COPY

EXECUTIVE CHAMBERS

HONOLULU

GEORGE R. ARIYOSHI
GOVERNOR

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P/E

October 18, 1983

Mr. Roy R. Takemoto, Chairman
Environmental Quality Commission
550 Halekauwila Street, Room 301
Honolulu, Hawaii 96813

Dear Mr. Takemoto:

Subject: Revised Environmental Impact Statement for Kahana "315" Reservoir

Based upon the recommendation of the Office of Environmental Quality Control, I am pleased to accept the subject document as satisfactory fulfillment of the requirements of Chapter 343, Hawaii Revised Statutes. This environmental impact statement will be a useful tool in the process of deciding whether the action described therein should be allowed to proceed. My acceptance of the statement is an affirmation of the adequacy of that statement under applicable laws, and does not constitute an endorsement of the proposed action.

When the decision is made regarding the proposed action itself, I expect the proposing agency to weigh carefully whether the societal benefits justify the environmental impacts which will likely occur. These impacts are adequately described in the statement, and, together with the comments made by reviewers, provide a useful analysis of alternatives to the proposed action.

With warm personal regards, I remain,

Yours very truly,

George R. Ariyoshi

George R. Ariyoshi

cc: Mr. Kazu Hayashida

Revised Environmental Impact Statement for Kahana "315" Reservoir Project

TMK: 5-2-01, 02, 03 & 06

July 1983

BOARD OF
WATER SUPPLY
CITY AND COUNTY
OF HONOLULU

CITY AND COUNTY OF HONOLULU
BOARD OF WATER SUPPLY

REVISED

ENVIRONMENTAL IMPACT STATEMENT FOR KAHANA "315" RESERVOIR PROJECT

TMK: 5-2-01, 02, 03 & 06

This Environmental Document is Submitted
Pursuant to Chapter 343, HRS

PROPOSING AGENCY:

BOARD OF WATER SUPPLY
City and County of Honolulu
630 South Beretania Street
Honolulu, Hawaii 96843

ACCEPTING AUTHORITY:

Governor, State of Hawaii

BOARD MEMBERS:

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7/26/83
Date

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JULY 1983

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SUMMARY

A. DESCRIPTION AND OBJECTIVES OF THE PROPOSED ACTION

The Board of Water Supply (BWS) proposes to construct a 6.0 MG reservoir at a pad elevation of 285 feet on the western slopes of Kahana Valley on the Windward side of Oahu. Kahana Valley, comprising of 5,260 acres, is owned by the State of Hawaii and is under the jurisdiction of the Department of Land and Natural Resoures (DLNR).

The reservoir is intended to provide a more stable water system by alleviating the fluctuating pressures and surges in the 21 miles of transmission main which provides water to various communities along Windward Oahu from Punaluu to Waimanalo. The long length of the existing transmission main, with intermediate peaks and dips along its route, coupled by peak water demands, induce intense surge pressures in the existing system. These conditions are conducive to pipe wear, breakage and interrupted service to users.

Initially, a 2.0 MG reservoir was considered adequate to achieve the desired result. Feasibility studies on five selected sites on the eastern slopes of Puu Piei Ridge were undertaken. These sites were Punaluu Site 1 and Site 2, Kahana Site 1, Site 2A and Site 2B. Kahana Site 1 was assessed to be the most feasible of the five sites studied. On October 23, 1979 an Environmental Impact Statement (EIS) Preparation Notice was prepared and published for a 2.0 MG Reservoir at Kahana Site 1.

Subsequent to the date of the EIS Preparation Notice, the Board of Water Supply reevaluated the 2.0 MG reservoir system and concluded that a larger 6.0 MG reservoir will more adequately achieve the results desired by the proposed action. The five sites considered for the 2.0 MG reservoir were considered environmentally undesirable for placement of the larger 6.0 MG reservoir. The reason for this was

because of the large exposed cut banks that would be required uphill of the reservoir pads. After further site investigations, Kahana Reservoir Site 3, approximately 3,000 feet south of Kahana Reservoir Site 1, was determined to possess the physical features needed for construction of the 6.0 MG reservoir. This Revised Environmental Impact Statement now addresses a 6.0 MG reservoir at Kahana Reservoir Site 3 in place of the 2.0 MG reservoir previously discussed in the EIA.

The 6.0 MG reservoir, 30 feet high by 189 feet in diameter, with the spillway at elevation 315 feet, will be constructed on a pad cut into the ridge at elevation 285 feet. The reservoir perimeter will be backfilled to elevation 300 feet so that only the top 15 feet of the reservoir will be above finished ground. A 10-foot wide coral service road will encircle the reservoir's perimeter. The existing Kahana Valley Road and an abandoned jeep road (now a hiker's trail) will be rehabilitated as required to provide a 12-foot wide coral access road to the lower side of the reservoir site from which a new 12-foot wide coral service road will connect the access road to the reservoir perimeter road. A 42-inch influent-effluent main connecting the 30-inch transmission main in Kamehameha Highway to the reservoir will be laid underground along the access roads to the reservoir.

The preliminary construction cost for the entire project is estimated to be approximately $8.0 million and will be funded through the capital improvement program monies of the Board of Water Supply.

B. DESCRIPTION OF THE AFFECTED ENVIRONMENT

Kahana Valley is a large, deep valley located at the southern end of the Koolauloa District in Windward Oahu. It spreads over 5,260 acres ranging in elevation from sea level at Kahana Bay to over 2,700 feet along the crest of the Koolau Range. The ridges on either side of the valley are from 1,000 to 2,000 feet high.

The dominant soil types are clays, silty clays and silty clay loams. Thick vegetation covers most of the valley. Studies have identified 13 major plant communities in the valley ranging from native kukui forests in the gulches, ohia forests in the back portions and cultivated fields and pastures at the mouth of the valley.

Kahana Valley and Kahana Stream are natural resources of great value. To preserve the scenic beauty of the valley, the Department of Land and Natural Resources plans to develop the valley into a State Park. The Kahana marsh and stream are classified as areas of secondary importance to endangered water bird species and have been proposed as a wildlife refuge. Kahana Stream has also been identified as one of two streams on Oahu still of high natural quality and has been included in the U. S. Department of the Interior, National Park Services Nationwide Rivers Inventory.

Native and introduced waterbirds have been observed in the lower valley areas. Two endangered species, the Hawaiian Coot and the Hawaiian Gallinule have been found in Huilua Pond adjacent to Kahana Bay. Kahana marsh lands, stream and pasture lands have been identified as areas of secondary importance to endangered species in the "Hawaii Waterbirds Recovery Plan."

Introduced species of birds are common in the mid-elevation areas and native songbirds exist in the upper valley areas. The Oahu honeycreeper, a rare and endangered species may be found in the ohia forests.

With the exception of the feral pig, relatively few animals are found in Kahana Valley. Kahana Stream supports 24 species or groups of freshwater aquatic macrofauna of which 11 are either endemic or indigenous. Of these, the mountain shrimp, o'opu nakea, o'opu okuhe, mullet, Hawaiian prawn, Tahitian prawn and aholehole are of economic importance.

The State-owned valley supports a small, rural, agrarian community. Most of the residents reside in the lower makai portion of the valley. Some tenants are engaged in commercial agricultural activities and most of them raise fowl and grow vegetables in their backyards.

The Department of Land and Natural Resources has developed plans to create a low-density use, multi-purpose park for the entire valley with particular emphasis on preserving an environment where Hawaiian values and culture will be embodied in a "living park" concept wherein individuals living there shall participate in the purpose of the park.

No archaeological or historic sites of significance other than an auwai will be affected by the proposed project. This has been verified by archaeological surveys.

C. RELATIONSHIP OF THE PROPOSED ACTION TO LAND USE PLANS, POLICES AND CONTROLS FOR THE AFFECTED AREA

The project site is within the State-owned Kahana Valley which is designated as conservation on the State Land Use District Boundary Map. It is zoned P-1 on the County's General Plan. A major portion of the 42-inch influent-effluent line is in the Special Management Area.

The proposed action does not conflict with the general objectives of the land use plans, policies and controls of the State and County.

D. PROBABLE IMPACTS OF THE PROPOSED ACTION AND MITIGATIVE MEASURES PROPOSED

The adverse physical impacts expected from the project are those short-term impacts normal to any construction activity of a similar nature. Temporary increases in noise levels, air pollution from dust and vehicular emissions, disruption of traffic and inconvenience to tenants of the valley and other users of Kahana Valley Road are to be expected. Dust control measures, such as sprinkling, will be implemented to reduce dust levels. Air pollution control devices to lessen vehicular emissions will be required for all construction

equipment. Compliance to the conditions of a noise permit required by the Department of Health will be enforced to control noise levels. Construction will be restricted to off peak hours during weekdays only to minimize disruption to traffic.

The project will involve a large alteration of the physical landscape. The long term adverse impact will be the visual effect of a 189-foot diameter reservoir, the top 15 feet of which will be exposed to view, and a 75-foot high cut bank uphill of the reservoir pad. The site is approximately 1.7 miles straight inland from Kahana Bay. The dense vegetation and/or terrain relief of the valley will shield the reservoir site from open view from almost all areas of the valley. The service road connecting the access road to the reservoir perimeter road will be curved so that the reservoir will not be visible from the access road. Landscaping of the reservoir site will soften the adverse visual impact of the hillside cut. The natural and densely vegetated terrain of the Koolau Range rising to over 2,700 feet in the background will further minimize any possible visual impact.

The only known archaeological site which will be affected is an auwai which crosses the existing Kahana Valley Road via a pipe and cement conduit. On site archaeological monitoring will be implemented during construction to preclude damage to the auwai and to ascertain the possible existence of any subsurface archaeological resources at the reservoir site.

The proposed project will improve water service to the communities along the Windward side of Oahu from Punaluu to Waimanalo. When implemented, it will provide a storage reservoir which will reduce pumping demands at the Punaluu Wells and reduce water pressure surges in the existing transmission main.

E. PROBABLE ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

The unavoidable adverse environmental impacts which are short term in nature, will be associated with the construction work for the project.

They will consist of air pollution from dust and vehicular emissions, noise from construction equipment and inconveniences to resident traffic.

The long term adverse impact, which is unavoidable because of the nature of the project, will be the visual impact of the reservoir structure and the scarification of the ridge due to excavation.

F. ALTERNATIVES

The "no project" alternative will perpetuate the existing adverse hydraulic conditions in the transmission main.

"Delay of the project" to a future date will result in increased construction costs due to inflation. The adverse hydraulic conditions will continue to plague water users until such time as the project is completed. As the State's plans for the "living park" progress in development, the number of park users will increase. Construction at a late date will cause temporary inconveniences to a greater number of people.

Although all five of the alternate sites originally investigated for a 2.0 MG reservoir can physically accommodate a larger diameter, 6.0 MG reservoir, the large exposed cut banks uphill of the reservoir pads make all of the five alternate sites environmentally undesirable.

SECTION II

GENERAL DESCRIPTION OF THE PROJECT'S TECHNICAL CHARACTERISTICS

A. PROJECT LOCATION

Kahana Valley is located at the southern end of the Koolauloa District in Windward Oahu (Figure 1). The valley which is large and amphitheater-shaped covers over 5,260 acres. It ranges in elevation from sea level at Kahana Bay to over 2,700 feet along the crest of the Koolau Range at its head. The elevations of the ridges on either side of the valley range from 1,000 to 2,000 feet high.

Kahana Valley supports a small rural community and its residents, for the most part, live in the lower makai portion of the valley. The valley is owned in its entirety by the State of Hawaii and has been designated as a State Park.

The proposed Kahana "315" Reservoir project will be located on the western slopes of Kahana Valley at an elevation of 285 feet (Figure 2). The proposed Reservoir site (Site 3) is approximately 1.7 miles straight inland from Kamehameha Highway along Kahana Bay. Access from Kamehameha Highway to the reservoir will be along approximately 2.1 miles of improved roadways.

B. PROJECT OBJECTIVE

The 6.0 MG reservoir proposed by the BWS is intended to alleviate the adverse conditions which presently plague the existing transmission system. It is the objective of the proposed reservoir to reduce pressure fluctuation by stabilizing the water pressure, prevent "lock out" of the Kapaa Reservoir, improve pump efficiency and prevent severe water hammer should power failure occur.

C. BACKGROUND

The communities of Windward Oahu from Punaluu to Waimanalo receive their water supply from a number of wells and tunnels in the Windward

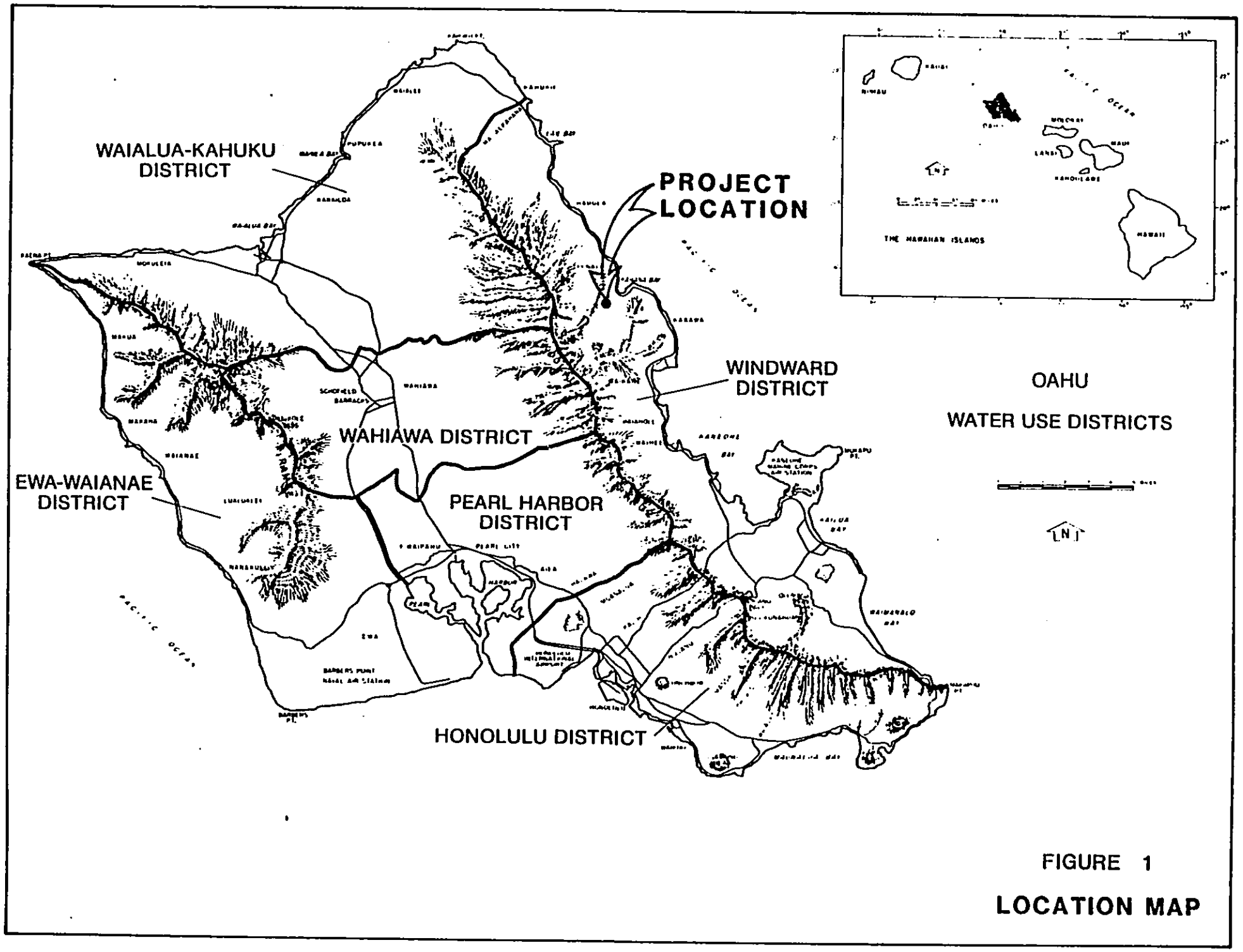


FIGURE 1

LOCATION MAP

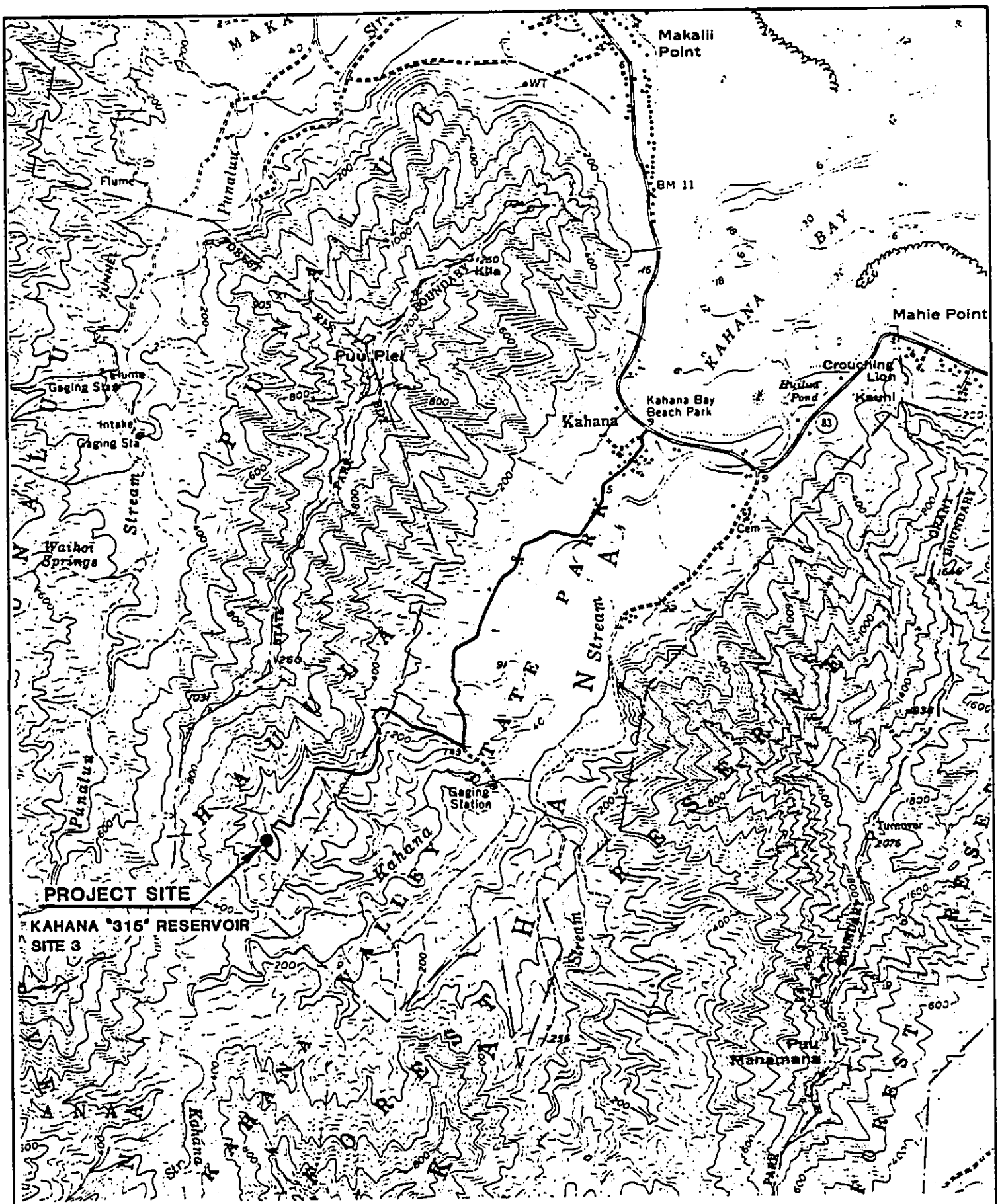


FIGURE 2

VICINITY MAP

Water Use District (Figure 1). The major source of supply is Punaluu Wells II which is supplemented by Punaluu Wells III, Kahana I, Waihee Inclined, Waihee I, Kuou and Waimanalo Wells. Other water sources which contribute to the water supply in this area are the Waihee, Kahaluu, Haiku, Luluku and Waimanalo I, II, III and IV Tunnels. The water received from these wells and tunnels are transmitted along a transmission main following Kamehameha Highway. This main is a 30-inch line between Punaluu to Lanikai. From Lanikai to Waimanalo it reduces in size to 20 inches. The distance from approximate the Punaluu Wells to Waimanalo is about 21 miles.

The length of the transmission main in this area is a major contributor to pressure surges within the water system. The intermediate peaks and dips along the transmission main system, combined with peak water demands, induce surge pressures within the system. These pressures are intensified by the long length of the transmission pipeline. Fluctuating pressures caused by these surges have constantly plagued the residents and commercial users between Punaluu and Kapaa. These pressure fluctuations also cause excessive wear on the pipes making them more susceptible to corrosion and even pipe breakage.

Pressure fluctuations along the transmission main are experienced when the pumps at the Punaluu Wells II are turned on and off. This is particularly so between Punaluu and Lanikai. Kailua and Kaneohe no longer experience erratic pressure fluctuations since the BWS installed pressure regulators on the lines in these two towns.

When the Punaluu Wells II pumps are turned on, the initial water pressure is greater than the normal 40 psi. This creates a surge within the transmission main going in the direction toward Pohakupu Reservoir. Surges are also created when the pumps are turned off. A pressure wave continues to the reservoir even after the pumps are turned off and upon reaching the reservoir it then reverses direction

and heads back toward the pumps. After reaching the pumps it reverses direction again. This continual back and forth motion is maintained until all the energy is expended. This action also causes pressure fluctuations within the line.

Another problem experienced within this system is the "lock out" of Kapaa Reservoir when Punaluu Wells II are on. Presently, Pohakupu Reservoir is being used to receive water from Punaluu Wells II. These wells have a head of 370 feet and targets Pohakupu Reservoir which has a head of 272 feet. The difference of almost 100 feet reflects the loss of head due to friction along the long length of pipeline. However, the pressure along the transmission main between the Punaluu Wells II and Pohakupu Reservoir is so great that other water sources are prevented from discharging their water. Instead, water is charged into these sources.

The pressure flow along the 30-inch transmission main while the Punaluu well pumps are engaged also prevents the use of the Waihee Line Booster. Should this booster ever be put into operation, cavitation would result.

In the case of a possible power failure where the pumps are turned off with the control valve still open the pressure becomes intense causing water hammer. This condition puts an even heavier strain on the transmission main than the normal pressure fluctuations and may cause pipe damage.

D. SITE SELECTION

Initially, a 2.0 MG reservoir approximately 136 feet in diameter and 20 feet high was deemed adequate to achieve the objectives desired. Feasibility studies on five selected sites on Puu Piei Ridge were conducted by the Board of Water Supply. These were the Punaluu Sites 1 and 2 and the Kahana 1, 2A and 2B sites (Figure 3) which are addressed in Section V-6, Alternate Reservoir Sites. Kahana Reservoir Site 1 was selected as being the most feasible site for a 2.0 MG

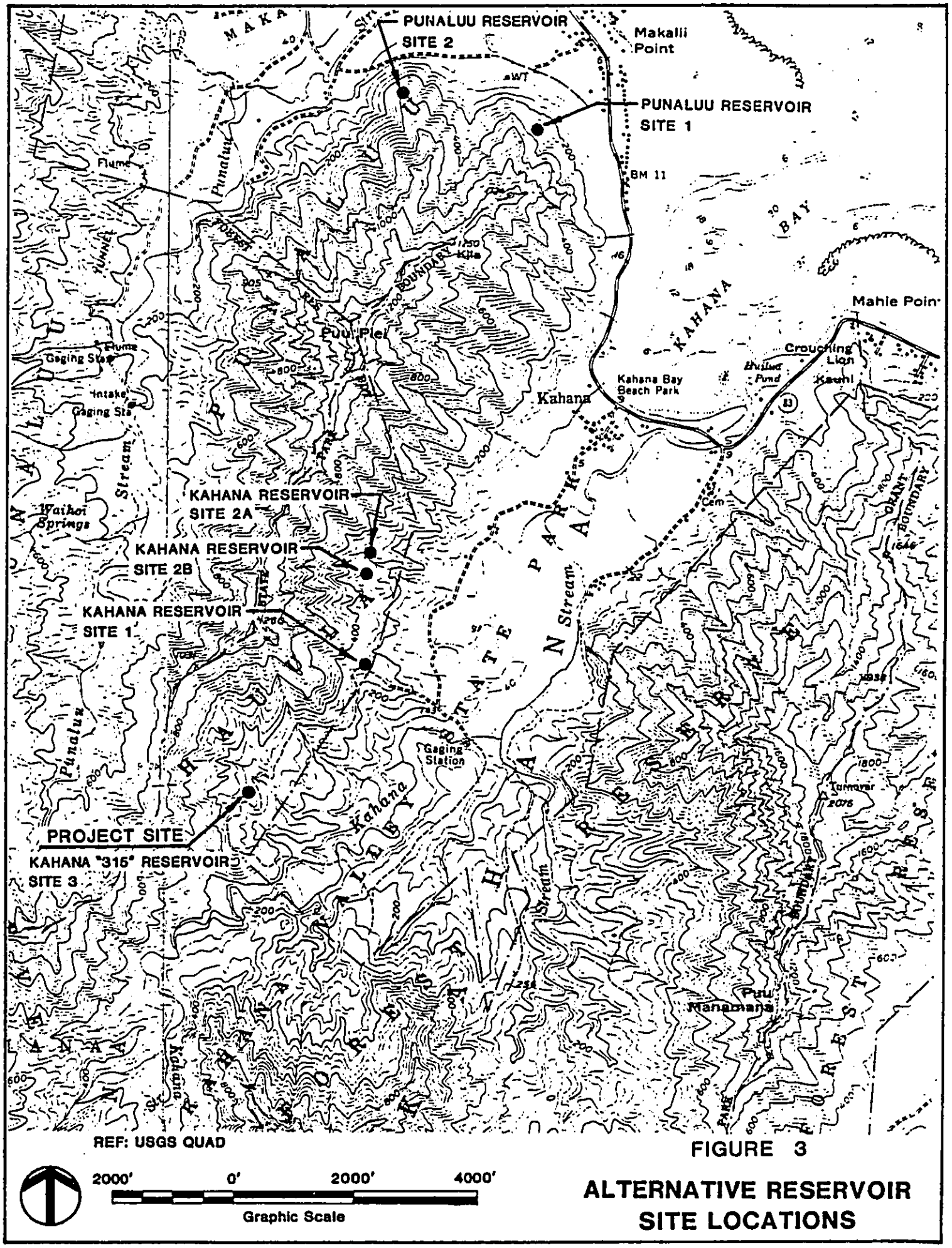


FIGURE 3

ALTERNATIVE RESERVOIR SITE LOCATIONS

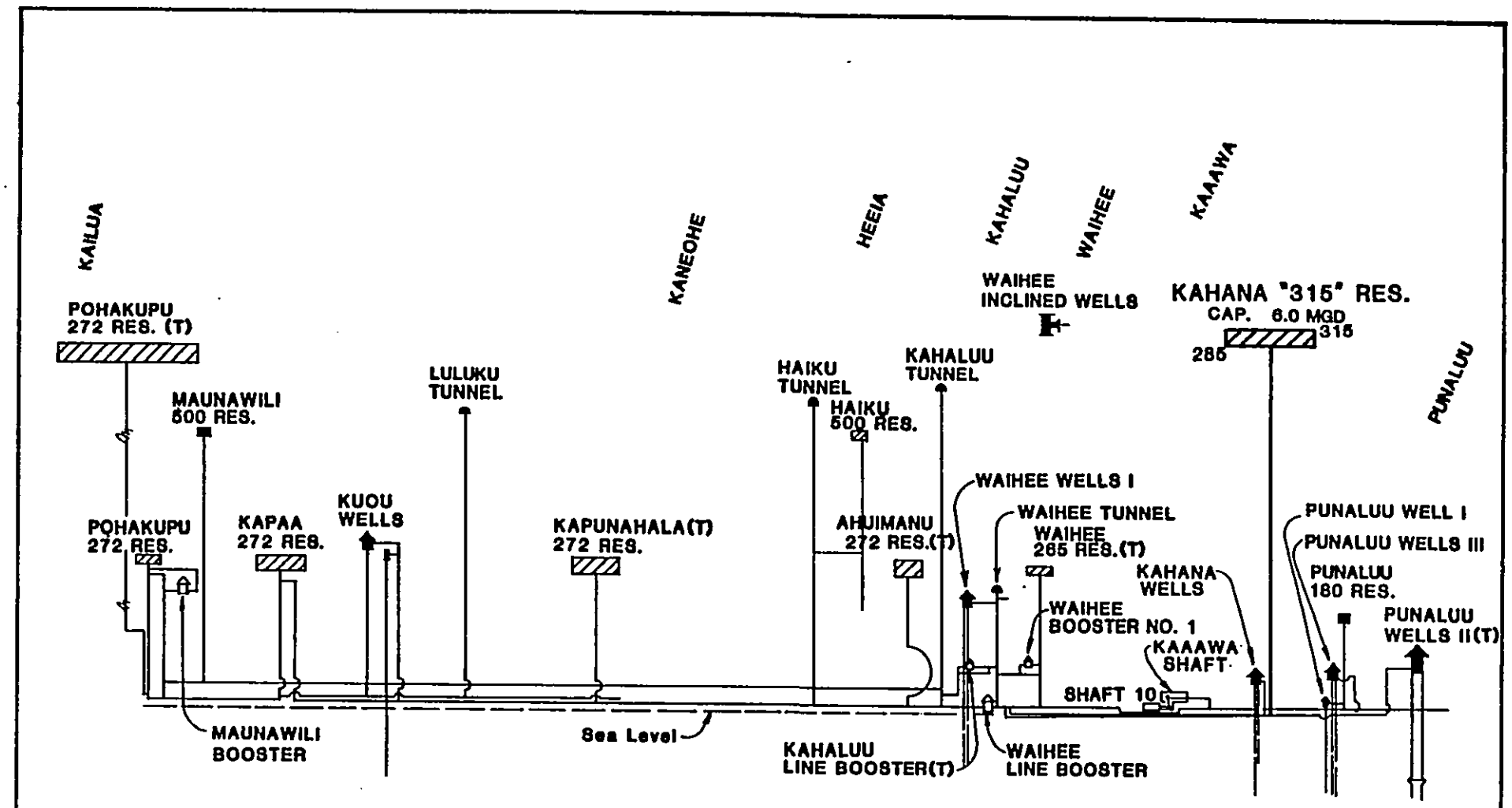
reservoir. An Environmental Impact Assessment was prepared and published as an EIS Preparation Notice on October 23, 1979 for a 2.0 MG Reservoir at Kahana Reservoir Site 1.

Subsequent to filing of the EIS Preparation Notice, the Board of Water Supply reevaluated the 2.0 MG reservoir system and determined that a 6.0 MG reservoir would more adequately satisfy the technical and operational requirements of the proposed action. The proposed 6.0 MG reservoir will be 30 feet high with an inside diameter of 189 feet. All five of the sites considered for the 2.0 MG (136 feet diameter) reservoir were found to be undesirable for the siting of the larger 6.0 MG reservoir.

Studies for alternate site locations for the 6.0 MG reservoir were undertaken using the best topographic maps available. Following field reconnaissance and a partial topographic survey, Kahana Reservoir Site 3 (Figure 3) was determined to be a feasible site for placement of the 6.0 MG reservoir.

E. TECHNICAL DESCRIPTION

The Kahana "315" Reservoir system (schematically illustrated in Figure 4) will be comprised of a 42-inch influent-effluent main connecting the existing 30-inch transmission main in Kamehameha Highway to a 6.0 MG concrete reservoir. The reservoir will be constructed on a pad at an elevation of 285 feet. The spillway will be set at elevation 315 feet (hence, the name Kahana "315") and the perimeter of the tank will be backfilled to elevation 300 feet This will expose only the top 15 feet of the reservoir. An instrument house, a small hollow tile structure about 6 feet wide by 8 feet long and 8 feet high, will house the electrical control system which will regulate the flow of water to the reservoir. The existing Kahana Valley Road and an abandoned jeep trail will be rehabilitated, as required, to provide access to the bottom of the reservoir site. A new 12-foot wide coral service road will be constructed from the access road to the reservoir perimeter



REF: BOARD OF WATER SUPPLY
LONG RANGE PLANNING SECTION

NOT TO SCALE

FIGURE 4

PRELIMINARY KAHANA RESERVOIR SCHEMATIC

road. Landscaping will be provided to minimize erosion and to lessen the visual impact of the cut slopes of the reservoir site.

1. Reservoir Site

The ridge where Reservoir Site No. 3 is located will be excavated at an elevation of 385 feet for a pad which will accommodate a 6.0 MG reservoir, 30 feet high with an inside diameter of about 189 feet, and a 10-foot wide perimeter service road. The spillway of the reservoir will be set at elevation 315 feet. Figures 5 and 6 show the plan and longitudinal and transverse sections of the proposed 6.0 MG reservoir at the selected site. The lower portion of the reservoir will be underground with the invert at elevation 285 feet. The excavated pad will be backfilled to elevation 300 feet leaving the top 15 feet of the tank exposed. A 10-foot wide coral service road around the perimeter of reservoir will be constructed at elevation 300. Downhill of the reservoir and adjacent to the service road a small area will be graded to elevation 280 or lower to accommodate the instrument house.

A preliminary soils reconnaissance report was completed in June of 1979 for the initially proposed 2.0 MG Kahana "300" Reservoir sites. After the BWS reevaluated the 2.0 MG water system and decided on a 6.0 MG reservoir further in Kahana Valley, the data from the 1979 report was extrapolated and applied to the new Kahana "315" Reservoir site. This data was then included in the project EIS published in December 1982. Subsequent to the filing of the EIS, a foundation investigation for the Kahana "315" site was received by the BWS. This investigation was performed by Ernest K. Hirata & Associates, Inc., for William Hee & Associates, Inc. Although the actual investigation was performed in February of 1982, the results were not received by the BWS until this year. This lapse in time was due to the fact that the BWS had suspended work on the project until such a time that they could receive assurances from DLNR that the Kahana "315" Reservoir site was acceptable. This being the case, the results

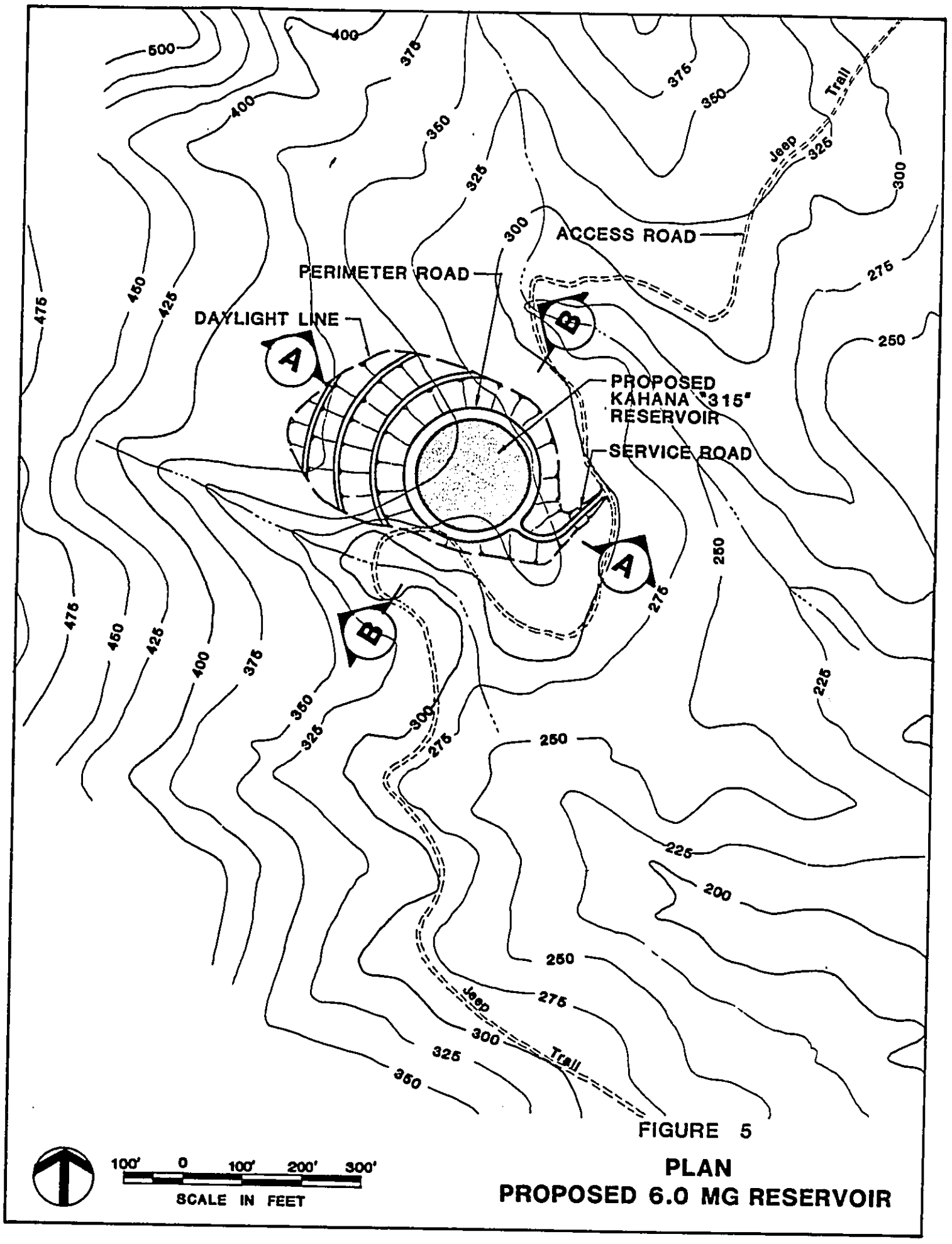


FIGURE 5

PLAN
PROPOSED 6.0 MG RESERVOIR

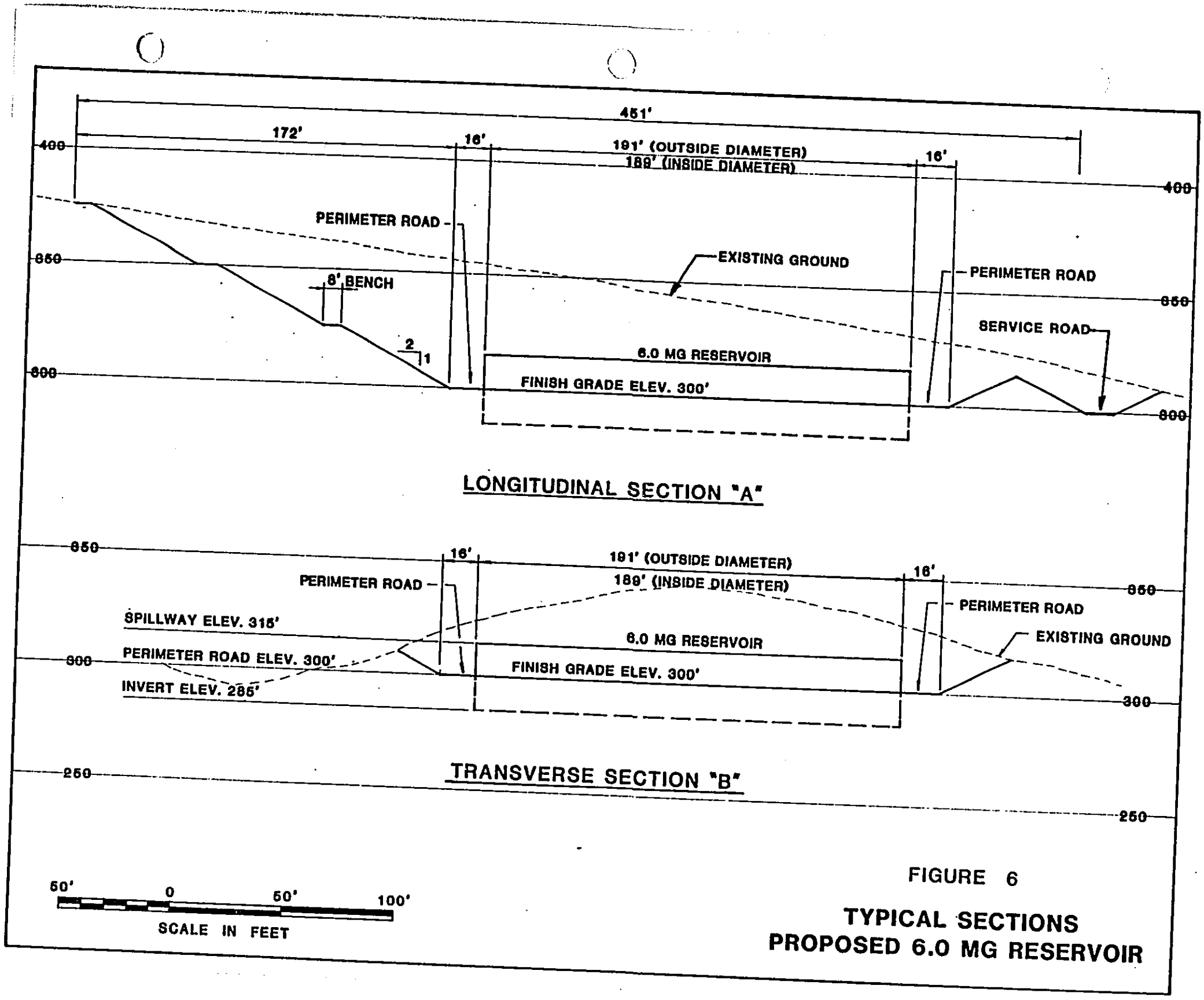


FIGURE 6

TYPICAL SECTIONS
PROPOSED 6.0 MG RESERVOIR

of the soils investigation, although completed, were not received by the BWS until the proposed site met with DLNR's approval. Both soils reconnaissance reports for the 2.0 MG Kahana "300" and 6.0 MG Kahana "315" Reservoirs are respectively reproduced in full in Appendices A and B. The conclusions and recommendations given for the Kahana "315" Reservoir site in the April 1982 report are briefly discussed below. The foundation investigation for the Kahana "315" Reservoir site included "drilling three exploratory test borings, obtaining representative soil samples, laboratory testing and analysis." Based on these investigations, the project's design and BWS requirements, the following conclusions and recommendations were given.

> "Based on preliminary grading plans, the reservoir will be situated at elevation 285, resulting in cuts ranging from 20 feet on the southern side to 60 feet on the northwestern side. Excavations will extend into the stiff, mottled orange brown clayey silt also described as a highly weathered rock. The clayey silt underlies the surface silty clay at elevations varying from approximately 290 to 303. As required by Board of Water Supply standards, all footings must be founded on undisturbed material, which in this case will be the stiff highly weathered rock. In the event softer pockets are encountered, excavations should extend down to completely remove the softer pockets, and should be backfilled with lean concrete.
>
> The differences in the amount of overburden material to be removed between one end of the reservoir and the other are significant. This could result in differential settlements to the foundation system. Settlement calculations indicate that settlements ranging from 3/4 to 1-1/2 inches could occur between the two ends of the tank. A rough approximation of the differential settlement that might occur between interior columns could range from 1/8 to 3/8 of an inch.
>
> We suggest that the structural system selected be able to account for the possible differential settlement. The use of either a mat type foundation or spread footings connected with grade beams should be considered. The final determination as to the foundation system to use will need to be based on the economics of each system.

