls.

Suitable mitigation is not archaeological monitoring of construction of the wildlife habitats. We believe that more survey work (as noted above) is needed before mitigation is even considered. This will clearly show what is present and how deep and give an idea of how many walls. However, if walls and deposits are present (which is likely) and recognizing that they are likely to be significant for multiple criteria, mitigation could take one of two forms -- salvage archaeology to recover information or preservation. We would like to suggest that perhaps restoration efforts could focus on two aims -- (1) creating a bird habitat and (2) restoring the fishponds (or at least starting to remove fill deposits, so the walls and shallow water are visible).

Clearly, this situation is more complicated that what your division probably envisioned. We would like to suggest that you meet further with some of our staff on this matter. Dr. Ross Cordy (our Branch Chief for Archaeology) and Dr. Sara Collins (our O'ahu Archaeologist) are our contacts for this project. Please feel free to contact Sara (587-0013) to arrange a meeting.

RC:jk

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BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

MICHAEL D. WILSON, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES

GILBERT COLOMA-AGARAN

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION DIVISION
LAND DIVISION
STATE PARKS
WATER AND LAND DEVELOPMENT

STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

January 15, 1998

MEMORANDUM

LOG NO: 20873
DOC NO: 9801SC06

TO: Michael Buck, Administrator
Division of Forestry and Wildlife

FROM: Don Hibbard, Administrator
Historic Preservation Division

SUBJECT: **Chapter 6E-8 Revised Historic Preservation Review of an Enhancement Plan for Pouhala Marsh, O'ahu**
Waikele, 'Ewa District, O'ahu
TMK: 9-3-001, portions of 9-3-002

We wish to provide a revised comment on the proposed enhancement plan prepared for Pouhala Marsh in Waikele, O'ahu. Previously, we expressed concerns about the potential "adverse effect" the proposed enhancement could have on significant historic sites known to be present in the Pouhala Marsh area (DOC NO: 9709RC01, dated September 5, 1997, Hibbard to Conry). In October 1997, Elaine Jourdane and Sara Collins of my staff made a field inspection of the Pouhala Marsh area in the company of representatives from the Division of Forestry and Wildlife (DOFAW) and the U.S. Fish and Wildlife Service (USFWS). We now wish to provide a revised review of the proposed undertaking.

At the site visit, the DOFAW and USFWS representatives indicated that, due to funding limitations, implementation of the enhancement plan is restricted to two actions at this time: (1) the removal of about 10 - 15 cm of recently deposited fill soils; (2) partial clearing of pickleweed (*Batis maritima*) growth which would result in soil removal down to similar depths since pickleweed has a shallow root mass. The significant historic sites are likely to be below the recently deposited fill and the soil accumulated around the pickleweed root masses in the water. In view of these facts, we can now state that implementation of these two steps in the proposed implementation plan will have "no effect" on significant historic sites.

However, our prior comments about likely significant historic sites in the marsh (fishponds and irrigated taro fields) are still relevant. The Draft EA does not mention these sites, and we believe the impact on them should be considered. While we can agree this project will have "no effect" to this site, the sites must be kept in mind for any future projects in this area -- notably those altering land surfaces.

Should you have any questions, please feel free to call Sara Collins at 587-0013.

SC:jk

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BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

MICHAEL D. WILSON
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCE

DEPUTY
GILBERT S. COLOMA-AGARAN

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

May 12, 1998

MEMORANDUM

To: Don Hibbard, Administrator
Historic Preservation Division

From: Michael Buck, Administrator
Division of Forestry and Wildlife

Subject: Final Environmental Assessment and Negative Declaration for the Pouhala Marsh Restoration Project, Oahu, Hawaii

Thank-you for reviewing and commenting on the Draft *Environmental Assessment and Enhancement Plan for Pouhala Marsh, Oahu, Hawaii* [Environmental Assessment (EA)]. We acknowledge your concern for potential historic sites in the marsh (fishponds and irrigated taro fields) and your determination that these sites are likely at depths below the fill material and soil that will be removed during this project-specific enhancement of the marsh. At this time, we have no plans to alter the landscape beyond what is described in the EA, and we do not anticipate that any historic fishpond walls or other historic artifacts that may be buried within the marsh will be exposed.

Nevertheless, an archaeologist with experience in identifying and documenting historic-period artifacts and architecture will monitor the project components that include shallow excavation of soil and clearing and removal of vegetation cover. In the unlikely event that historic sites are uncovered, we will halt construction temporarily so that any significant archaeological materials can be documented in situ and any intact archaeological deposits can be avoided. In addition, your office would be consulted for further recommendations at that time. This mitigation measure has been included in the EA to support a Negative Determination Finding for the project.

This memorandum confirms that all comments and concerns for the project have been addressed in the Final Environmental Assessment and a Negative Declaration Finding for the project will be filed with the Office of Environmental Quality Control (OEQC) for announcement in the OEQC Bulletin.