> The insitu moisture contents of the onsite soils range from 60 to 70 percent while the optimum moisture content is 40 percent. This would indicate that the workability of the soil is poor and difficulty can be anticipated in achieving compaction requirements of 90 percent if conventional methods are specified.
>
> Because of the large quantity of soil that will be needed, air drying of soil to the optimum moisture content may be impractical if not impossible.
>
> Laboratory tests were conducted on remolded samples of the onsite soils at various moisture contents. In general, the strength properties of the soil were high when moisture contents were less than 60 percent. We believe that a combination of some air drying as well as modification to conventional compaction requirements will be necessary if onsite soils are to be acceptable for reuse in compacted fills."

Further conclusions and recommendations were given as follows:

> "Since the surface silty clay is compressible, all silty clays underlying slabs on grade should be removed down to the stiff clayey silt and replaced with lean concrete. In accordance with Board of Water Supply standards, Class C concrete should be used in fill areas under the proposed tank in lieu of structural fill. Fill areas which slope steeper than 5:1 (horizontal to vertical) should be keyed and benched prior to placement of lean concrete."

"Both cut and fill slopes should be stable using slope gradients of 2:1 (horizontal to vertical) or flatter." The soil at the project site belongs to the Waikane soil series which is subject to moderate to severe erosion hazard. The foundation investigation report therefore recommends cut slopes of a maximum height of 15 feet with eight-foot wide benches. To minimize the effects of erosion and weathering, the slopes should be revegetated as soon as practicable.

The existing grading ordinance, Chapter 23, Revised Ordinance of Honolulu 1969, "Grading, Soil Erosion and Sediment Control," calls for cuts greater than 15 feet in height to have benches or terraces at vertical intervals not exceeding 15 feet. The

minimum width of the bench or terrace is 8 feet. Based on these requirements, the proposed reservoir site will have a 76-foot high cut bank which will extend horizontally approximately 451 feet into the ridge (Figure 7).

The BWS is planning for a 25-foot height interval for the cut benches contingent upon results received from actual soil borings. This interval would reduce the cut face to 74 feet instead of 76 feet. The amount of benches required would also be reduced from four to three (Figure 7).

All exposed cut slopes will be revegetated to prevent soil erosion and trees will be planted to partially shield the exposed cut banks. Fencing will be provided around the perimeter of the reservoir pad and around the instrument house.

2. Access Roads

Access to the project site will be along the existing Kahana Valley Road and an old abandoned jeep "road" which runs along the lower side of the project site. The existing roads will be improved as necessary to provide a 12-foot wide coral based travelway.

Kahana Valley Road extends approximately 1.3 miles inland from Kamehameha Highway and terminates at Kahana Stream near the U. S. Geological Survey stream gaging station.

The abandoned jeep "road" begins at Kahana Valley road near its terminus. It was once a military road constructed during World War II. Lacking maintenance, it has since deteriorated to a hiking trail used by hunters and hikers. Only the initial 1,800± feet is wide enough to allow jeeps to travel.

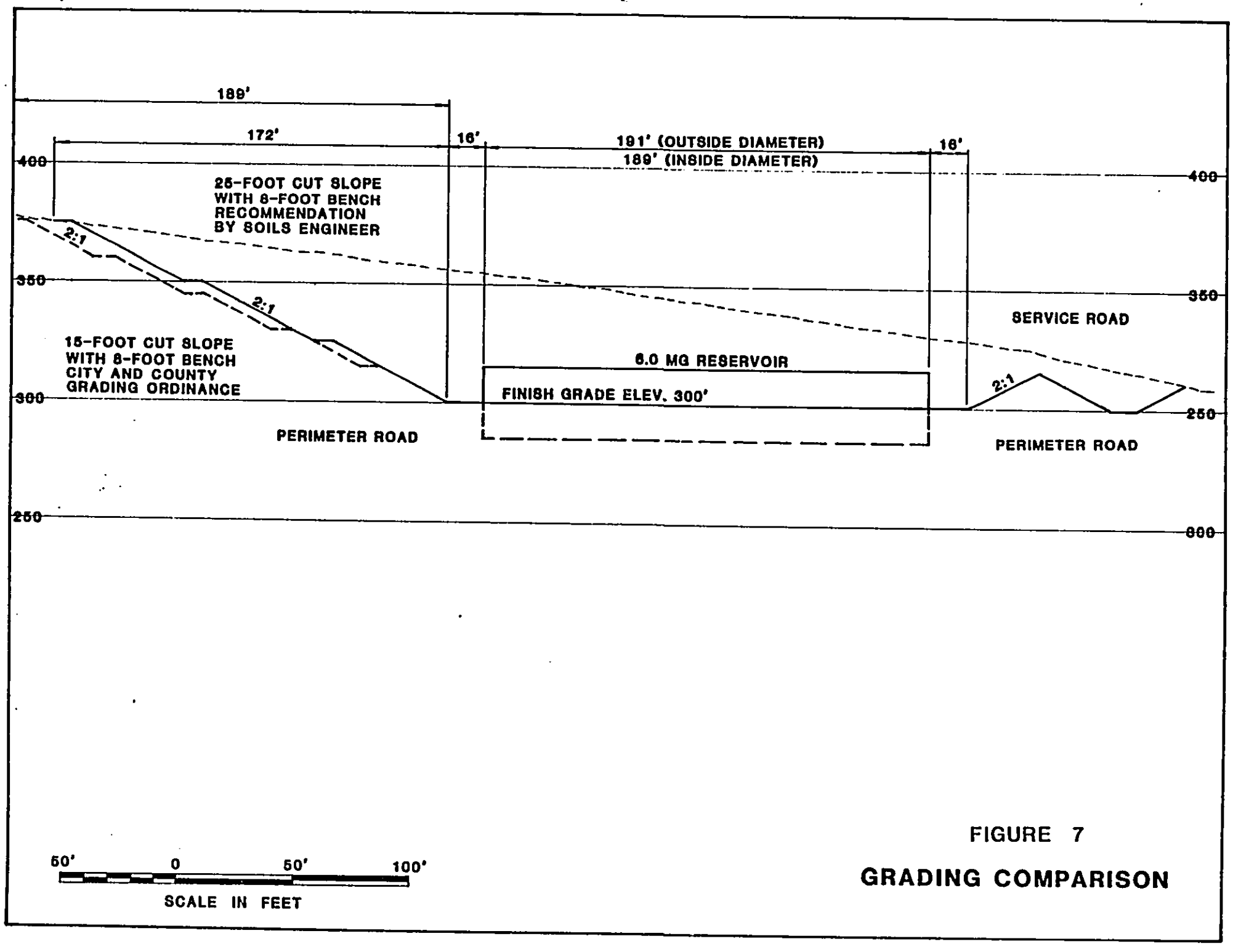


FIGURE 7

GRADING COMPARISON

Improvement of the jeep "road" will require culvert crossings over three streambeds.

A new 12-foot wide coral road approximately 200 feet in length will be constructed from the jeep "road" to the reservoir perimeter road. A horizontal curve will be incorporated into its alignment so that direct frontal view of the reservoir from the access road is not possible. The road will be in cut varying from 0 to 25 feet in height and will have hardly any grade since the jeep road is at the same 300-foot elevation as the proposed perimeter road.

3. Transmission Line

The new 42-inch influent-effluent main will be laid underground along one side of the 12-foot wide coral access road to the new reservoir site, connecting the existing 30-inch transmission main in Kamehameha Highway to the reservoir (Figure 2).

F. PROJECT COST

The preliminary estimated construction costs for the project, summarized below, total to $7.942 million and will be funded through the Capital Improvements Program monies of the Board of Water Supply.

6.0 MG KAHANA "315" RESERVOIR
PRELIMINARY CONSTRUCTION COST ESTIMATE

Item	Amount
Reservoir Structures, Sitework and Landscaping	$4,525,000
Access and Perimeter Roads	142,000
Influent-Effluent Main	3,150,000
Mechanical & Electric Work	125,000
TOTAL	$7,942,000

SECTION III

DESCRIPTION OF THE ENVIRONMENTAL SETTING

A. PHYSICAL CHARACTERISTICS

1. Climate

a. General

Hawaii's mild seasons are a direct consequence of its latitude and its location in the middle of the Pacific Ocean. Because of its location there is little seasonal variation in the amount of energy received from the sun and the ocean acts to decrease large temperature swings. The range of temperature between day and night averages about 7 degrees. During the summer, the day time temperature averages in the mid 80's while the night time temperature is in the low 70's. In the winter, the average day time temperature is in the high 70's and the night time temperature is in the mid 60's.

Oahu is the third largest island in the Hawaiian Island chain. On the Windward side of Oahu, the Koolau Mountain range has elevations generally in the range of 2,000 to 2,500 feet. The highest peak is Puu Konahuanui at 3,150 feet. On the Leeward side, the higher Waianae Mountain range has elevations generally in the range of 2,000 to 3,000 feet and includes Mount Kaala with an elevation of 4,020 feet, the highest on Oahu. These mountains determine the rainfall distribution of Oahu and therefore the distribution of water resources.

On Oahu, the northeasterly trade wind prevails 90 percent of the time from May to October but drops in frequency to 50 percent from November to April.

There are parts of the Koolau Range that average over 300 inches of rain a year. This rainfall recharges the water supply for Honolulu. East of the Koolau Mountains the coastal rainfall averages between 30 and 50 inches of rain a year. Central Oahu receives about 30 to 40 inches. The Honolulu area receives about 24 inches a year but this amount increases to about 60 or 70 inches by moving inland 2 miles. The driest area is the coast west of the Waianae Mountains where rainfall averages abut 20 inches a year. However, these are only long-term averages and the rainfall variations from year to year are considerable. This is also true for month to month values but the trend is more rain over the entire island during the winter months from large scale cyclonic disturbances that move in when the trades are absent or weakened.

Severe weather is uncommon in Hawaii. The "winter" season from October to April brings intense rain that can cause localized flash flooding. Thunderstorms are infrequent and usually mild. A few tropical cyclones have struck the island since 1950.

b. Kahana Valley

The climate of Kahana Valley is the two-season year that typifies the climate of the State. Mild temperatures and humid conditions exist all year round. There are extreme variations in rainfall between Kahana Bay and the upper reaches of the valley. The trade winds are the predominant wind of the valley. The minimum and maximum daily temperature have the same seasonal variation that the island does.

The rainfall of Kahana Valley averages 60 inches per year at the coast and increases to over 300 inches per year at the crest of the Koolau Range. The recording station at the mauka end of the valley measures a monthly rainfall average of 20 inches that is relatively constant. On the makai end, the average rainfall is about 6 inches a month and varies from 3 inches in the summer to over 8 inches in the winter. Measurable rainfall occurs 55 to 60 percent of the time at the makai end of the valley and 65 to 70 percent of the time near the Koolau Range.

The trade winds move through the valley from the north-northeast over 90 percent of the time during the summer. The wind velocity in the valley averages about 11.7 knots with small deviations from the average velocity. During the winter the trade winds are present less than 50 percent of the time and are usually weaker than in the summer. Storms coming mainly from the southwest are present more often than the trade winds and have gust velocities frequently over 30 knots. The topographic relief and vegetation play an important a role as the wind in determining the microclimatic conditions of specific sites.

Over the year the average humidity for the late morning is 70 percent, although the winter seasons has days with humidities much higher and lower than the average.

2. Topography

The topography of Kahana Valley ranges from a flat flood plain at the mouth of the valley to the steep rugged terrain that form the valley sides. A zero to ten percent slope is characteristic of the broad flood plain which forms the valley floor. A steeper slope

of 10 to 20 percent is encountered further in along the valley's water courses and the rest of the valley is comprised of slopes of 30 percent or more.

The project site for the proposed Kahana "315" Reservoir is located on the western slope of Kahana Valley at an approximate elevation of 285 feet. The slope gradient in this area is well over 30 percent.

3. Geology

Kahana is a large, deep, amphitheater-headed valley located at the southern end of the Koolauloa District in Windward Oahu. It encompasses over 5,260 acres, with elevations ranging from sea level at Kahana Bay to over 2,700 feet along the crest of the Koolau Range. The ridges on either side of the valley vary in elevation from 1,000 to 2,000 feet above sea level.

The valley has been eroded into the relatively thin bedded basaltic lava flows and the nearly vertical basaltic dikes of the Koolau Volcanic Series. Overall, 71 percent of the total area has a slope in excess of 30 percent. By excluding the floor of the lower valley that lies within the flood plain, the usable area is reduced to under 10 percent of the total.

All of Kahana Valley falls within one of the dike regions of the major rift zone of the Koolau Volcano. The dike zone is the dominant geologic feature of the valley and may be divided into two components called the dike complex and the marginal dike zone. The essential difference between the dike complex and the marginal dike zone is the greater number of dikes across the trend of the rift in the dike complex as compared to the marginal dike zone. In Kahana the dike complex extends from an elevation

of 270 feet to the range crest while the marginal dike zone begins below this elevation including the lower valley and extends offshore.

4. Hydrology

Kahana Stream is the largest stream on the Windward side of Oahu. It originates up in the Koolaus and cuts across the dike complex and marginal dike zone of Kahana Valley. By dissecting the dike complex and marginal dike zone normal to its trend, dike-impounded water drains preferentially into Kahana Stream. For this reason, Kahana Stream continually gains flow from the headwaters to the mouth.

Kahana Stream along with Kawa Stream (principal tributary), are the main water courses in Kahana Valley. The U. S. Department of the Interior, National Park Service's Nationwide Rivers Inventory, has included Kahana Stream for its important scenic and historic values. The characteristics of Kahana Valley vary from steep, narrow and rocky gorges in the upper valley to a wide, level, and heavily vegetated flood plain in the lower area.

Data from Water Resources Data for Hawaii and Other Pacific Areas, Volume 1 Hawaii for the U. S. Geological Survey (USGS) stream gaging station (USGS gage no. 16296500) on the valley floor registers an average flow of 35.8 cubic feet per second (cfs) or 23.1 mgd. During an 18-year period, the lowest and highest discharges were 6.3 and 3512.3 mgd, respectively. The entire watershed discharges an average flow of over 30 mgd. As a result of the withdrawal of water through the Waiahole Ditch/Kahana Tunnel system, streams above elevation 800 feet display intermittency except during periods of moderate to heavy rains. Flooding of the valley floor to depths of about 12 inches occurs at least once every 2 years, and to depths of bout 3.5 feet every 7 to 10 years. Due to the low velocities, damage from flood waters has been minimal.

Groundwater in Kahana Valley is stored underground in two ways. The first is a basal freshwater lens, truncated by dikes, that floats on top of denser salt water. The second is high level water stored in porous and permeable rock between volcanic structures of low porosity and permeability, called dikes. Dikes are leaky yet prevent the water in the porous rock compartments from effectively flowing down and out to sea. In Kahana the basal fresh water forms a wedge under the valley floor while the high level dike water is found several miles inland from the coast.

Well No. 405 taps the artesian basal water of Kahana Valley. This free flowing well provides the water used by most of the families in Kahana Valley. The confining sedimentary deposits that underlie the valley floor give the well an artesian head that averages about 15 feet above mean sea level. According to the Kahana Valley State Park Revised EIS, Well No. 405 provides only for the water needs of about 90 residents at Kahana Valley. Present withdrawal does not exceed 3,000 gallons per day (gpd).

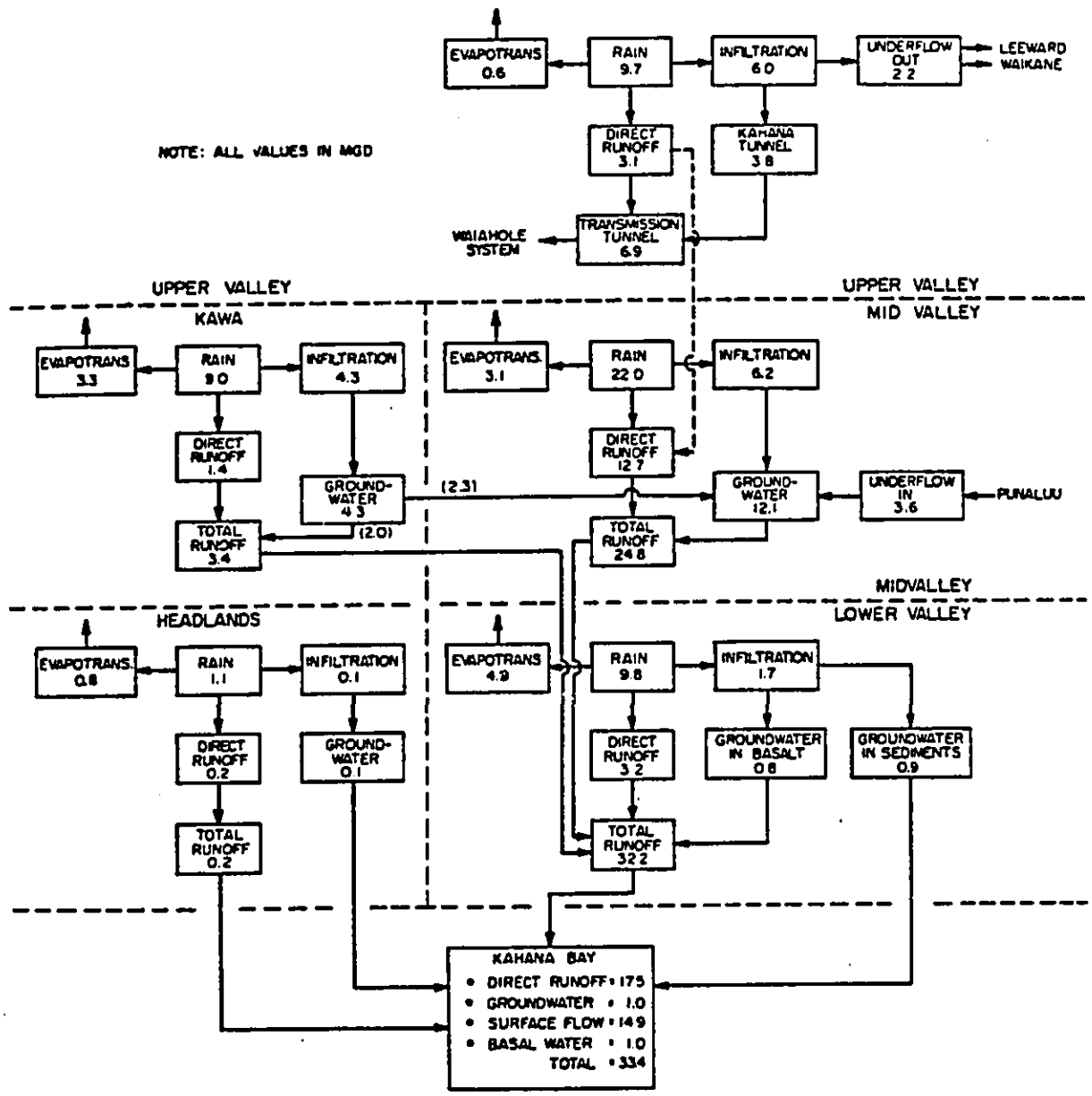
Lava flows of the Koolau Volcanic series comprise the aquifer in which groundwater is stored. Over half of the rainfall in the valley percolates through the lava to replenish the aquifer. It is estimated that if no water were withdrawn from this system the backed up water in the Koolau dike system might exceed 1,000 feet in elevation. This dike water is tapped by the Kahana Development Tunnel for the Waiahole Ditch System. The water flows essentially parallel to the dikes and therefore enters the tunnel, which is driven perpendicular to the trend of the dikes. The taking of about 4.0 mgd water by the Waiahole Ditch system from the Kahana Development tunnel has lowered the water in the dike system to an elevation of 800 feet, which is the elevation of the tunnel.

The hydrologic system can be described by a "water budget" for the area. This budget takes into account all the water "deposited" into the system by rainfall and all the water "withdrawn" by evapotranspiration, runoff, wells, diversions and underflow. The water budget for Kahana Valley was initially made by the USGS in Water Resources of Windward Oahu. The budget was revised by the Water Resources Research Center. Figure 8 presents this water budget in diagrammatic form. More detailed hydrologic data is provided by an excerpt (Appendix C) from the University of Hawaii Water Resources Research Center's Technical Report No. 77, The Quality of Coastal Waters; Second Annual Progress Report.

The major withdrawal of water from the Kahana Valley watershed is being made by the Waiahole Ditch/Kahana Tunnel Complex. The Waiahole Ditch system takes water from both the dike complex and Kahana Stream. Since 1931 an average of 3.2 million gallons per day (mgd) has been withdrawn from Kahana Stream and another 4.0 mgd is withdrawn from the high level groundwater system by the Waiahole Ditch system. The Waiahole Water Company uses the water for irrigation use on the leeward side of Oahu.

5. Water Quality

The waters of Kahana are divided into an embayment and inland streams. Kahana Bay, the embayment, is a seaward extension of the valley. Its width varies from 2,400 to 4,000 feet and it is nearly 3/4 of a mile long. According to Chapter 37-A, Water Quality Standards, Public Health Regulations, Department of Health, State of Hawaii, Kahana Bay is one of few coastal embayments designated as Class AA. This classification also applies to the estuarine sector. The Class AA classification is the most restrictive standard for marine waters in the regulations. The specific criteria for embayments and estuaries are given on Tables 1 and 2.



REFERENCE: TECHNICAL REPORT NO. 77
THE QUALITY OF COASTAL WATERS:
SECOND ANNUAL PROGRESS REPORT
WATER RESOURCES RESEARCH CENTER
UNIVERSITY OF HAWAII , HONOLULU, HAWAII
SEPTEMBER 1973

FIGURE 8

HYDROLOGIC BUDGET

TABLE 1

SPECIFIC CRITERIA FOR EMBAYMENTS

Parameter	Geometric mean not to exceed the given value	Not to exceed the given value more than 10% of the time	Not to exceed the given value
Total Kjeldahl Nitrogen (ug N/1)	200.00* 150.00**	350.00* 250.00**	500.00* 350.00**
Ammonia Nitrogen (ug NH_3 - N/1)	6.00* 3.50**	13.00* 8.50**	20.00* 15.00**
Nitrate + Nitrite Nitrogen (ug [NO_3 + NO_2] - N/1)	8.00* 5.00**	20.00* 14.00**	35.00* 25.00**
Orthophosphate Phosphorus (ug PO_4 - P/1)	10.00* 7.00**	25.00* 12.00**	40.00* 17.00**
Total Phosphorus (ug P/1)	25.00* 20.00**	50.00* 40.00**	75.00* 60.00**
Light Extinction Coefficient (k units)	0.40* 0.15**	0.80* 0.35**	1.20* 0.60**
Chlorophyll *a* (ug/1)	1.50* 0.50**	4.50* 1.50**	8.50* 3.00**
Turbidity (Nephelometric Turbidity Units)	1.50* 0.40**	3.00* 1.00**	5.00* 1.50**
Non-filtrable Residue (ug/1)	25,000.00* 15,000.00**	40,000.00* 25,000.00**	50,000.00* 35,000.00**

*"Wet" criteria apply when the average fresh water inflow from the land equals or exceeds 1% of the embayment volume per day.

**"Dry" criteria apply when the average fresh water inflow from the land is less than 1% of the embayment volume per day.

Applicable to both "wet" and "dry" conditions:

pH Units shall not deviate more than 0.5 units from a value of 8.1.

Dissolved Oxygen - Not less than 75% saturation.

Temperature - Shall not vary more than 1°C from ambient conditions.

Salinity (ppm) - Shall not vary more than 10% from natural or seasonal changes considering hydrologic input and oceanographic factors.

TABLE 2

SPECIFIC CRITERIA FOR ESTUARIES
(APPLICABLE TO ALL ESTUARIES EXCEPT PEARL HARBOR)

Parameter	Geometric mean not to exceed the given value	Not to exceed the given value more than 10% of the time	Not to exceed the given value
Total Kjeldahl Nitrogen (ug N/l)	200.00	350.00	500.00
Ammonia Nitrogen (ug NH_4 - N/l)	6.00	10.00	20.00
Nitrate + Nitrite Nitrogen (ug [NO_3 + NO_2] - N/l)	8.00	25.00	35.00
Orthophosphate Phosphorus (ug PO_4 - P/l)	10.00	30.00	40.00
Total Phosphorus (ug P/l)	25.00	50.00	75.00
Light Extinction Coefficient (k units)	0.40	0.80	1.00
Chlorophyll *a* (ug/l)	2.00	5.00	10.00
Turbidity (Nephelometric Turbidity Units)	1.50	3.00	5.00
Non-filtrable Residue (ug/l)	35,000.00	45,000.00	50,000.00

pH units shall not deviate more than 0.5 units from ambient conditions and shall not be lower than 7.0 nor higher than 8.6.

Dissolved Oxygen - Not less than 75% saturation.

Temperature - Shall not vary more than 1°C from ambient conditions.

Salinity (ppm) - Shall not vary more than 10% from ambient conditions.

Oxidation - Reduction Potential (E_H) in the uppermost 10 cm. (4 inches) of sediment shall not be less than -100 mv.

The streams and tributaries of Kahana Valley are classified as inland waters and as such are given the designation of Class 1.a. Class 1.a. is the highest and most restrictive classification for inland waters in the State regulations. The demarkation between fresh and estuarine portions has not been determined exactly but it has been estimated to be about 3/4 mile from the stream mouth. The specific criteria for this class of water is given on Table 3.

Kahana Bay is used for recreational swimming and other beach-related activities. Therefore, it is subject to additional criteria related to recreational areas. This criteria is listed below.

"SPECIFIC CRITERIA FOR RECREATIONAL AREAS

In inland recreational waters and marine recreational waters within 1,000 feet of the shoreline, including natural public bathing areas:

(A) Fecal coliform content shall not exceed a geometric mean of 200 per 100 ml. in ten or more samples collected during any 30-day period and not more than 10 percent of the samples shall exceed 400 per 100 ml. in the same period.

(B) Raw or inadequately treated sewage or other pollutants of public health significance, as determined by the Director of Health, shall not be present in a natural public bathing or wading area."

Kahana Bay also has a wave-exposed reef community which is also protected by the same Health regulations. The classification the Kahana Bay reef community is designated is Class I. The specific criteria is shown on Table 4.

6. Tsunami and Flood Hazard

The average gradient for the estuarine section of Kahana Stream is 10 feet per mile. The channel width varies from 35 to about 245 feet and depth varies from 4 to 16 feet. Peak flows during

TABLE 3

SPECIFIC CRITERIA FOR STREAMS
(WATER COLUMN CRITERIA FOR STREAMS)

Parameter	Geometric mean not to exceed the given value	Not to exceed the given value more than 10% of the time	Not to exceed the given value
Total Kjeldahl Nitrogen (ug N/1)	250.0* 180.0**	520.0* 380.0**	800.0* 600.0**
Nitrate + Nitrite Nitrogen (ug [NO_3 + NO_2] - N/1)	70.0* 30.0**	180.0* 90.0**	300.0* 170.0**
Total Phosphorus (ug P/1)	50.0* 30.0**	100.0* 60.0**	150.0* 80.0**
Total Non-filtrable Residue (ug/1)	20,000.0* 10,000.0**	50,000.0* 30,000.0**	80,000.0* 55,000.0**
Turbidity (Nephelometric Turbidity Units)	5.0* 2.0**	15.0* 5.5**	25.0* 10.0**

*Wet Season - November 1 through April 30.
**Dry Season - May 1 through October 31.

pH Units shall not deviate more than 0.5 units from ambient conditions and shall not be lower than 5.5 nor higher than 8.0.

Dissolved Oxygen - Not less than 80% saturation.

Temperature - Shall not vary more than 1°C from ambient conditions.

Specific Conductance - Not more than 300 micromhos/cm.

TABLE 4

SPECIFIC CRITERIA FOR WAVE EXPOSED REEF COMMUNITIES

(C) Specific criteria to be applied to all reef flats and reef communities: No action shall be undertaken which would substantially risk damage, impairment, or alteration of the biological characteristics of the areas named herein. When a determination of substantial risk is made by the Director, the action shall be declared to be contrary to the public interest and no other permits shall be issued pursuant to HRS Chapter 342.

(1) Oxidation-reduction potential (E_H) in the uppermost 10 cm. (4 inches) of sand patches shall not be less than +100 mv.

(2) No more than 50% of the grain size distribution of sand patches shall be smaller than 0.125 mm. in diameter.

(3) Episodic deposits of flood-borne soil sediment shall not occur in quantities exceeding equivalent thicknesses for longer than 24 hours after a heavy rainstorm as follows:

(a) No thicker than an equivalent of 2 mm. (0.08 inch) on living coral surfaces.

(b) No thicker than an equivalent of 5 mm. (0.2 inch) on other hard bottoms.

(c) No thicker than an equivalent of 10 mm. (0.4 inch) on soft bottoms.

(d) The Director of Health shall determine parameters, measures, and criteria for bottom biological communities which may be affected by proposed actions. Permanent benchmark stations may be required where necessary for monitoring purposes. The water quality standards for this subsection shall be deemed to be met if time series surveys of benchmark stations indicate no relative changes in the relevant biological communities, as noted by biological community indicators or by indicator organisms which may be applicable to the specific site.

the winter storms flush debris and sediment from the estuary, minimizing its potential as an incubator of adverse water quality.

Kahana Stream, as most Hawaiian streams, is subject to flash floods because of the steep slopes and high rainfall of the valley. During a large rainstorm the peak flows may be 1,000 times greater than the lowest recorded flow. The main source of Biochemical Oxygen Demand (BOD) is the organic matter washed into the stream by surface runoff.

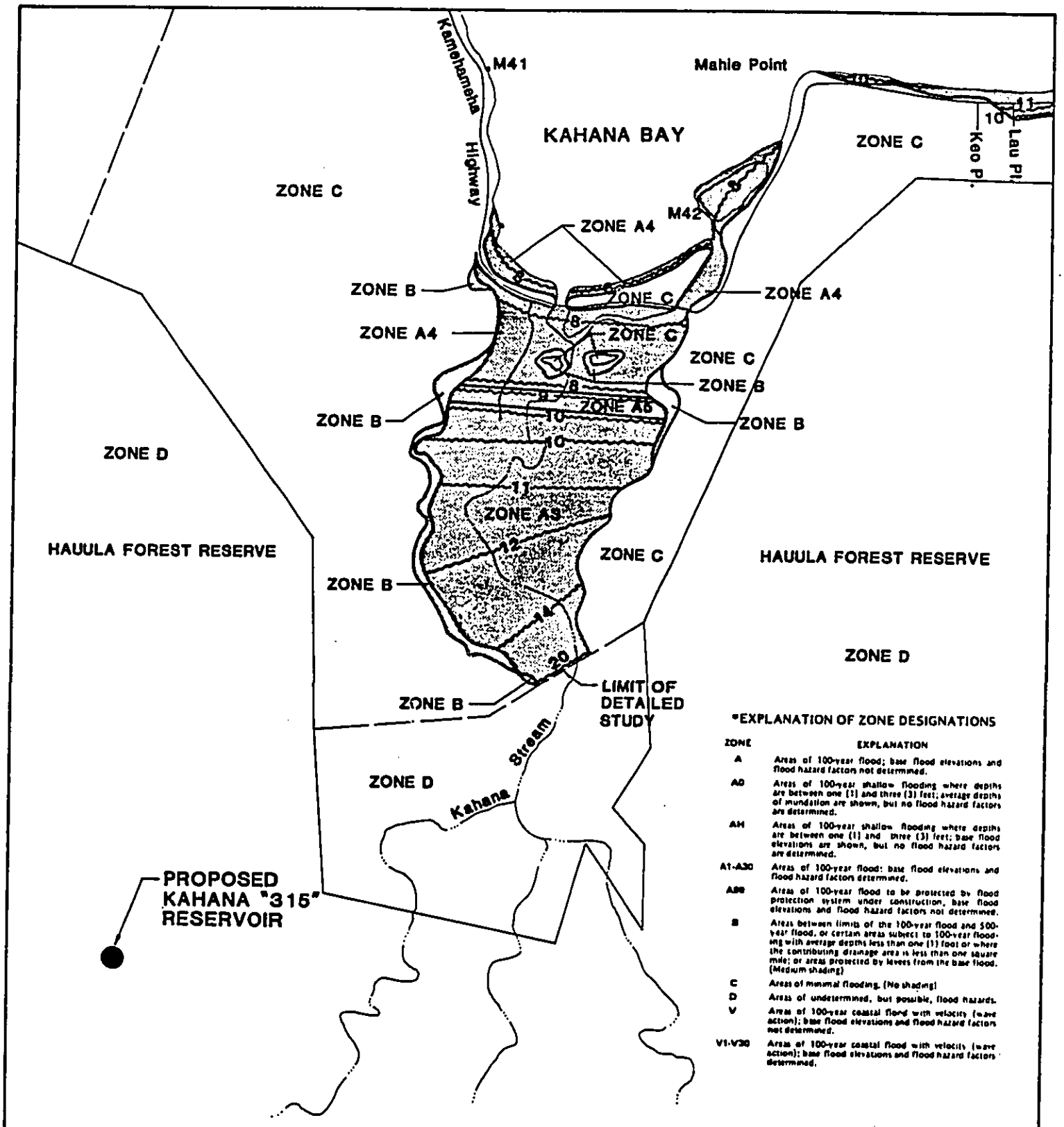
According to the Flood Insurance Rate Map published by the U. S. Department of Housing and Urban Development, Kahana Valley is variously zoned. The valley floor is, for the most part, under Zones A3 to A5. There are isolated spots of Zones B and C on the floor and along the edges of the A Zones (Figure 9). The slopes of the valley are Zoned C and D.

The project site is located in Zone D which is an area "of undetermined but possible, flood hazard."

The Civil Defense Tsunami Inundation maps show the valley floor subject to tsunami inundation for 1/2 mile inland.

7. Soils

The Soil Conservation Service has classified the soils present in Kahana Valley into 15 different soil series and 17 soil types. Each is defined by a unique range of values for a large number of different parameters. Texture, color, structure, consistence, presence or absence of hardpan, and type of parent material, are measures of the physical characteristics inherent in the soil material. Other measurements, such as depth to seasonal high water table, slope, and depth to bedrock, are more the function of the soil's location rather than the material of which it is made.



*EXPLANATION OF ZONE DESIGNATIONS

ZONE	EXPLANATION
A	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
AO	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
A99	Areas of 100-year flood to be protected by flood protection system under construction, base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood, or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C	Areas of minimal flooding. (No shading)
D	Areas of undetermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.

REFERENCE: FLOOD INURANCE RATE MAP
CITY AND COUNTY OF HONOLULU
U.S. DEPARTMENT OF HOUSING AND
URBAN DEVELOPMENT
FEDERAL INSURANCE ADMINISTRATION

FIGURE 9

FLOOD ZONE

The dominant soil types in Kahana Valley are clays, silty clays and silty clay loams. The specific soils at the project site belong to the Waikane series.

According to the Soil Survey of Islands of Kauai, Oahu, Maui, Molokai and Lanai, State of Hawaii put out by the Soil Conservation Service of the U. S. Department of Agriculture the specific soil type found at the proposed Kahana "315" Reservoir site is Waikane silty clay, 40 to 70 percent slopes (WpF). This soil type belongs to the Waikane Series which is composed of "well-drained soils on alluvial fans and terraces on the island of Oahu. These soils developed in alluvium and colluvium derived from basic igneous rock. They are nearly level to very steep. Elevations range from 200 to 1,000 feet."

Runoff on WpF soil type is "rapid to very rapid and the soil erosion hazard is severe." This type of soil is primarily used for pasture and woodland. Natural vegetation for this soil and soil series is Christmas berry, guava, Hilo grass and rice grass.

B. BIOLOGICAL CHARACTERISTICS - FLORA AND FAUNA

Kahana Valley has been the focus of various scientific studies concentrating on its floral and limnological communities. These studies have been performed under the auspices of the U. S. Corps of Engineers, the Hawaii Cooperative Fishery Research Unit, the Division of State Parks, Outdoor Recreation and Historical Sites of the DLNR as well as by private individuals doing research for their thesis. Because of the concentration of these studies on the previously mentioned communities the available information on the larger mammal communities is not as extensive.

In 1973, a study was performed by members of the Department of Botany at the University of Hawaii. This study, "Kahana Valley Botanical Survey "preliminarily identified 13 major plant communities which are

enumerated on Table 5 with the associated plant species found in each community. The prevalent communities in Kahana are "Metrosideros Woodlands" toward the head of the valley and the "Koa-Pandanus Woodlands" in the valley's central portion. These woodland communities account for approximately one-third of the valley's floral community. These are interspersed and surrounded by the other plant communities in varying distribution (Figure 10). The valley floor near the valley's mouth reflects the agriculturalization of Kahana Valley and is designated as "Pasture and Cultivated Ecosystems."

In May 1978, Nengah Wirawan presented the results of a study in his thesis, Vegetation and Soil Water Regimes in a Tropical Rain Forest on Oahu, Hawaiian Islands. The study area encompassed the entire valley excluding the cliffs, pasture and agricultural land areas. Wirawan, who was part of the survey team for the May 1973 DLNR report, identified nine of the thirteen major plant communities in his study area. He describes the study area as having three major structural units consisting of forest, woodland and mixed forest-scrub to grass-scrub units. These are further described as follows:

"Five forest types and two woodlands are recognized on the basis of dominant tree species. The forest types are scattered in small areas over the valley. The Albizzia falcataria forests occur along the Waiahole ditch trail, the Aleurites moluccana forests in the head gulches, the Hibiscus tiliaceous forests primarily along the streams, the Brassaia actinophylla forests along the gulches and on lower slopes near the valley floor, and the Acacia koa - Pandanus odoratissimus forests are scattered on upper slopes and ridges in the middle portion of the valley. In contrast to the forest types, the two woodlands are the major vegetation types in the valley. The Acacia koa - Pandanus odoratissimus and the Metrosideros collina woodlands occupy two-thirds of the valley area, which are located in the middle and back portions of the valley, respectively. The major differences between the two woodlands are the tree components. Whereas the ground cover is closely and densely covered by the Dicranopteris linearis fern, the trees are either predominantly Metrosideros collina or a mixture of Acacia koa and Pandanus odoratissimus.

TABLE 5

MAJOR PLANT COMMUNITIES OF KAHANA VALLEY

Community	Description	CHARACTERISTIC PLANTS	
		Dominant Species	Associated Species
1	Kukui Forests	Aleurites moluccana (Kukui)	Eugenia malaccensis Pandanus odoratissimus Brassaia actinophylla Hibiscus tiliaceus Psidium guajava Cordyline terminalis Morinda citrifolia Zingiber zerumbet Cyrtandra spp. Oplismenus hirtellus
2	Koa-Pandanus Forests	Acacia koa (Koa) Pandanus odoratissimus (Hala)	Osmanthus sandwicensis Oplismenus hirtellus Dicranopteris linearis Hibiscus tiliaceus Eugenia malaccensis Psidium guajava Cibotium splendens Cordyline terminalis Zingiber zerumbet Ophioglossum pendulum Microsorium scolopendria Psilotum spp. Metrosideros collina Freycinetia arborea Clidemia hirta Eugenia cumini Terminalia catappa Brassaia actinophylla Leucaena leucocephala Lantana camara Rubus rosaefolius Nephrolepis hirsutula Cyclosorrus dentatus Paspalum conjugatum Diascorea bulbifera Passiflora foetida Passiflora pulchella Passiflora suberosa
3	Koa-Pandanus Woodlands	Acacia koa (Koa) Pandanus odoratissiumus	Dicranopteris linearis Nephrolepis hirsutula Scaevola gaudichaudiana
4	Metrosideros Woodlands	Metrosideros collina (Ohia Lehua)	Eugenia sandwicensis Acacia koa Psychotria Antidesma pulvinatum Spathodea campanulata Dicranopteris linearis Clidemia hirta Pritchardia sp. Scaevola gaudichaudiana Cyrtandra spp. Cibotium chamissoi Cibotium splendens Touchardia latifolia Pisonia umbellifera Hibiscus arnottianus Musa spp.