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SUSPENSE DATE: 8/26/97

STATE OF HAWAII
Department of Land and Natural Resources
DIVISION OF AQUATIC RESOURCES

75 / MEMORANDUM

TO: William Devick, Acting Administrator
FROM: Annette Tagawa, Aquatic Biologist
SUBJECT: *Comments on Draft Environmental Assessment*, File No.: NONE
Comments Requested By: Paul Conry, Acting Administrator, Division of Forestry & Wildlife
Date of Request 8/14/97 Date Received 8/18/97

Summary of Project

Title: **Enhancement Plan for Pouhala Marsh (DEA)**

Project By: **Department of Land and Natural Resources Division of Forestry and Wildlife, Oahu District**

Location: **Pouhala Marsh, Ewa District, Waipahu, Oahu TMK: 1-9-3-01, portions of 1-9-3-02**

Brief Description:

The applicant proposes to secure and restore nearly 70 acres of wetlands in Pearl Harbor's West Loch area. Restoration activities include 1) enhancement of 20 acres of existing wetland basins by clearing vegetation, sculpting basins, and removing obstructions, 2) cleaning the marsh of debris and trash, 3) fencing 70-acres to exclude humans, vehicles and predators, 4) restoring 8 acres of shallow ponds through removal of 66,000 cu. yds. of fill, 5) construction of temporary haul roads and stream crossing, 6) creation of a hydrologic link from Kapakahi Stream to the 8-acre ponds, and 7) reintroduction of damselfly naiads.

Comments:

The Division has no objections to this request since the proposed project is not expected to have significant long-term adverse impact on aquatic resource values in this area. However, the Division is concerned since the project area is bordered by Waikele and Kapakahi Streams, and is adjacent to nearshore waters in Pearl Harbor. Of particular concern to the Division are those activities involved with the construction of a temporary stream crossing over Kapakahi Stream and the creation of an entrance through the west side berm of Kapakahi Stream to establish a hydrologic link from the stream to the 8-acre damselfly ponds. Kapakahi Stream is known to harbor a number of exotic freshwater fauna and possibly a few native species as well. Clearing and construction activities could have short-term impacts on aquatic resources such as temporary turbidity, biota displacement and disturbance.

In regard to using fish screens to prevent predator fish from entering the 8-acre damselfly habitat, we feel that this may be impractical to implement. The stainless steel screens with a mesh size of 3/32" will quickly clog with material and will have to be changed more than once a day. In addition, the screens will not prevent tilapia or any other aquatic predator(s) from entering the damselfly ponds during times of flood. However, we are aware that this habitat is important for the damselfly species and realize that some barrier must exist to exclude predator fish. We suggest the applicant explore other alternatives for this purpose.

The timing of construction activities during periods of minimal rainfall would minimize erosion and siltation during construction and prevent excessive impact to aquatic resource values. In addition, lands denuded of vegetation should be replanted or covered as quickly as possible to control erosion. The applicant should also take mitigative measures to prevent construction materials, sediment, petroleum products, and debris from entering into the aquatic environment.

cc: Dean Uchida, Administrator
Land Division

0000 0022 25 15

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

May 12, 1998

MEMORANDUM

To: William Devick, Acting Administrator
Division of Aquatic Resources

From: Michael Buck, Administrator
Division of Forestry and Wildlife

Subject: Final Environmental Assessment and Negative Declaration for the Pouhala Marsh Restoration Project, Oahu, Hawaii

Thank-you for reviewing and commenting on the Draft *Environmental Assessment and Enhancement Plan for Pouhala Marsh, Oahu, Hawaii* [Environmental Assessment (EA)]. Your comments concerning the potential for short-term impacts to Kapakahi Stream and its native fauna have been incorporated into the Final EA for the project. The suggested mitigation measures to prevent erosion and siltation during construction and to prevent construction materials and debris from entering the aquatic environment have also been incorporated into the Final EA and will be implemented during construction. We continue to explore alternate fish screen devices. Additional input from your staff will be sought prior to the final decision on a method to prevent predator fish from entering the created damselfly habitat and the 8-acre restored wetland habitat.

This letter confirms that all comments and concerns for the project have been addressed in the Final Environmental Assessment and a Negative Declaration Finding for the project will be filed with the Office of Environmental Quality Control (OEQC) for announcement in the OEQC Bulletin.

0000 0022 25 16

DEPARTMENT OF LAND UTILIZATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 7TH FLOOR • HONOLULU, HAWAII 96813
PHONE: (808) 523-4414 • FAX: (808) 527-6743

JEREMY HARRIS
MAYOR

JAN NAOE SULLIVAN
DIRECTOR

LORETTA K.C. CHEE
DEPUTY DIRECTOR

97-05835(ST)
'97 EA Comments Zone 9

September 8, 1997

Mr. Michael G. Buck, Administrator
Division of Forestry and Wildlife
Department of Land and
Natural Resources
State of Hawaii
Kalanimoku Building
1151 Punchbowl Street
Honolulu, Hawaii 96813

Dear Mr. Buck:

Environmental and Enhancement Plan for Pouhala Marsh
West Loch, Pearl Harbor, Oahu
Tax Map Keys: 9-3-01 and 9-3-02

We have reviewed the above document transmitted by your letter dated August 14, 1997, and find that there are a number of modifications/additions which should made in order for it to be utilized as a Final Environmental Assessment (FEA) pursuant to the State's Environmental Impact Statement regulations, Title 11, Chapter 200, Hawaii Administrative Rules (HAR) and Chapter 343, Hawaii Revised Statutes (HRS).

1. The document should clearly indicate which organization will be serving as the "applicant" and list all permits and approvals which this document is intended to support (i.e., SMA, CDUA, U.S. COE, 401, etc.).

2. Insofar as your *transmittal letter* indicates that a Special Management Area Use Permit (SMP) will be required, this document should include an exhibit illustrating the project area relative to the SMA boundaries.

3. Section 1-A, Project Overview, should include a discussion of the impacts, if any, of the significant recent, as well as planned urban developments occurring in the upstream mauka areas (ie. Waikele subdivisions and retail areas, Amfac's Waipahu Sugar Mill light industrial/commercial redevelopments, etc.).

4. Section 1-B should specify the owner of each Tax Map Key (TMK) parcel involved and include an exhibit illustrating the project boundaries relative to these TMK boundaries (i.e., overlay the project area on a tax map).

5. The document incorrectly states on pages 1 and 6 that "a(n) area of the landfill may be zoned urban, but this remains unclear on the zoning maps for the region". We suggest that the State Land Use Commission (SLUC) be contacted for a boundary interpretation of the State Land Use District Boundaries in this area.

6. Figure 2-1, Topography of Pouhala Marsh, is illegible. The FEA should include either a larger scaled version of this exhibit or a clearer reproduction.

7. Pursuant to Section 11-200-10(6) HAR, there should be a discussion of the alternative(s) which were considered.

8. Pursuant to Section 11-200-10(8) HAR, there should be an anticipated determination of significance and an accompanying list of the findings and reasons supporting this determination.

9. Pursuant to Section 11-200-10(3) HAR, there should be a list of all agencies and organizations to which this draft document was sent for comment.

Thank you for the opportunity to comment on this matter. We have no other comments to offer at this time.

Should you have any questions, please contact Steve Tagawa of our staff at 523-4817.

Very truly yours,

JAN NAOE SULLIVAN
Director of Land Utilization

JNS:am

g:ppd\705835.sht

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BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

MICHAEL D. WILSON
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY
GILBERT S. COLOMA-AGARAN

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

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

May 12, 1998

Ms. Jan Naoe Sullivan
Director of Land Utilization
City and County of Honolulu
650 South King Street, 7th Floor
Honolulu, Hawaii 96813

Re: Final Environmental Assessment and Negative Declaration for the Pouhala Marsh Restoration Project, Oahu, Hawaii

Dear Ms. Sullivan:

Thank-you for reviewing and commenting on the Draft *Environmental Assessment and Enhancement Plan for Pouhala Marsh, Oahu, Hawaii* [Environmental Assessment (EA)]. We have revised the EA for the project and have addressed your comments within the Final EA in the following manner.

The applicant for the project will be the Department of Land and Natural Resources, Division of Forestry and Wildlife. Federal, State, and City and County permits that are required prior to project initiation include:

Federal

Clean Water Act Section 404 Permit;
Section 401 Water Quality Certification (administered through the Hawaii Department of Health, Clean Water Branch); and
Coastal Zone Management Consistency Determination.

State

Special Management Area Use Permit;
Conservation District Use Permit; and
Stream Channel Alteration Permit and Stream Diversion Work Permit (Authorized by the Commission on Water Resource Management).

City and County of Honolulu

Clearing and Grading Permit.

Maps of the project area in relation to the TMK boundaries and the SMA boundaries have been included in the Final EA, as well as a clearer version of the topography map. The information on pages 1 and 6 regarding the zoning designation of the landfill area has been changed to reflect the State Land Use Commission's designation as Conservation District. A section on anticipated impacts and mitigation and a section with the required information to support a Negative Determination finding have been added. No other sites were evaluated for restoration since Pouhala Marsh represents the largest, contiguous area of the remaining wetland habitats in Pearl Harbor. The list of agencies and organizations contacted during the review process, comment letters, and responses to the comments are included in the Final EA.

This letter confirms that all comments and concerns for the project have been addressed in the Final Environmental Assessment and a Negative Declaration Finding will be filed with the Office of Environmental Quality Control (OEQC) for announcement in the OEQC Bulletin.

Sincerely yours,

MICHAEL G. BUCK
Administrator

0000 0022 2520

BENJAMIN J. CAYETANO
GOVERNOR

GARY GILL
DIRECTOR

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
235 SOUTH BERETANIA STREET
SUITE 702
HONOLULU, HAWAII 96813
TELEPHONE (808) 586-4185
FACSIMILE (808) 586-4186

August 12, 1997

Michael Buck, Administrator
Department of Land and Natural Resources
Division of Forestry & Wildlife
P.O. Box 621
Honolulu, Hawaii 96809

Attention: Paul Conry

Dear Mr. Buck:

Subject: Draft Environmental Assessment (EA) for Pouhala Marsh Restoration Project, Oahu

Please include the following in the FEA:

1. Agency and community contacts:
   a. Please contact the Army Corps of Engineers regarding proposed activities in these wetlands.
   b. Notify the nearest neighbors or neighboring landowners of the proposed project and document your contacts. Include copies of any correspondence in the final EA. Please do not submit your revised consultation list as a loose enclosure, but attach it to the body of the final EA.

2. Permits and approvals: Please indicate the status of permit applications for any activity in the Special Management Area and Shoreline Setback Area, and any other required permits and approvals.