TABLE 5 (CONTINUED)

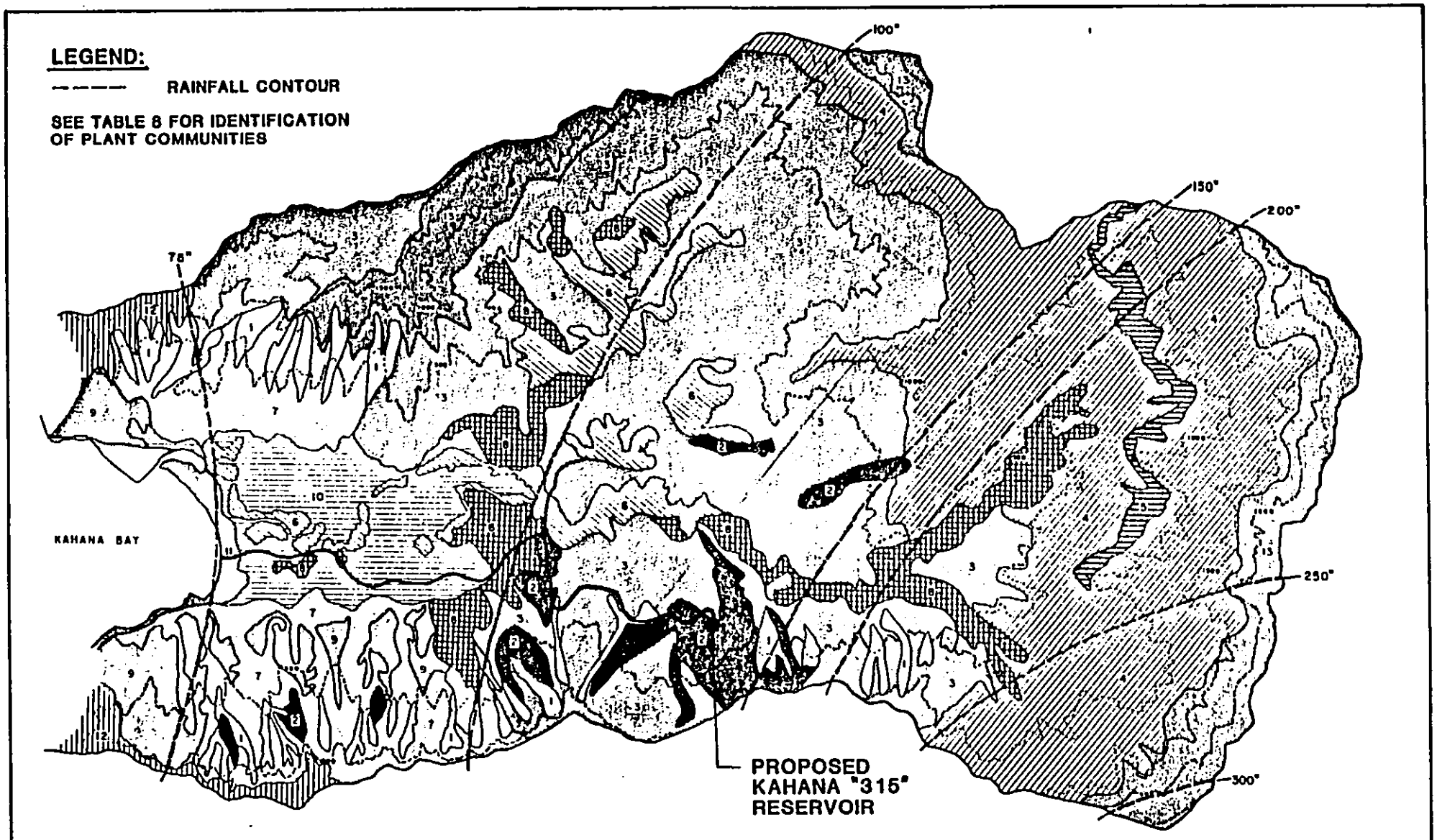
MAJOR PLANT COMMUNITIES OF KAHANA VALLEY

Community	Description	CHARACTERISTIC PLANTS	
		Dominant Species	Associated Species
5	Albizia Forest	Albizia falcataria	Ficus sp. Psidium cattleianum Psidium guajava Melaleucca leucadendra Eugenia malaccensis Cryptomeria japonica Zingiber zerumbet Rubus rosaefolius Alyxia olivaeformis Freycinetia arborea Oplismenus hirtellus Paspalum conjugatum Selaginella sp. Sphenomeris chusana Ophioglossum spp. Hymenophyllaceous (ferns, mosses) Selaginella
6	Hibiscus (Hau) Forests	Hibiscus tiliaceus (Hau)	Hedychium coronarium Dioscorea bulbifera
7	Brassaia Forests	Brassaia actinophylla (Umbrella Tree, Octopus Tree)	Pandanus odoratissimus Eugenia cuminii Schinus terebinthifolius Cordyline terminalis Wikstroemia sp. Nephrolepis sp. Microsorium scolopendria Spathoglottis plicata Oplismenus hirtellus Brassaia
8	Mixed Forest-Scrub	Bamboo (Stands)	Phyllostachys bambusoides Schizostachyum glaucifolium Meloccana baccifera Dioscorea alata
		Eugenia jambos (Stands) (Rose Apple, 'Ohia Loke)	
		Eugenia cuminii (Stands) (Palama)	Cyclosorus dentatus Microsorium scolopendria Nephrolepis hirsutula Paspalum conjugatum Oplismenus hirtellus
		Psidium guajava (Stands) (Kuawa, Guava)	Oplismenus hirtellus Paspalum conjugatum
		Stands of Mixed Species	Eugenia cuminii Psidium guajava Eugenia malaccensis Brassaia actinophylla Pandanus odoratissimus Metrosideros collina Mangifera indica Artocarpus altilis Hibiscus tiliaceus Leucaena leucocephala Schinus terebinthifolius Scaevola gaudichaudiana Wikstroemia oahuense

TABLE 5 (CONTINUED)

MAJOR PLANT COMMUNITIES OF KAHANA VALLEY

Community	Description	CHARACTERISTIC PLANTS: Dominant Species	CHARACTERISTIC PLANTS: Associated Species
			Pluchea odoratia Stachytarpheta jamaicensis Lantana camara Mimosa pudica Urena lobata Andropogon virginicus Cyclosorus dentatus Nephrolepis hirsutula Alocasia macrorhiza Colocasia esculenta Hedychium flavenscens Hedychium coronarium Spathoglottis plicata
9	Mixed Grass-Scrub	Andropogon virginicus (Beard Grass)	Setaria geniculata Paspalum conjugatum Chrysopogon aciculatus Cassia leschenaultiana Osteomeles anthyllidifolia Brassaia actinophylla
		Schinus terebinthifolius (Wilelaiki, Christmas Berry Tree) Psidium guajava (Kuawa, Guava)	Brassaia Wikstroemia oahuense Sphenomeris chusana Dicranopteris linearis Bidens populifolia Spathoglottis plicata Cocculus ferrandianus Cuscuta sandwichiana Passiflora suberosa
10	Pasture and Cultivated Ecosystems	Paspalum conjugatum (Mau'u Malihini, Hilo Grass)	Paspalum orbiculare Setaria geniculata Commelina diffusa Carex sp. Desmodium sp. Stachytarpheta cayennensis Nephrolepis sp. Ludwigia octivalis Psidium guajava Schinus terebinthifolius
11	Strand	Cocos nucifera (Coconut, Niu) Pandanus odoratissimus (Screw Pine, Hala) Hibiscus tiliaceus (Hau) Scaevola taccada (Beach Naupaka, Naupaka-Kahakai) Terminalia catappa (Kamani Haole, False Kamani) Casuarina equisetifolia (Iron Wood)	Calophyllum inophyllum Rhizophora mucronata Scirpus sp. Unidentified Grass Species
12	Dry Cliffs	Andorpogon virginicus (Beard Grass)	Sphenomeris chusana Microsorium scolopendria Brassaia
13	Wet Cliffs	Eupatorium riparium (Toe-Pye Weed) Other Herbaceous Plants	Pritchardia sp. Acacia koa Various Lobeliads



REFERENCE: KAHANA VALLEY BOTANICAL SURVEY
KOOLAULOA DISTRICT, ISLAND OF OAHU
DIVISION OF STATE PARKS, OUTDOOR RECREATION AND HISTORICAL SITES, DEPARTMENT OF LAND AND NATURAL RESOURCES, STATE OF HAWAII
MARCH 1973

3000' 0 3000' 6000'
SCALE IN FEET

FIGURE 10

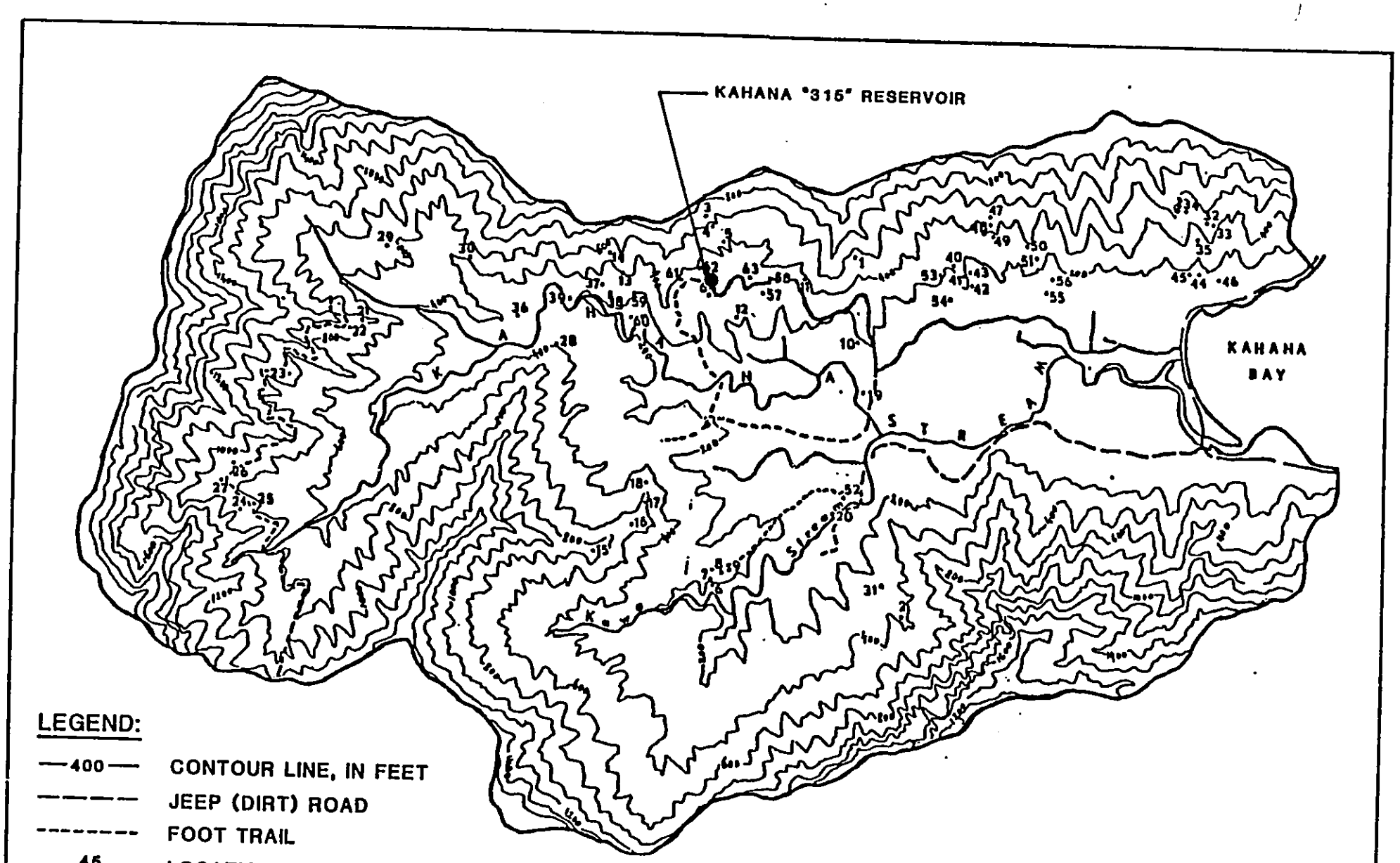
KAHANA VALLEY PLANT COMMUNITIES

> The mixed unit consists primarily of forest-scrub and grass-scrub. Each of these units consists of small patches of forest and scrub or grass (herb) and scrub. They occur all over the valley, particularly in the flat to gently sloping areas where past disturbances were intense."

Wirawan had 64-sample stands scattered throughout Kahana Valley (Figure 11). A number of these were along the existing jeep trail which extends into the valley from the Kahana Valley Road and two are near the proposed reservoir site. Table 6 lists the numbered sample stands found within the project area and the floral species found in each stand.

As can be seen from Table 6 the array of floral species includes a mixture of endemic, indigenous and introduced species. None within the sample stands in the vicinity of the project area are listed on either the Federal or State endangered species list. However, Wirawan does list a number of genus of which there are rare species represented on Oahu. According to "Rare Endemic Plants of the Hawaiian Islands," published by the DLNR Division of Forestry and Wildlife, these include the Euphorbia and Panicum spp. It is unknown whether or not the rare species of these genus may be found in Kahana. The name 'Akoko is applied to several species of the genus Euphorbia, one of which is Euphorbia celastoides, so far found at Kaena Point. Panicum carteri or Carter Panic Grass has thus far been found only on a low rocky islet in Kaneohe Bay.

One rare species that is found in Kahana Valley is Santalum ellipticum Gaud. which is a member of the sandalwood family. Wirawan found a member of this species at Sample Stand 40 in a mixed forest-scrub community approximately one mile from the reservoir site and about 1,500 feet mauka from the jeep trail.



LEGEND:

—400— CONTOUR LINE, IN FEET

———— JEEP (DIRT) ROAD

-------- FOOT TRAIL

•45 LOCATION OF A PARTICULAR SAMPLE STAND USED IN VEGETATION ANALYSIS OF KAHANA VALLEY

REFERENCE: WIRAWAN, NENGAH
VEGETATION AND SOIL-WATER REGIMES IN A TROPICAL RAIN FOREST VALLEY ON OAHU, HAWAIIAN ISLANDS. MAY 1978

FIGURE 11

LOCATION AND DISTRIBUTION OF SAMPLE STANDS

TABLE 6

FLORAL SPECIES OF SAMPLE STANDS WITHIN THE PROJECT AREA

Sample Stand No.	Community Type	Identified Species Within Sample Stands Scientific Name	Vernacular Name	Origin*
10	Acacia-Pandanus Forest	Acacia Koa Gray	Koa	E
		Cibotium splendens	Hapu'u Pulu, Hapu'u, Hawaiian Tree Fern	E
		Clidemia hirta	--	X
		Erechtites valerianaefolia	--	X
		Eugenia cumini	Palama, Java Plum, Jambolan Plum	X
		Lantana camara L.	Lakana, Mikinolia Hihiu, Lantana	X
		Pandanus odoratissimus	Hala, Pu Hala Pandanus, Screw Pine	E
		Scaevola gaudichaudiana Cham	Naupaka Kauhiwi, Mountain Naupaka	E
		Spathoglottis plicata Bl	--	X
		Sphenomeris chinensis(?)	Pala'a, Palapala'a, Lace Fern	I
		Wikstroemia oahuensis	'Akia, False 'Ohelo	E
11	Pandanus-Oplismenus Forest	Brassaia actinophylla Endl.	Umbrella Tree, Octopus Tree	X
		Cibotium splendens	Hapu'u Pulu, Hapu'u, Hawaiian Tree Fern	E
		Clidemia hirta	--	X
		Commelina diffusa Burm. f.	Honohono, Day Flower, Wandering Jew	X
		Cordyline terminalis	Ki, Ti	P
		Cyclosorus dentata	Pai'i'iha, Oak Fern, Downy Wood Fern	X
		Emilia sonchifolia	Flora's Paint Brush	X
		Eugenia malaccensis L.	'Ohia 'Ai, Mountain Apple, Malay Apple	P
		Microsorium scolopendria	Laua'e	X
		Oplismenus hirtellus	Honohono Kukui, Honohono Maoli, Basket Grass	X
		Pandanus odoratissimus	Hala, Pu Hala, Pandanus, Screw Pine	I
		Paspalum conjugatum Berg.	Mau'u Malahini, Mau'u Hilo, Hilo Grass, Sour Paspalum	X
		Psidium guajava L.	Kuawa, Guava	X
		Rubus rosaefolius Sm.	'Ola'a, 'Akala, 'Akalakala Thimbleberry	X

TABLE 6 (CONTINUED)

FLORAL SPECIES OF SAMPLE STANDS WITHIN PROJECT AREA

Sample Stand No.	Community Type	Identified Species Within Sample Stands Scientific Name	Vernacular Name	Origin*
57	Aleurites-Eugenia Forest	Aleurites moluccana	Kukui, Candlenut Tree	P
		Cibotium splendens	Hapu'u Pulu, Hapu'u, Hawaiian Tree Fern	E
		Clidemia hirta	--	X
		Cordyline terminalis	Ki, Ti	P
		Cyclosorus dentata	Pai'i'iha, Oak Fern, Downy Wood Fern	X
		Dioscorea bulbifera L.	Hoi, Bitter Yam	P
		Dioscorea pentaphylla L.	Pi'a	P
		Eugenia malaccensis L.	'Ohia Ai, Mountain Apple Malay Apple	P
		Hibiscus tiliaceus L.	Hau	P
		Nephrolepis hirsutula	Kupukupu, Okupukupu, Ni'ani'au, Swordfern	X
		Oplismenus hirtellus	Honohono Kukui, Honohono Maoli, Basket Grass	X
		Pandanus odoratissimus	Hala, Pu Hala, Pandanus Screw Pine	E
		Spathoglottis plicata Bl	--	X
		Zingiber zerambet	'Anapuhi, Kuahiwi, 'Opuhi Wild Ginger	P
58	Hibiscus Forest	Clidemia hirta	--	X
		Cordyline terminalis	Ki, Ti	P
		Dioscorea pentaphylla L.	Pi'a	P
		Microsorium scolopendria	Laua'e	X
		Oplismenus hirtellus	Honohono Kukui, Honohono Maoli, Basket Grass	X
		Pandanus odoratissimus	Hala, Pu Hala, Pandanus, Screw Pine	P
		Wikstroemia oahuensis	'Akia, False 'Ohelo	E
		Zingiber zerambet	'Awapahi, Kuahiwi, 'Opuhi Wild Ginger	P
62	Acacia-Pandanus Forest	Acacia Koa Gray	Koa	E
		Cibotium splendens	Hapu'u Pulu, Hapu'u Hawaiian Tree Fern	E

TABLE 6 (CONTINUED)

FLORAL SPECIES OF SAMPLE STANDS WITHIN PROJECT AREA

Sample Stand No.	Community Type	Identified Species Within Sample Stands Scientific Name	Vernacular Name	Origin*
		Dicranopteris linearis	Uluhe, False Staghorn	E/I
		Niphrolepis hirsutula	Kupukupu, Okupukupu Ni'ani'au, Swordfern	X
		Pandanus odoratissimus	Hala, Pu Hala, Pandanus, Screw Pine	P
63	Pandanus-Clidemia Woodland	Eugenia camini	Palama, Java Plum, Jambolan Plum	X
		Brassaia actinophylla Endl.	Umbrella Tree, Octopus Tree	X
		Cibotium splendens	Hapu'u Pulu, Hapu'u, Hawaiian Tree Fern	E
		Clidemia hirta	--	X
		Cordyline terminalis	Ki, Ti	P
		Cyclosorus dentata	Pai'i'ha, Oak Fern Downy Wood Fern	X
		Nephrolepis hirsutula	Kupukupu, Okupukupu, Ni'ani'au, Swordfern	X
		Pandanus odoratissimus	Hala, Pu Hala, Pandanus Screw Pine	E
		Paspalum conjugatum Berg.	Mau'u Malihini, Mau'u Hilo, Hilo Grass, Sour Paspalum	X
		Psidium guajava L.	Kuawa, Guava	X
64	Acacia-Pandanus Forest	Acacia koa Gray	Koa	E
		Cibotium splendens	Hapu'u Pulu, Hapu'u, Hawaiian Tree Fern	E
		Clidemia hirta	--	X
		Dicranopteris linearis	Uluhe, False Staghorn	E/I
		Oplismenus hirtellus	Honohono Kukui, Honohono Maoli, Basket Grass	X
		Pandanus odoratissimus	Hala, Pu Hala, Pandanus Screw Pine	E
		Spathoglottis plicata Bl	--	X

LEGEND: E = Endemic
I = Indigenous
P = Polynesian Introduction Before Cook
X = Exotic Introduction Before Cook

A detailed list from Wirawan's thesis of the valley's flora can be found in Appendix D. Other rare, interesting or unusual plants are listed on Table 7 and the more common species found in Kahana are listed on Table 8.

The proposed reservoir will be located in an area characterized by a Koa-Pandanus community. General floral species found in this area are listed on Table 5. A specific listing of plants within the vicinity of the reservoir can be found on Table 6. Sample Stands 62 and 64 are closest to the reservoir site. The access road will traverse through portions of the following plant communities; Kukui Forests, Koa-Pandanus Forests, Koa-Pandanus Woodlands, Mixed Forest Scrub, Pasture and Cultivated Ecosystems and strand. The associated species of these communities can be found on Table 5. Sample stands from Wirawan's study that are within the near vicinity of the access road are 10, 11, 57, 58 and 63. Species found in these stands are again listed on Table 6.

The avifauna found in Kahana Valley is, like its floral community, a mixture of endemic, indigenous and exotic species. Table 9 lists those birds which are known to inhabit the valley as well as which those are believed to use the valley as a habitat. The actual presence or absence of those presumed avifauna, especially the endemic forest birds will have to be determined by actual field observations. However, it is considered likely that the 'Apapane, 'Amakihi and 'I'iwi may exist in the upper valley, particularly along the crests of ridges. It is also possible that a few Oahu Honeycreepers may be found in the 'Ohi'a forests.

Native and introduced waterbirds such as the Black-Crowned Night-Heron and the Cattle Egret can occasionally be found in the lower areas of the valley. The Hawaiian Coot and the Hawaiian Gallinule, which are

TABLE 7

INTERESTING, RARE, OR UNUSUAL PLANTS OF THE KAHANA VALLEY

Scientific Name	Vernacular Name	Origin*	Use
Acacia koa	Koa	E	many uses
Aleurites moluccana	Kukui	P	many uses
Artocarpus altilis	'Ulu	P	many uses
Bixa orellana	'Alaea	I	several uses
Canavalia cathartica	Mauna-Loa	X	medicinal
Charpentiera obovata	Papala	E	botanical interest
Cibotium chamissoi	Hapu'u 'I'i	E	several uses
Cibotium splendens	Hapu'u Pulu	E	several uses
Clidemia hirta	Koster's Curse	X	introduced pest
Colocasia esculenta	Taro	P	several uses
Cordyline terminalis	Ki, Ti	P	many uses
Cuscuta sandwichiana	Kauna'oa	E	leis
Cyrtandra spp.	Largest Genus in Hawaii	E	--
Diospyros ferrea	Lama	I	lumber
Elaeocarpus bifidus	Kalia	E	several uses
Eucalyptus sp.	Pale-Piwa	X	timber, medicinal
Korthalsella latissima	Kaumahana	I	--
Morinda citrifolia	Noni	P	several uses
Osmanthus sandwichensis	Olopua	E	timber
Peperomia spp.	Large Genus in Hawaii	E	--
Pisonia umbellifera	Papala-Kepau	E	lumber
Pityrogramma spp. -	--	X	--
Pritchardia sp.	Loulu Palm	E	--
Psilotum spp.	Moa	I	--
Scaevola spp.	Naupaka	E	--
Sida fallax	'Ilima	E	leis, medicinal
Stypelia tameiameiae	Pukiawe	E	several uses
Touchardia latifolia	Olona	E	rope, fish netting

*LEGEND: E = Endemic
I = Indigenous
P = Polynesian Introduction Before Cook
X = Exotic Introduction After Cook

Source: Kahana Valley Botanical Survey, William L. Theobald and Nengah Wirawan, March 1973.

TABLE 8

COMMON NATIVE AND NATURALIZED SPECIES OF VASCULAR PLANTS
OF THE KAHANA VALLEY

Scientific Name	Vernacular Name	Origin*
Acacia koa	Koa	E
Aleurites moluccana	Kukui	P
Bidens pilosa	Ko'oko'olau, Koko'olau, Ko'olau	X
Brassaia actinophylla	Octopus Tree	X
Cibotium splendens	Hapu'u Pulu	E
Clidemia hirta	Koster's Curse	X
Cordyline terminalis	Ti	P
Dicranopteris linearis	Uluhe, False Staghorn Fern	I
Eugenia cuminii	Palama	X
Euptatorium riparium	Pa'-makani	X
Freycinetia arborea	'ie'ie	E
Heychium coronarium	'Awapuhi Ke'oke'o, White Ginger	X
Hibiscus tiliaceus	Hau	P
Metrosideros collina	'Ohi'a-lehua	E
Microsorium scolopendria	Laua'e	X
Pandanus odoratissimus	Hala, Pu Hala, Pandanus, Screw Pine	I
Psidium cattleianum	Waiawi 'Ula'ula, Purple Strawberry Guava, Cattley Guava	X
Psidium guajava	Kuawa, Guava	X
Rubus rosaefolius	'Ola'a	X
Scaevola gaudichaudiana	Naupaka - Kauhiwi, Mountain Naupaka	E
Sphenomeris chusana	Pala'a	I
Wikstroemia oahuense	'Akia	E
Zingiber zerumbet	'Awapuhi Kuahiwi, 'Opuhi	P

*Legend:

E = Endemic
I = Indigenous
P = Polynesian Introduction Before Cook
X = Exotic Introduction After Cook

Source: Kahana Valley Botanical Survey, William L. Theobald and Nengah Wirawan, March 1973.

TABLE 9

AVIFAUNA KNOWN OR THOUGHT TO EXIST IN KAHANA VALLEY

	Scientific Name	Vernacular Name(s)	Distribution
Endemic Species	Chasiempis sandwichensis gayi	'Elepaio	Seen on most forest trails on Oahu.
	Loxops virens chloris	'Amakihi	One of the most common native birds. Frequents leafy branches of koa, 'ohi'a, sandalwood and other plants for insects, nectar and fruit.
	Loxops maculatus[2]	'Alauwahio Oahu Creeper	Extremely rare on Oahu. Found in both Waianae and Koolau Ranges.
	Himatione sanguinea	'Apapane	Abundant in native forests and occasionally common in flowering exotic forest.
	Vestiaria coccinea[1]	'I'iwi	Rare on Oahu, often seen in upper canopy, especially 'ohi'a.
Birds	Himantopus mexicanus[2] knudseni	Ae'o Hawaiian Stilt	Found in ponds, marshy areas, and mudflats. Rarely seen in Kahana possibly due to continual human disturbance along the highway.
	Fulica americana alai[2]	'Alae Ke'oke'o Hawaiian Coot	Found in fresh and brackish water marshes and ponds, preferring open water areas. Known to feed in lower marsh of Kahana Valley and Huiloa Fishpond.
	Gallinulla chloropus[2] sandvicensis	'Alae 'Ula Hawaiian Gallinule	Frequents freshwater ponds, marshes, reservoirs and taro patches, known to feed in partially flooded pastureland of Kahana Valley above Kamehameha Highway.
Indigenous Species	Nycticorax nycticorax hoactli	'Auku'u, Black-Crowned Night-Heron	Feeds in ponds, streams, marshes, lagoons and tidepools. Observed feeding on mudflats in lower marsh and fishpond in Kahana Valley.
Migrant Species	Pluvialis dominica	Kolea, American Golden Plover	Found in mudflats, lawns, fields and grassy mountain slopes from sea level to 10,000 feet or more. Recorded regularly at Kahana.
	Heteroscelus incanus	'Ulili, Wandering Tattler	Feeds along rocky shorelines, streams and mudflats. Appears regularly in count records for Kahana.
	Arenaria interpres	'Akekeke, Ruddy Turnstone	Frequents shoreline, mudflats and fields. Appears regularly in records for Kahana.
Introduced Species	Bulbulcus ibis	Cattle Egret	Common on Oahu where it frequents cattle pens, pastures, garbage dumps, etc.
	Acridotheres tristis	Common Myna	Common in Kahana Bay Beach Park area. Found on all main islands generally at lower elevations.

TABLE 9 (CONTINUED)

AVIFAUNA KNOWN OR THOUGHT TO EXIST IN KAHANA VALLEY

Scientific Name	Vernacular Name(s)	Distribution
Geopelia striata	Barred Dove Zebra Dove	On all main islands from sea level to 4,000 feet. Common in Kahana Bay Beach Park area.
Streptopelia chinensis	Spotted Dove, Lace-Necked Dove, Chinese Dove	On all main islands from sea level to 8,000 feet. Common in Kahana Bay Beach Park area.
Passer domesticus	House Sparrow English Sparrow	Common in lowland urban areas on all main islands. Common in mid-elevation areas of Kahana Valley.
Carpodacus mexicanus	House Finch, Linnet, Papaya Bird	Common in urban areas and forest on all main islands. Common in mid-elevation areas of Kahana Valley.
Lonchura punctulata	Spotted Munia, Ricebird, Nutmet Mannikin	Widespread at virtually all elevations on main islands. Feeds in open grassy areas.
Cardinalis cardinalis	Northern Cardinal Kentucky Cardinal	Common on all main islands in lowlands, exotic forests and in native forests to a lesser extent. usually found in or near dense underbrush or in forests. Found in forested lower valley in Kahana.
Cettia diphone	Japanese Bush Warbler, Uguisu	Found in dense underbrush commonly in exotic forests. In Kahana found in forested lower valley.
Garrulax canorus	Hwa-mei, Chinese Thrush, Melodious Laughing Thrush	On all main islands keeping to the underbrush. Found in Kahana's lower forested areas.
Copysychus malabaricus	Shama	Common on Oahu's exotic forests in valleys and locally on ridges of southern Koolau Range. Usually well hidden in dense vegetation. In Kahana found on lower forested valley.
Zosterops japonicus	Japanese White-Eye, Mejiro	Inhabits both wet and dry habitats from sea level to tree line on all main islands. Found in lower forested valley in Kahana Valley.

[1]State Endangered Species List

[2]State and Federal Endangered Species List

recorded annually in Huilua Pond, are listed as endangered species by the Federal and State Governments. For this reason, Kahana marsh lands, streams, and pasture lands have been identified as areas of secondary importance to endangered species in the Hawaii Waterbirds Recovery Plan. Introduced species of birds such as the Kentucky Cardinal, California Linnet, Mynah, White-Eye, House Sparrow and Rice Birds are common throughout mid-elevation areas.

There are relatively few species of land mammals known to exist in Kahana Valley. Table 10 lists those mammals known to inhabit Kahana Valley. The majority of these mammals are recent introductions either intentionally or inadvertently brought in by man. As noted on the table, the Hawaiian Hoary Bat, an endangered species, may be only occasionally spotted and it is not known to use the valley as a habitat. The wild pig population is presently controlled by public hunting. The remaining mammalian species are known to exist on an island-wide basis.

Kahana Stream has been included in the National Park Service's Nation-wide Rivers Inventory. The entire stream from the mouth to its source has been included and represents one of the highest quality stream systems on the Island of Oahu. A portion of Kahana Stream beginning approximately 4.8 miles inland along the stream has been designated as a "critical habitat" (Figure 12). A "critical habitat" is defined as a physical pristine stream which has a complement of native animals.

There have been several survey studies performed on the macrofauna of Kahana Stream, its tributaries and estuary. Table 11 is a compilation of the macrofauna found in these waterways in various surveys. As can be seen a large number of the macrofauna found are native to Hawaii. In the most recent study available, Biological Survey of Kahana Stream System 24 animal species or groups were found in the freshwater

TABLE 10

MAMMALS KNOWN TO EXIST IN THE PROJECT AREAS

Vernacular	Scientific Name	Distribution
Hawaiian or Hoary Bat* ('Ope'ape'a)	Lasiurus cinereus semotus	Primarily concentrated on the Island of Hawaii but occasionally spotted on Oahu during the months from August to December. Most commonly seen in elevations ranging from sea level to 4,000 feet and prefers open or mixed habitats. Not seen in dense, closed wet forests.
Feral or Wild Pig (Pua'a)	Sus scrofa	Commonly found in rainforests and high elevation areas. However, these creatures are highly adaptable and may be found in "any tropical to subalpine area that is not intensely used by humans."
Pacific or Hawaiian Rat ('Iole)	Rattus exulans	Prefers wild lowland habitats such as gulches and seldom inhabits buildings or wet forest.
Norway Rat, also known as Brown Sewer or Wharf Rat ('Iole-po'o-wai)	Rattus norvegicus	Prefers lower elevations but can be found in mid elevation planted forest. They are rarely found in higher elevation dry grasslands, canefields or wet forests.
Roof Rat, also known as House Rat or Black Rat ('Iole-nui)	Rattus rattus	These rats are "very adaptable and can be found in many diverse habitats." Prefers the middle elevations and are found in canefields, gulches, brush areas, grasslands, and wet and dry forests. May be a major factor in decline of native land snails and birds as they are often observed in trees. They are found throughout Oahu.
House Mouse ('Iole li'ili'i)	Mus musculus	Like the Roof Rat, it is found in a number of diverse habitats ranging from dry beach areas to high elevation wet forest. Found throughout Oahu.
Feral Dog (Ilio)	Canis familiaris	There are a number of dogs in the project vicinity which may range into Kahana Valley. These are usually strays or abandoned animals which forage around the City and County Beach Park or may venture further in.
Feral Cat (Popoki)	Felis catus	The majority of feral cats on Oahu are concentrated along the lower and drier elevations but are known to go into higher and wetter areas. They often congregate near food sources, such as camp grounds and picnic areas.
Mongoose ('Iole-manakuke)	Herpestes auropunctatus	They are known to inhabit all habitats from sea level to the highest peaks on Oahu. They seem to prefer warm humid areas below the 2,000-foot elevation where there is a natural mixed vegetative pattern with an abundance of cover and shelter.

*Only endemic land mammal in Hawaii.

TABLE 11

LIST OF MACROFAUNA IN KAHANA STREAM AND ITS TRIBUTARIES, HANALELE AND KAWA, AND KAHANA ESTUARY

Scientific Name	Vernacular Names	Origin[1]
Annelids (worms)		
Hirudinea	Leech	Unknown
Nemalycastis abiuma	Polychaete Worm	Endemic
Oligochaeta	Earthworm	Unknown
Insects		
Diptera: Chironomidae	Midge Larva	Endemic
Tipulidae	Cranefly Larva	Endemic
Ephemeroptera: Unidentified	Mayfly Nymph	Unknown
Odonata: Anisoptera	Dragonfly Naiad	Unknown
Zygoptera	Damselfly Naiad	Unknown
Trichoptera:		
Cheumatopsyche analis	Caddisfly Larva	Exotic
Oxyethira maya	Microcaddisfly Larva	Exotic
Mollusks		
Melania sp.	Pond Snail	Indigenous
Theodoxus (Neritina) vespertina	Brown Wi	Indigenous
Crustaceans		
Atya bisulcata	Mountain Shrimp, Black Opae, Opae Kala'ole	Endemic
Macrobrachium grandimanus	Opae Oehaa, Hawaiian Prawn	Endemic
Macrobrachium lar	Tahitian Prawn, Guamanian Prawn	Exotic
Macrobrachium rosenbergii	Malaysian Prawn	Exotic
Macrobrachium volenhovenii	African Prawn	Exotic
Metopograpsus (thukuhar) messor	Black Land Crab, Thukuhar	Indigenous
Palaemon (Leander) debilis	Red-Tipped Opae, Grass Shrimp	Indigenous
Palaemon pacificus		
Palaemonella sp.		
Penaeus marginatus	Long-eyed Swimming Crab	Indigenous
Podophthalmus vigil	Haole Crab, Blood-Spotted Swimming Crab	Indigenous
Portunus sanguinolentus	Crayfish	Exotic
Procambarus clarkii	Samoan Crab	Endemic
Scylla serrata	Hapa Crab	Indigenous
Thalamita crenata		
Fishes		
Acanthurus triostegus	Manini	Endemic
Albula vulpes	loi'o	Indigenous
Apogon brachygrammus	Short-Lined Cardinal Fish	Indigenous
Arothron meleagris	Speckled Ballonfish	Indigenous
Arothron hispidus*	Makimaki	Indigenous
Bathygobius fuscus*	Goby, O'opu 'Ohune	Indigenous
Bothus pantherinus*	Paku, Flatfish	Indigenous
Caranx sp	Ulua, Papio, Jackfish	Indigenous
Chelon engeli	Engel's Mullet	Exotic
Chonophorus (Awaous) genivittatus*	O'opu Anihaniha	Indigenous
Chonophorus (Awaous) stamineus	O'opu Nakea	Indigenous
Clarias fuscus	Chinese Catfish, O'opu Kui	Exotic
Diodon holocanthus*	O'opu Hue, Ballonfish	Exotic
Eleotris sandwicensis*	O'opu Akupa	Endemic
Epinephelus sp.	Grouper	Indigenous
Epinephelus spiniger	Gunther Grouper	Exotic
Fistularia commersoni	Cornetfish	Indigenous
Gambusia affinis	Mosquitofish	Exotic
Kuhlia sandvicensis*	Aholehole	Endemic
Lebistes reticulatus	Guppy	Exotic

TABLE 11 (CONTINUED)

LIST OF MACROFAUNA IN KAHANA STREAM AND ITS TRIBUTARIES, HANALELE AND KAWA, AND KAHANA ESTUARY

Scientific Name	Vernacular Names	Origin[1]
Mugil cephalus*	Amaama, Mullet	Indigenous
Mulloidichthys samoensis	Weke, Samoan Goatfish	Indigenous
Neomyxus chaptalii*	Uouoa	Indigenous
Oxyurichthys lonchotus*	Paoo Kaulaloa Pointed Tail Goby	Indigenous
Parupeneus porphyreus	Kumu	Indigenous
Poecilia reticulata	Wild Guppy	Exotic
Sarotherodon mossambica	Tilapia	Exotic
Saurida gracilis*	Ulae, Lizardfish	Indigenous
Seriola dumerilii (?)	Kahala	Indigenous
Sphyraena barracuda*	Kaku, Barracuda	Indigenous
Vitraria clarescens	Goby	Indigenous
Xiphophorus helleri	Swordtail	Exotic

[1]Terms used in this column: Endemic - occurring naturally in Hawaii only.
Indigenous - occurring naturally in Hawaii and also elsewhere.
Exotic - brought to Hawaii either intentionally or accidentally.

*Perennial Fish.

NOTE: The O'opu Nakea is considered as a depleted species for Kahana Stream and Oahu.

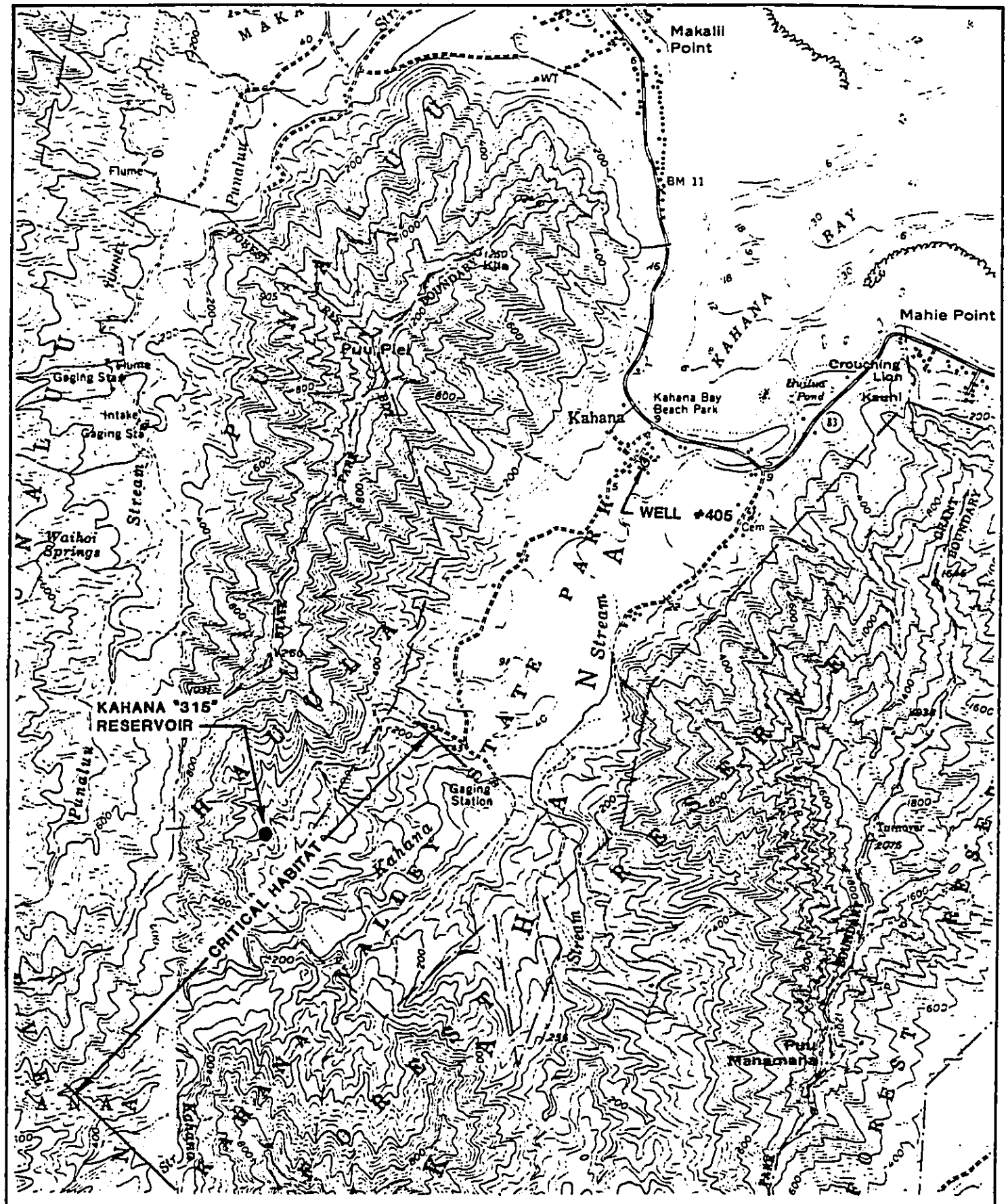


FIGURE 12

CRITICAL HABITAT

streams. Of these, 11 were either endemic or indigenous. In the estuarine area, 21 fish and decapod crustacean species were found, of which 17 were endemic or indigenous. It had been noted that since the previous 1972 surveys the disappearance of two endemic species had occurred. These were a freshwater mollusc, Neritina granosa or Hihiwai (also known as Black Wi or River Opihi) and Sicydium stimpsoni or O'opu nopili, a freshwater goby.

Possible reasons for the disappearance of these endemic species include increased siltation and over-harvesting for the Hihiwai and the loss of habitat for the O'opu nopili.

Kahana's critical habitat (Figure 12) is "a series of strong rapids and pools" of which the "substratum is mostly boulder-cobble in rapids and large pebbles and sand in pools. No silt accumulates at midstream."

"The macrobiota consists of O'opu nakea, Tahitian Prawns, Mountain Shrimp, some poeciliid fishes and insect larvae consisting mostly of Cheumatopsyche analis (Trichoptera)." This critical habitat in Kahana Stream is not only intrinsically valuable but it also has value as a fisheries resource. The Mountain Shrimp, O'opu nakea, O'opu okuhe, and Tahitian Prawn are of economic value. Kahana Stream may also support Lentipes concalor, a rare endemic goby. Studies on Kahana Stream's physical and chemical parameters indicate that it is well within temperature, conductivity, pH and oxygen ranges to support this goby.

The Kahana Estuary was also part of this survey and it was found that there had been no major changes in the decapod crustacean and fish species. There were seven crustaceans and 14 fish species found during the survey and they represent all of the more prevalent consumer species. Previous studies have identified 11 decapod crustaceans and 24 species of fish and it has been estimated that there may be as many as 50 native species in Hawaii's estuaries.

Some of the crustaceans found during the 1980 survey include Haole Crab, Samoan Crab, Tahitian and Hawaiian Prawns, and Opae oehaa. Fish species collected include O'opu nakea, Ulua, Aholehole, and Amaama. Of these, the Prawns, Aholehole and Amaama or Mullet are of economic importance.

C. SOCIO-ECONOMIC CHARACTERISTICS

1. Population

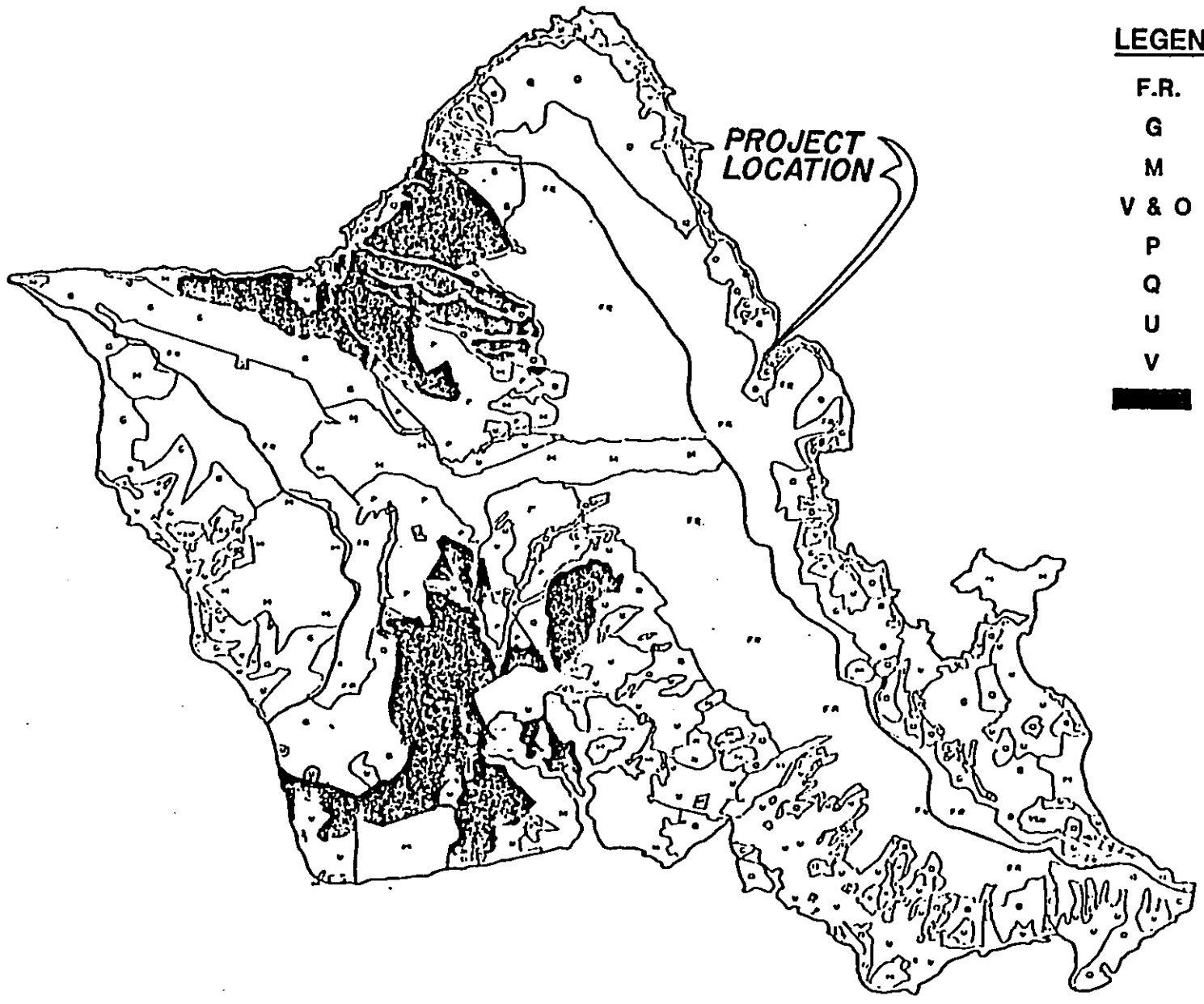
The 1980 general census established the resident population of the Island of Oahu at 762,565. This data, obtained from the 1982 State of Hawaii Data Book includes military personnel and their dependents and represents 79 percent of the total State resident population (964,691). According to the Revised Population and Economic Projections, 1975-2000 published by the Department of Planning and Economic Development, population projections for the year 1985 based on the Series II-F projection is estimated to be 803,800.

The population trend of the Koolauloa District where Kahana Valley is located shows an increase of 34.9 percent for the years 1970-1980. The general trend for the district over the past 20 years has been toward population increase.

At the time the Kahana Valley State Park Revised Environmental Impact Statement was published in 1978, it was estimated that approximately 150 persons were residents of the valley. In 1982, when the Revised Environmental Impact Statement for the Kahana Water Development Project was published, the population included approximately 90 residents.

2. Land Use

The land uses of the area of the water system to be served covers the entire list from Forest Reserve to sugar. Figure 13 is a



LEGEND:

F.R.	FOREST RESERVE
G	GRAZING
M	MILITARY
V & O	VEGETABLE & ORCHARD
P	PINEAPPLE
Q	MISC. PUBLIC USE
U	URBAN
V	RICE, TARO, VEG.
■	SUGAR

NO SCALE

FIGURE 13

GENERALIZED LAND USE

Generalized Land Use map of the area developed for the Hawaii Water Resources Regional Study in 1970. Within Kahana Valley, land use ranges from forest reserve to grazing, miscellaneous public use (park), and other agricultural utilization.

There are approximately 12 acres of State and County property that is easily accessible and currently being used for park purposes. The beach area makai of Kamehameha Highway is under the jurisdiction of the City and County and its recreational uses include fishing, crabbing, swimming and camping. The park areas mauka of the highway which includes the coconut grove and Kahana Valley State Park is under the jurisdiction of the State DLNR. A permit is required from DLNR to gain entry beyond the coconut grove which is used as a picnic area. The inland portion of Kahana Valley extending into the Hauula and Ewa Forest Reserves are included in Hunting Unit C of the DLNR's Public Hunting Areas. This area has been set aside for the hunting of wild pigs. Another activity that is enjoyed within the inner confines of the valley is hiking. However, this activity also requires a permit for entry into the valley.

There is a small residential area located in the makai area of the valley floor. Most of the families grow and/or raise fruits, vegetables, chickens, ducks and geese. There are also various commercial agricultural activities allowed by DLNR which include cattle and horse grazing, and growing of papayas, bananas and ti plants. Much of the areas once used for other agricultural activities are now overgrown with vegetation. The greater portion of the lower valley is part of the State Park while the higher elevation areas are part of a forest reserve.

3. Kahana Valley State Park

Much of Phase I for the Kahana Valley State Park development plan has been started. The main access road, parking and comfort

station, orientation building and the Hawaiiana Demonstration Area are all under construction. The implementation of Phase II (the remainder) awaits the allocation of the necessary funds.

4. Economic Aspects

The economy of Hawaii, its growth and development, is directly related to its location and climate. About 80 percent of the economic activity of Hawaii takes place on Oahu. The economy is basically service oriented with some manufacturing and agriculture. Part of this is due to the decline of agriculture.

Tourism, defense, sugar and pineapple are the four major export industries. Tourism is now the major industry, but at one time it was sugar and pineapple. Other industries exist because of the revenues earned by the people who work for the major export industries.

Kahana Valley is owned in its entirety by the State of Hawaii and supports a small rural community. Most of the residents live in the lower makai portion of the valley. Their homes are generally old, most of which are in poor condition. A majority of the families raise chickens, ducks and geese and grow fruits and vegetables in their backyards. Some are engaged in commercial agricultural activities such as grazing of cattle and horses and growing of papayas, bananas and ti leaves.

The lifestyle within Kahana Valley can best be described as being a rural/agrarian community. Many individuals possess skills in quilt making, lauhala weaving, net making, taro raising, and canoe building. Most of the men in the area are knowledgeable in fishing methods. Hui O Kanani O Kahana is the association that speaks for most of the valley's long term residents.

D. INFRASTRUCTURE

1. Roads and Traffic

Kahana Valley Road leads into the western portion of the valley and is the only access for the village and upper valley residents to and from Kamehameha Highway. The roadway is paved for approximately 3/4 of a mile into the valley but degenerates beyond this in the mauka portion. The remaining internal road system is generally substandard and transportation is restricted to four-wheel drive vehicles or foot.

A military road which once served the armed forces for jungle warfare training during World War II forms the backbone of the present transportation network. Much of it, however, now serves as hiking trails primarily used by hunters and hikers.

2. Water

The BWS has recently installed two new wells (Kahana Wells I) in the lower portion of Kahana Valley. A 12-inch transmission line links Kahana Wells I wells to the 30-inch transmission main which runs along Kamehameha Highway. The originally desired sustained capacity from the two wells was 1.0 mgd. However, this capacity could not be achieved due to the geologic structure of the sites. Presently, the average pumpage from the wells is about 0.5 mgd, even though the installed pump capacities equal 1.0 mgd. The State Department of Health has given its approval to use the new wells in accordance with the State's Safe Drinking Water Regulations.

The BWS also proposes to develop an additional four well fields within Kahana Valley. Kahana Wells II, III, IV and V is anticipated to produce an estimated total of 6 million gallons per day (mgd) of potable water. Kahana Wells II, located on the southern slope, will produce an estimated 1.0 mgd of potable water. The remainder will be located on the northern slope of

Kahana Valley. Each well field will have an associated control building and access road. The wells will be connected to either the proposed Kahana Reservoir or the existing transmission main along Kamehameha Highway. The BWS hopes to develop the water resources in Kahana Valley to help meet the increasing water needs of Oahu. Development of the facilities is estimated to cost $9 million.

High level water is presently withdrawn from the Kahana Tunnel system which is located in the upper valley region. Approximately 5 mgd of water presently enters the Waiahole Ditch system which conveys water to the Leeward side of Oahu for sugarcane irrigation. Water rights for this system are currently leased by Oahu Sugar Company from the State.

The Board of Water Supply is proposing to build a 6.0 million gallon reservoir along the same hunting road that will serve as the alignment for the access road to the proposed well fields. The function of the 6.0 MG reservoir in the vicinity of Kahana would (1) increase transmission capability on the narrow winding Kamehameha Highway, (2) reduce the need for high operating pressures to meet peak hour loads and the inherent increased risk of service disruptions due to main breaks as a result of high operating pressures and pressure surges, and (3) allow efficient operation of the 23 mgd existing and planned sources between Kahana and Laie. This will be achieved by the storage tank's large size which will allow more efficient pump operations through steadier, longer duration pumping.

E. ARCHAEOLOGICAL/HISTORICAL CHARACTERISTICS

Previous archaeological surveys performed by the Bishop Museum for the Hawaii State Parks Division uncovered more than 100 archaeological sites in Kahana Valley. These sites were basically clustered in three areas of the valley (Figure 14) and were composed of a number of

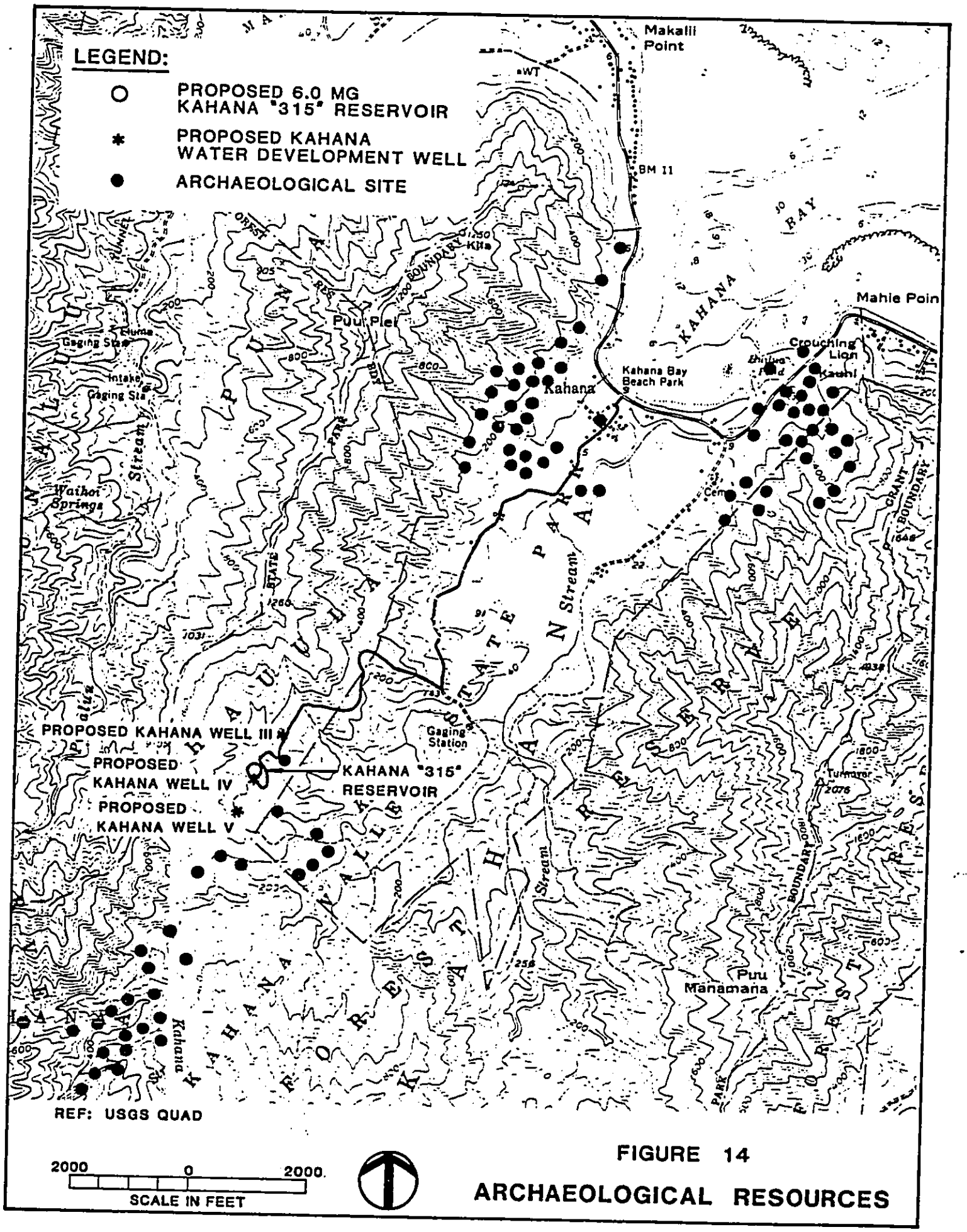


FIGURE 14

ARCHAEOLOGICAL RESOURCES

different types. The sites were generally located on either side of Kahana Bay and along Kahana Stream in the inland portion of the valley. The sites surveyed are divided into three major categories; living quarters, religious ceremonies and economic purposes. Agricultural activities are characterized by animal enclosures, auwai's and wet and dry terraces. These sites are discussed in greater detail in the Revised Environmental Impact Statement for the Kahana Valley State Park dated October 1978. Other archaeological sites include cleanups, graves, kuleanas, midden deposits, mounds, platforms, walls, wells, habitation structures and the Huilua Fishpond. This fishpond has been a National Historic Landmark since 1966 and was included on the Hawaii Register of Historic Places in February 1979.

At the time the Kahana Reservoir Site No. 1 was being considered for a 2.0 MG reservoir, the Bishop Museum was engaged to conduct an archaeological survey covering the route of the proposed influent-effluent main, i.e., the access road and Kahana Reservoir Site 1. The results of this survey, conducted in April 1980, and herein included as Appendix E, revealed no surface archaeological sites within this project area other than an auwai. At a point approximately 4,000 feet from Kamehameha Highway, the auwai crosses Kahana Valley Road via a pipe and cement conduit. The survey did not evaluate subsurface archaeological resources and recommended on site archaeological monitoring during construction.

Later, in May 1980, the Bishop Museum was again engaged by the BWS to conduct an additional archaeological reconnaissance along the jeep road and for three proposed well fields (Kahana Valley Water Development Project). At the time of the survey, the 2.0 MG Kahana Reservoir Site 1 was still under consideration which accounts for the use of 2,400 feet in the Addendum (Appendix E) as the distance of the well from the reservoir. The now proposed 6.0 MG Kahana "315"

Reservoir Site 3 is approximately 150 feet uphill of the proposed Kahana Wells IV. The results of this survey are stated below and included as an addendum to the archaeological report (Appendix E).

> "The archaeologists encountered no significant archaeological remains. Since the area was once used as an Army road, it has already been greatly modified and disturbed.
>
> Based on this surface reconnaissance, there are no archaeological objections to the proposed project. Although unlikely, it is possible that subsurface archaeological features such as stone alignments or artifacts could be encountered once the project has begun. If this occurs, archaeologists at Bishop Museum should be contacted immediately."

With the exception of an auwai which crosses Kahana Valley Road, along which the 42-inch influent-effluent main will be laid, no archaeological sites currently known to exist will be affected by the project.

Additional surveys of the reservoir site were made by State Park archaeologists on January 28, 1982 and on February 19, 1983. The first survey was made when the site was overgrown with uluhe fern. There was no evidence of surface archaeological or historical sites. The site was visited again when some clearing work had been performed. Again, there was no evidence of archaeological surface features in the reservoir vicinity. The Board will arrange for the State Parks archaeologists to observe the excavation work for any evidence of subsurface cultural remains when the work takes place.

SECTION IV

RELATIONSHIP OF THE PROPOSED ACTION TO LAND USE PLANS, POLICIES AND CONTROLS FOR THE AREA

A. GENERAL

The land use controls for the project site are as follows:

1. State of Hawaii

As shown on Figure 15, Kahana Valley and the surrounding Forest Reserve are designated as Conservation District land by the State Land Use Commission. The DLNR, under whose jurisdiction these lands are under, has further designated the area as a Resource (R) Subzone. THe objective of the establishment of this subzone is the development, with proper management, of areas to ensure the sustained use of the natural resources of those areas.

The boundaries for this subzone includes:

- Lands necessary for providing future park land and lands presently used for national, State, County or private parks;

- Lands suitable for growing and harvesting of commercial timber or other forest products;

- Lands suitable for outdoor recreational uses such as hunting, fishing, hiking, camping, and picnicking;

- Offshore islands of the State of Hawaii, unless placed in a (P) or (L) Subzone;

- Lands and territorial waters below the upper reaches of the wash of waves, usually evidenced by the edge of vegetation or by the debris left by the wash of waves, unless placed in a (P) or (L) Subzone; and

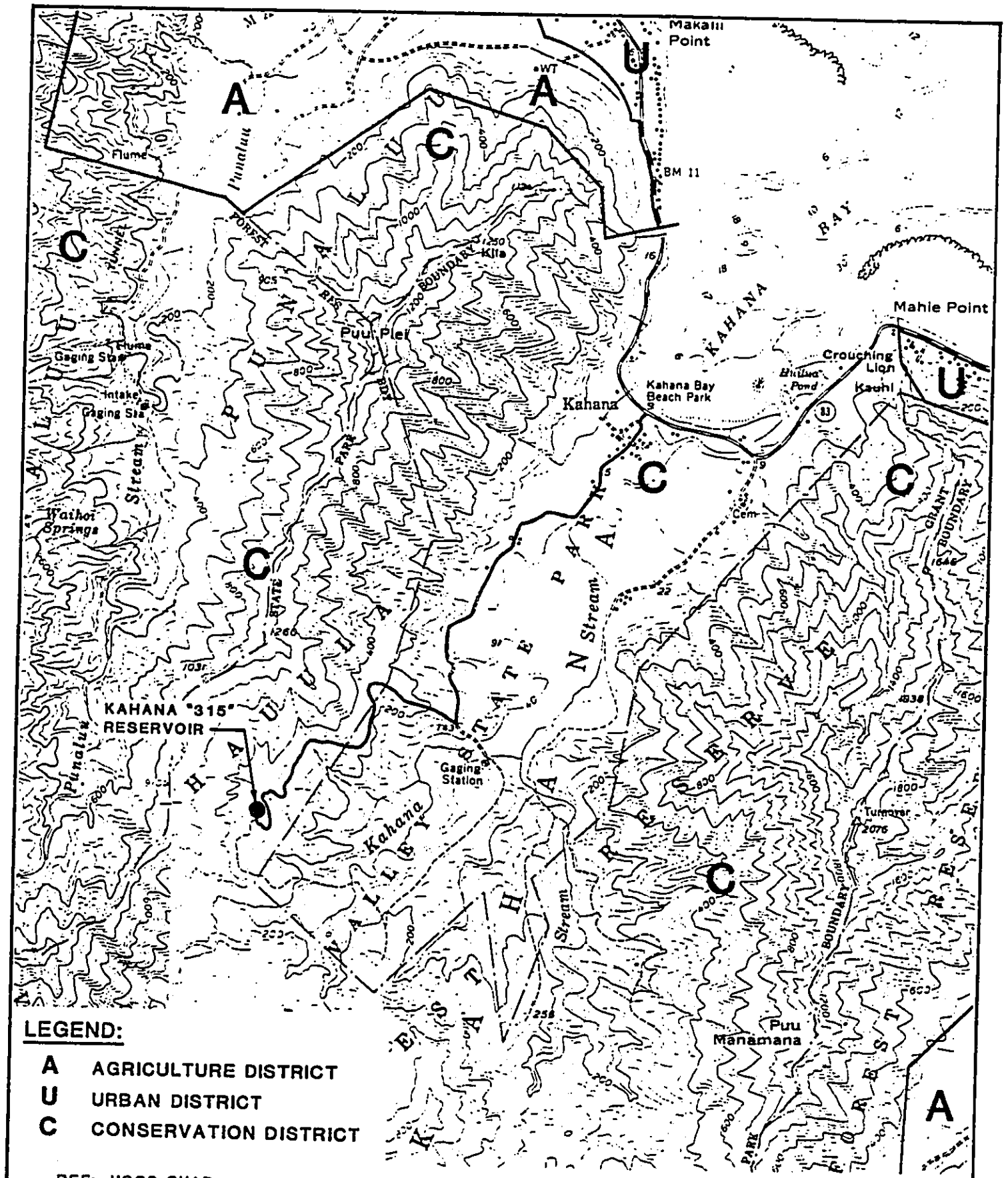


FIGURE 15

STATE LAND USE DISTRICTS

- All territorial water not expressly assigned to any subzone shall be in the (R) Subzone.

The uses that are permitted within the subzone is a combination of those permitted within the Preservation and Limited Subzones together with those assigned to the (R) Subzone. These uses include:

- Research, recreational, and educational use which require no physical facilities;

- Establishment and operation of marine, plant, and wildlife, sanctuaries and refuges, wilderness and scenic areas, including habitat improvements;

- Restoration or operation of significant historic and archaeological sites listed on the National or State Register;

- Maintenance and protection of desired vegetation, including removal of dead, deteriorated and noxious plants;

- Programs for control of animal, plant, and marine population, to include fishing and hunting;

- Monitoring, observing, and measuring natural resources;

- Occasional use; and

- Governmental use not enumerated herein where public benefit outweighs any impact on the Conservation District.

- Emergency warning systems or emergency telephone systems;

- Flood, erosion, or siltation control projects; and

- Growing and harvesting of forest products.

- Aquaculture;

- Artificial reefs; and

- Commercial fishing operations.

The Conservation District designation of the land proposed for the project will require a Conservation District Use Application (CDUA) for the construction of the reservoir and its associated features.

2. City and County of Honolulu

According to the Comprehensive Zoning Code (CZC) for the City and County of Honolulu, Kahana Valley and the surrounding Forest Reserve are zoned as a Preservation (P-1) District (Figure 16). The State Park is further designated as Parks and Recreation by the City and County's General Plan. The following is an excerpt from Article 3 of the CZC.

"The purpose of creating this district is to establish areas to protect and preserve park lands, wilderness areas, open spaces, beach reserves, scenic areas and historic sites, open ranges, watersheds and water supplies; to conserve fish and wildlife; and to promote forestry and grazing. It is intended that all lands within a preservation district which are under state conservation district jurisdiction shall be governed by the requirements and procedures of Chapter 205, HRS, as amended. (Am. Ord. 3234)

Use Regulations

Within a P-1 Preservation district, only the following uses and structures shall be permitted:

(a) Principal uses and structures:

(1) Fish hatcheries and fish ponds;

(2) Forests and forestry;

(3) Game preserves;

(4) Private, non-illuminated golf courses, including par-3 but not minature, with a minimum area of 10 acres;

(5) Open agricultural uses not requiring intensive cultivation, including orchards, vineyards, nurseries, and the raising and grazing of livestock other than swine;

(6) Parks, recreational areas, botanical and zoological gardens, golf courses, marinas and other public buildings and uses;

(7) Public utilities installations and substations; provided that offices or storage or maintenance facilities therefor shall be permitted only as conditional uses;

(8) Watersheds, wells, water reservoirs and water control structures.

(b) Accessory uses and structures:

Uses and structures which are customarily accessory and clearly incidental and subordinate to prinicipal uses and structures; provided that roadside stands for sale of agricultural products shall not be permitted as accessory to agricultural uses in this district; provided further, that in connection with golf courses, accessory uses shall be designed and scaled to meet only the requirements of the members, guests or users of the golf course.

Private utilities, including temporary sewage treatment plants, shall also be permitted as accessory uses, provided such use is approved by the Director of Land Utilization. Private utilities so approved shall be permitted notwithstanding the location on a non-contiguous zoning lot or in another zoning district of the principal use or uses served thereby, and paragraph (1) of the definition of "accessory use" in Section 21-1.10 shall be inapplicable thereto.

(c) Conditional uses and structures:

Uses and structures hereinafter specified, subject to compliance with the provisions of Part D of Article 2 hereof:

(1) Cemetery, columbarium, crematory, and mausoleum;

(2) Extractive industries, including the removal of sand, rock, soil and gravel;

(3) Private marinas, including facilities for storage and repair of boats and sale of boating supplies and fuel;

(4) Private refuse dumps, sanitary fills and incinerators;

(5) Recreation and amusement facilities of an outdoor nature, other than as specified under permitted principal uses and structures;

(6) Storage or maintenance installations for public utilities;

(7) Television or other broadcasting stations and line-of-sight relay devices;

(8) Private recreational camps;

(9) Private riding academies;

(10) Facilities for movie and television program production.

(d) Special permit uses and structures:

Uses and structures hereinafter specified, subject to compliance with the provisions of Part E of Article 2 hereof:

(1) Private vacation cabins;

(2) Temporary structures and uses incidental to land development or building construction (Am. Ord. 3234, 3906, 4412)"

Figure 16 illustrates the general zoning of the project vicinity in accordance with the Department of General Planning's Development Plan. The designation of land where the project is

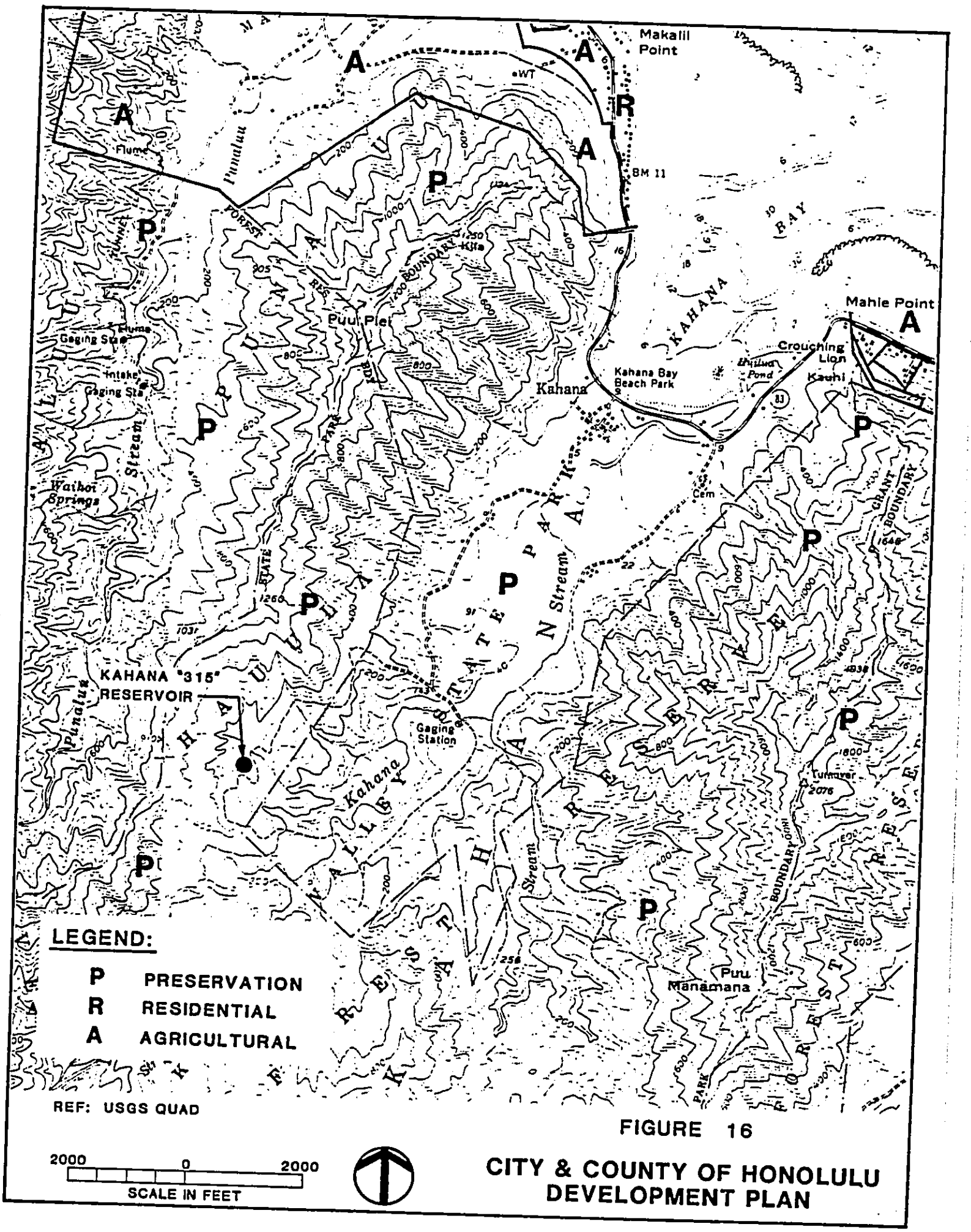


FIGURE 16

CITY & COUNTY OF HONOLULU
DEVELOPMENT PLAN

included is "Preservation" which corresponds with the City and County CZC.

Kahana Valley is also within the City and County of Honolulu's Special Management Area (SMA) (Figure 17). The SMA describes an area that the City and County of Honolulu has chosen to protect under the State's Coastal Zone Management Program. The SMA was enacted to avoid the permanent loss of valuable resources along the shoreline and its objectives is stated as follows:

> "The objectives of the special management area shall be the maintenance, restoration and enhancement of the overall quality of the coastal zone environment, including but not limited to its amenities and aesthetic values."

The project site for the proposed 6.0 MG reservoir is located outside the SMA. As such, it will not require an application for Special Management Area Use Permit (SMP) for its construction. The 42-inch influent-effluent main which will be along the improved access road is for the most part within the SMA and will require a SMP.

The proposed action of the BWS will comply with the requirements of the City and County of Honolulu SMA Program and the State of Hawaii's CZM Program.

3. Kahana Valley State Park

The Department of Land and Natural Resources has developed plans to create a "living park" out of the State-owned Kahana Valley. The Kahana Valley State Park EIS which was prepared by H. Mogi - Planning and Research, Inc., to assess the consequences of this proposal describes the proposed park plan. The first phase includes the development of a visitor's center in the lower valley near the highway. New houses for the valley residents and the development of hiking trails are also part of the overall plan. The concept requires that everyone living in the valley

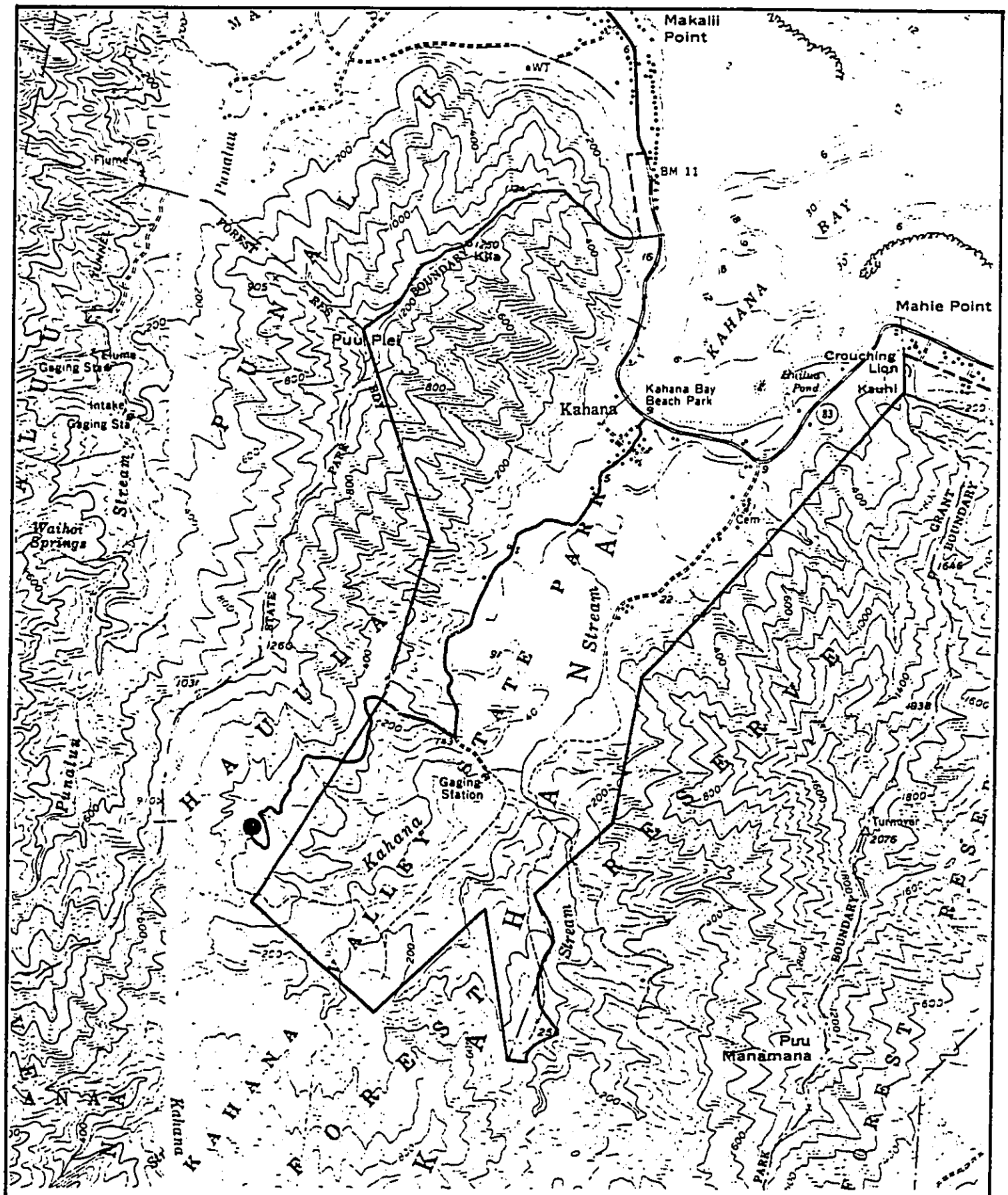


FIGURE 17

SPECIAL MANAGEMENT AREA

take part in operating and maintaining the park as a requirement of residency there. Any use of the valley by government agencies must be in consonance with the "living park" concept.

Although much of the knowledge and skills from the old Hawaiian culture are not practiced today, DLNR's park plan has been instigated to foster these diminishing Hawaiian ways. An important goals of the "living park" is to nurture the old lifestyle and to promote the teachings of its culture and values.

B. STATE OF HAWAII

1. Hawaii State Plan

The Hawaii State Plan "establishes for Hawaii an overall theme, goals, objectives, policies, priority directions and a system for plan formulation and program coordination to provide for the integration of all major State and County activities." There are several objectives and policies in the Hawaii State Plan which relate to the proposed project in some way.

A policy relating to the population objective of the State Plan and which the proposed project is consistent with is as follows:

"Section 5 (b) (3): Insure that adequate support services and facilities are provided to accommodate the desired distribution of future growth throughout the State."

The proposed reservoir and influent-effluent transmission main will be consistent with this objective. Together they will improve the existing system and provide for more efficient service now and for the future.

Section 11 of the State Plan deals with the State's physical resources that are land based, shoreline and marine. The policies and objectives in this section which relates to the proposed project are as follows:

"Section 11 (a) (1): Effective protection of Hawaii's unique and fragile environmental resources.

Section 11 (b) (2): Ensure compatibility between land-based and water-based activities and natural resources and ecological systems.

Section 11 (b) (3): Take into account the physical attributes of areas when planning and designing activities and facilities.

Section 11 (b) (4): Encourage the beneficial use of statewide forest resources without generating costly or irreparable environmental damage.

Section 11 (b) (5): Consider multiple uses in watershed areas, provided such uses to do not detrimentally affect water quality and recharge functions.

Section 11 (b) (6): Encourage the protection of rare of endangered plant and animal species and habitats native to Hawaii.

Section 11 (b) (8): Pursue compatible relationships among activities, facilities and natural resources, especially within shoreline areas."

The anticipated impacts from the project is expected to adversely affect the physical environment. This will occur not only during the construction phase but after completion of the project. Design considerations will take into account the existing physical features of the site and pending boring data. Regulations dealing with construction practices to minimize dust, noise and erosion impacts will help to mitigate construction impacts. Landscaping complementing the surrounding flora will soften the visual impact of the reservoir and its attendent instrument house. The effect on the existing fauna is not anticipated to be permanent. No doubt noises produced during construction would discourage the continued presence of land and avifauna in the project vicinity. After the construction stops it is hoped that they will return.

Section 13 also deals with the physical environment. The objectives and policies of this section however deals with land, air and water quality. The relavent policies related to the Kahana "315" Reservoir are as follows:

"Section 13 (b) (5): Reduce the threat to life and property from erosion, flooding, tsunamis, earthquakes, and other natural or man-induced hazards and disasters.

Section 13 (b) (6): Encourage design and construction practices that enhance the physical qualities of Hawaii's communities."

The proposed project will be consistent with both policies. Design considerations and construction regulations and practices will be adhered to ensure not only safety of life and property but keeping to a minimum adverse impact on the physical environment.

Section 16 of the State Plan deals with water facilities. The pertinent policies which the State uses as guidelines for the fulfillment of their objectives are:

"Section 16 (b) (1): Relate growth activities to existing and potential water supply.

Section 16 (b) (2): Support research and development of alternative water sources.

Section 16 (b) (3): Reclaim and encourage the productive use of runoff water and waste water discharges.

Section 16 (b) (4): Assist in improving the quality, efficiency, service, and storage capabilities of water systems for domestic and agricultural use.

Section 16 (b) (5): Support water supply services to areas experiencing critical water problems.

Section 16 (b) (6): Promote water conservation practices."

The BWS is actively involved in the conservation and development of water resources and facilities. It have established a municipal water use plan and in a report of the same name (Municipal Water Use Plan, Pearl Harbor Ground Water Control Area) the BWS has put forth its planning goals and programs. The water use planning goals and program are as follows:

"- Improve integration of the island-wide system so that water may be freely transported from areas of surplus to areas of need.

- Promote conservation and wise use of water supplies to extend utilization of existing sources and delay the need to develop expensive alternative sources.

- Achieve optimum development and use of potable ground and surface water resources by conversion, exchange, substitution, and recycling before resorting to more costly treatment alternatives.

- Install additional storage capacity to the maximum extent practicable, in order to promote the concept of steady state pumpage.

- Manage sources within the system to insure preservation of the groundwater basin to serve future generations in perpetuity.

- Review and comment on all requests for land use boundary and land rezoning changes to insure that any resultant growth in consumer demand will be compatible with available water supply.

The Board's planning program is capsulated as follows: Water use planning utilizes given population data from State and City agencies to project future consumer demands on the water system, thereby allowing for timely decisions regarding the development and financing of source, storage, and transmission facilities to meet those demands, all within the context of available water resources."

The Kahana "315" Reservoir is consistent with both the BWS's planning goals and programs and the State's General Plan objectives and policies.

2. Coastal Zone Management

The Hawaii Coastal Zone Management Program (HCZMP) was established to guide the use, protection and development of the land and ocean resources within Hawaii's coastal zone. There are seven major categories that make up the program, each with an objective to aid in the guidance program of CZM. The seven categories under the program are as follows:

- Recreational Resources
- Historic Resources
- Scenic and Open Space Resources
- Coastal Ecosystems
- Economic Uses
- Coastal Hazards
- Managing Development

The relevant categories, their objectives and policies and the relationship of the project to them are discussed below:

a. Historic Resources

Objective: Protect, preserve and where desirable restore those natural and man-made historic and prehistoric resources in the coastal zone management area that are significant in Hawaiian and American history and culture.

Policies: (1) Identify and analyze signficant archaeological resources; and (2) Maximize information retention through preservation of remains and artifacts or salvage operations.

A surface archaeological reconnaissance survey was performed in the vicinity of the proposed reservoir site and along the existing road which will serve as an access road. The only surface archaeological feature that will be impacted is an auwai which travels under the Kahana Valley Road via a pipe and cement conduit. Recommendations by a Bishop Museum archaeologist includes on-site archaeological monitoring during construction periods. Should any subsurface archaeological structural features or other evidences of cultural occupation be encountered during excavation, an on-site archaeologist will be notified. Thus far, however, it has been determined that the area does not possess any

archaeological significance that would prohibit the proposed construction.

b. Scenic and Open Spaces Resources

Objective: Protect, preserve and, where desirable, restore or improve the quality of coastal scenic and open space resources.

Policy: Insure that new developments are compatible with their visual environment by designing and locating such developments to minimize the alteration of natural land forms and existing public views to and along the shoreline.

Due to the size and nature of the project, an immediate and adverse visual impact will be caused by the large excavation requirements. However, the location of the reservoir is such that the reservoir will be shielded from view from almost all areas of the valley. This will be effected by the steep terrain, the dense vegetation in the general vicinity of the project and landscaping of the filled and excavated slopes and benches.

c. Coastal Ecosystems

Objective: Protect valuable coastal ecosystems from disruption and minimize adverse impacts on all coastal ecosystems.

Policies: Minimize disruption or degradation of coastal water ecosystems by effective regulation of stream diversions, channelization, and similar land and water uses, recognizing competing water needs.

The construction of the proposed 6.0 MG reservoir within the upper reaches of Kahana Valley is anticipated to create a

measure of water quality degradation in Kahana Stream. This impact may be aggravated by the project area's steep terrain and high rainfall. The increased siltation resulting from excavation and construction operations may not only affect Kahana Stream but may also impact the estuary and bay. Not only will water quality suffer but the ensuing siltation can be detrimental to the freshwater macrofauna of Kahana.

To control the extent and amount of erosion and silation entering the waterways of the valley, the excavation and construction phases of the project will conform to the City's Grading Ordinance. Additional erosion controls may include mass excavation operations during the drier months of the year, use of silting ponds and cutoff trenches. These methods or any other will be dependent on the final topographic survey and design of the reservoir, instrument house service and access roads. The use of these methods and conformance to the County's grading ordinance is anticipated to minimize the impact of siltation and water turbidity.

3. 208 Water Quality Management Plan for the City and County of Honolulu By the State Department of Health and the City and County of Honolulu

The Environmental Ethic that forms the basis of the Hawaii 208 Plan is stated in the Preface as follows:

"Following an initial reaction of dismay, in view of the awesome requirements, limited budget, and the time allowed, the Department of Health saw the 208 planning process as a way to improve the management of the State's environmental programs, provide better coordination between the State and the Counties, and between the Department of Health and other State and Federal agencies. The Department could also use the planning process to open up the lines of communication to citizens and industry, to get them involved in the decision making. In particular, the Department could really look at ways to prevent pollution instead of just chasing after the problems, cleaning up the messes, It

was an opportunity to turn the environmental policy goals of the State into reality, and, incidentally, meet the Federal requirements.