3. Significance criteria: Please discuss the reasons, according to the significance criteria listed in HAR Title 11-200-12, that support the anticipated Finding of No Significant Impact (FONSI) determination. You may use the enclosed sample as a guideline.

If you have any questions, please call Nancy Heinrich at 586-4185.

Sincerely,

for GARY GILL
Director

Enc.

c: Andy Engilis, Ducks Unlimited

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BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

MICHAEL D. WILSON
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURC

DEPUTY
GILBERT S. COLOMA-AGARAN

AQUACULTURE DEVELOPMENT PROGRAM
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HISTORIC PRESERVATION
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT
WATER RESOURCE MANAGEMEN

May 12, 1998

Mr. Gary Gill
Director
Hawaii Office of Environmental and Quality Control
235 Beretania Street, Suite 702
Honolulu, Hawaii 96813

Re: Final Environmental Assessment and Negative Declaration for the Pouhala Marsh Restoration Project, Oahu, Hawaii

Dear Mr. Gill:

Thank-you for reviewing and commenting on the Draft *Environmental Assessment and Enhancement Plan for Pouhala Marsh, Oahu, Hawaii* [Environmental Assessment (EA)]. We have revised the EA and included information on the permit requirements for the project. A section on anticipated impacts and mitigation and a section with the information to support a Negative Determination Finding have been added. The list of adjacent landowners, agencies, and organizations contacted during the review process; comment letters; and responses to the comments are included in the Final EA.

This letter confirms that all comments and concerns for the project have been addressed in the Final Environmental Assessment. The Final Environmental Assessment and a Negative Declaration Finding for the project will be submitted to your agency for announcement in the OEQC Bulletin.

Sincerely yours,

MICHAEL G. BUCK
Administrator

0000 0022-2523

JUN-16-1998 10:45 P.01

IF HAWAII
ND NATURAL RESOURCES
LAND DIVISION
P.O. BOX 621
HONOLULU, HAWAII 96809

DEC - 3 1997

AQUACULTURE DEVELOPMENT PROGRAM
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HISTORIC PRESERVATION
LAND DIVISION
STATE PARKS
WATER RESOURCE MANAGEMENT

MEMORANDUM

File:Cor.97-138

TO: Paul Conry
DOFAW

FROM: Dean Uchida, Administrator
Land Division

SUBJECT: Draft Environmental Assessment and Enhancement Plan for Pouhala Marsh, Oahu

We reviewed the subject draft EA document and concur with your transmittal memo that a Conservation District Use Application (CDUA) will be required, since the project is located within the Conservation District (Protective Subzone). This fact, along with a relevant map, should be noted in a section of the document that describes the permit requirements for the project. The information required for a thorough CDUA analysis (i.e., a discussion of the criteria noted in Section 13-5-30(c), HAR) should also be included in the final EA for the project.

Thank you for the opportunity to comment on this project. Should you have additional questions, please contact our Planning Branch at 587-0386.

0000 0022 2524

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

MICHAEL D. WILSON
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCE

DEPUTY
GILBERT S. COLOMA-AGARAN

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

AQUACULTURE DEVELOPMENT PROGRAM
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HISTORIC PRESERVATION
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT
WATER RESOURCE MANAGEMENT

May 12, 1998

MEMORANDUM

To: Dean Uchida, Administrator
Land Division

From: Michael Buck, Administrator
Division of Forestry and Wildlife

Subject: Final Environmental Assessment and Negative Declaration for the Pouhala Marsh Restoration Project, Oahu, Hawaii

Thank-you for reviewing and commenting on the Draft *Environmental Assessment and Enhancement Plan for Pouhala Marsh, Oahu, Hawaii* [Environmental Assessment (EA)]. We have revised the EA and included information on the permit requirements for the project. A map indicating that the project is located within the Conservation District [Protective Subzone (P2)] is included in the Final EA. A section on anticipated impacts and mitigation and a section with the information to support the issuance of a Conservation District Use Permit and a Negative Determination Finding have been added.

This memorandum confirms that all comments and concerns for the project have been addressed in the Final Environmental Assessment and a Negative Declaration Finding will be filed with the Office of Environmental Quality Control (OEQC) for announcement in the OEQC Bulletin.

0000 0022 2525

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

MICHAEL D. WILSON
CHAIRPERSON

ROBERT G. GIRALD
DAVID A. NOBRIGA
LAWRENCE H. MIIKE
RICHARD H. COX
HERBERT M. RICHARDS, J.

RAE M. LOUI, P.E.
DEPUTY

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT
P. O. BOX 621
HONOLULU, HAWAII 96809

AUG 27 1997

TO: Mr. Paul Conry, Acting Administrator
Division of Forestry and Wildlife

FROM: Rae M. Loui, Deputy Director
Commission on Water Resource Management

SUBJECT: Draft Environmental Assessment and Enhancement Plan for Pouhala Marsh, Oahu

After reviewing the subject document, it appears that the project may require approvals from the Commission Water Resource Management.

Stream channel alteration permits are required when the bed or banks of streams are altered. (HRS §174C-71)

Stream diversion works permits are required when water is diverted from streams, or when diversion works structures are modified or abandoned. (HRS §174C-93)

Interim instream flow standards must be amended when stream flows are altered. (§13-169-49, HAR)

We will appreciate receiving more specific information on how the proposed project will affect Kapakahi Stream.

Thank you for allowing us to review the subject document. If you have any questions, please call David Higa at extension 70249.

DH:fc

0000 0022 2526

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

May 12, 1998

Mr. Edwin Sakoda
Acting Deputy Director
Commission on Water Resource Management
State of Hawaii
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Re: Final Environmental Assessment and Negative Declaration for the Pouhala Marsh Restoration Project, Oahu, Hawaii

Dear Mr. Sakoda: Ed.

This letter responds to comments by Ms. Rae Loui on the above referenced document. Thank-you and your staff for reviewing and commenting on the Draft *Environmental Assessment and Enhancement Plan for Pouhala Marsh, Oahu, Hawaii* [Environmental Assessment (EA)]. We acknowledge that creation of the damselfly habitat will require permits from the Commission on Water Resource Management (CWRM). Construction of the damselfly habitat will require placement of a flapgate along Kapakahi Stream, which will allow gravity flow of water from the stream into the damselfly habitat. The water will then either be discharged back into the stream or diverted into the 8-acre restored wetland.

A temporary crossing will be constructed over Kapakahi Stream to allow access to an adjacent disposal area on land owned by the City and County of Honolulu. This temporary stream crossing is necessary to facilitate disposal of fill material from the 8-acre restoration site. Two 48-inch culverts will be placed in the stream to maintain the hydrology of the stream and to allow fish and other aquatic species upstream passage. According to the Hawaii Division of Aquatic Resources, Kapakahi Stream harbors a number of exotic and possibly a few native aquatic species. These species may be negatively impacted during construction and placement of the fill material. These impacts will be temporary, and all fill material will be removed after the restoration of the 8-acre site is complete.

Best management practices to prevent erosion of sediment into the stream and to prevent construction materials and debris from entering the stream will be implemented. In addition, the restoration will take place during periods of minimal rainfall [summer and early fall months (June-October)] to further minimize impacts to the aquatic environment.

No long-term impacts to Kapahaki Stream or its fauna are anticipated from these actions. Permit applications from your agency have been received and will be forwarded to your office for review. This letter confirms that all comments and concerns for the project have been addressed in the Final Environmental Assessment and a Negative Declaration Finding will be filed with the Office of Environmental Quality Control (OEQC) for announcement in the OEQC Bulletin.

We look forward to working closely with your staff to ensure that all applicable CWRM permits are approved prior to initiation of the restoration project.