This has become the theme of the 208 planning program, to make the concept of an environmental ethic a working policy guideline."

The proposed project will comply with the intent, standards and criteria of the Hawaii 208 Plan.

4. State Environmental Policies

The State Environmental Policy Act, Chapter 344, H.R.S. The first section of the Act states that:

"The purpose of this chapter is to establish a state policy which will encourage productive and enjoyable harmony between man and his environment, promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man, and enrich the understanding of the ecological systems and natural resources important to the people of Hawaii.

The environmental policy of the State is set forth as follows:

It shall be the policy of the State, through its programs, authorities, and resources to:

(1) Conserve the natural resources, so that land water, mineral, visual, air and other natural resources are protected by controlling pollution, by preserving or augmenting natural resources, and by safeguarding the State's unique natural environmental characteristics in a manner which will foster and promote the general welfare, create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of the people of Hawaii.

The second portion of the policy reads in part:

(2) Enhance the quality of life by:

(D) Establishing a commitment on the part of each person to protect and enhance Hawaii's environment and reduce the drain on nonrenewable resources.

The recommended policies in this plan are designed to implement the overall Environmental Policy of the State. The key elements

are conservation, prevention management, and cooperation. The major policies are designed to support the ahupua'a concept of managing the land on a watershed basis, from the mountains to the sea, for long-range sustained use of resources in harmony with the environment. This translates to:

*Keep the soil and water on the land. Keep natural drainage channels.

*Recycle, reuse. A pollutant is only a resource in the wrong place.

*Manage first. Regulate only as necessary. Keep regulations simple.

*Take responsibility. Everyone--government agencies, industry, individuals. When everyone is willing to care for the environment, it will be protected.

*Open up the system. Open decisions, public participation.

*Develop a process. A plan is a beginning, not an end."

The proposed project will comply with the intent, standards and criteria of the State Environmental Policy.

5. State Environmental Impact Statement Regulations

The State EIS Regulation, Chapter 343, HRS, are applicable to the proposed project. Their requirements make this EIS document necessary as described in Section 343-5, Applicability and Requirements:

"(a) Except as otherwise provided, an environmental assessment shall be required for actions which:

(1) Propose the use of state or county lands or the use of state or county funds, other than funds to be used for feasibility or planning studies for possible future programs (or) projects which the agency has not approved, adopted, or funded, or funds to be used for the acquisition of unimproved real property; provided that the agency shall consider environmental factors and available alternatives in its feasibility or planning studies.

(2) Propose any use within any land classified as conservation district by the state land use commission under chapter 205.

(3) Propose any use within the shoreline area as defined in section 205-31.

(4) Propose any use within any historic site as designated in the National Register or Hawaii Register as provided for in the Historic Preservation Act of 1966, Public Law 89-665, or chapter 6E.

(5) Propose any use within the Waikiki-Diamond Head area of Oahu, the boundaries of which are delineated on the development plan for the Kalia, Waikiki, and Diamond Head areas (map designated as portion of 1967 City and County of Honolulu General Pan Development Plan Waikiki-Diamond Head Section A.

(6) Propose any amendments to existing county general plans where such amendment would result in designations other than agriculture, conservation, or preservation except actions proposing any new county general plan or amendments to any existing county general plan initiated by a county.

(b) Whenever an agency proposes an action which falls within the categories in subsection (a), other than feasibility or planning studies for possible future programs or projects which the agency has not approved, adopted, or funded, or other than the use of state or county funds for the acquisition of unimproved real property, which is not included in any of the specific types of actions referred to in section 343-6, that agency shall prepare an environmental assessment for such action at the earliest practicable time to determine whether an environmental impact statement shall be required. A statement shall be required if the agency finds that the proposed action may have a significant effect on the environment. The agency shall file notice of such determination with the commission which shall, in turn, publish the agency determination for the public's information pursuant to section 343-3. The statement, if required, shall be made available for public review and comment through the commission. The commission shall inform the public of the availability of the statement for public review and comments pursuant to section 343-3. The agency shall respond in writing to comments received during the review. Following this review by the public and any subsequent revision by the agency, the commission, when requested by the agency, may make a recommendation as to the acceptability of the statement. The final authority to accept such a statement shall rest with:

(1) The governor, or his authorized representative, whenever an action proposes the use of state lands or the use of state funds or, whenever a state agency proposes an action within the categories in subsection (a); or

(2) The mayor, or his authorized representative, of the respective county whenever an action proposes only the use of county lands or county funds.

Acceptance of a required statement shall be a condition precedent to implementation of the proposed action. Upon acceptance or nonacceptance of the statement, the governor or mayor, or his authorized representative, shall file notice of such determination with the commission. The commission shall, in turn, publish the determination of acceptance or nonacceptance of the statement pursuant to section 343-3."

This EIS is in compliance with Chapter 343 of the Hawaii Revised Statutes.

C. CITY AND COUNTY OF HONOLULU

The City and County of Honolulu has put forth a General Plan which states its objectives and policies. The General Plan's purpose is to serve as a guideline not only for the City and County, but for all levels of government and for private organizations and individuals. The plan deals with nine areas of concern relating to Oahu's social, economic, environmental and design objectives. The following are those objectives and policies which are directly related to the proposed reservoir. .

There are four classifications for population areas in the General Plan. They are Primary Urban Center, Secondary Urban Center, Urban-Fringe and Rural. Of these, Kahana Valley is classified as a Rural population center.

Under population there are three objectives which the City and County desires to achieve. Of these, the following are relavent to the project.

"1. Objective B

To plan for future population growth.

a. Policy 1

Allocate efficiently the money and resources of the City and County in order to meet the needs of Oahu's anticipated future population.

2. Objective C

To establish a pattern of population distribution that will allow the people of Oahu to live and work in harmony.

a. Policy 4

Seek a year 2000 distribution of Oahu's residential population which would be in accord with the following table. (This table has been revised in accordance with Department of General Planning Distribution No. 4.):

DISTRIBUTION OF THE RESIDENTIAL POPULATION
1980 AND 2000

Location	1980 Population	% of Total	2000 Population	% of Total
Oahu Total	753,700	100.0	947,200	100.0
Primary Urban Center	488,340	64.8	570,740	60.3
Honolulu	366,840	48.7	419,440	44.3
Pearl Harbor	121,500	16.1	151,300	16.0
Secondary Urban Center				
Ewa-Waianae	74,150	9.8	137,600	14.5
Urban-Fringe	173,600	23.1	215,030	22.7
Windward	117,320	15.6	131,670	13.9
Wahiawa	56,280	7.5	83,360	8.8
Rural				
Waialua-Kahuku	17,610	2.3	23,830	2.5

The proposed reservoir, by reducing the current problems afflicting the present system and thereby improving service will reduce future problems that would be encountered if the transmission system were

left as is. The increased population projected for the Kahuku-Kahaluu area would put an added strain on the transmission system if no improvements are made. This would possibly cause a greater number of service disruptions and increase maintenance costs.

There are seven objectives concerned with the economic activity of Oahu. Of these, Policy 2 of Objective G is most directly related to the proposed reservoir. Stated as follows this objective is related to the population concern.

"1. Objective G
To bring about orderly economic growth on Oahu.

a. Policy 4
Permit the moderate growth of business centers in the urban fringe areas."

Kailua and Kaneohe-Ahuimanu are included in the Windward Urban Fringe in the table, "Distribution of the Residential Population 1980 and 2000" (Population Objective C, Policy 4). These two areas are serviced by the same transmission main that the proposed reservoir will be connected to. Although these areas are on the same system, they do not experience the same pressure problems that affect the Punaluu to Lanikai area because of pressure regulators that were installed. However, if population growth and its attendent economic aspect continue with the present transmission system remaining unimproved, then service disruptions in the system could impede the planned economic growth of the windward area.

The third concern of the City and County's General Plan deals with the natural environment. This subject has evolved to become an important consideration in the planning and design of both major and minor projects. The majority of policies of both environmental objectives are related to the proposed project.

"1. Objective A

To protect and preserve the natural environment of Oahu.

a. Policy 1

Protect Oahu's natural environment, especially the shoreline, valleys, and ridges, from incompatible development.

b. Policy 2

Require development projects to give due consideration to natural features such as slope, flood and erosion hazards, and water-recharge areas.

c. Policy 3

Seek the restoration of environmentally damaged areas and natural resources.

d. Policy 5

Design surface drainage and flood control systems in a manner which will help preserve their natural settings.

e. Policy 7

Protect plants, birds, and other animals that are unique to the State of Hawaii and the Island of Oahu.

2. Objective B

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

a. Policy 1

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

b. Policy 2

Protect Oahu's scenic views, especially those seen from highly developed and heavily travelled areas.

c. Policy 3

Locate roads, highways, and other public facilities and utilities in areas where they will least obstruct important views of the mountains and the sea."

The engineering design of the Kahana "315" Reservoir is calculated to take into consideration the effect of the project upon the environment. Although a Punaluu site was considered, environmentally it would have had a greater adverse impact on the environment than the present proposed site. The site design will be such as to avoid, as much as possible, extensive scarification of the ridge. It will also take into consideration the slope, erosion hazard and drainage. Although excavation will be extensive it is not anticipated that the reservoir will be visible from Kamehameha Highway due to the manner of excavation (Section II-E). The access road to the site will be hidden from view by natural foliage. After completion of the tank pad and road, revegetation will be implemented. Construction practices will be conducted in such a manner to prevent serious disruption to the natural environment.

The next area of concern related to the project is transportation and utilities. There are 5 objectives under this heading and of these the following is affected by the proposed project.

"1. Objective C

To maintain a high level of service for all utilities.

a. Policy 2

Provide improvements to utilities in existing neighborhoods to reduce substandard conditions.

b. Policy 3

Plan for the timely and orderly expansion of utility systems.

c. Policy 4

Increase the efficiency of public utilities by encouraging a mixture of uses with peak periods of demand occurring at different times of the day."

The project is consistent with the above objective and its policies. The proposed reservoir will reduce the existing pressure surges in the transmission main thus improving the system. The reservoir is part of the BWS's plan to improve the system in the Windward area to better serve the communities there and for future growth.

D. UNITED STATES DEPARTMENT OF THE INTERIOR

1. Hawaiian Waterbirds Recovery Plan

The Hawaiian Waterbirds Recovery Plan was published in August 1977 and approved in June 1978. "The primary objective of the plan is to provide and maintain populations of at least 2,000 Hawaiian stilts, 2,000 Hawaiian coots and 2,000 Hawaiian gallinules in, at a minimum, the habitats and island distribution existing in 1976 and to remove these endangered species from endangered and threatened status lists. This must be done by assuring that populations reach self-sustaining levels and are able to withstand normal morality factors. Habitat availability and viability are keys to attaining these objectives. Areas for nesting, feeding and loafing must be made secure. In addition, mortality must be minimized and productivity increased."

The marsh, streams and pastures of Kahana is considered as areas of secondary importance to endangered species. The definition for this designation is that it includes areas of lesser importance than primary habitats where small numbers of birds exist which should be preserved or protected.

The design and construction practices of the proposed reservoir and 42-inch line will comply with the requirement to preserve these waterbird habitats.

SECTION V

ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATIVE MEASURES TO MINIMIZE ADVERSE IMPACTS

A. INTRODUCTION

The construction of the proposed 6.0 MG reservoir and 42-inch influent-effluent main in Kahana Valley will generate both long-term and short-term impacts on the environment. These impacts will affect the physical, biological and human facets and may be considered as either beneficial or adverse. The majority of the short-term impacts will be generated by the construction of the reservoir, the 42-inch main and the improvement and construction of the existing access road and new service road. The potential long-term impacts will arise from the use of the planned facilities.

B. DISCUSSION OF IMPACTS FROM THE PROPOSED PROJECT

1. Short Term Impacts from Construction

Several short term physical impacts will arise from the construction of the proposed project. These impacts will be adverse and are those normally associated with construction activities and as such are unavoidable. To mitigate these anticipated impacts, construction will be confined to weekdays (Monday to Friday) and limited to daylight hours (generally between 7:00 a.m. and 4:00 p.m.). It is not anticipated that these impacts will be significant. Since access to the valley inland of the park and picnic areas near Kamehameha Highway is permitted by Department of Land and Natural Resources permit request only (generally by hunters and hikers), construction impacts will primarily affect the small number of residents of the valley. These residences are widely scattered and only a few homes are located within the immediate construction area in the lower valley floor.

a. Dust and Emissions

Dust and vehicular emissions will be generated during excavation for the reservoir, pipeline and the hillside

access road. Dust control measures, such as sprinkling, will be implemented to reduce dust levels when they are unacceptable.

b. Noise

Construction equiment will raise noise levels higher than those normally experienced in the valley. The project operations must conform to the State Department of Health's Public Health Regulations, Chapters 44A and 44B. A noise permit will be required from the Noise and Radiation Branch of the Department of Health and the Contractor must comply with the conditions issued with the permit. Mufflers for noise control will be required for all construction equipment.

c. Traffic

Construction of the proposed facilities will require use of the existing Kahana Valley Road. The transmission main will also be laid in a trench excavated along the road shoulders. Construction equipment will use the road to haul away surplus excavation and to bring in construction material needed to construct the facilities proposed. The increased traffic from construction vehicles will cause some inconvenience to residents of the valley.

Residents of the valley will be apprised of pending construction. The Contractor will be required to keep Kahana Valley Road open to traffic at all times and to use proper construction signs, barricades, flagmen and any other devices necessary to insure minimum inconvenience and maximum safety to motorists and pedestrians.

d. Economic

The construction will have a beneficial impact by providing jobs to local construction firms and residents. Local

material suppliers and retail businesses may also benefit from the increased construction activities.

e. Archaeological Resources

The only known archaeological site which will be affected by the project is an auwai which crosses the existing Kahana Valley Road along which the influent-effluent main will be placed. This auwai is described in the Archaeological Reconnaissance Survey for Proposed Reservoir, Kahana Valley, Oahu, April 1980, (Appendix E) prepared by Bishop Museum specifically for the feasibility study of the 2.0 MG Kahana Reservoir Site No. 1.

The report states that "The auwai, the only known site to be impacted, is already crossed by the existing road and pipe and cement conduit, so that its integrity has, to some extent, been violated." To preclude further damage to the auwai, the influent-effluent main alignment will be placed within the area of the auwai road crossing already spanned by the pipe and cement conduit.

The Bishop Museum survey did not evaluate subsurface archaeological resources. However, recommendations were made for archaeological monitoring by an archaeologist during construction of the pipeline when it crosses the auwai, during grading operations of the reservoir site and monitoring of the remaining areas of construction. The monitoring recommendations of the report will be incorporated in the specifications and contract documents for the 6.0 MG Reservoir project and implemented during construction.

g. Recreational Resources

The recreational resources of the Kahana Valley State Park will be adversely impacted upon by the construction of the

proposed project. The natural beauty of the valley and its streams have made it a favorite place for hiking enthusiasts. Recreational hunting will also be disrupted by the intrusion of heavy equipment and construction activities. The improvement of the only access road in the valley, the placement of the 42-inch main and the general construction activities for the reservoir will not only impede recreational traffic through the valley, but will destroy part of the existing hiking trails. Hikers who prefer a natural environment may find the improved roadway as an unacceptable replacement of the trail.

Although no hunting will be allowed in the vicinity of construction activities, other areas will be still open. However, the existing road is used as an access to the inland portion of the valley and its use as a construction access road will impact any hunters wishing to use the road. Noise generated by construction activities and equipment will probably scare off any game animals within the project vicinity further impacting the hunters.

In order to mitigate these impacts the BWS will coordinate their plans with the State Parks Division, DLNR to retain the recreational value of the valley. This would include the reuse of trails that may be temporarily impacted by construction activities. Since the reservoir will be set back from the trail-proposed roadway, the recreational use of the area should not be significantly impacted. It is anticipated that the shoulders of the road should revert to its natural state within a year or so. Once construction traffic has ceased, there should be no unauthorized or additional vehicular traffic since the State Parks Division has administrative control over all access in the park.

h. Biological Resources

According to the "Plant Communities Map of the Kahana Valley Area" developed for the Division of State Parks By W. L. Theobald and Nengah Wirawan in their report called the Kahana Valley Botanical Survey, Koolauloa District, Island of Oahu, the Kahana "315" Reservoir and access road will intrude into seven different plant communities (see Figure 10 and Table 5. They are:

- Kukui Forest
- Koa-Pandanus Forest
- Koa-Pandanus Woodlands
- Hibiscus Forests
- Mixed Forest Scrub
- Pasture and Cultivated Ecosystems
- Strand

Excavation for the placement of the 6.0 MG reservoir, 42-inch main, and necessary road construction will necessitate the removal of all existing vegetation in the project area. This would also result in the destruction of various habitats currently utilized by the mammal and avifauna populations of the valley.

The erosion resulting from the massive excavation anticipated could affect the macrofauna of Kahana's waterways. Increased siltation arising from these activities and entering Kahana Stream could increase turbidity levels which would be detrimental to the stream's aquatic life. If the siltation arising from excavation erosion are sufficiently high enough, the fauna of the estuarine and bay areas could also be adversely impacted. It is believed that the endemic Hihiwai may have disappeared from Kahana Stream due to overharvesting and to increasing stream turbidity.

To mitigate the effects and control siltation, erosion control measures will be provided during construction as required by the grading permit. Considerations will be given to do mass grading operations during the drier months of the year. The use of silting ponds and cutoff trenches are other alternatives that will be considered to minimize siltation of the stream from the construction activities.

Excess excavated materials may be used by the State Parks for improvements to their planned developments within Kahana Valley. Location of storage areas during construction would be at the direction of State Parks. This question will be coordinated with State Parks before a construction contract is finalized.

The determination of excessive turbidity can be made on a visual basis only. The accumulation of sediment at Huilua Pond indicates that natural siltation already occurs in the stream. Only by implementing one or several of the mitigative measures mentioned earlier can siltation from the construction activities be minimized.

The abandoned jeep trail will be rehabilitated to follow the existing profile as closely as possible in plan and elevation to minimize excavation and vegetative destruction. By siting the influent-effluent main along this jeep road, the need for a construction road would be eliminated. By trenching in dry weather and in short segments and backfilling immediately, silting to Kahana Stream and Bay would be minimized. Road culverts will be placed in the stream crossing at the invert elevations of the stream to maintain as close as possible the present conditions. The need to establish new hiking trails parallel to the jeep

road for the satisfaction of the hiking purists will be coordinated with the State Department of Land and Natural Resources.

2. Long Term Impacts

Because of the nature of the proposed facilities, long term impacts on the environment will be associated with the presence and use of the reservoir, control building and the hillside roadway from Kahana Valley Road. The proposed reservoir and transmission main, due to their size and required space for placement will adversely impact the environment. Mitigative measures will be taken during the design and construction phases to prevent any other than necessary impact on the environment. These measures will deal with but not be limited to erosion and drainage control of cut slopes during and after construction and design considerations of the reservoir site and perimeter, service and access roads.

a. Reservoir Site

The Kahana "315" Reservoir site will consist of a 6.0 MG reservoir, an instrument house and an access road. The construction of these facilities will necessitate the excavation and removal of all plants in the immediate vicinity of the wells and control building. The stream will not be crossed by the access road.

The reservoir will require approximately 2.8 acres of land and will be enclosed by a chain link fence. The height of the tank is 30 feet. Of this only the top 15 feet will be exposed. The remainder will be backfilled to achieve an elevation of 300 feet. The pad the tank will be placed on will be at elevation 285 and the spillway of the tank will be at 315 elevation.

The instrument house will consist of a small hollow tile structure approximately 6 feet wide by 8 feet long and 8 feet high. This will house the electrical control system which will regulate the flow of water to the reservoir. The instrument house will require about 600 square feet and will also require some excavation and the removal of vegetation in the immediate vicinity.

An immediate adverse impact will be visual due to the large amount of excavation required for the project site. The excavation will cut into the ridge 431 feet horizontally and will have an approximately 74-foot bank with benches exposed. The 15-foot exposed portion of the reservoir will also present a visual impact. The instrument house although a small structure will be adjacent to the service road and easily visible from it.

The location of the reservoir site is situated far enough within the valley that the reservoir will be shielded from view from almost all areas of the valley. The reservoir will be visible only to hikers using a portion of the access road fronting the reservoir or by hikers on the ridgelines above the valley. The reservoir site will be excavated into a "sunken bowl" shape which, aided by the steep terrain and canopy of dense vegetation, will obscure the reservoir from site. The cut into the slope, using the 25-foot high benches, is such that the view line will pass over the top of the reservoir. This would essentially shield it from view from the lower valley.

Landscaping will further minimize the visual impact of the reservoir site. Vegetation used will be of a nature to blend with the existing vegetation. It will not have any

exotic species of plants that would encroach on the existing plant communities and thereby endangering the present ecosystem any more than necessary.

Precautions must be taken prior to landscaping to prevent erosion of the cut face. Drainage may also become a problem.

b. Access Roads

The existing Kahana Valley Road and an old jeep "road" will be improved to provide access to the reservoir site.

Except for the beginning 3/4-mile of surface treated coral pavement, Kahana Valley Road is in poor condition. During periods of heavy rain, the roadway is usually impassable for vehicles without four-wheel drive. The State's Kahana Valley State Park plans do not consider any additional access roads into the valley.

Only the initial 1,800± feet of the jeep "road" is usuable by four-wheel drive vehicles. The remaining jeep "road' has eroded and overgrowth has narrowed it down to a foot trail.

Kahana Valley Road and the jeep "road" will be improved to a width of 12 feet. In keeping with the State's "living park" concept for the valley, surface treated coral will be used for the roadway wearing surface instead of asphalt or concrete. The rehabilitated access road will provide the benefit of improved access to the upper valley for hikers and for emergency use.

The new road connecting the access road to the reservoir perimeter service road will be curved as it approaches the service road so that there is no direct frontal view of the reservoir from the access road.

Access to the Kahana Wells I will be via the existing valley roads and the old military road. Thus, the land has already been impacted. The access road to the reservoir will only impact the affected are to a limited extent. The old military road has become overgrown now so it could be considered as having almost returned to its natural state in several sectors.

The access road will have a physical impact on the area. The road areas will be changed from an overgrown area to a cleared road alignment with no plants and a crushed coral surface. Still, the access road width will be limited to only 12 feet so its effect on the environment will be minimized. Care will be taken where the road crosses small streambeds. Culverts will be put in to allow the flood waters to follow in their natural course to the valley floor. At no time will the access road cross Kahana Stream. The Contractor will be required to develop the road improvements during the dry summer season when stream turbidity by runoff will be minimized. He will also be required to use special construction techniques to carefully control his construction activities in order to minimize the downstream impacts of erosion and stream turbidity. The BWS will also monitor the stream to insure the prevention of excessive turbidity due to runoff.

The access road will provide a benefit of improved access to the upper valley for hikers and for emergency use. All utilities to and from the instrument house will be buried in the access roads.

c. Water Mains

A 42-inch influent-effluent transmission main will carry water from Punaluu Wells II to the proposed Kahana Reservoir

and into the transmission main along Kamehameha Highway. The trench excavation will be along the road and no adverse long term impacts are expected to be generated.

d. Long Term Benefits

There are benefits to be gained by the reservoir that are believed to outweigh the adverse visual and physical impacts on the land. The installation of the proposed reservoir and transmission main will improve the water transmission system presently servicing the area between Punaluu and Kapaa. By providing a storage reservoir, pressure fluctuations presently experienced within the system will be reduced; pumping demands on Punaluu Wells II will be reduced and more water sources would become available as they would no longer be "locked out."

The adverse hydraulic conditions presently experienced, i.e., pressure surges, cavitation of the Waihee Booster Pump, water hammer, etc., all promote pipe breakage and general deterioration of the water system. This in turn affects the plumbing of individual residences and businesses. These pipes are not as large or as strong as the transmission mains and therefore are more likely candidates for breakage. Cracks or breaks in the line could also promote the introduction of contaminants into the water system.

The proposed reservoir will improve the existing transmission system by reducing the pressure surges. This will for the present and in the long run improve service to consumers, reduce the possibility of pipe breakage and therefore reduce maintenance and repair costs. This would benefit both the BWS and the consumers by constituting a savings.

The access roads in Kahana Valley will also provide an easier access into the deeper reaches of the valley, benefiting visitors, scientists, hikers, emergency rescue groups and others.

A possible benefit arising from the improved water service to Windward Oahu communities may be the encouragement for development of additional residential areas for low to moderate income families.

e. Long Term Adverse Effects

The development of the reservoir in Kahana Valley, will enable population growth in the Windward area as projected in the States II-F population. This growth will change the lifestyle of the area to a faster pace and will increase the stresses related to overcrowding. Growth will also increase the demands upon the other public services such as sewage treatment, police protection, hospitals and schools. Only the orderly planning of the City and County of Honolulu can mitigate these adverse effects.

f. Cumulative Effects of the Water Reservoir Water Development, and State Park Projects

The three projects now planned for Kahana Valley will have a cumulative short term effect due to construction activities unless these activities are coordinated so that the effects can be mitigated. This is the reason that the BWS is working closely with the DLNR's Division of State Parks, Outdoor Recreation and Historic Sites, to insure the orderly development of the resources of the valley and preserve its natural beauty. The sensitivity of some of the Kahana Stream biota to excess turbidity is of continuing concern and will require careful construction techniques to mitigate this problem.

The proposed 6 million gallon water reservoir will have a visual impact because it may not be possible to completely shield it from views from other parts of the valley. The wells and control buildings will impact visually upon the visitors that hike the old jeep trail and will require careful landscaping to decrease the adverse effect as will the reservoir site. This is a problem that cannot be mitigated completely.

The combined activities of water recreation, fishing, agriculture and water development will be coordinated by the State Department of Land and Natural Resources to assure that these activities are compatible and do not affect the environment adversely.

SECTION VI

PROBABLE ADVERSE ENVIRONMENTAL IMPACTS WHICH CANNOT BE AVOIDED

The unavoidable short term adverse impacts are those related to construction activities. Temporary air pollution from dust, vehicular emissions, noise from construction equipment and inconvenience to resident traffic will occur. Particular care will be taken to avoid any damage to archaeological sites involved and to prevent excess turbidity in Kahana Stream during construction to the extent practicable.

The long term adverse impact, which is unavoidable because of the nature of the project, will be the visual impact and physical land changes caused by the reservoir and the access road and the potential adverse effect on the flow of Kahana Stream and the endangered species secondary habitat in the lower valley due to siltation from construction.

Improvements to the access road will again signal man's intrusion into the valley as will the reservoir and the associated instrument house. It should be noted that the reservoir sites and the valley at higher elevations were used extensively for jungle warfare training by Army troops during World War II. Still, the affected area is relatively small and only those traveling along the access roads will be able to see the effects of construction. The access road on the opposite side of the valley is available as an alternate route for visitors on foot and avoids the visual intrusion of the reservoir. Proper landscaping will blend the individual wells and control buildings into their surroundings.

SECTION VII
ALTERNATIVES

A. NO PROJECT

The Kahana "315" Reservoir project has been proposed primarily to alleviate adverse hydraulic conditions within the BWS water transmission system. The "no project" alternative would result in continued inconveniences to consumers caused by service disruption due to line breaks and repairs. These line breaks can also increase the potential contamination of the system.

B. DELAY OF PROJECT

Delay of the project will initially have the same effect as the "no project" alternative. Construction at a later date will also result in increase construction costs due to inflation.

C. ALTERNATIVE RESERVOIR SITES

1. Preliminary Planning Sites

During the preliminary planning phase of the study, alternative sites were considered between Kaaawa and Punaluu. However, except for the area around Hakipuu-Kaaawa and Kahana-Punaluu, the steep topography of the valleys between Punaluu and Kaaawa precluded constructing a reservoir without astronomical construction costs. The huge cost arises from excavations requiring cuts 400 feet to 600 feet and ugly scarring of the area will result. Potential sites in the Kaaawa-Hakipuu area were considered but they were not previously selected because of the high cost of providing an additional pipeline between Kaaawa and Punaluu. The pipeline is not needed if the reservoir is built in Kahana Valley. In addition, except for a site at Hakipuu that had a high visual impact from Kamehameha Highway, the other Kaaawa sites could not accommodate a large reservoir to meet the hydraulic gradeline elevation requirements for gravity flow to Kailua.

Alternative grading plans are very limited in reservoir design because of topography, elevation, soil stability, allowble soil bearing, and construction considerations. Thus, costs were developed for the grading plan that would best fit the site. The cost figures were evaluated and where they appeared prohibitively high, the BWS terminated further study and alternative sites were then investigated.

2. Punaluu Valley Sites

A 2.0 MG reservoir at an elevation of 370 feet was considered adequate to achieve the objectives of the proposed action. The Punaluu slopes of the ridge separating Kahana Valley from Punaluu Valley were investigated for potential reservoir sites. The two sites offering the best potential for the reservoir were studied in greater detail. These two sites are shown on Figure 3 and are identified as Punaluu Reservoir Sites 1 and 2.

The results of this study, Feasibility Study, Proposed 370 Reservoir Site, Punaluu, Koolauloa, Oahu, Hawaii, Sept. 1978, indicated that a 2.0 MG reservoir could be constructed with some difficulty at either of the two sites. However, the extremely high cut banks anticipated for both the reservoir sites and the access roads leading to the sites would result in an adverse environmental impact which will be difficult, if not impossible, to mitigate. These cuts through soil and rock will be difficult to obscure from public view and the revegetation process would be long and tedious. This is due to the high steep slopes and the removal of the topsoil from those slopes.

Siting a 6.0 MG reservoir at either of these two sites, while physically possible, will further aggravate the adverse environmental impact. The primary concern would be this 60-foot

increase in height of the cut bank due to the larger pad required to support a 189-foot diameter reservoir.

Summarized below are the major aspects of the Punaluu Valley Alternate sites. Since these sites are considered environmentally unfeasible due to the large cut slopes for the 2.0 MG reservoir, the reservoir site excavation quantities and costs for the 6.0 MG reservoir were not developed.

2.0 MG PUNALUU RESERVOIR SITE 1

Item	Reservoir Site	Hillside Access Rd. (2370 LF)
Terrain Slope	80% to 250%	15% to 80%
Height of Cuts	500 Feet	5 Ft. to 100 Ft.
Excavation Quantity	763,000 cy	36,000 cy
Excavation Cost	$4,630,000	$330,000

ESTIMATED TOTAL PROJECT COST = $7,330,000

2.0 MG PUNALUU RESERVOIR SITE 2

Item	Reservoir Site	Hillside Access Rd. (2700 LF)
Terrain Slope	20% to 80%	15% to 100%
Heights of Cuts	225 Feet	5 Ft. to 200 Ft.
Excavation Quantity	104,000 cy	250,000 cy
Excavation Cost	$850,000	$2,190,000

ESTIMATED TOTAL PROJECT COST = $5,820,000

3. Kahana Valley Sites

Subsequent to the determination that the large cut slopes required at the Punaluu sites were environmentally unfeasible,

three potential reservoir sites in Kahana Valley were next evaluated. These sites, designated as Kahana Reservoir Site 1, 2A and 2B, are shown on Figure 2. As in the case of the Punaluu sites, these studies were initially made for placement of a 2.0 MG reservoir.

The selection of alternate sites in Kahana Valley was confined to the westerly slopes for the following reasons.

a. Since the westerly slopes are closest to the Punaluu Wells II (source of water), the pumping costs will be kept to a minimum. This is because of the reduced distance the water has to be pumped.

b. The Board of Water Supply also proposes to develop three well fields along the westerly slopes of Kahana Valley. The access road to be improved to serve the well fields will also serve the 6.0 MG reservoir. Locating a reservoir on the easterly slopes will require improvement of an additional access road resulting in increased environmental disturbance to the valley and construction cost.

Kahana Reservoir Site 1 was selected as being the most feasible of the three sites for a 2.0 MG reservoir and the one that will have the least adverse impact upon the environment.

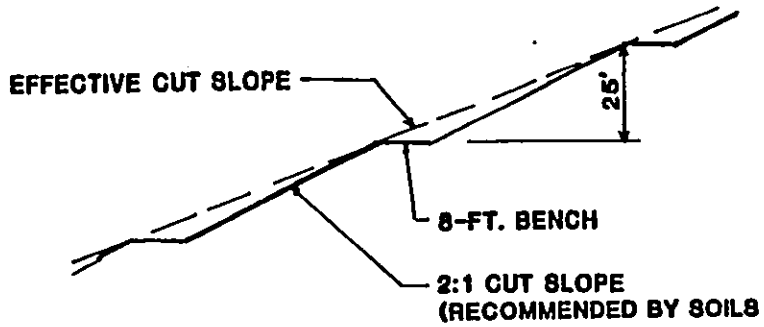
The three sites, being within 2,000 feet of each other have the same general physical environment.

The access road from Kahana Valley Road to each tank site follows the ridge line leading directly to the respective reservoir site. The access road to Site 1, following a ridge profile that is generally uniform, will have maximum cuts of about 8 feet.

The ridge to Sites 2A and 2B has a profile that is steeper at the lower end and flattens out as it approaches the reservoir site. Approximately one-third the distance uphill from the Kahana Valley Road to the reservoir an abrupt rise of 80 feet occurs in a short distance of 100 feet. The roadway wedge cut into the ridge will produce cut heights as high as 80 feet and substantially greater volumes of excavation.

Grading of the reservoir pad for Site 1 will result in a 60-foot high cut bank. The ridge profiles uphill of Sites 2A and 2B are steeper than that for Site 1 and the respective heights of cut are 177 feet and 195 feet. Grading at Sites 2A and 2B will encroach into the drainage ways of the adjoining gullies and will entail additional drainage improvements to safeguard the reservoir improvements from storm waters.

The cut slope required to place a 6.0 MG reservoir at the Kahana Valley alternate sites is graphically illustrated on Figure 18. The alternate sites are situated on narrow ridges protruding from the main ridge which separates Kahana Valley from Punaluu Valley. In order to provide an adequate foundation pad at elevation 285 feet to support the larger diameter 6.0 MG reservoir, the pad must be cut further into the ridge. The uphill edge of the perimeter service road will be about 50 to 60 feet below existing ground. The effective cut slope recommended by the City Grading Ordinance for the reservoir pad cut (2:1 cut slope with an 8-foot bench after each 15 feet of cut) is flatter than the slopes of the ridge profiles. Consequently, the cut banks for a 6.0 MG reservoir at the Kahana Valley alternate sites will daylight on the Punaluu Valley side of the main ridge at heights above the pads of about 760 feet, 635 feet and 710 feet for Sites 1, 2A and 2B, respectively. The extreme adverse environmental impact of the high cut banks make all three sites environmentally undesirable for a 6.0 MG reservoir.



SITE NO.	ELEV. TOP RIDGE	D (FT)	D-1 (FT)	H (FT)
1	1210	1700	300	760
2A	1050	1450	240	635
2B	1120	1650	235	710

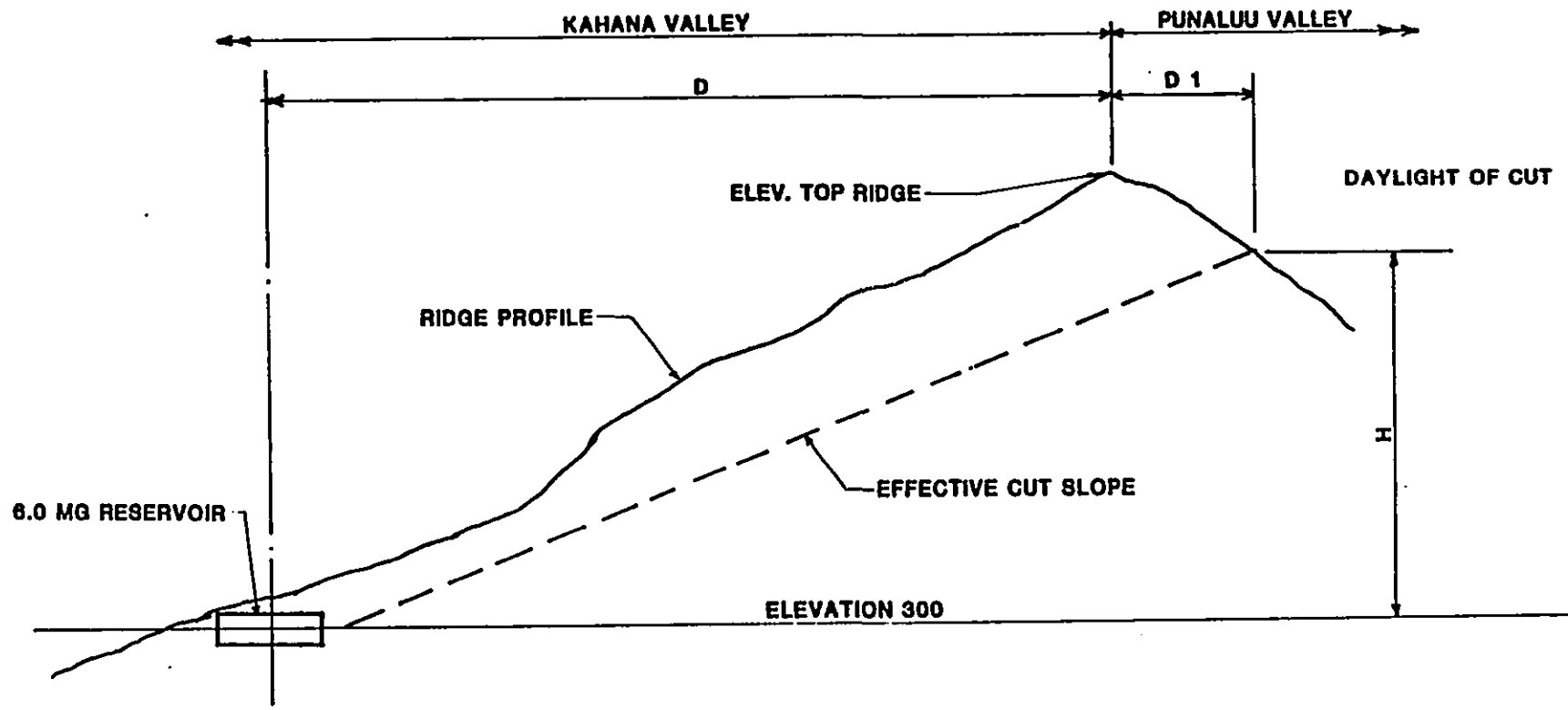


FIGURE 18

6.0 MG RESERVOIR
AT KAHANA ALTERNATIVE SITES

NOT TO SCALE

Summarized below are the major aspects of the Kahana Valley alternate sites. Since the extreme cut slopes are considered environmentally undesirable for a 6.0 MG reservoir, the site excavation quantities and costs for the 6.0 MG reservoir were not developed.

2.0 MG KAHANA VALLEY RESERVOIR SITES

	Site 1	Site 2A	Site 2B
Total Est. Cost	$3,500,000	$3,930,000	$3,970,000
Transmission Mains	8,000 LF	5,500 LF	5,700 LF
Access Road	1,200 LF	1,600 LF	1,900 LF
Excavation	3,000 cy	81,500 cy	82,000 cy
Max. Cut Height	8 feet	80 feet	80 feet
Reservoir Site			
Excavation	22,000 cy	74,000 cy	74,000 cy
Height of Cut	60 feet	177 feet	195 feet

4. Summary

None of the Punaluu and Kahana Valley sites considered for a 2.0 MG reservoir were found suitable for the larger 6.0 MG reservoir. The excessive excavation and high cut slopes required for the reservoir sites and access roads would be increased by the larger 6.0 MG reservoir site. Figure 18 gives an indication of the large amount of excavation required for the 6.0 MG reservoir. The cut slope would be high and difficult to obscure from public view. Revegetation would be harder to accomplish due to the high cut slopes and the removal of the topsoil during construction. The previously studied 2.0 MG reservoir sites in the Punaluu and Kahana Valleys were found to have high adverse environmental impacts and construction costs. The change in reservoir size from 2.0 MG to 6.0 MG would only increase the impact and cost.

As part of the BWS ongoing studies regarding system efficiencies, they determined that in the Windward area, a storage tank in the vicinity of Kahana would (1) increase transmission capability on the narrow winding Kamehameha Highway, (2) reduce the need for high operating pressures to meet peak hour loads and the inherent increased risk of service disruptions due to main breaks as a result of high operating pressures and pressure surges, and (3) allow efficient operation of the 23 mgd existing and planned sources between Kahana and Laie, provided the tank could be sized large enough to allow more efficient pump operations through steadier, longer duration pumping. The proposed 6 MG reservoir in Kahana provides all of the operating advantages described.

SECTION VIII

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

The proposed action, when implemented, will reduce the pumping requirements of the Punaluu Wells and lessen the adverse pressure surges in the transmission system. In this way the proposed action will improve the service to the communities of Windward Oahu.

The proposed reservoir site is located in the State owned Kahana Valley. The entire valley comprising of 5,260 acres of land is in a conservation district designated for parks and recreational use. The area required for the reservoir site is minimal when compared to the entire area of the conservation district and will not foreclose future recreational options or narrow the range of beneficial uses of the environment. The proposed reservoir will change the land form permanently, however, the reservoir site and access road can be reclaimed for purely recreational use if it is desired. The proposed reservoir will not hamper the utilization of the valley as a State park nor pose any long-term visit to the public's health and safety.

SECTION IX

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The resources that will be irreversibly and irretrievably committed will be funds, raw material, labor and energy required during construction and operation of the proposed facility. Land area will be committed for the reservoir and pipeline facilities, however, the pipeline will be laid underground so the surface above it will be usable for the activities of the State Park. Excavation of the reservoir site and the access road to the site will permanently alter the landscape, and the hillside cut will be visible to varying degrees from the more open spaces of the lower flood plain area of the valley.

SECTION X

OTHER INTERESTS AND CONSIDERATIONS OF GOVERNMENT POLICIES THOUGHT TO OFFSET THE ADVERSE ENVIRONMENTAL EFFECTS OF THE PROPOSED ACTION

In Section V, "Probable Impacts of the Proposed Action on the Environment and Mitigating Measures Taken to Minimize Adverse Impacts," it was concluded that there are no significant long-term adverse impacts expected. The adverse impacts from construction activities are all short term and can be mitigated. The long-term impacts are basically visual in nature and can easily be deemed necessary to provide improved water service to the communities along the Windward side of Oahu from Punaluu to Waimanalo.

SECTION XI

SUMMARY OF UNRESOLVED ISSUES

The proposed project could affect the aesthetic quality of the Kahana Valley State Park. The steep cut slope and reservoir site will have to be revegetated and properly landscaped to minimize the visual impact to people utilizing the State Park. This issue cannot be completely resolved until the reservoir is constructed and the State Park Officials can assess the adequacy of the landscaping.