Sincerely yours,

MICHAEL G. BUCK
Administrator

0000 0022 2528

OVERSIZED DRAWING/MAP

PLEASE SEE 35MM ROLL

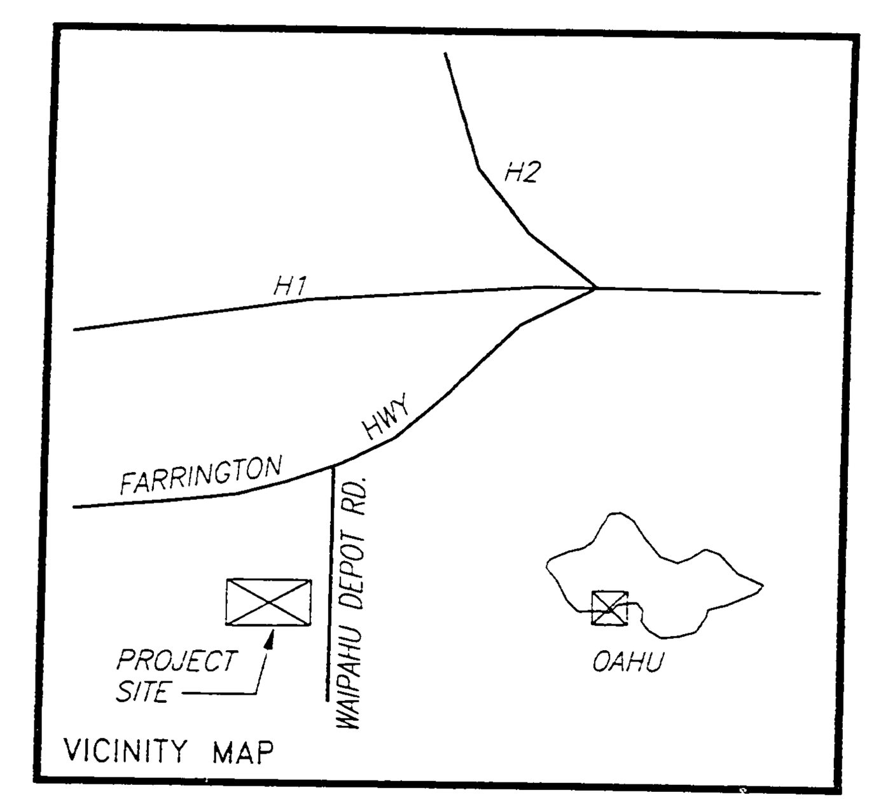
0008

PEARL HARBOR
POUHALA MARSH
DU-HI-0010-001

100% DESIGN

DUCKS UNLIMITED, INC.
3074 GOLD CANAL DRIVE
RANCHO, CORDOVA, CA. 95670-6116

Surveying By:
MILLER & ASSOCIATES



VICINITY MAP

ABBREVIATIONS

C-C	CENTER TO CENTER	N	NORTH
CMP	CORRUGATED METAL PIPE	NO	NUMBER, NORTH
DIA	DIAMETER	NTS	NOT TO SCALE
Dp	PIPE DIAMETER	OC	ON CENTER
Dr	RISER DIAMETER	PP	POWER POLE
DU	DUCKS UNLIMITED, INC	PSI	POUNDS PER SQUARE INCH
EL, ELEV	ELEVATION	PVC	POLYVYNYL CHLORIDE
EX	EXISTING	R	RIGHT
ID	INSIDE DIAMETER	RD	ROAD
IN	INCH, INCHES	REF	REFERENCE DIMENSION
IE	INVERT ELEVATION	REQD	REQUIRED
FB	FLASHBOARD	SCH	SCHEDULE
FT	FOOT, FEET	SO	SOUTH
FTG	FITTING	SP	SPECIAL
GA	GUAGE	STA	STATION
H	RISER HEIGHT	TE	TOP ELEVATION
L	LENGTH, LEFT	TYP	TYPICAL
LBF	POUNDS-FORCE	USA	UNDERGROUND SERVICE ALERT
LF	LINEAR FEET	VLV	VALVE
MAX	MAXIMUM	W	WIDTH
MIN	MINIMUM	WS	WATER SURFACE
MISC	MISCELLANEOUS	WWF	WELDED WIRE FABRIC

LEGEND

- NEW LEVEE
- SLIDE GATE
- HALF-ROUND FLASHBOARD RISER
- FISH SCREEN
- FLAP GATE
- INTAKE STRUCTURE SOUTH
- TYPE 1 FENCE
- TYPE 2 FENCE

SHEET INDEX

UNAUTHORIZED CHANGES & USES

CAUTION: The engineer preparing these plans will not be responsible for, or liable for, unauthorized changes to or uses of these plans. All changes to the plans must be in writing and must be approved by the preparer of these plans.

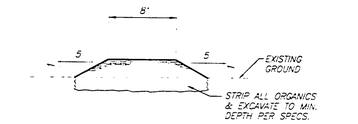
DUCKS UNLIMITED INC. WESTERN REGIONAL OFFICE	PROJECT NO DU-HI-0010-001		DESIGNED BY: PG
	PEARL HARBOR POUHALA MARSH		DRAWN BY: JC
			SURVEYED BY:
			CHECKED BY:
DATE: 3-3-97	SHEET NO 1 OF 3	APPROVED BY:	APPROVED BY:

0000 0022 2529

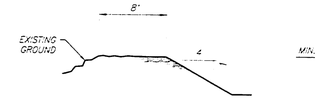
OVERSIZED DRAWING/MAP

PLEASE SEE 35MM ROLL

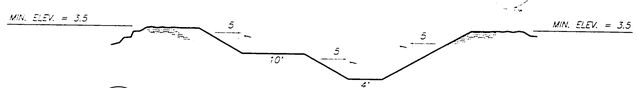
0009



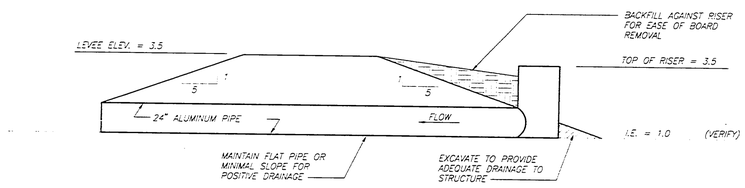
1/2 LEVEE SECTION, CONSTRUCTED FILL



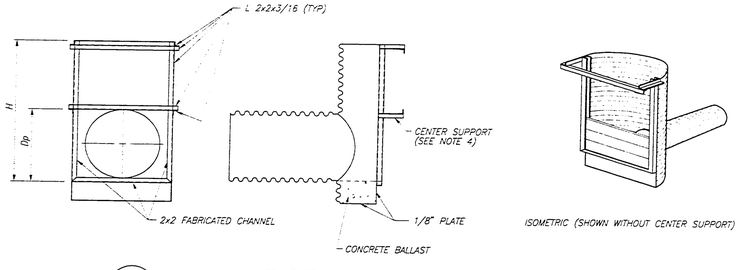
2/2 LEVEE SECTION, EXISTING FILL



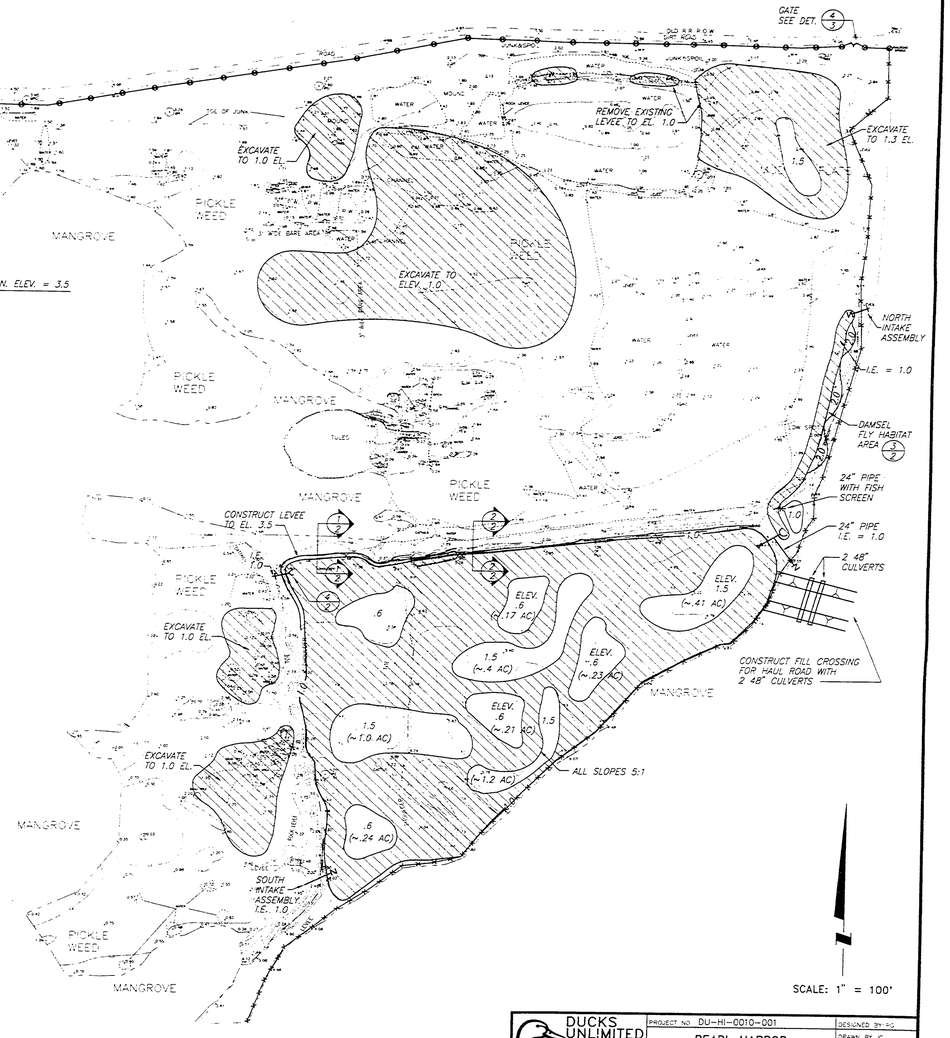
3/2 TYPICAL DAMSEL FLY HABITAT SECTION



4/2 SECTION @ WATER CONTROL STRUCTURE



5/2 ALUMINUM FLASHBOARD RISER



DUCKS UNLIMITED INC. WESTERN REGIONAL OFFICE	PROJECT NO. DU-HI-0010-001		DESIGNED BY: PG
	PEARL HARBOR POUHALA MARSH		DRAWN BY: JC
			SURVEYED BY: XX
			CHECKED BY: XX
DATE 3/3/97	SHEET NO 2 OF 3	APPROVED BY: X	APPROVED BY: X