SECTION XII

ORGANIZATIONS AND PERSONS CONSULTED

FEDERAL GOVERNMENT

- Department of the Interior, Fish and Wildlife Service
- Department of the Army, Corps of Engineer
- Department of Agriculture, Soils Conservation Service

STATE OF HAWAII

- Department of Health
- Department of Accounting and General Services
- Department of Transportation
- Department of Agriculture
- Department of Defense
- Department of Planning and Economic Development
- Department of Hawaiian Home Lands
- Department of Land and Natural Resources
- University of Hawaii at Manoa, Water Resources Research Center
- Office of Environmental Quality Control

CITY AND COUNTY OF HONOLULU

- Department of Housing and Community Development
- Department of Land Utilization
- Department of Parks and Recreation
- Department of Public Works
- Department of Transportation Services

PRIVATE

- Kahaluu Neighborhood Board No. 29
- Sierra Club

SECTION XIII

LIST OF NECESSARY PERMITS

STATE OF HAWAII

Department of Health

Noise Permit

Department of Transportation

Permit for Construction within a State Highway

Department of Land and Natural Resources

Conservation District Use Application

CITY AND COUNTY OF HONOLULU

Department of Land Utilization

Special Management Area Permit

Department of Public Works

Grading Permit

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APPENDIX A

PROPOSED 2.0 M.G. KAHANA "300" RESERVOIR SITES
PRELIMINARY SOIL RECONNAISSANCE

PROPOSED 2.0 M.G. KAHANA "300" RESERVOIR SITES
PRELIMINARY SOIL RECONNAISSANCE

KAHANA VALLEY, OAHU, HAWAII
TAX MAP KEY: 5-2-01: POR. 1

To:
R. M. TOWILL CORPORATION

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

JUNE 7, 1979

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

WALTER LUM
EDWARD WATANABE
EZRA KOIKE
WALLACE WAKAHIRO
3030 WAIALAE AVE., HONOLULU, HAWAII 96816 • TEL. 737-7931

June 7, 1979

R. M. TOWILL CORPORATION
Gold Bond Building
677 Ala Moana Boulevard, Suite 1016
Honolulu, Hawaii 96813

Gentlemen:

Subject: Proposed 2.0 M.G. Kahana "300" Reservoir Sites
Preliminary Soil Reconnaissance
Kahana Valley, Oahu, Hawaii
Tax Map Key: 5-2-01: Por. 1

As requested, a reconnaissance of the soil conditions at 3 sites for a Proposed 2.0 M.G. Reservoir at Kahana Valley, Oahu, Hawaii was made on March 12 and April 5, 1979. Sites 1 and 2A were selected by the Board of Water Supply and Site 2B by R. M. Towill Corporation.

The purpose of the reconnaissance was to estimate preliminary guidelines for cut and fill slopes for site studies.

The reconnaissance consisted of a review of selected soil and geologic maps and visual observations by walking two sites. Selected soil samples were recovered for laboratory testing and identification.

PROJECT DESCRIPTION

The proposed plan is to excavate a bench into the narrow ridge at about Elev. 300 ft to form a pad for a 2.0 M.G. tank about 20 ft in height by 138 ft in diameter with a 14-ft roadway around the tank.

GEOLOGIC AND SOIL DESCRIPTIONS BY OTHERS

According to Stearns, H. T. and U. S. Geological Survey, "Geologic and Topographic Map, Island of Oahu," USGS, 1938, the geologic formations at the sites fall under the classification of:

Sites 1 and 2B

Tkdc - Kailua Volcanic Series.
A denuded rift zone with basalt dikes intruded into the basalt flows.

Site 2A

Tkb - Koolau Volcanic Series.
Deeply weathered basalt.

According to the U. S. Soil Conservation Service, "Soil Survey of Islands of Kauai, Oahu, Maui, Molokai and Lanai, State of Hawaii," August 1972, the surface soils have been classified as:

Soils at all 3 Sites

WpF - Waikane silty clay, 40 to 70% slopes.
Well drained soils on alluvial fans and terraces. The soils developed in alluvium and colluvium derived from basic igneous rocks. Runoff is rapid to very rapid and the erosion hazard is severe.
Shrink-swell potential - low.
Unified Soil Classification - MH.

Uphill of all Sites

rRT - Rough mountainous land.
Very steep land broken by numerous intermittent drainage channels. The soil mantle may be thin (less than 10 in.) over Saprolite. The Saprolite is relatively soft and permeable. Rockland, rock outcrop, soil slips and eroded spots make up part of the acreage.

SITE CONDITIONS

Aerial topographic maps were reviewed for 3 sites. Sites 1 and 2B only were observed in the field.

The proposed tank sites are located on ridges on the lower slopes of the steep Koolau mountains and about 1 mile southwesterly of Kahana Bay and about 3,000 ft west of Kahana Stream.

An elevation of 350 ft was flagged at Site 1 and an elevation of 319 ft was flagged at Site 2B by R. M. Towill Corporation.

The sites are accessible only by foot trails. A dirt access road is located fairly close to Site 1.

From visual observations, the proposed soils at the 2 sites observed in the field may be generally described as high moisture silty clays (MH and MH-CH soils). No rock exposures were noted within the vicinity of either tank sites.

Both tank sites are overgrown with a heavy growth of brush and small trees.

Site 1

The site is situated on a ridge at about Elev. 300 ft.

At the site, the ridge varies from about 30 to 50 ft or more in width and slightly rounded and slopes about 15 to 20% down in an easterly direction. Above the tank site, the ridge becomes narrow and the ridge slope may vary from about 15 to 50% or more.

At the site, the sides of the ridge slope down on the south side at about 50% and on the north side at about 40 to 50%. Above the site, the side slopes appear steeper.

Site 2B

The site (located about 400 ft south of Site 2A) is situated on a narrow ridge at about Elev. 300 ft.

At the site, the top of the ridge line varies from about 10 to 15 ft wide and slopes down at about 20%. Below the tank site, the ridge slopes down at about 30% and above the site, the slopes may vary from 20 to 40% or more.

The sides of the ridge slope down on the south side at about 60 to 70% and on the north side at about 50%.

Site 2A (from topo map)

The site (located about 2,000 ft north of Site 1) is situated on a fairly narrow ridge at about Elev. 300 ft.

At the site, the ridge slopes down at about 30%. Below the site, the ridge slopes down at about 30% and above the site, the slopes may vary from 30 to 60% or more.

The south side slope of the ridge slopes down at about 60 to 70%. At the north side of the ridge, there is a gully about 15 to 20 ft deep with side slopes of about 30%.

ANNUAL RAINFALL

The average annual rainfall at the 3 sites may vary from about 75 to 100 inches.

DISCUSSION AND RECOMMENDATIONS

Sites 1 and 2B located about 2,000 ft apart were reconnoitered in the field. Both sites that were visited in the field are quite similar in regards to the topography, soil types and vegetative growth. Site 2A, located about 400 ft north of Site 2B, appears to be similar also.

Some preliminary guidelines for site studies are discussed as follows:

Soil Conditions

The surface clayey soils at the site have high moisture contents (± 130%) and high liquid limits (120 to 170%).

The depths of the high moisture soils at the sites are not known at this time.

Site Grading

The depth of excavation to the finish floor at any point around the perimeter of the tank should be about 1/2 or more of the height of the tank, if practicable. By making the tank excavation approximately equal to 1/2 the height of the tank, the weight of a full water tank will be approximately equal to the weight of the materials removed. This may reduce differential settlements because little, if any, additional stresses are added to the underlying foundation materials. However, some settlements and differential settlements should be expected because of soil rebound, the non-uniformity of the surface loads and variations in the subsurface materials.

Slopes

Because of the possibility of fairly deep deposits of high moisture soils, cut slopes with a 2 horizontal to 1 vertical overall average with benches at about 25-ft height intervals may be considered for preliminary studies for the 3 sites. The tops of slopes should be flattened or rounded off.

For preliminary design studies, slopes should be kept less than 100 ft in total height.

Slope planting or some other method of slope protection is recommended.

Foundations

Because the steep slopes are subject to creep movements, the tank structure should be located a horizontal distance of about 30 ft from the rim of the excavation for the preliminary design studies.

If this is not practicable, pile or pier type foundation may be considered for the perimeter footings and some interior columns.

The three sites are discussed below as follows (see Figure 1):

Site 1

No rock outcrops were noted in the vicinity of this site.

In general, the existing side slopes at the site vary from 40 to 50% or steeper. Because of the fairly narrow ridge and steep slopes, the excavation for a tank and perimeter road pad (about 164-ft total diameter) may be about 20 to 30 ft from both existing side slopes of the ridge. The cut slope uphill of the tank would extend about 70 to 80 ft in height.

The construction of the access road to this site may be less costly than the other sites since an existing unimproved road is located close to the site.

Site 2B

No rock outcrops were noted in the general vicinity of this site.

The side slopes on this ridge are very steep and similar to those above Site 1.

The excavation for a tank and roadway pad may be entirely in cut and away from the side slopes of the ridge.

In general, the existing slopes above and below the site may vary from about 20 to 40% or steeper. Because of the existing steep slopes, the excavation for a tank pad into the ridge will probably require a high cut with a total slope height of about 180 ft or more.

Also, an access road up to this site would probably cut deeply into the steep slopes and cross some drainageways.

Site 2A

The following comments refer to Site 2A which was not visited in the field. Observations are from geologic and soil maps and topographic map furnished by R. M. Towill Corporation.

Site 2A has a gully along the north side slope of the tank location. A tank located at this site may have cuts across this drainageway and may cause flooding and possibly damage.

The south side slope of this ridge is also steep and similar to that at Site 2B.

The excavation for a tank and roadway pad would probably be entirely in cut and away from the side slopes of the ridge.

In general, the existing slopes above and below the site may vary from about 30 to 60% or steeper. Because of the existing steep slopes, the excavation for a tank pad into the ridge with a slope averaging 2 horizontal to 1 vertical may not daylight on the steep uphill slope.

Also, an access road up to this site would probably cut deeply into the steep slopes and cross some drainageways.

Because this site may require a steeper cut slope, wind, water erosion and slumping of the soil slopes may cause more maintenance problems than at either Site 1 or Site 2B.

ADDITIONAL FIELD EXPLORATIONS

After a site is selected, a few exploratory borings should be made initially to establish preliminary design guidelines for cut slopes. If the exploratory borings indicate that the site may be developed, additional borings should be made to develop foundation and grading design guidelines.

Access to either Site 2A or 2B is difficult and subsurface explorations would probably require moving drilling equipment by helicopter. An access road could probably be made to Site 1.

Attached are a site location sketch, laboratory test results, schematic sections and limitations.

Respectfully submitted,

WALTER LUM ASOCIATES, INC.

By Edward K. Watanabe
Edward K. Watanabe

JWS/EKW:vl

PROPOSED 2.0 M.G. KAHANA "300" RESERVOIR SITES

TABLE I___ - SUMMARY OF LABORATORY TEST RESULTS

SITE NO.	1	1	2B	2B
ELEVATION	±352	±330	±320	±300
LOCATION	TOP OF RIDGE	NORTH SLOPE	TOP OF RIDGE	NORTH SLOPE
DESCRIPTION	BROWN SILTY CLAY W/SOME ROOTS	REDDISH-BROWN SILTY CLAY W/ SOME ROOTS	BROWN SILTY CLAY W/SOME ROOTS	BROWN SILTY CLAY
SAMPLE NO.	①	②	③	④
GRAIN-SIZE ANALYSIS (% Passing) Sieve				
1-1/2"				
1"				
1/2"				
#4				
#10				
#20				
#40				
#100				
#200				
ATTERBERG LIMITS				
Air Dried or Natural	NATURAL	NATURAL	NATURAL	NATURAL
Liquid Limit	120	156	171	176
Plastic Limit	55	75	87	63
Plasticity Index	65	81	84	113
Dilatancy	RAPID-SLOW	SLOW	SLOW	RAPID-SLOW
Toughness	WEAK	WEAK	MED.-STIFF	WEAK
Dry Strength	MED.-HIGH	MED-HIGH	HIGH	HIGH
UNIFIED SOIL CLASSIFICATION	MH	MH	MH	MH-CH
WATER CONTENT, %	-	135	144	139
CBR TEST (Surcharge - 51 P.S.F.)				
Molding Moisture, %				
Molding Dry Density, P.C.F.				
Swell upon saturation, %				
CBR at 0.1" Penetration				
MOISTURE-DENSITY RELATIONS OF SOILS (ASTM D-1557-70, Method)				
Dry to Wet or Wet to Dry				
Max. Dry Density (P.C.F.)				
Optimum Moisture (%)				

REMARKS:

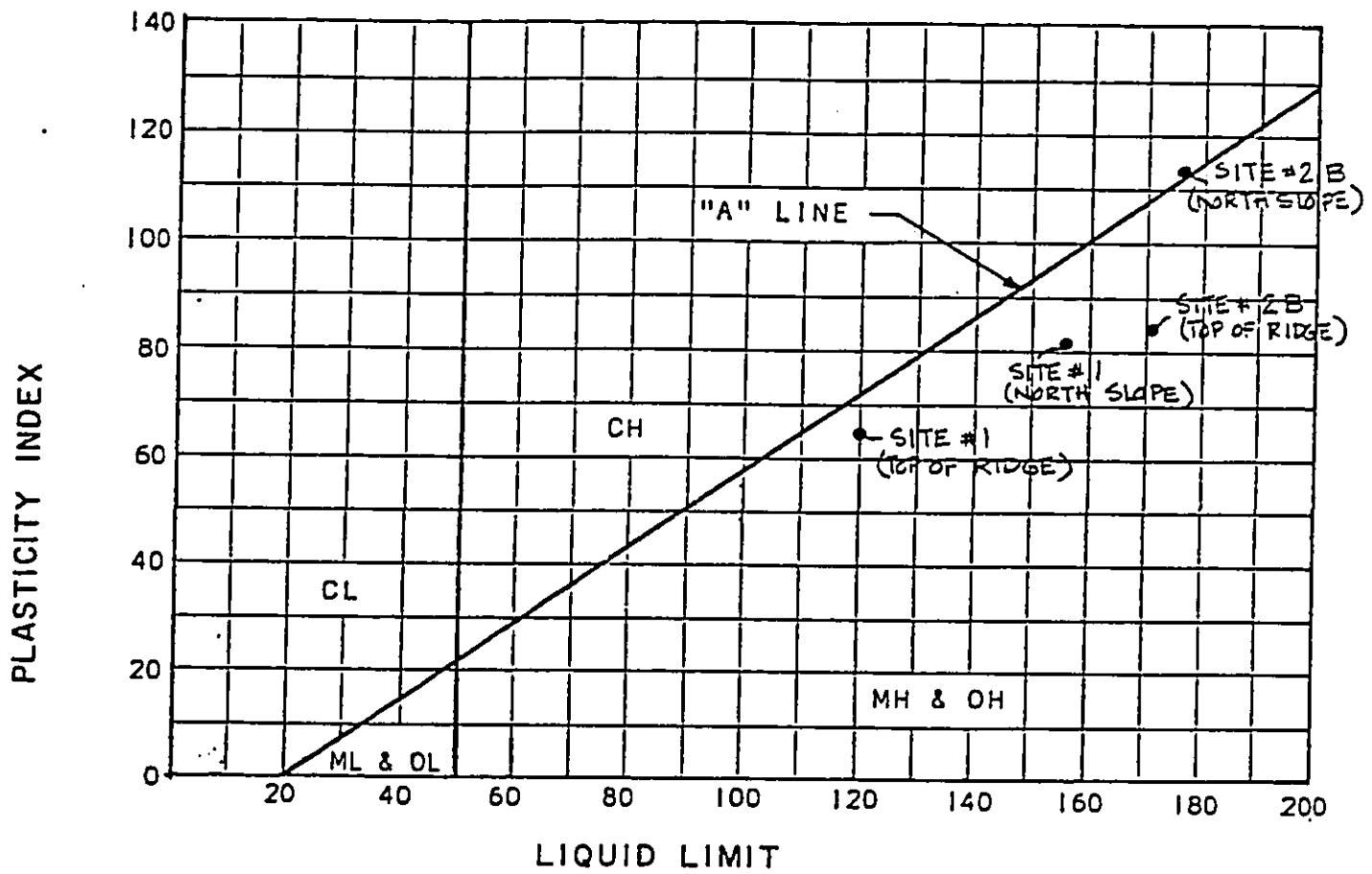
WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

Date 4-27-79 By JWS

PLASTICITY CHART

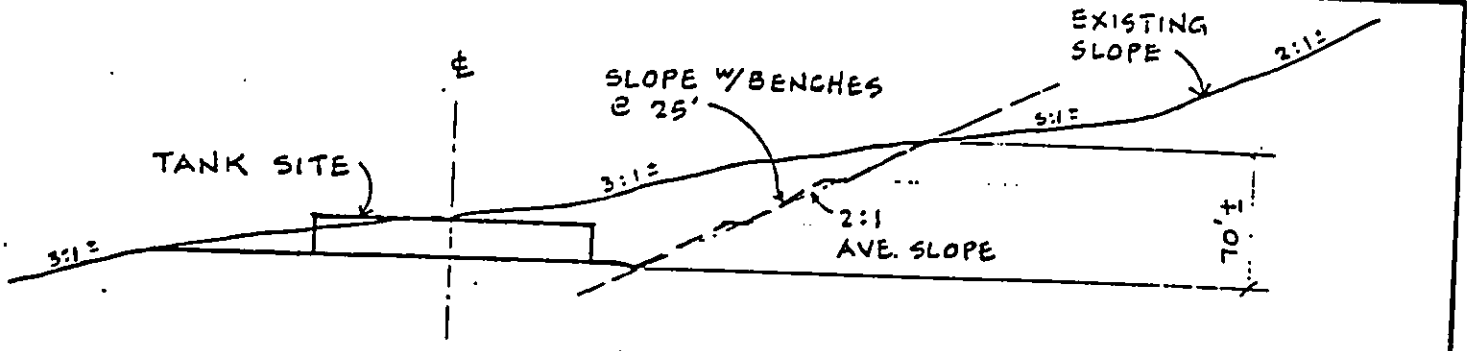
PROJECT : PROPOSED 2.0 M.G. KAHANA "300" RESERVOIR SITES

LOCATION : KAHANA VALLEY, OAHU, HAWAII

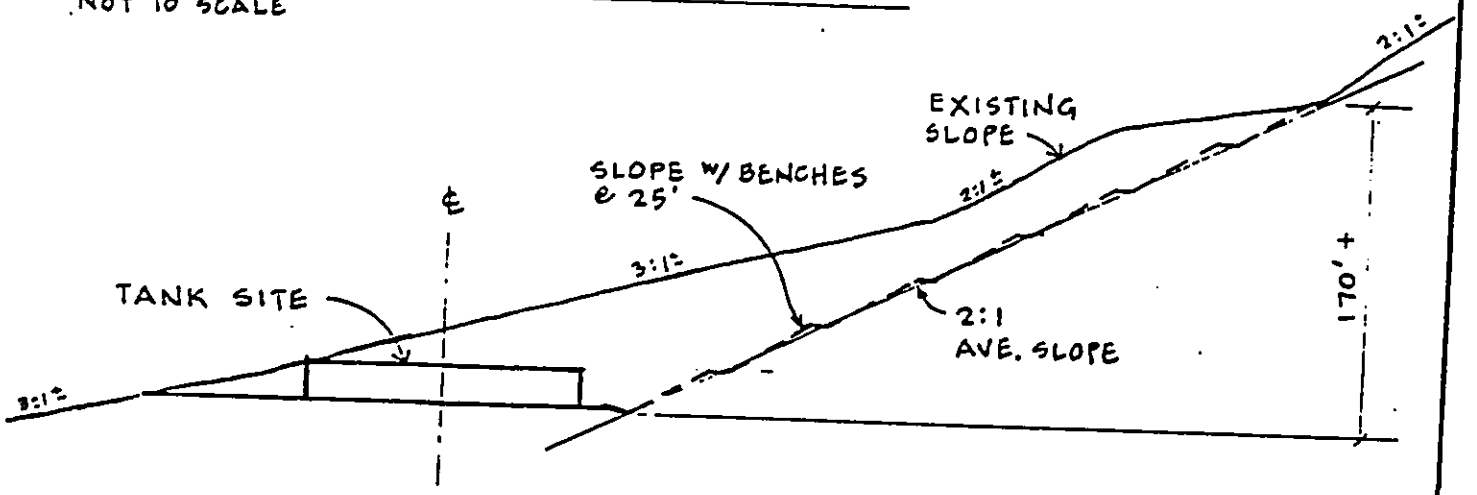


DATE 4-27-79 BY JWS

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS



SCHEMATIC SECTION - SITE NO. 1
NOT TO SCALE



SCHEMATIC SECTION - SITE NO. 2A
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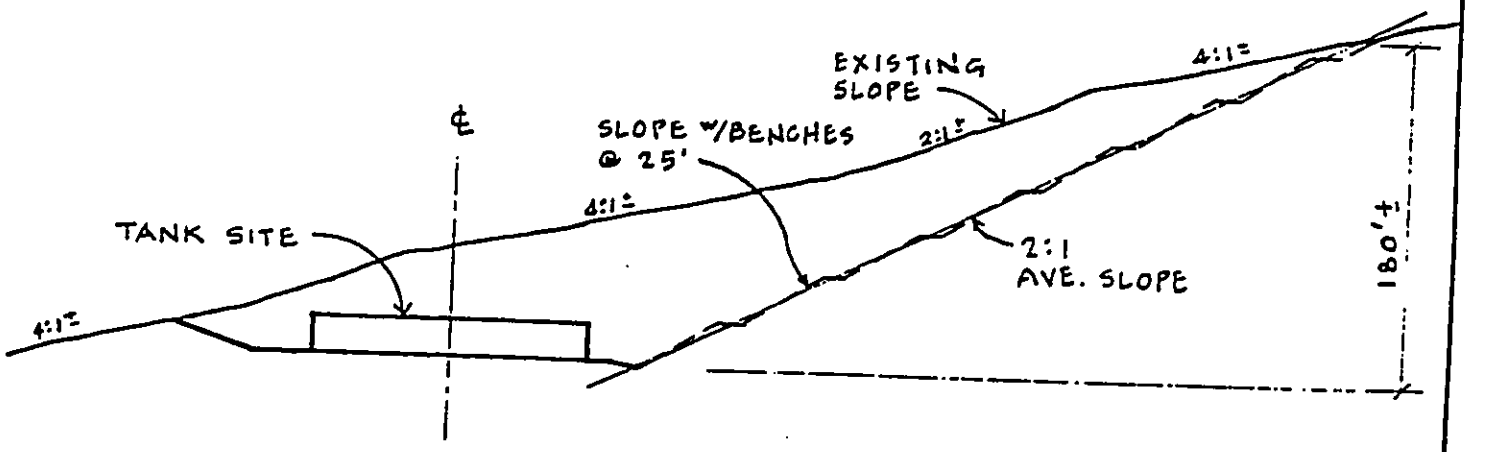

SCHEMATIC SECTION - SITE NO. 2B
NOT TO SCALE

FIGURE 1
SCHEMATIC SECTIONS
PROPOSED 2.0 M.G. KAHANA
"300" RESERVOIR SITE
KAHANA VALLEY, OAHU, HAWAII

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

JUNE, 1979

LIMITATIONS

In general, soil formations are commonly erratic and rarely uniform or regular. The estimated soil conditions are based on visual observations at the site at about the time of this report and may not represent conditions at other locations, or at other dates. Soil conditions and water levels may change with the weather, passage of time and construction methods or improvements at the site.

Should soil conditions much different from our estimates be observed, encountered, or otherwise indicated, we should be advised immediately to review or reconsider our recommendations in light of the new developments.

This soil reconnaissance report was prepared only for preliminary studies of the site. If there is a substantial lapse of time between the submission of this report and the start of design studies at the site, or if conditions have changed due to natural causes, plan changes, or construction operations at or adjacent to the site, it is recommended that this report be reviewed to determine the applicability of the recommendations considering the time lapse, changed conditions, and changes in the practice of soil engineering.

Our professional services were performed, findings obtained and recommendations prepared in accordance with generally accepted soil engineering practices. This is in lieu of all other warranties expressed or implied.

APPENDIX B

6.0 SOILS REPORT
FOUNDATION INVESTIGATION
KAHANA "315" RESERVOIR

FOUNDATION INVESTIGATION

KAHANA 315 RESERVOIR

KAHANA VALLEY STATE PARK

KAHANA VALLEY, OAHU, HAWAII

for

WILLIAM HEE & ASSOCIATES, INC.

W. O. 81-840

April 15, 1982

EH ERNEST K. HIRATA & ASSOCIATES, INC.

ERNEST K. HIRATA & ASSOCIATES, INC.
Soils and Foundation Engineering

905 Makahiki Way, Makai Suite • Honolulu, Hawaii 96826 • Phone 941-5055

April 15, 1982
W. O. 81-840

William Hee & Associates, Inc.
Bldg. No. 1
1020 Auahi Street
Honolulu, Hawaii 96814

Attention: Mr. William Hee

Gentlemen:

Our report, "Foundation Investigation, Kahana 315 Reservoir, Kahana Valley State Park, Kahana Valley, Oahu, Hawaii", dated April 15, 1982, our Work Order 81-840 is enclosed. This is the report requested by you and planned in cooperation with personnel of your staff and SSFM Engineers, Inc., Structural Engineers.

The surface soil covering the reservoir site consists of a firm to medium stiff silty clay ranging in thickness from 4 to 54.5 feet. Underlying the silty clay is a stiff clayey silt also referred to as highly weathered rock. Based on a finish floor elevation of 285, excavations should expose the highly weathered rock.

Due to the differences in overburden pressure to be removed, we suggest that the structural system selected be able to account for possible differential settlements. The use of either a mat type foundation or spread footings connected with grade beams should be considered. An allowable bearing value of 4000 PSF for either type of foundation founded a minimum of 12 inches into the highly weathered rock is recommended.

We appreciate this opportunity to be of service. Should you have any questions concerning this report, please feel free to call on us.

Very truly yours,

Ernest K. Hirata & Associates, Inc.

Ernest K. Hirata President

EKH:yk

W. O. 81-840

FOUNDATION INVESTIGATION
KAHANA 315 RESERVOIR
KAHANA VALLEY STATE PARK
KAHANA VALLEY, OAHU, HAWAII

INTRODUCTION

This report presents the results of our foundation investigation performed for the six million gallon reservoir in Kahana Valley on the windward side of Oahu. The purpose of this investigation was to determine the nature of the soils underlying the site, to ascertain their engineering properties, and to provide recommendations for foundation design, lateral pressures, floor slabs and site grading.

This investigation included drilling three exploratory test borings, obtaining representative soil samples, laboratory testing and analysis, and the preparation of this report. The exploratory boring locations are shown on the enclosed Topographic Survey. Also attached is an Appendix which describes the laboratory testing procedures.

STRUCTURAL CONSIDERATIONS

Information concerning the proposed development was furnished by personnel of your staff and SSFM Engineers, Inc., Structural Engineers.

The proposed project will be a six million gallon reservoir of reinforced concrete construction. The water reservoir will be approximately 190 feet in diameter and 30 feet in height. Reinforced concrete columns will support the roof of the reservoir. The maximum column load will be on the order of 108 kips while wall loads will be approximately 6.5 kips per lineal foot.

Based on preliminary grading plans, grading techniques of cutting for the proposed tank and filling for the roadway will be required to construct the new reservoir. Maximum cuts of approximately 61 to 66 feet are anticipated to attain the reservoir base elevation of 285. The perimeter of the tank will be backfilled to elevation 300 for the roadway, leaving approximately 15 feet of the reservoir exposed.

SITE CONDITIONS

The proposed project is located approximately two miles into Kahana Valley State Park from Kamehameha Highway on the windward side of Oahu. The reservoir site is situated on a finger ridge sloping down from the western slopes of the valley, formed by Puu Piei Ridge. Access to the tank site is presently provided by a hiking trail.

The site slopes down in a southeasterly direction toward Kahana Stream. The total relief of the reservoir site is approximately 40 feet. The site is covered by a heavy growth of forest

vegetation along with several large trees.

FIELD EXPLORATION

The site was explored from February 16th through the 24th, 1982 by drilling three exploratory test borings with a portable drilling machine transported by helicopter. The borings varied in depth from 31.5 to 75 feet. The soils were continuously logged by our field engineer and classified by visual examination in accordance with the Unified Soil Classification System. The boring locations are shown on the enclosed Topographic Survey, and soils encountered are logged on Plates A1 through A7.

Undisturbed and bag samples were recovered from the borings for laboratory testing and analyses. Undisturbed samples were obtained by driving a 3 inch O. D. thin-walled split tube sampler with a 140 pound hammer from a height of 30 inches. The required blow count for twelve inches of penetration is shown on the enclosed Boring Logs.

SOIL CONDITIONS

The surface soil covering the proposed reservoir site consists of an orange brown silty clay in a firm to medium stiff condition. The thickness of the surface silty clay varies from 4 feet in boring B1 to 54.5 feet in boring B3.

Underlying the surface soil at elevations ranging from approximately 290 to 303 is a mottled orange brown clayey silt, which

can also be classified as a highly weathered rock, down to the maximum depths drilled. The clayey silt is in a stiff condition with weathered rock fragments. Several pockets of medium stiff clayey silt with higher moisture contents were encountered within the stratum.

Water level readings due to groundwater or seepage could not be measured since water was used in the drilling of the borings. Boring B3 was drilled with an auger down to a depth of 25 feet and groundwater was not encountered.

CONCLUSIONS AND RECOMMENDATIONS

Based on preliminary grading plans, the reservoir will be situated at elevation 285, resulting in cuts ranging from 20 feet on the southern side to 60 feet on the northwestern side. Excavations will extend into the stiff, mottled orange brown clayey silt also described as a highly weathered rock. The clayey silt underlies the surface silty clay at elevations varying from approximately 290 to 303. As required by Board of Water Supply standards, all footings must be founded on undisturbed material, which in this case will be the stiff highly weathered rock. In the event softer pockets are encountered, excavations should extend down to completely remove the softer pockets, and should be backfilled with lean concrete.

The differences in the amount of overburden material to be removed between one end of the reservoir and the other are significant. This could result in differential settlements to the foundation system. Settlement calculations indicate that settlements ranging from 3/4 to 1-1/2 inches could occur between the two ends of the tank. A rough approximation of the differential settlement that might occur between interior columns could range from 1/8 to 3/8 of an inch.

We suggest that the structural system selected be able to account for the possible differential settlement. The use of either a mat type foundation or spread footings connected with grade beams

should be considered. The final determination as to the foundation system to use will need to be based on the economics of each system.

The insitu moisture contents of the onsite soils range from 60 to 70 percent while the optimum moisture content is 40 percent. This would indicate that the workability of the soil is poor and difficulty can be anticipated in achieving compaction requirements of 90 percent if conventional methods are specified.

Because of the large quantity of soil that will be needed, air drying of soil to the optimum moisture content may be impractical if not impossible.

Laboratory tests were conducted on remolded samples of the onsite soils at various moisture contents. In general, the strength properties of the soil were high when moisture contents were less than 60 percent. We believe that a combination of some air drying as well as modification to conventional compaction requirements will be necessary if onsite soils are to be acceptable for reuse in compacted fills.

We will wish to review the final grading plans and specifications to ensure that proper guidelines for moisture content and air drying are indicated.

Foundations

Either mat type foundations or conventional spread footings tied

together with grade beams may be used to support the tank structure, provided foundations are founded on the undisturbed stiff clayey silt also described as highly weathered rock. Foundations may be designed for a bearing value of 4000 pounds per square foot and should be embedded into the stiff clayey silt a minimum of 12 inches.

Lateral Design

The bearing value indicated above is for the total of dead and frequently applied live loads, and may be increased by one-third for short duration loading which includes the effect of wind or seismic forces. Resistance to lateral loading may be provided by friction acting at the base of foundations and by passive earth pressure. An allowable coefficient of friction of 0.4 may be used with the dead load forces. Passive earth pressure may be computed as an equivalent fluid having a density of 200 and 350 pounds per cubic foot with a maximum earth pressure of 2000 and 3500 pounds per square foot for the surface silty clay and clayey silt, respectively. When combining passive and friction for lateral resistance, the passive component should be reduced by one-third.

For active earth pressure considerations, an equivalent fluid pressure of 45 pounds per cubic foot per foot of depth may be used for the surface silty clay in both its undisturbed and remolded states for a level backfill condition.

The effect of wall friction between the backfill and reservoir wall will have an affect on the lateral forces acting on the wall. A wall friction angle of 17°, measured from the horizontal, may be used for compacted backfill against the reinforced concrete reservoir wall.

The active earth pressure values do not include the effect of any live loads due to use of mechanical compaction equipment during backfilling of the roadway around the perimeter of the tank. Assuming a 10 ton roller is used to compact the soil and maintains a clear distance of 12 inches from the tank wall, an additional uniform live load surcharge of 4 feet should be used. Mechanical equipment used for compacting the onsite soils should not exceed 10 tons in weight.

Slabs on Grade

Since the surface silty clay is compressible, all silty clays underlying slabs on grade should be removed down to the stiff clayey silt and replaced with lean concrete. In accordance with Board of Water Supply standards, Class C concrete should be used in fill areas under the proposed tank in lieu of structural fill. Fill areas which slope steeper than 5:1 (horizontal to vertical) should be keyed and benched prior to placement of lean concrete.

Slope Stability

Both cut and fill slopes should be stable using slope gradients

of 2:1 (horizontal to vertical) or flatter.

Cut slopes will consist primarily of the silty clay which is in a firm to medium stiff condition. The Soil Survey Manual published by the Soil Conservation Service classifies the soil in the Waikane series with moderate to severe erosion hazard. Therefore, we recommend maximum heights of 15 feet with 8 foot wide benches in the construction of the slopes.

All slopes should be planted as soon as practical upon completion of grading to minimize the effects of erosion and weathering.

Site Grading

As stated earlier, the insitu moisture content of the onsite soils are high with respect to the optimum moisture content. However because of the large quantity of material involved, air drying of the soil to optimum moisture content may be impractical. Difficulty can be anticipated in achieving compaction requirements of 90 percent if conventional methods are specified.

We believe that a combination of some air drying of the soil as well as modifications to conventional compaction requirements will be necessary if onsite soils are to be acceptable for reuse in compacted fills. Laboratory tests indicate that the strength properties of the soils decrease when the moisture contents are in excess of 60 percent. We therefore recommend that all fill be placed at moisture contents less than 60 percent.

We further recommend that all structural fill be compacted to a minimum of 90 percent of the maximum wet density. The maximum wet density curve may be obtained using laboratory test procedures similar to ASTM D 1557-78. Due to the poor workability of the soil and the difficulty anticipated in achieving proper compaction, these guidelines may need to be revised in the field during construction.

Prior to placement of fill, the existing ground should be scarified to a depth of six inches and compacted to a minimum of 90 percent of the maximum wet density. All structural fill should be placed in horizontal lifts restricted to six inches in thickness. Fill areas which slope steeper than 5:1 (horizontal to vertical) should be keyed and benched during grading operations.

Any imported structural fill shall be non-expansive granular material. Specifications for imported structural fill should state that not more than 15 percent of soil by weight shall pass the #200 sieve. In addition, the P. I. of the soil shall not be greater than 10. Yard fill necessary for landscaping need not adhere to these specifications.

Excavations into the onsite soils can be made using conventional earth moving equipment.

Inspection

It is recommended that all footing excavations be inspected by a qualified foundation engineer prior to placing concrete or steel. Any structural fill which is placed should be inspected and tested.

Limitations

The boring logs indicate the approximate subsurface soil conditions encountered only at those locations where the borings were made, and may not represent conditions at other locations.

During construction, should subsurface conditions differ from those encountered in the borings, we should be advised immediately in order to review and to revise our recommendations.

Our professional services were performed, findings obtained, and recommendations prepared in accordance with generally accepted engineering practices. This warranty is in lieu of all other warranties expressed or implied.

Respectfully submitted,

Ernest K. Hirata & Associates, Inc.

Ernest K. Hirata, P. E.

EKH:yk

APPENDIX OF LABORATORY TESTING

Classification

The field classification is verified in the laboratory, also in accordance with the Unified Soil Classification System. Laboratory classification is determined by both visual examination and Atterberg Limit Tests according to ASTM D423 and D424. The final classification is shown on the Boring Logs.

Moisture-Density

The field moisture content and dry unit weight are determined for each of the undisturbed soil samples. The information is useful in providing a gross picture of the soil consistency between borings and any local variations. The dry unit weight is determined in pounds per cubic foot while the moisture content is determined as a percentage of the dry unit weight. These samples are obtained from a 3" O.D. split tube sampler.

Consolidation

Settlement predictions of the soil's behavior under load are made on the basis of the consolidation tests. Loads are applied in several increments in a geometric progression, and the resulting deformations are recorded at selected time intervals. Porous stones are placed in contact with the top and bottom of each specimen having an inside diameter of 2.40 inches and a height of 1 inch to permit addition and

release of pore fluid. Results of undisturbed and remolded samples are plotted on the Consolidation Test Report.

Compaction Tests

Compaction tests were performed on bag samples to determine the optimum moisture content at which each type of proposed fill material compacts to 100% density. The tests were performed according to ASTM D-1557-78.

Swell Tests

Swell tests were performed to determine the expansiveness of the onsite surface soils. The tests were performed on undisturbed ring and remolded samples taking a one inch high specimen under different surcharge loads.

Shear Tests

Shear tests are performed in the Direct Shear Machine which is of the strain control type. The rate of deformation is approximately 0.02 inches per minute. Each sample is sheared under varying confining loads in order to determine the Coulomb shear strength parameters, cohesion and angle of internal friction. Eighty percent of the maximum value is taken to determine the shear strength parameters.

ERNEST K. HIRATA & ASSOCIATES, INC.
Soils and Foundation Engineering
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BORING LOG

W.O. 81-840

BORING NO. B1 DRIVING WT. 140 lb. DATE OF DRILLING 2-23-82
SURFACE ELEV. 307±* DROP 30 in. WATER LEVEL None

DEPTH (FEET)	GRAPH SYMBOL	UNIFIED SOIL CLASSIFICATION	BLOWS/FT.	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	RELATIVE COMPACTION (%)	DESCRIPTION
0		MH					Silty CLAY-Orange brown, moist, firm to medium stiff.
5		ML	19	68.5	51.3		Clayey SILT (Highly weathered rock)- Mottled orange brown, moist, medium stiff.
10			26	63.0	64.0		Grading stiff at 10 feet.
15			30	65.2	53.3		Grading to mottled purplish brown color from 18 feet.
20			35	62.0	64.9		Grading to mottled orange brown color from 23 feet.
25			39	65.9	61.0		
30							

Plate A1

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BORING LOG

W.O. 81-840

BORING NO. B1 (cont.) DRIVING WT. 140 lb. DATE OF DRILLING 2-24-82
SURFACE ELEV. 307± DROP 30 in. WATER LEVEL None

DEPTH (FEET)	GRAPH SYMBOL	UNIFIED SOIL CLASSIFICATION	BLOWS/FT.	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	RELATIVE COMPACTION (%)	DESCRIPTION
30			28	60.7	69.8		
							End boring at 31.5 feet.
							*Elevations based on Topographic Survey prepared by William Hee & Associates, Inc. dated April 1982 Revised
35							
40							
45							
50							
55							
60							

Plate A2

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BORING LOG

BORING NO. B2 | DRIVING WT. 140 lb. | W.O. 81-840
SURFACE ELEV. 315± | DROP 30 in. | DATE OF DRILLING 2-22-82
WATER LEVEL None

DEPTH (FEET)	GRAPH SYMBOL	UNIFIED SOIL CLASSIFICATION	BLOWS/FT.	DRY DENSITY (PCF.)	MOISTURE CONTENT (%)	RELATIVE COMPACTION (%)	DESCRIPTION
0		MH					Silty CLAY-Orange brown, moist, firm to medium stiff.
5			16	64.3	59.7		
10			22	61.6	64.8		Grading medium stiff with highly weathered rock fragments from 9 feet.
15			22	62.7	66.3		
20			19	59.9	70.7		
25			28	65.7	61.8		Grading to mottled purplish brown color from 23 feet.
		ML					Clayey SILT (Highly weathered rock)- Mottled orange brown, moist, stiff.
30			39	67.2	59.1		

Plate A3

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BORING LOG

W.O. 81-840

BORING NO. B2 (cont.) DRIVING WT. 140 lb. DATE OF DRILLING 2-23-82

SURFACE ELEV. 315± DROP 30 in. WATER LEVEL None

DEPTH (FEET)	GRAPH SYMBOL	UNIFIED SOIL CLASSIFICATION	BLOWS/FT.	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	RELATIVE COMPACTION (%)	DESCRIPTION
30							
35			21	60.7	70.3		Grading medium stiff to stiff from 34 feet.
40			26	69.5	56.8		Grading stiff with weathered rock fragments from 37 feet.
45			41	65.7	59.3		
50			31	62.3	66.7		
							End boring at 50.5 feet.
55							
60							

Plate A4

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BORING LOG

W.O. 81-840

BORING NO. B3 | DRIVING WT. 140 lb. | DATE OF DRILLING 2-16-82

SURFACE ELEV. 345+ | DROP 30 in. | WATER LEVEL None

DEPTH (FEET)	GRAPH SYMBOL	UNIFIED SOIL CLASSIFICATION	BLOWS/FT.	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	RELATIVE COMPACTION (%)	DESCRIPTION
0		MH					Silty CLAY-Orange brown, moist, firm to medium stiff, with weathered gravels.
5			16	62.1	62.9		
10			19	63.0	64.3		
15			22	61.9	64.3		
20			12	63.9	62.4		Grading silty with highly weathered rock fragments from 19 feet.
25			11	61.9	66.7		
30			10	60.4	69.1		

Plate A5

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BORING LOG

BORING NO. B3 (cont.) DRIVING WT. 140 lb. W.O. 81-840
SURFACE ELEV. 345± DROP 30 in. DATE OF DRILLING 2-17-82
WATER LEVEL None

DEPTH (FEET)	GRAPH SYMBOL	UNIFIED SOIL CLASSIFICATION	BLOWS/FT.	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	RELATIVE COMPACTION (%)	DESCRIPTION
30							
35			22	65.6	63.9		
40			18	66.8	60.5		
45			19	64.7	64.9		
50			12	60.9	70.0		
55		ML	48	72.3	52.7		Clayey SILT (Highly weathered rock)- Mottled orange brown, moist, stiff.
60			23	63.7	67.3		Grading medium stiff to stiff from 59 feet.

Plate A6

ERNEST K. HIRATA & ASSOCIATES, INC.
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905 Makahiki Way, Makai Suite • Honolulu, Hawaii 96826 • Phone 941-5055

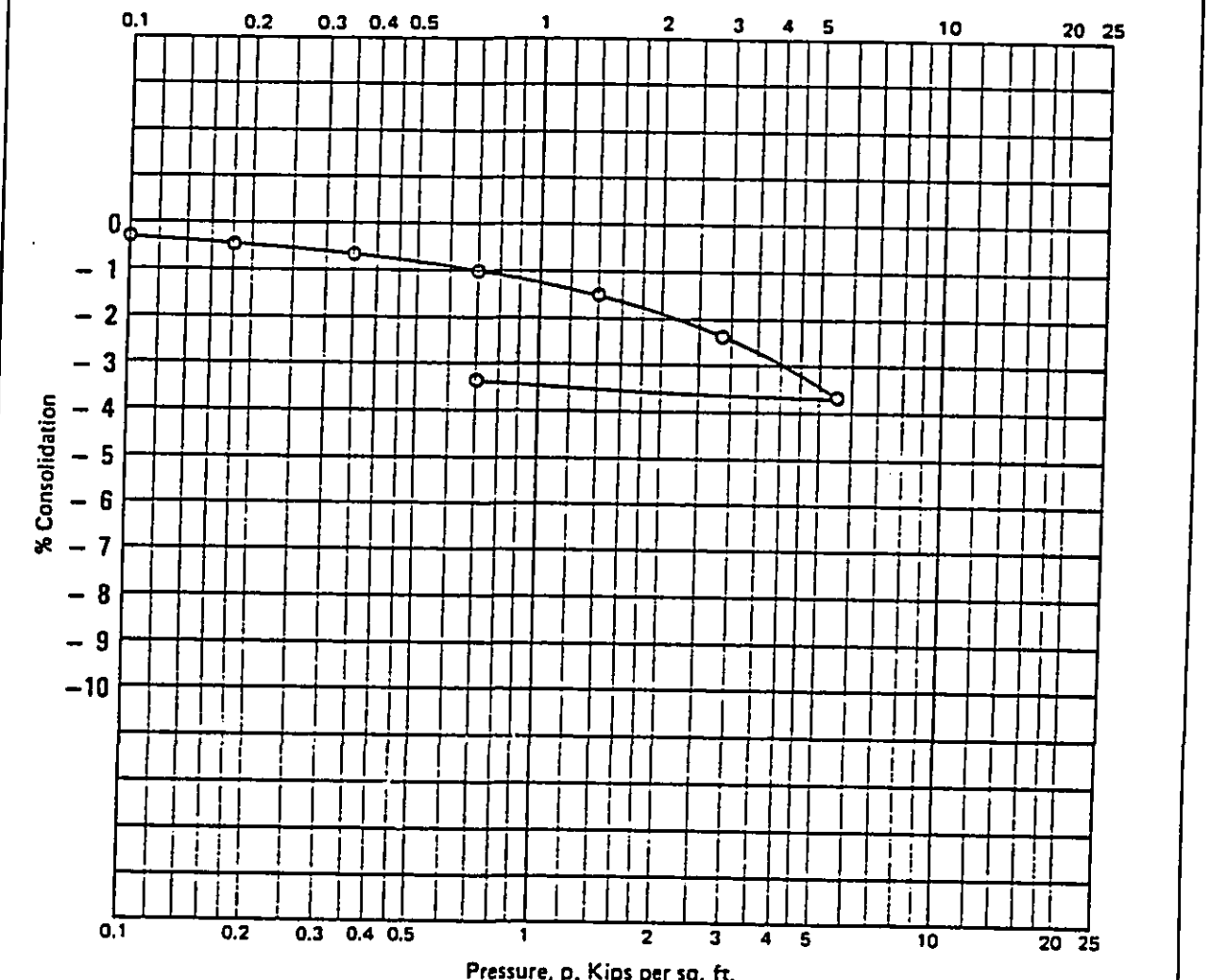
BORING LOG

W.O. 81-840

BORING NO. B3 (cont.) DRIVING WT. 140 lb. DATE OF DRILLING 2-17-82
SURFACE ELEV. 345± DROP 30 in. WATER LEVEL None

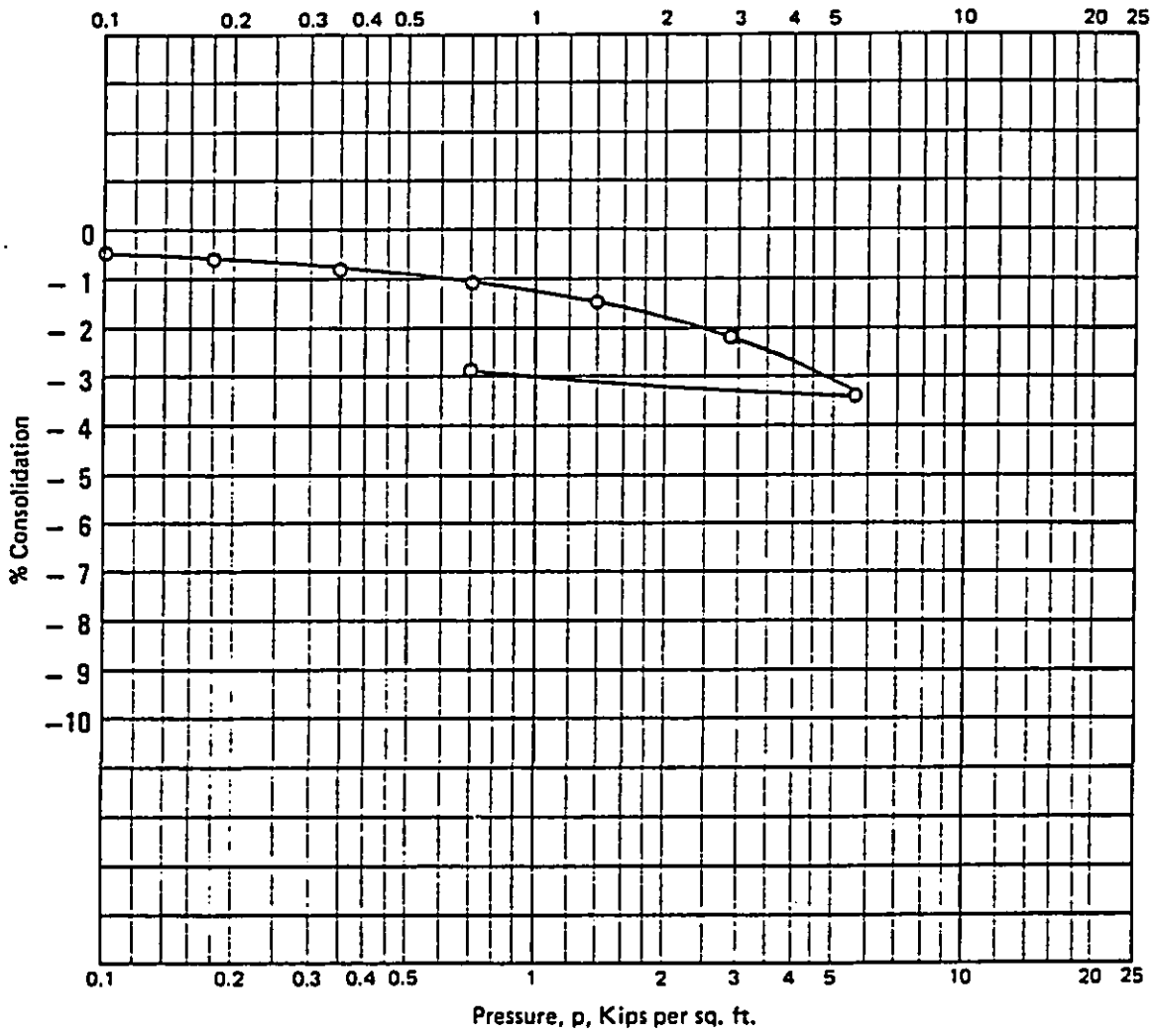
DEPTH (FEET)	GRAPH SYMBOL	UNIFIED SOIL CLASSIFICATION	BLOWS/FT.	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	RELATIVE COMPACTION (%)	DESCRIPTION
60							
65			52/8"	74.0	49.2		Grading stiff with weathered rock fragments from 64 feet.
70			62	64.7	62.4		
75			74/11"	73.5	50.6		
							End boring at 75 feet.
80							
85							
90							

Plate A7



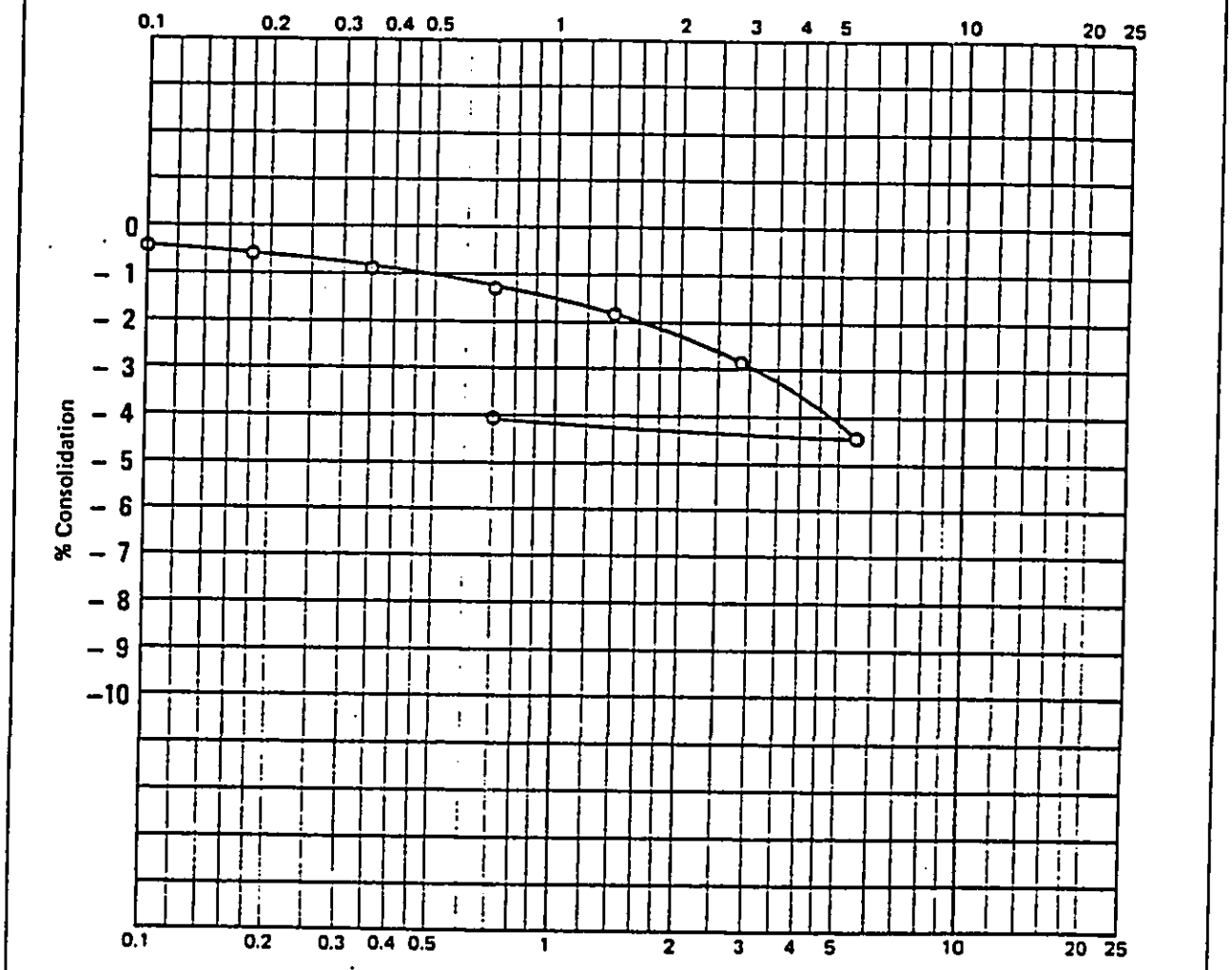
Type of Specimen: Undisturbed		Before Test		After Test	
Diam 2.40 in. Ht 1.0 in.		Water Content, w_o	53.3 %	w_f	%
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o		e_f	
Preconsol. Pressure, p_c T/sq ft		Saturation, s_o	%	s_f	%
Compression Index, c_c		Dry Density, γ_d	65.2 lb/ft^3		
Classification ML					
LL		Project: Kahana 315 Reservoir			
PL		Kahana Valley			
Remarks		W.O. 81-840			
		Boring No. B1		Sample No.	
		Depth 15'		Date 2-25-82	
		CONSOLIDATION TEST REPORT			

Plate B1



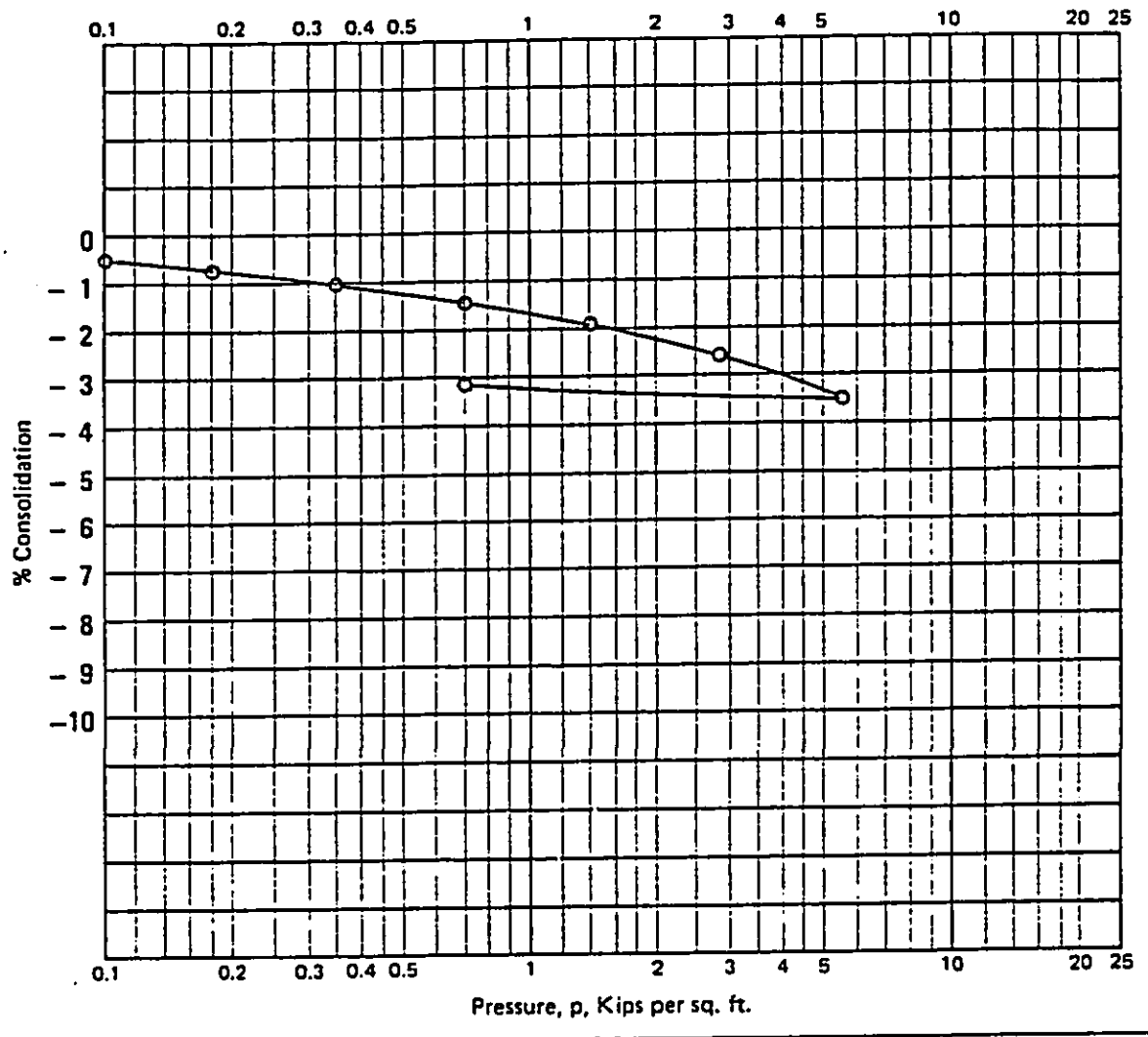
Type of Specimen: Undisturbed		Before Test		After Test	
Diam: 2.40 in. Ht: 1.0 in.		Water Content, w_o	69.8 %	w_f	63.1 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o		e_f	
Preconsol. Pressure, p_c T/sq ft		Saturation, s_o	%	s_f	%
Compression Index, c_c		Dry Density, γ_d	60.7 lb/ft^3		
Classification: ML					
LL		Project: Kahana 315 Reservoir			
PL		Kahana Valley			
Remarks: Water added at 700 PSF		W.O.: 81-840			
		Boring No.: B1		Sample No.	
		Depth: 30'		Date: 3-1-82	
		CONSOLIDATION TEST REPORT			

Plate B2



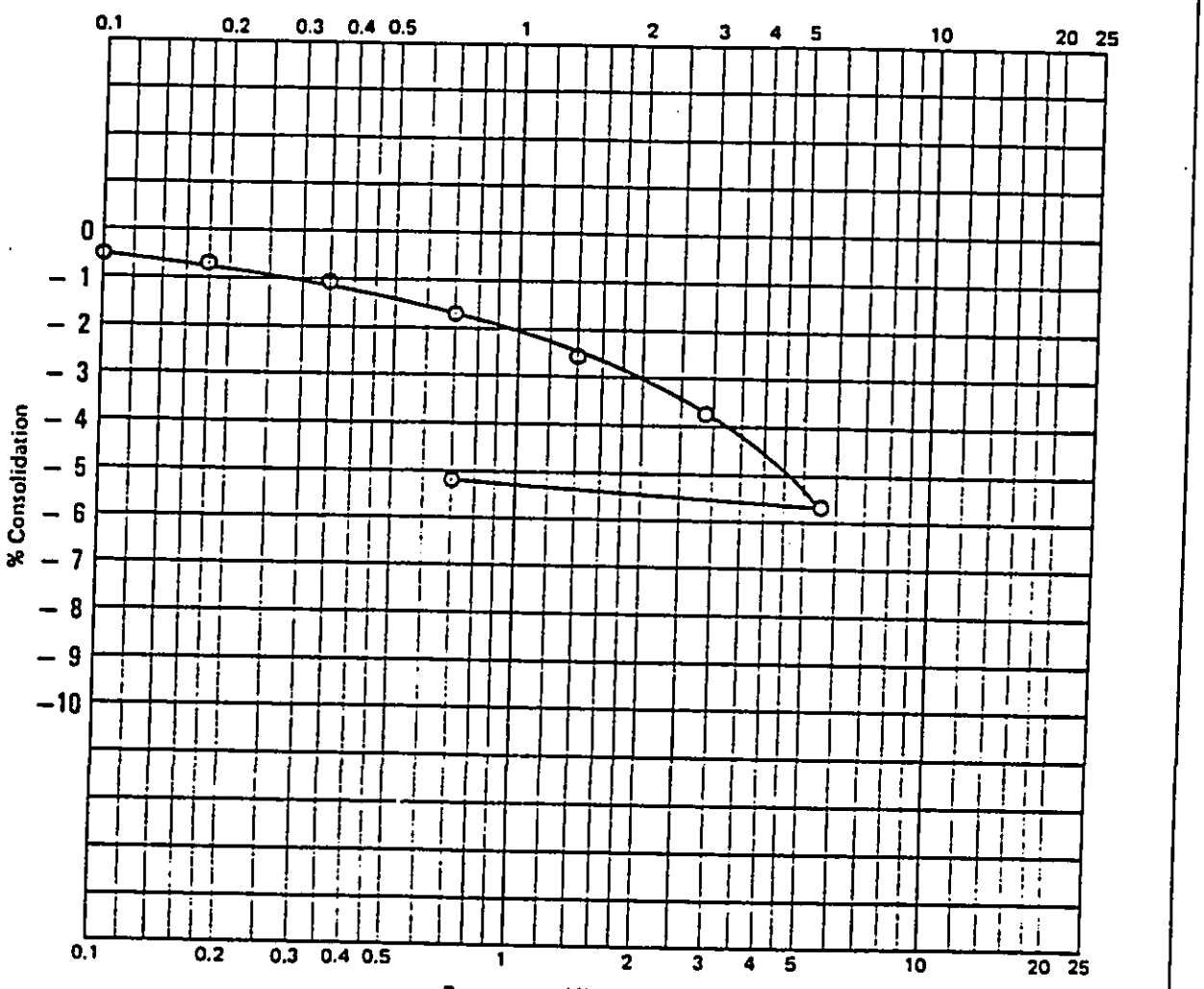
Type of Specimen Undisturbed		Before Test		After Test	
Diam 2.40 in. Ht 1.0 in.		Water Content, w_o	70.3 %	w_f	65.3 %
Overburden Pressure, p_o	T/sq ft	Void Ratio, e_o		e_f	
Preconsol. Pressure, p_c	T/sq ft	Saturation, s_o	%	s_f	%
Compression Index, c_c		Dry Density, γ_d	60.7 lb/ft^3		
Classification ML					
LL		Project	Kahana 315 Reservoir		
PL			Kahana Valley		
Remarks		W.O.	81-840		
		Boring No.	B2	Sample No.	
		Depth	34'	Date	2-25-82
		CONSOLIDATION TEST REPORT			

Plate B3



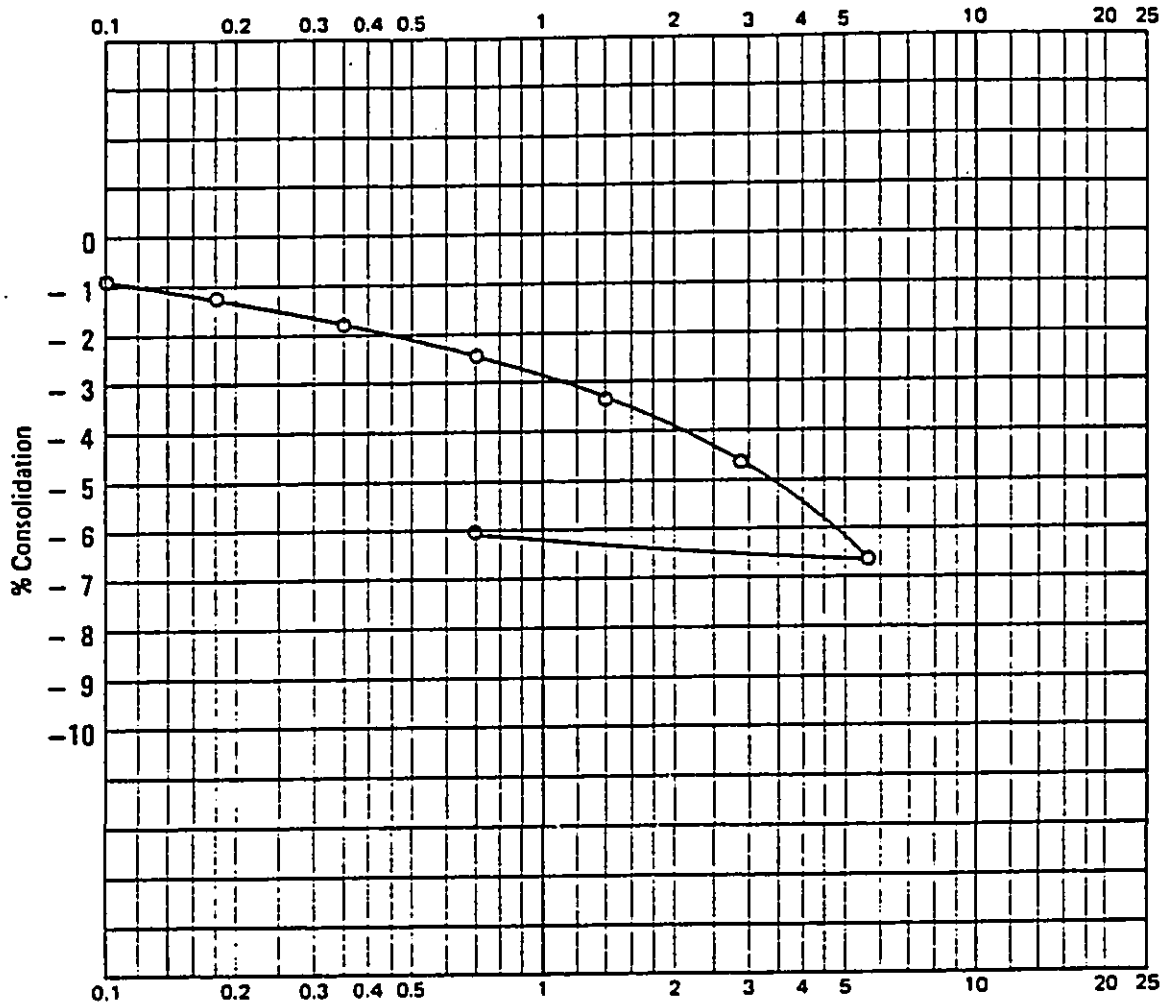
Type of Specimen: Undisturbed		Before Test		After Test	
Diam: 2.40 in. Ht: 1.0 in.		Water Content, w_o	56.8 %	w_f	53.3 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o		e_f	
Preconsol. Pressure, p_c T/sq ft		Saturation, s_o	%	s_f	%
Compression Index, c_c		Dry Density, γ_d	69.5 lb/ft^3		
Classification: ML					
LL		Project: Kahana 315 Reservoir			
PL		Kahana Valley			
Remarks		W.O.: 81-840			
		Boring No.: B2		Sample No.:	
		Depth: 39'		Date: 2-25-82	
		CONSOLIDATION TEST REPORT			

Plate B4



Type of Specimen: Undisturbed		Before Test		After Test	
Diam: 2.40 in.	Ht: 1.0 in.	Water Content, w_o	70.0 %	w_f	56.4 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o		e_f	
Preconsol. Pressure, p_c T/sq ft		Saturation, s_o	%	s_f	%
Compression Index, c_c		Dry Density, γ_d	60.9 lb/ft^3		
Classification: MH					
LL		Project: Kahana 315 Reservoir			
PL		Kahana Valley			
Remarks		W.O.: 81-840			
		Boring No.: B3	Sample No.		
		Depth: 49'	Date: 3-19-82		
		CONSOLIDATION TEST REPORT			

Plate B5



Type of Specimen Undisturbed		Before Test			After Test
Diam 2.40 in. Ht 1.0 in.		Water Content, w_o	67.3 %	w_f	66.8 %
Overburden Pressure, p_o	T/sq ft	Void Ratio, e_o		e_f	
Preconsol. Pressure, p_c	T/sq ft	Saturation, s_o	%	s_f	%
Compression Index, c_c		Dry Density, γ_d	63.7 lb/ft^3		
Classification ML					
LL		Project Kahana 315 Reservoir			
PL		Kahana Valley			
Remarks		W.O. 81-840			
		Boring No. B3		Sample No.	
		Depth 59'		Date 2-18-82	
		CONSOLIDATION TEST REPORT			

Plate B6

LABORATORY TEST RESULTS

Project: Kahana 315 Reservoir W.O. 81-840

Boring or Test Pit No.	B1	B2	B2	B3	B3
Depth (ft)	20	9	29	1	4
Atterberg Limit Tests					
Liquid Limit				69	
Plastic Limit				40	
Plasticity Index				29	
Soil Classification	ML	MH	ML	MH	MH
Expansion at 90 PSF					
Natural					
Remolded				7.4%	
Expansion at PSF					
Natural					
Remolded					
Unconfine Stress (PSF)	3150	2300	2850		930
Proctor					
Max. Dry Unit Wt. (PCF)				82.5	
Optimum Moisture (%)				40.0	
Wet Unit Wt. In-Place (PCF)	103.2	101.4	106.9		101.1
Moisture In-Place (%)	64.9	64.8	59.1		62.9
Dry Unit Wt. In-Place (PCF)	62.0	61.6	67.2		62.1

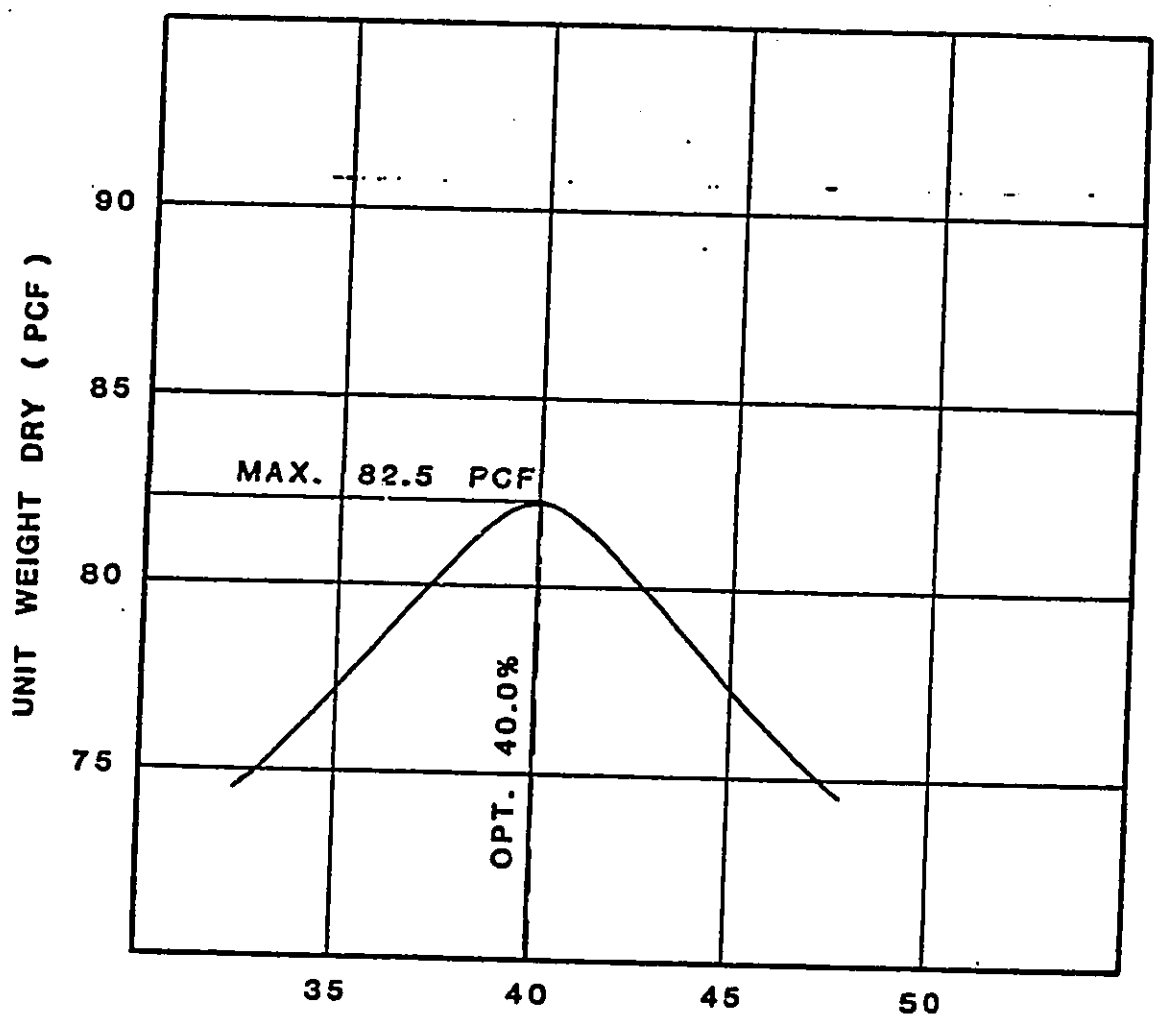
Plate C1

LABORATORY TEST RESULTS

Project: Kahana 315 Reservoir W.O. 81-840

Boring or Test Pit No.	B3	B3	B3		
Depth (ft)	19	39	54		
Atterberg Limit Tests					
Liquid Limit					
Plastic Limit					
Plasticity Index					
Soil Classification	MH	MH	ML		
Expansion at 90 PSF					
Natural			0.1%		
Remolded					
Expansion at PSF					
Natural					
Remolded					
Unconfine Stress (PSF)	1220	3080			
Proctor					
Max. Dry Unit Wt. (PCF)					
Optimum Moisture (%)					
Wet Unit Wt. In-Place (PCF)	103.7	107.2	110.5		
Moisture In-Place (%)	62.4	60.5	52.7		
Dry Unit Wt. In-Place (PCF)	63.9	66.8	72.3		

MAXIMUM DENSITY CURVE



Boring: B3

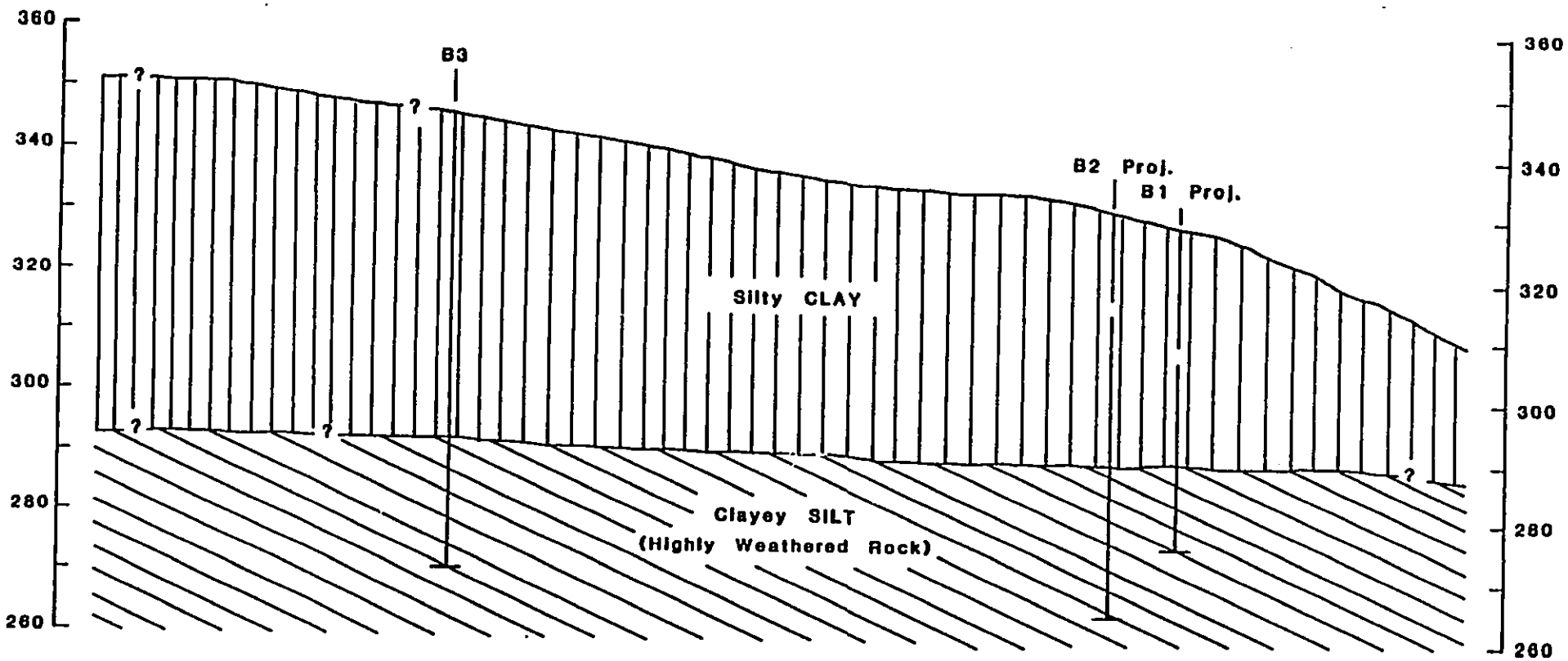
Depth: 1 foot

Classification:

Orange Brown Silty CLAY

W.O. 81-840

Plate D

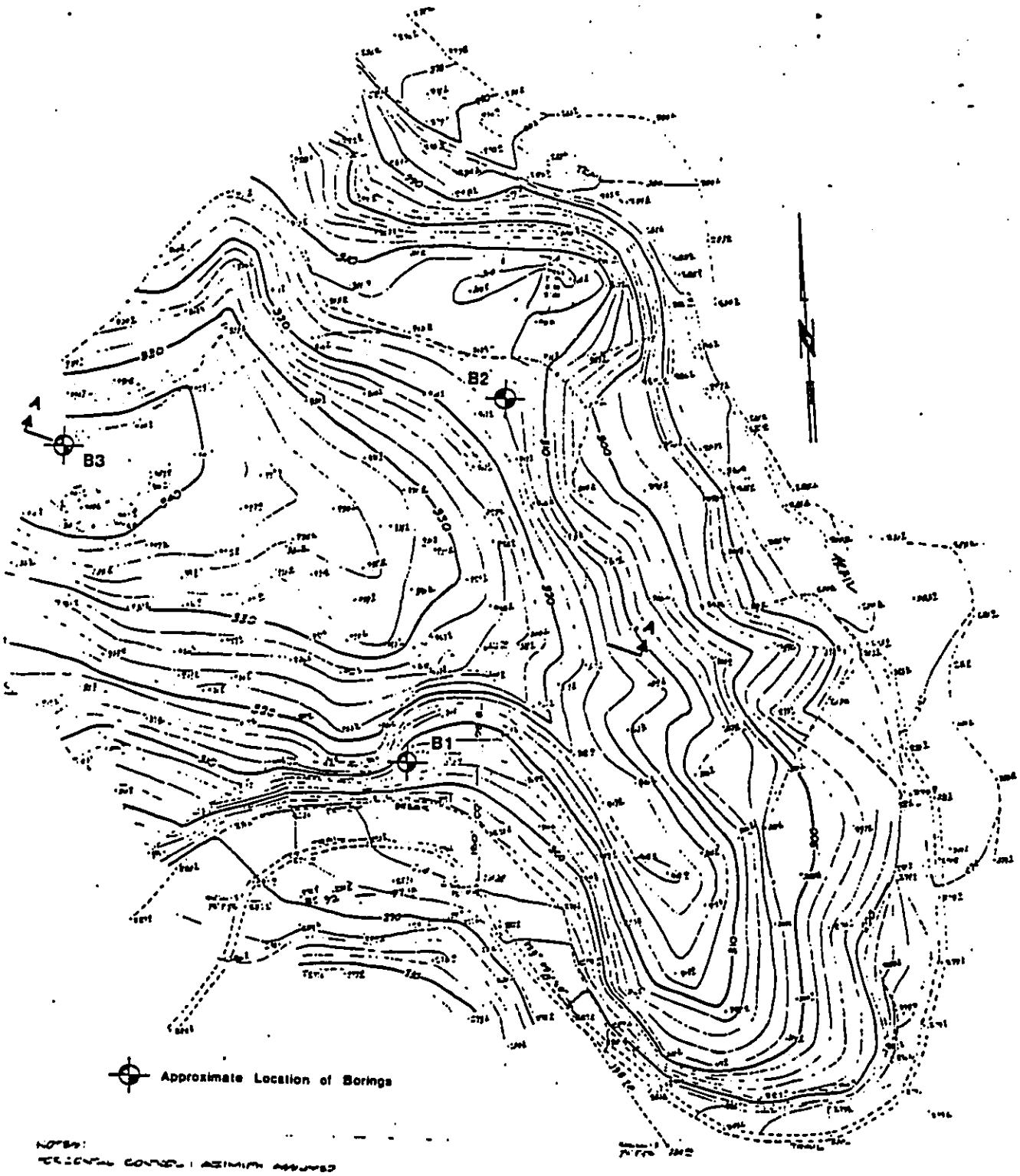


CROSS SECTION A-A

Scale: Horiz. 1" = 30'
Vert. 1" = 20'

W.O. 81-840
Plate 1

NOTE: FIGURE IS REDUCED REPRODUCTION.



ERNEST K. HIRATA & ASSOCIATES, INC.
W. O. 81-840

TOPOGRAPHIC SURVEY OF KAHANA '315' RESERVOIR SITE AT KAHANA KO'OLAU-DA, OAHU, HAWAII

NOTE: FIGURE IS REDUCED REPRODUCTION.

APPENDIX C

EXCERPT FROM REPORT NO. 77, THE QUALITY OF COASTAL WATERS: SECOND ANNUAL PROGRESS REPORT

Geochemistry

Kahana Valley consists of a monolithologic terrain except for marine detritus in the Lower Valley. Parent rock is exclusively basaltic in composition; the only lithologic products not derived from Koolau basalt are calcareous marine sediments near the bay and in the caprock wedge at the mouth of the valley. The normal weathering sequence culminating in latasoli soils prevails except below the approximate 30-foot (9.144 m) elevation wher marine submergence has given rise to heavy plastic soils.

Warm temperatures and high rainfall weathered parent rock containing few resistant minerals have produced saprolite thicknesses of up to 100 ft (30.48 m) in favorable locations. Saprolite is thin, or transitory, on the steep slopes at the head of the valley and along the lateral ridges. Also, as the gradient of the stream channel increases toward the Upper Valley it incises the saprolite to reach fresh rock.

The parent basalt is composed predominantly of calcic plagioclase, pyroxene, olivine, magnetite, ilmenite, some apatite, and varying percentage: of glass. An average analysis for the Koolau basalt is given in Table 2.4 (Visher and Mink 1964, p. 87). None of the silica in Hawaiian basalts occur: in free oxide form as quartz or its polymorphs.

During the weathering process, silica and the alkalies and alkaline earths are readily leached, leaving a saprolite composed largely of hydrated oxides of iron and aluminum, with kaolinite clays where marine submergence have had to be inferred.

The topographic and hydrologic boundaries of Kahana Valley do not coincide; groundwater moves into the valley chiefly from Punaluu and flows from the upper valley to the leeward side of the Koolau Range and probably also to Waikane Valley. The input-output equation for the drainage basin is:

$$P + U_i = ET + D + I + U_o$$

in which P is rainfall over the basin, U_i is underflow into the valley from outside the surface drainage boundaries, ET is evapotranspiration, D is direct runoff, I is infiltration, and U_o is underflow from the valley. At the mouth of the valley the total surface water flow, S, is composed as follows:

$$S = aD + bU_i + cI$$

where a, b, and c are fractions. Not all of D discharges to the sea because a portion is diverted to the Waiahole system. Groundwater flow to the bay consists of fractions of U_i and I.

Because of the water development project at the head of the valley and the location of the USGS continuous flow measurement station relatively close to the inland edge of the estuarine portion of the stream, for hydrologic budget purposes the valley can be conveniently divided into four major units and a minor one, which consists of headlands draining directly to the bay. The major units are:

1) The Upper Valley, bounded by the Waiahole transmission tunnel running along the 800-foot (243.84 m) contour elevation and the crest of the range, totalling 0.86 sq mi (2.227 km^2). All of the surface water, except during periods of heavy flooding, flows to the transmission tunnel; most of the groundwater drains to Kahana Tunnel but some also moves to the leeward side of the Koolaus and some to Waikane Valley. Flows have been diverted from this part of Kahana since 1916.