D:\ACAD\PUHI0010-001\P001.SHT2 Thu Jun 18 13:54:24 1998

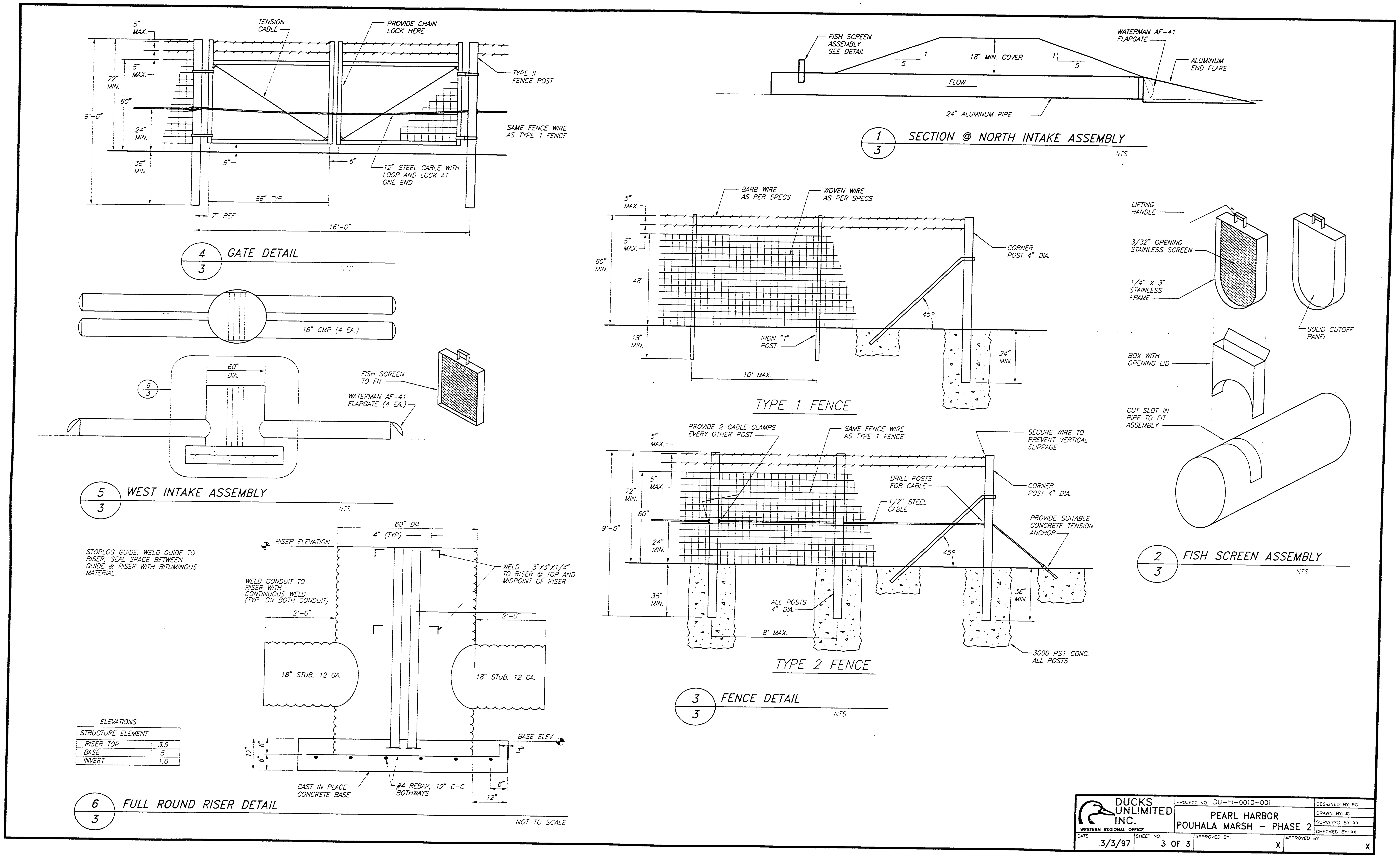
0004

0000, 0022 2530

OVERSIZED DRAWING/MAP

PLEASE SEE 35MM ROLL

0010



5" MAX.
TENSION CABLE
PROVIDE CHAIN LOCK HERE
TYPE II FENCE POST
72" MIN.
5" MAX.
60"
9'-0"
24" MIN.
36" MIN.
SAME FENCE WIRE AS TYPE 1 FENCE
6"
12" STEEL CABLE WITH LOOP AND LOCK AT ONE END
88" TYP.
7' REF.
16'-0"
4/3 GATE DETAIL
NTS
18" CMP (4 EA.)
60" DIA.
6/3
FISH SCREEN TO FIT
WATERMAN AF-41 FLAPGATE (4 EA.)
5/3 WEST INTAKE ASSEMBLY
NTS
STOPLOG GUIDE, WELD GUIDE TO RISER, SEAL SPACE BETWEEN GUIDE & RISER WITH BITUMINOUS MATERIAL.
RISER ELEVATION
60" DIA
4" (TYP)
WELD 3"X3"X1/4" TO RISER @ TOP AND MIDPOINT OF RISER
WELD CONDUIT TO RISER WITH CONTINUOUS WELD (TYP. ON BOTH CONDUIT)
2'-0"
18" STUB, 12 GA.
18" STUB, 12 GA.
ELEVATIONS
STRUCTURE ELEMENT
RISER TOP 3.5
BASE .5
INVERT 1.0
BASE ELEV
3"
12"
6"
CAST IN PLACE CONCRETE BASE
#4 REBAR, 12" C-C BOTHWAYS
6/3 FULL ROUND RISER DETAIL
NOT TO SCALE
FISH SCREEN ASSEMBLY SEE DETAIL
18" MIN. COVER
WATERMAN AF-41 FLAPGATE
ALUMINUM END FLARE
FLOW
24" ALUMINUM PIPE
1/3 SECTION @ NORTH INTAKE ASSEMBLY
NTS
BARB WIRE AS PER SPECS
WOVEN WIRE AS PER SPECS
CORNER POST 4" DIA.
60" MIN.
48"
45°
18" MIN.
IRON "T" POST
24" MIN.
10' MAX.
TYPE 1 FENCE
PROVIDE 2 CABLE CLAMPS EVERY OTHER POST
SAME FENCE WIRE AS TYPE 1 FENCE
SECURE WIRE TO PREVENT VERTICAL SLIPPAGE
DRILL POSTS FOR CABLE
1/2" STEEL CABLE
CORNER POST 4" DIA.
PROVIDE SUITABLE CONCRETE TENSION ANCHOR
ALL POSTS 4" DIA.
8' MAX.
3000 PSI CONC. ALL POSTS
TYPE 2 FENCE
3/3 FENCE DETAIL
NTS
LIFTING HANDLE
3/32" OPENING STAINLESS SCREEN
1/4" X 3" STAINLESS FRAME
SOLID CUTOFF PANEL
BOX WITH OPENING LID
CUT SLOT IN PIPE TO FIT ASSEMBLY
2/3 FISH SCREEN ASSEMBLY
NTS
DUCKS UNLIMITED INC.
WESTERN REGIONAL OFFICE
PROJECT NO. DU-HI-0010-001
PEARL HARBOR
POUHALA MARSH - PHASE 2
DESIGNED BY: PG
DRAWN BY: JC
SURVEYED BY: XX
CHECKED BY: XX
DATE: 3/3/97
SHEET NO. 3 OF 3
APPROVED BY: X
APPROVED BY: X

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