2) The Mid Valley, consisting of 2.88 sq mi (7.459 km^2) and extending from the 30-foot elevation (9.144 m) to 800 ft (243.84 m) as measured in the stream channel.

3) The Kawa Stream Valley, with an area of 1.9 sq mi (4.921 km^2) and an elevation range from 25 ft to 2265 ft (7.62 to 690.372 m). Kawa meets the main Kahana Stream a short distance below the USGS gage. Numerous miscellaneous stream flow measurements have been made at the mouth of Kawa Stream.

4) The Lower Valley, comprising 2.41 sq mi (6.242 km^2) including Kahana Stream between the bay and the Kawa-Kahana confluence. This sector includes the estuary and the stream underlaid by sediments which thicken toward the coast. Stream flow measurements are extremely difficult to make in the estuary, although a few miscellaneous measurements are available.

The headlands that drain directly into the bay have a total area of 0.33 sq mi (0.8547 km^2). They contribute surface runoff and groundwater flow from small Ghyben-Herzberg lenses into the bay.

Dike water is subdivided into that which occurs within the dike complex and that in the marginal dike zone. The groundwater of the dike complex is restrained in permeable flow rock intersected by many dikes, causing innumerable small aquifers. In the marginal dike zone the aquifers between dikes are relatively large but well-bound.

Both the dike complex and the marginal dike zone carry large quantities of groundwater. Above the 800-foot (243.84 m) elevation, which lies in the dike complex, all of the water passes into the Waiahole system. Of the average 6.9 mgd (26,116.5 m^3/day) that leaves the valley via the transmissio: tunnel, 3.8 mgd (14,383.0 m^3/day) is groundwater from the development tunnel

The dike complex extends from the crest of the range down to about the 270-foot (82.296 m) elevation in the mid-valley. Between elevations 800 and 270 ft (243.84 and 82.30 m), the dike compartments are saturated but a plaster of talus and alluvium in conjunction with many intersecting dikes prevents easy discharge into the streams. Small swamps are common on flat areas between streams because the water table is at the surface. From this part of the dike complex the Q_{90}, which may be considered the groundwater component of stream flow, is about 4 mgd (15,140 m^3/day).

The rocks of the marginal dike zone are saturated with water, some of which does not discharge into Kahana Stream but leaves the area as underflow either into the caprock sediments or the sea. The upper portion of the zone between the 30- and 270-foot (9.144 and 82.296 m) elevation contribute about 5.5 mgd (20,817.5 m^3/day) to Q_{90} at the USGS gage. Kawa Stream is almost entirely in the marginal zone.

Below the approximate 30-foot elevation, the stream flows over marine-deltaic caprock sediments and no longer drains the marginal dike zone. The underlying dike compartments are saturated and leak into the caprock and the sea. Continuity with the sea exists and therefore a small Ghyben-Herzberg lens occurs along the coast within the marginal dike zone. Active springs of the shoreline show chlorides of up to 100 ppm, while the range in a well (405) drilled through the caprock into the basalt varies from 30 to 50 ppm.

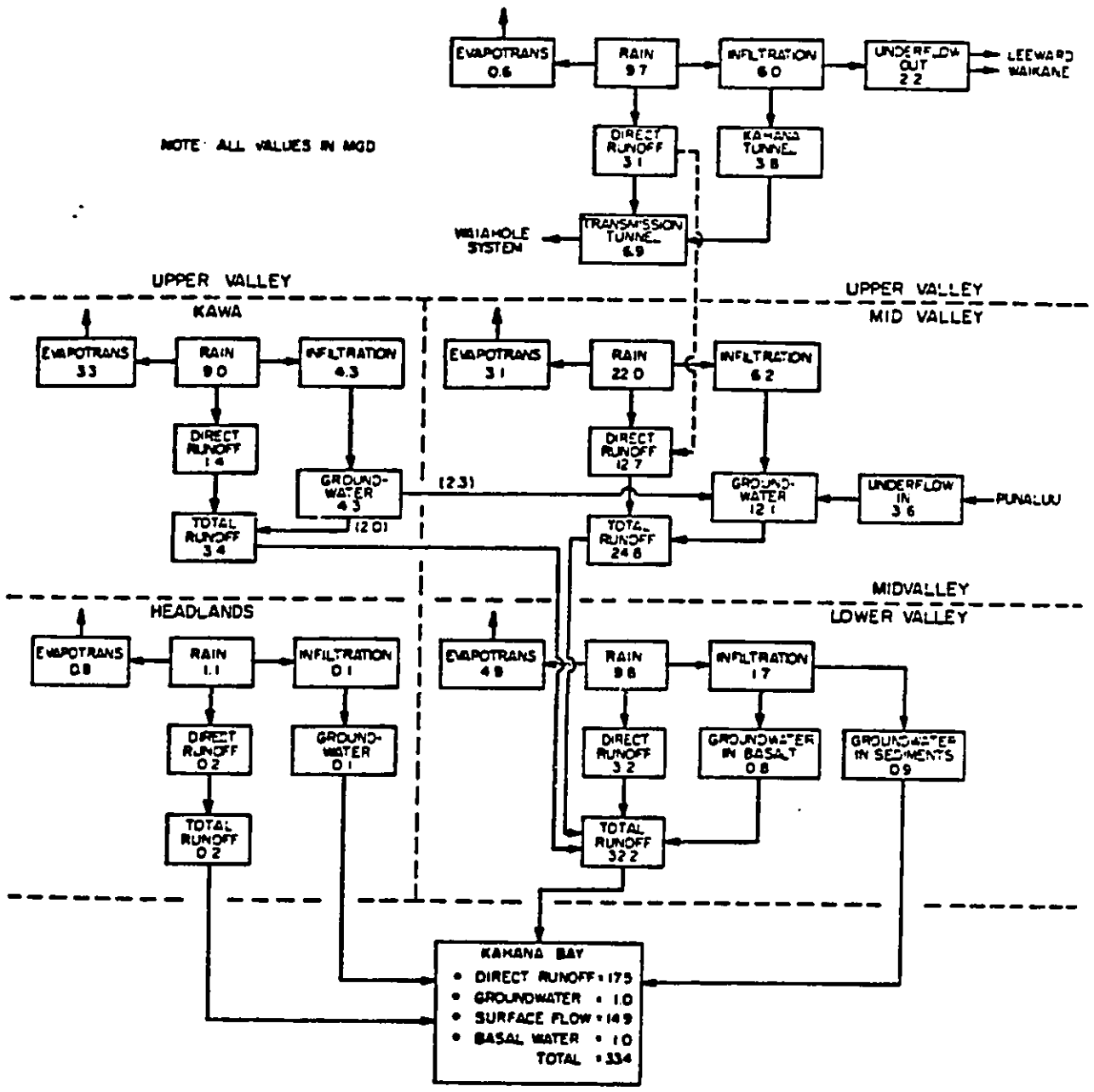


FIGURE 2.5. HYDROLOGIC BUDGET OF KAHANA VALLEY, OAHU.

APPENDIX D

CHECKLIST OF VASCULAR PLANTS OF KAHANA VALLEY

Source: Wirawan, Nengan, "Vegetation and "Soil-Water Regimes in a Tropical Rain Forest Valley on Oahu, Hawaiian Islands," May 1978.

CHECKLIST OF VASCULAR PLANTS OF KAHANA VALLEY

LYCOPODOPHYTA

Lycopodiaceae

Lycopodium cernuum L.
Lycopodium phyllanthum Hook. & Arn.

Selaginellaceae

Selaginella arbuscula (Kaulf.) Spring

PSILOPHYTA

Psilotaceae

Psilotum complanatum Sw.
Psilotum nudum (L.) Griseb.

PTEROPHYTA

Adiantaceae

Adiantum cuneatum Langsd. & Fisch.
Doryopteris sp.
Pityrogramma calomelanos (L.) Link
Pityrogramma chrysophylla (Sw.) Link

Aspidiaceae

Athyrium sandwichianum Presl.
Cyclosorus dentata (Forsk.) Ching
Cyclosorus goggilodus (Schkuhr) Link
Elaphoglossum gorgoneum (Kaulf.) Brack
Elaphoglossum reticulatun (Kaulf.) Gaud.
Tectaria gaudichaudii (Mett.) Maxon

Blechnaceae

Blechnum occidentale L.
Sadleria sp.

Davalliaceae

Nephrolepis hirsutula (Forst.) Presl.

A. CHECKLIST OF VASCULAR PLANTS OF KAHANA VALLEY

LYCOPODOPHYTA

Lycopodiaceae

Lycopodium cernuum L.
Lycopodium phyllanthum Hook. & Arn.

Selaginellaceae

Selaginella arbuscula (Kaulf.) Spring

PSILOPHYTA

Psilotaceae

Psilotum complanatum Sw.
Psilotum nudum (L.) Griseb.

PTEROPHYTA

Adiantaceae

Adiantum cuneatum Langsd. & Fisch.
Doryopteris sp.
Pityrogramma calomelanos (L.) Link
Pityrogramma chrysophylla (Sw.) Link

Aspidiaceae

Athyrium sandwichianum Presl.
Cyclosorus dentata (Forsk.) Ching
Cyclosorus goggilodus (Schkuhr) Link
Elaphoglossum gorgoneum (Kaulf.) Brack
Elaphoglossum reticulatun (Kaulf.) Gaud.
Tectaria gaudichaudii (Mett.) Maxon

Blechnaceae

Blechnum occidentale L.
Sadleria sp.

Davalliaceae

Nephrolepis hirsutula (Forst.) Presl.

Dicksoniaceae

Cibotium chamissoi Kaulf.
Cibotium splendens (Gaud.) Krajina ex Skotts.

Gleicheniaceae

Dicranopteris linearis (Burm.) Underw.
Hicriopteris pinnata (G. Kunze) Ching

Grammitidaceae

Adenophorus sarmentosum (Brack.) K.A. Wilson.
Adenophorus tamariscinus (Kaulf.) H. & G.
Grammitis tenella Kaulf.

Hymenophyllaceae

Gonodormus sp.
Mecodium recurvum (Gaud.) Copel.
Sphaerocionium sp.
Vandenboschia davalioides (Gaud.)

Lindsaeaceae

Sphenomeris chinensis (L.) Maxon

Ophioglossaceae

Ophioglossum spp.

Polypodiaceae

Microsorium scolopendria (Burm. f.) Copel.
Pleopeltis thunbergiana Kaulf.
Polypodium sp.

ANTHOPHYTA

Amaranthaceae

Amaranthus viridis L.
Charpentiera obovata Gaud.

Anacardiaceae

Mangifera indica L.
Schinus terebinthifolius Raddi

Apocynaceae

Alyxia olivaeformis Gaud.
Ochrosia compta K. Schum.

Araceae

Colocasia esculenta (L.) Schott
Alocasia indica (Roxb.) Schott

Araliaceae

Brassaia actinophylla Endl.
Tetraplasandra sp.

Bignoniaceae

Spathodea campanulata Beauv.

Bixaceae

Bixa orellana L.

Casuarinaceae

Casuarina equisetifolia L.

Commelinaceae

Commelina diffusa Burm. f.

Compositae

Bidens pilosa L.
Bidens populifolia Sherff
Cenchrus echinatus L.
Emilia javanica (Burm. f.) C.B. Robins.
Emilia sonchifolia (L.) DC.
Erechtites valerianaefolia (Wolf) DC.
Erigeron canadensis L.
Eupatorium riparium Regel
Pluchea odorata (L.) Cass.
Wedelia trilobata (L.) Hitchc.

Convolvulaceae

Convolvus arvensis L.
Cuscuta sandwichiana Choisy
Ipomoea alba L.
Ipomoea congesta R. Br.

Cruciferae

Coronopus didymus (L.) Sm.

Cyperaceae

Bulbostylis capillaris (L.) Clarke
Carex wahuensis C.A. Mey.
Cyperus kyllinga Endl. f. humilis (Boeck.) Kuek.
Cyperus rotundus L.
Fimbristylis dichotoma (L.) Vahl.
Fimbristylis diphylla (Retz) Vahl.
Machaerina angustifolia (Gaud.)
Rhynchospora scleroides H. & A.
Scirpus sp.

Dioscoreaceae

Dioscorea bulbifera L.
Dioscorea pentaphylla L.

Ebenaceae

Diospyros ferrea (Willd.) Bakh. subsp. sandwicensis (A.DC.) Fosb

Elaeocarpaceae

Elaeocarpus bifidus H. & A.

Epacridaceae

Styphelia tameiameiae (Cham.) F. Muell.

Euphorbiaceae

Aleurites moluccana (L.) Willd.
Antidesma pulvinatum Hbd.
Euphorbia glomerifera (Millsp.) L.C. Wheeler
Euphorbia sp.
Ricinus communis L.

Gentianaceae

Centaurium umbellatum Gilib.

Gesneriaceae

Cyrtandra degenerans (Wawra) Heller
Cyrtandra stupantha St. John & Storey
Cyrtandra spp.

Goodeniaceae

Scaevola gaudichaudiana Cham.
Scaevola taccada (Gaertn.) Roxb.

Gramineae

Andropogon virginicus L.
Bambusa vulgaris Schrad. ex. Wendl.
Brachiaria brizantha (Hochst. ex. Rich.) Stapf
Brachiaria mutica (Forsk.) Stapf
Cenchrus echinatus L.
Chrysopogon aciculatus (Retz.) Trin.
Coix lacryma-jobi L.
Melocanna baccifera (Roxb.) Kurz
Oplismenus hirtellus (L.) Beauv.
Panicum sp.
Paspalum conjugatum Berg.
Paspalum orbiculare Forst. f.
Paspalum urvillei Steud.
Phyllostachys bambusoides Sieb. & Zucc.
Sacciolepis indica (L.) Chase
Schizostachyum glaucifolium (Rupr.) Munro
Setaria geniculata (Poir.) Beauv.
Setaria verticillata (L.) Beauv.

Guttiferae

Calophyllum inophyllum L.

Labiatae

Salvia coccinea Juss. ex Murr.

Leguminosae

Acacia koa Gray
Albizia falcataria (L.) Fosb.
Canavalia cathartica Thouars
Cassia leschenaultiana DC.
Crotalaria mucronata Desv.
Leucaena leucocephala (Lam.) de Wit
Mimosa pudica L.

Liliaceae

Cordyline terminalis (L.) Kunth

Loranthaceae

Korthalsella latissima (v. Tiegh.) Danser

Lythraceae

Cuphea carthagenensis (Jacq.) Macbride

Malvaceae

Abutilon grandifolium (Willd.) Sweet
Abutilon molle Sweet
Hibiscus arnottianus Gray var. arnottianus
Hibiscus arnottianus Gray var. punaluuensis Skottsb.
Hibiscus tiliaceus L.
Sida fallax Walp
Urena lobata L.

Melastomataceae

Clidemia hirta (L.) D. Don

Menispermaceae

Cocculus ferrandianus Gaud.

Moraceae

Artocarpus altilis (Parkins. ex Z.) Fosb.
Ficus sp.

Myrsinaceae

Ardisia crispa (Thunb.) A.DC.
Ardisia humilis Vahl.
Myrsine lessertiana A.DC.

Myrtaceae

Eucalyptus sp.
Eugenia cumini (L.) Druce
Eugenia dombeyi (Spreng.) Skeels
Eugenia jambos L.
Eugenia malaccensis L.
Eugenia sandwicensis Gray
Melaleuca leucadendra (Stickm.) L.
Metrosideros collina (J.R. & G. Forst.) Gray subsp. polymorpha (Gaud.) Rock.
Metrosideros tremuloides (Heller) Knuth
Psidium cattleianum Sabine
Psidium guajava L.

Nyctaginaceae

Pisonia umbellifera (J.R. & G. Forst.) Seem.

Oleaceae

Osmanthus sandwicensis (Gray) Knobl.

Onagraceae

Ludwigia octivalvis (Jacq.) Raven

Orchidaceae

Arundina bambusaefolia (Roxb.) Lindl.
Phaius tankervilliae (Banks ex L'Her.) Bl.
Spathoglottis pacifica Rehb. f. in Seem.
Spathoglottis plicata Bl.

Palmae

Pritchardia sp.

Pandanaceae

Freycinetia arborea Gaud.
Pandanus odoratissimus L.f.

Passifloraceae

Passiflora edulis Soms.
Passiflora foetida L.
Passiflora mollissima (HBK.) Bailey
Passiflora pulchella HBK.
Passiflora suberosa L.

Piperaceae

Peperomia sp.
Piper methysticum Forst. f.

Rhizophoraceae

Rhizophora mucronata Lam.

Rosaceae

Osteomeles anthyllidifolia Lindl.
Rubus rosaefolius Sm.

Rubiaceae

Gardenia mannii St. John & Kuykend.
Morinda citrifolia L.
Psychotria hexandra Mann

Santalaceae

Santalum ellipticum Gaud.

Thymeliaceae

Wikstroemia oahuensis (Gray) Rock

Ulmaceae

Trema orientalis (L.) Bl.

Umbelliferae

Centella asiatica (L.) Urban

Urticaceae

Pipturus sp.
Touchardia latifolia Gaud.
Urera sandvicensis Wedd.

Verbenaceae

Lantana camara L.
Stachytarpheta cayennensis (L.C. Rich.) Vahl.
Stachytarpheta jamaicensis (L.) Vahl.
Verbena litoralis HBK.

Zingiberaceae

Hedychium coronarium Koenig in Retz.
Hedychium flavescens Carey in Roscoe
Zingiber zerumbet (L.) Roscoe in Sm.

APPENDIX E

ARCHAEOLOGICAL RECONNAISSANCE SURVEY FOR PROPOSED RESERVOIR, KAHANA VALLEY, O'AHU

Ms. 042580

ARCHAEOLOGICAL RECONNAISSANCE SURVEY FOR PROPOSED RESERVOIR, KAHANA VALLEY, O'AHU

by
Susan Dobyns, M.A.

Prepared for
R. M. Towill Corporation
Honolulu, Hawai'i

April 1980

Addendum. Additional Archaeological Reconnaissance of Three Well Fields and Access Trail, Kahana Valley

May 1980

Department of Anthropology
BERNICE P. BISHOP MUSEUM
Honolulu, Hawai'i

INTRODUCTION

This report presents the results of a two-day archaeological reconnaissance survey of selected areas within Kahana Valley State Park, as well as the results of a brief literature review of prehistoric and historic utilization of the Valley. The field survey was conducted on March 31 and April 1, 1980, by Susan Dobyns and Ken Shun, of the Department of Anthropology, Bernice P. Bishop Museum at the request of R. M. Towill Corporation, Honolulu. Extensive pedestrian survey, the first phase in a cultural resource management program, provides an identification and assessment of surface prehistoric and historic archaeological resources. Based on these results, recommendations are made for any further work necessary to mitigate any adverse effects of land-use modifications.

In this instance, the Board of Water Supply proposes to construct a 2.0-mg. reservoir within the Kahana Valley (R. M. Towill letter, January 29, 1980). Proposed development in the survey area includes:

(1) installation of a transmission main along the existing Kahana Valley Road from Kamahameha Highway to the toe of the ridge of the reservoir site, approximately 6,000 feet inland; (2) installation of a transmission main and clearing of a new section of access road on the ridge from the toe at the Kahana Valley Road to the reservoir site; and (3) construction of the proposed reservoir itself.

ENVIRONMENTAL SETTING

The Kahana Valley, coterminous with the *ahupua'a* of Kahana, is located at the southern end of the Ko'olauloa District on windward O'ahu Island. Ka'a'awa Valley lies to the east and Punalu'u Valley to the west. Extending 6.4 km from the ocean to the crest of the Ko'olau Range, the 2,147-hectare Kahana Valley is drained by two permanent streams, Kawa Stream (Ka'a'awa side) and Kahawainui Stream (Punalu'u side), which join to become the Kahana Stream about 2 km inland. The valley rises steeply; 70% of the Valley has a slope over 30% and almost all (90%) of the level land is in

the broad floodplain at the *makai* end of Kahana Stream (Mogi 1974:7). Due to its physiographic configuration and its location in relationship to wind and current patterns, Kahana Valley is one of the wettest on O'ahu, receiving 1,778 mm (70") (*makai*) to 63,500 mm (250") (*mauka*) of rain annually (Hommon and Barrera 1971:1).

DEFINITION OF PROJECT AREA

The survey area lies on the Punalu'u side of the Kahana Stream in the flat floodplain (0 to 9% slope) and talus zones around the floodplain (10 to 29% slope) (see Mogi 1974:7 for slope data). The extant Kahana Valley Road runs through the floodplain, an area of present and undoubtedly past exploitation. Most of the Valley's 140 permanent residents (1972 census) live in this area, and the Park facilities, both existing and under construction, are located here, especially in the more *makai* areas. Thus, houses, active pastures, abandoned cars and other machinery, gardens, and Park facilities dot the landscape. Vegetation reflects these "pasture and cultivated ecosystems" (Theobald and Wirawan 1973:21). Vegetation includes grass cover of *mau'u-malihini* (*Paspalum conjugatum*) and *mau'u-laiki* (*Paspalum orbiculare*), shrubs (*Pluchea odoratia*), isolated areas of *hau* (*Hibiscus tiliaceus*) and guava (*Psidium guajava*), and cultivated crops such as dry taro (*Colocasia esculenta*), papaya (*Carica* sp.), and banana (*Musa* sp.). The endemic forests have long since been destroyed, probably through heavy cattle-grazing and burning for agriculture (Hulten 1965:1).

The access road area from the toe of the ridge to the reservoir essentially parallels the existing jeep road and is also disturbed, although somewhat less so than the floodplain. Shrubs such as false staghorn fern (*Dicranopteris linearis*) constitute the dominant ground cover, although scattered pandanus (*Pandanus odoratissimus*) also occur.

The reservoir area, which was located with the help of K. Y. Siu of Towill Corporation and Henry Domingos, caretaker of the Park, is a steep, pandanus (*Pandanus odoratissimus*) forest area with a ground cover of pandanus leaf litter.

PREVIOUS ARCHAEOLOGICAL RESEARCH

Archaeology is not simply the retrieval of material remains; rather, these material data are used to study prehistoric and historic cultural systems, i.e., how past living people interacted with both their physical (natural) and social environments. As it is currently understood by Hawaiian archaeologists, the *makai-mauka* valley *ahupua'a* is a crucial unit for understanding past Hawaiian cultural systems:

> Most of the economic, social, religious and political activities of this social unit took place within the *ahupua'a*. Thus, because archaeology is the study of extinct cultural systems, Kahana, like other Hawaiian valley *ahupua'a*, is an archaeological unit circumscribed by physiographic features (Hommon and Barrera 1971:74).

A fair amount of archaeological work has been conducted within the Kahana Valley *ahupua'a*, but the past cultural system as represented there is not yet well understood. Sterling and Summers (1978:168-170) have compiled place names and legends associated with physiographic features in Kahana Valley and informant reports of historical and legendary sites there. McAllister (1933) was the first archaeologist to record sites in Kahana Valley, during his pan-island survey in 1931. He listed six sites, including two fishing shrines on the west shore of Kahana Bay (Site 298, Kapaelele Ko'a; Site 299, Kauninio Ko'a), Hilo Laau Cave (Site 300), a Puu o Mahie ridge site (Site 302, Palani Ko'a), Huilua Fishpond and Ko'a (Site 301), and Puu Makane Heiau (Site 302) (McAllister 1933:163-165; see Hommon and Barrera 1971, Appendix A, for full site descriptions). More recently, Hommon and Barrera's (1971) survey, for the Division of State Parks, disclosed 114 previously unrecorded archaeological sites, most of which were in zones with a 0 to 30% slope (see Appendix A for these site locations). In an attempt to understand past cultural systems, Hommon and Barrera (1971) assigned sites to one of three functional categories--economic, habitation, and religious. Economic sites include animal enclosures, midden sites (with shell and bone remains), the Huilua Fishpond, and agricultural fields and garden plots. As Hommon and Barrera (1971) indicate, the agricultural pattern in the Valley included both "wet" agriculture, probably taro, using irrigated terraces, *lo'i* and *'auwai* (irrigation ditches) to channel water from permanent streams as well as "dry" agriculture utilizing terraces and

leveled areas for sweet potatoes and dry taro. Based on Handy's (1940:92) informant data and corroborated by archaeological evidence, wet agriculture along the Kawa Stream was abandoned prior to that along Kahawainui Stream, although the date of abandonment is not indicated. Although 120 wet terraces and 12 *'auwai* (including the 3,050-meter Wailua *'auwai*) have been recorded, the total area of the irrigated terraces is only 1.08 hectares (about 2.7 acres), a small amount when compared to wet agricultural systems in other Hawaiian valleys such as Mākaha, with more than 300 wet terraces involving 4.9 hectares (12.1 acres) (Hommon 1970:112-114; Hommon and Barrera 1971:43).

Most habitation sites, evidenced by house outlines, terraces, pavements, and platforms, are located in the lower valley. Religious structures include terraces and platforms.

In 1973, Hommon and Bevacqua continued archaeological research in Kahana Valley with instrument mapping and text excavation at six sites and two test areas in the lower valley. Test excavations revealed a small amount of subsurface cultural material, none of which was pre-European in nature.

Within the Valley, although not within the present survey area, the Huilua Fishpond was tested by A. Sinoto (Ms.) in 1979. He found few subsurface remains; again, they were all historic.

Obviously, there is potential for much more archaeological work in Kahana Valley. Further research on irrigation agriculture is needed, and comparisons of Kahana Valley with other Hawaiian valleys seem promising.

HISTORIC UTILIZATION OF KAHANA VALLEY

A brief literature review reveals few historic references to Kahana Valley; of these, several are undocumented references. Therefore, archaeological data becomes especially important in understanding past cultural systems in the Kahana Valley. Currently, the Draft Environmental Impact Statement on Kahana Valley State Park (1978) by H. Mogi Planning and Research, Inc., is the best available summary of historic utilization of the Valley.

The earliest known reference was by L. Chamberlain who observed a functioning missionary school (Mormon) in the Valley during his 1826 trip around O'ahu: "We passed by Kahana, a pleasant valley belonging to Naihe, where a large school had assembled" (Chamberlain 1957).

Most of the available information concerns land divisions and agricultural practices. For instance, Handy and Handy (1972:445) describe Kahana Valley as it appeared during the 19th century:

> North of Pu'uomahie is the beautiful bay of Kahana with its wide, crescent-shaped beach. The bay opens to the ocean through a wide passage in the reef, for the broad and deep valley of Kahana has a stream that is almost a small river by the time it reaches the bay. The main stream named Kahawainui, or Big Valley, is fed by four streams out of side valleys: Kawa, Pilali, Kalehua, and Koloahulu. Wet taro in *lo'i* was extensively cultivated here. There were also swampy areas where wet taro was planted in mounds (*pu'epu'e*). Breadfruit trees and Hawaiian bamboo were found in the interior valley, coconuts in the flatlands to seaward, sweet-potato patches on sandy soil near the bay; and there were two fishponds, one along the southern shore of the bay, the other behind the beach on the north side. Both fishponds were flanked by taro terraces. The broad flat valley bottom and adjacent hillsides of this verdant *ahupua'a* were all in *lo'i*. Throughout this area in recent years sugar cane was grown commercially where once were the *lo'i* of wet taro with banks planted to bananas, *wauke* and ti. In the interior there must formerly have been a large amount of *wauke* and, in wet gulches, *olona*. Yams undoubtedly grew on the slopes above cultivated areas. Kahana Bay is a notable fishing locality, famous for runs of *akule* and *kala*.

Coulter (1931:18) reports that there were 150 Valley residents in 1853. In 1881, the 150 people living in Kahana Valley formed a cooperative (*Hui Ku'ai 'aina o Kahana*) to purchase land from Chief Olopana, who also controlled lands at Punalu'u and Kapaka (Belt, Collins 1955:7). Monsarrat's 1901 map (see Hommon and Barrera 1971:51) shows *kuleana* boundaries for the *makai* area of the Valley. In 1905, Mary E. Foster gained control of these properties.

Taro was grown in the lower valley until 1906, although by the 1870s and 1880s at least 100 to 150 acres on the valley floor was in rice production by the Hui o Kahana (Coulter 1931; Mogi 1978:97). From 1910 through the late 1930s and early 1910s, lands along the valley sides were used for sugarcane (Hulten 1965:1). Sugarcane was grown by individuals, as well as by Mary E. Foster's Kahana Ranch, for sale to the Kahuku Plantation Co. Until 1931 a narrow-gauge railroad, affiliated with the Koolau Railway Co., transported the harvested sugarcane to Kahuku. As noted before, Handy (1940:92) reports that while cultivation continued at this time along Kahawainui Stream,

it had already been discontinued along Kawa Stream. During this period, Huilua Fishpond continued to provide protein to the Valley residents.

During World War II, the military conducted "jungle" training in the Valley (Belt, Collins 1955:9). In 1962, the State began seriously considering Kahana Valley for a State Park site (*The Comprehensive Plan for Hawaii State Parks* 1962; Hulten 1965) and from 1965-1969 acquired the entire Valley at a cost of $5 million. In 1969 Tongg Associates were hired by the Division of State Parks to plan park development (Tongg Associates 1970), but their unpopular proposal to relocate Valley residents and to flood the Valley floor to create "cultural islands" was defeated through public and private opposition. Instead, with support from the specially appointed Kahana Valley Task Force, Kahana Valley State Park was designed as a "living park" (Mogi 1974, 1978). As of 1972, there were 140 permanent Valley residents.

These isolated historical markers of Kahana Valley utilization are obviously inadequate for understanding past historical cultural systems in the valley. Considerably more detailed historical research would be necessary to reconstruct the Valley's history.

SURVEY METHODOLOGY

A right-of-way corridor, 5 to 7 meters wide, was surveyed along each side of the Kahana Valley Road; with the good visibility, as much as 10 to 12 meters was actually scanned. The ridge along the jeep trail was surveyed; the width of the corridor, again about 5 to 7 meters, was determined there by the steep dropoffs on either side of the road. Steep slopes made survey difficult and heavy pandanus-leaf litter hindered ground visibility in the reservoir area. Sweeps were made at 5-meter intervals. The one site located was recorded by written description and photographs.

SURVEY RESULTS

An *'auwai* or irrigation ditch, previously recorded by Hommon and Barrera in 1971 (Bishop Museum Site No. 50-Oa-F9-105/State Site No. 50-80-06-1590) was the only surface archaeological site encountered in the survey areas. Hommon and Barrera (1971:14) described the site:

> An *'auwai*, constructed by building walls up to 1.25 meters high against the banks of a natural stream. At some points, the walls extended above the ground level of the banks. The walls were eroded away in places, but enough remained so that it was apparent that the site extended from inside a steep-sided valley to the flat, marshy bottomland of Kahana Valley proper.

The present survey provides more complete description. The *'auwai* is oriented 100 degrees E of MN and travels under the existing Kahana Valley Road via a pipe and cement conduit. At this point, the site is approximately 1,045 meters from Kamehameha Highway. The *'auwai* is 2 meters wide; it has a 5 to 6 course stone facing on the *makai* Ka'a'awa side but the *mauka* Ka'a'awa and both Punalu'u sides are less clearly faced. Toward Ka'a'awa, it extends approximately 25 meters before losing its rock lining and flattening out, whereas toward Punalu'u, large boulders appear in the middle of the *'auwai* at 15 meters. The *'auwai* continues on, but no attempt was made to trace the boundaries more specifically.

RECOMMENDATIONS

The archaeological reconnaissance survey revealed only one surface site, an *'auwai*, but it did not (and could not) evaluate subsurface archaeological resources. Recommendations for mitigating impacts of development depend on the nature of those impacts. In this proposed development, impacts will be largely subsurface, i.e., burying a transmission main and leveling the ridge for reservoir construction (K. Y. Siu, personal communication, March 31, 1980). Many archaeologists have addressed the relationship between surface and subsurface archaeological evidence (e.g., Mueller 1975; Schiffer & Gumerman 1977), but no one-to-one correlation exists. Although both Hommon and Bevacqua's (1973) and A. Sinoto's (Ms.) subsurface testing suggest the absence of material remains, this cannot be assumed for the rest of the valley. Since no surface material other than the *'auwai* has been located in the survey area, a more intensive surface survey is unnecessary, and adequate subsurface testing would be an inefficient use of time, labor, and money. A more efficient alternative is archaeological monitoring--the on-site presence of an archaeologist during periods of construction activity. Specifically, the *'auwai* and reservoir areas should be monitored, and the remaining areas can be monitored selectively:

(1) *'Auwai:* The *'auwai*, the only known site to be impacted, is already crossed by the existing road and pipe and cement conduit, so that its integrity has, to some extent, been violated. Still, an archaeologist should be present so that further damage to the *'auwai* can be minimized.

(2) Reservoir: Although the steep slope and lack of surface structures make subsurface remains unlikely, an archaeological monitor should be on-site during ridge-leveling activities.

(3) Selective Monitoring in Remaining Areas: The remaining areas along the access roads should also be monitored, but perhaps less intensively than the *'auwai* and reservoir areas. The monitoring intensity will depend both on construction practices and on the discovery of additional archaeological data. If trenches are left open so that soil profiles are visible, the archaeologist may be able to do "spot-check" monitoring along the corridor. If, however, the pipe is to be laid immediately and the profile re-covered, then constant archaeological monitoring will be necessary. While both floodplain and talus slope areas should be checked, the exact monitoring schedule must

remain somewhat flexible so that the field monitor can determine amount and intensity based on the field conditions. Any subsurface archaeological structural features or other evidences of cultural occupation should be reported to the monitor. Of course, caution should be taken since this project will initiate subsurface disturbance and archaeological testing in the more *mauka* sections of the valley.

In summary, the area surveyed does not possess archaeological significance prohibitive of the proposed construction.

ADDENDUM

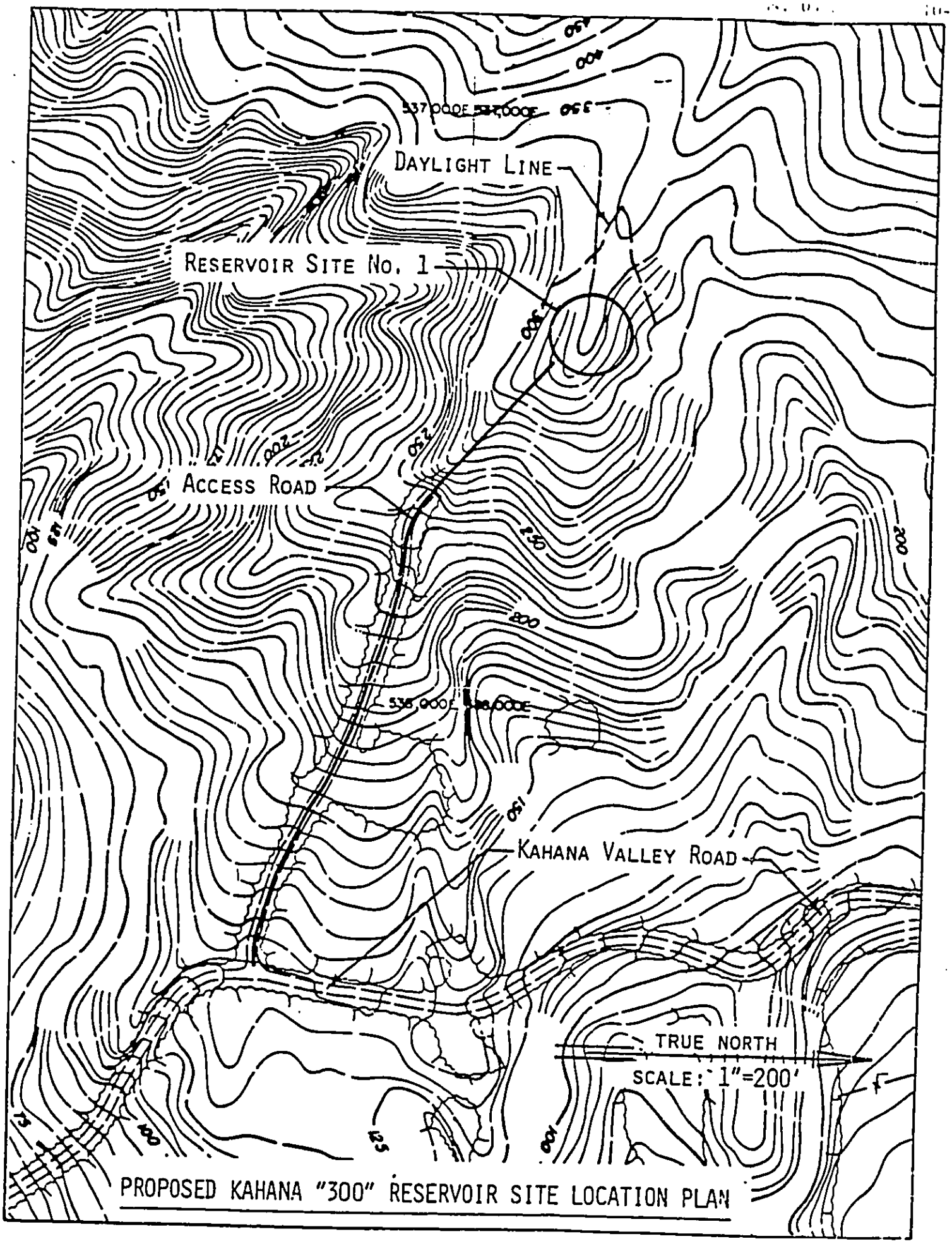
At the request of R. M. Towill, on May 21 and 22, 1980, Susan Dobyns and Ken Shun of Bishop Museum conducted additional archaeological reconnaissance of three well fields and the access trail in the Kahana Valley. The survey area, defined during an on-site visit with Towill personnel on May 9, consisted of:

(1) a 15-ft right-of-way corridor along each side of the Army road from the reservoir site at the 325-ft contour, extending *mauka* for approximately 3,500 ft, and

(2) three proposed well areas--site 1, a 200-by-400-ft area, located approximately 1,000 ft *mauka* of the reservoir; site 2, a 600-by-200 ft area approximately 2,400 ft from the reservoir; and site 3, a 300-by-200 ft area, approximately 3,200 ft from the reservoir.

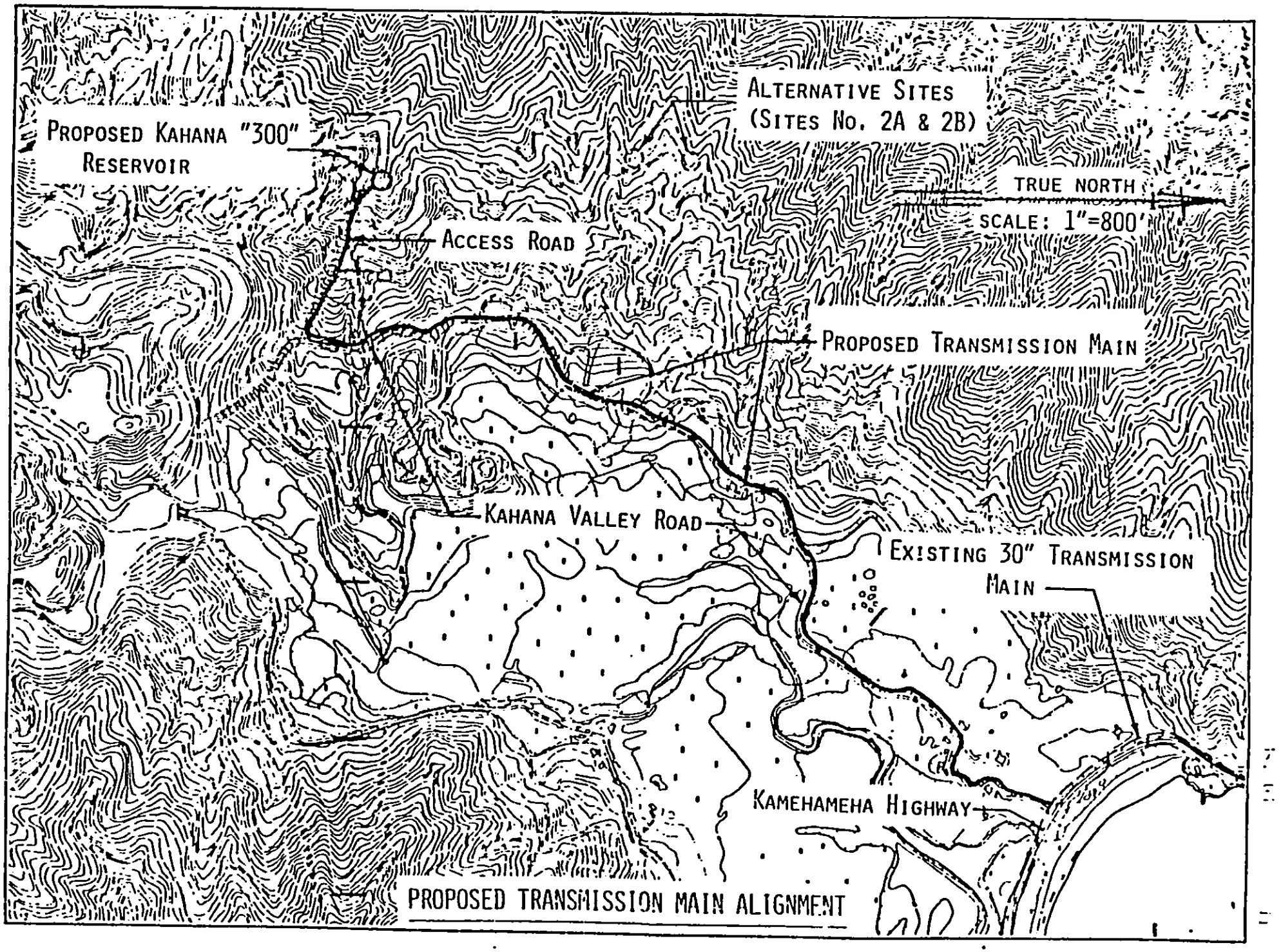
The archaeologists encountered no significant archaeological remains. Since the area was once used as an Army road, it has already been greatly modified and disturbed.

Based on this surface reconnaissance, there are no archaeological objections to the proposed project. Although unlikely, it is possible that subsurface archaeological features such as stone alignments or artifacts could be encountered once the project has begun. If this occurs, archaeologists at Bishop Museum should be contacted immediately.



PROPOSED KAHANA "300" RESERVOIR SITE LOCATION PLAN

FIGURE 4


PROPOSED KAHANA "300" RESERVOIR
ALTERNATIVE SITES (SITES NO. 2A & 2B)
TRUE NORTH
SCALE: 1"=800'
ACCESS ROAD
PROPOSED TRANSMISSION MAIN
KAHANA VALLEY ROAD
EXISTING 30" TRANSMISSION MAIN
KAMEHAMEHA HIGHWAY
PROPOSED TRANSMISSION MAIN ALIGNMENT

Makai (north) view of *'auwai* where it is crossed by the Kahana Valley Road.

View of the 1.25-meter stone lining on the *makai* (north) Ka'a'awa side of the *'auwai*.

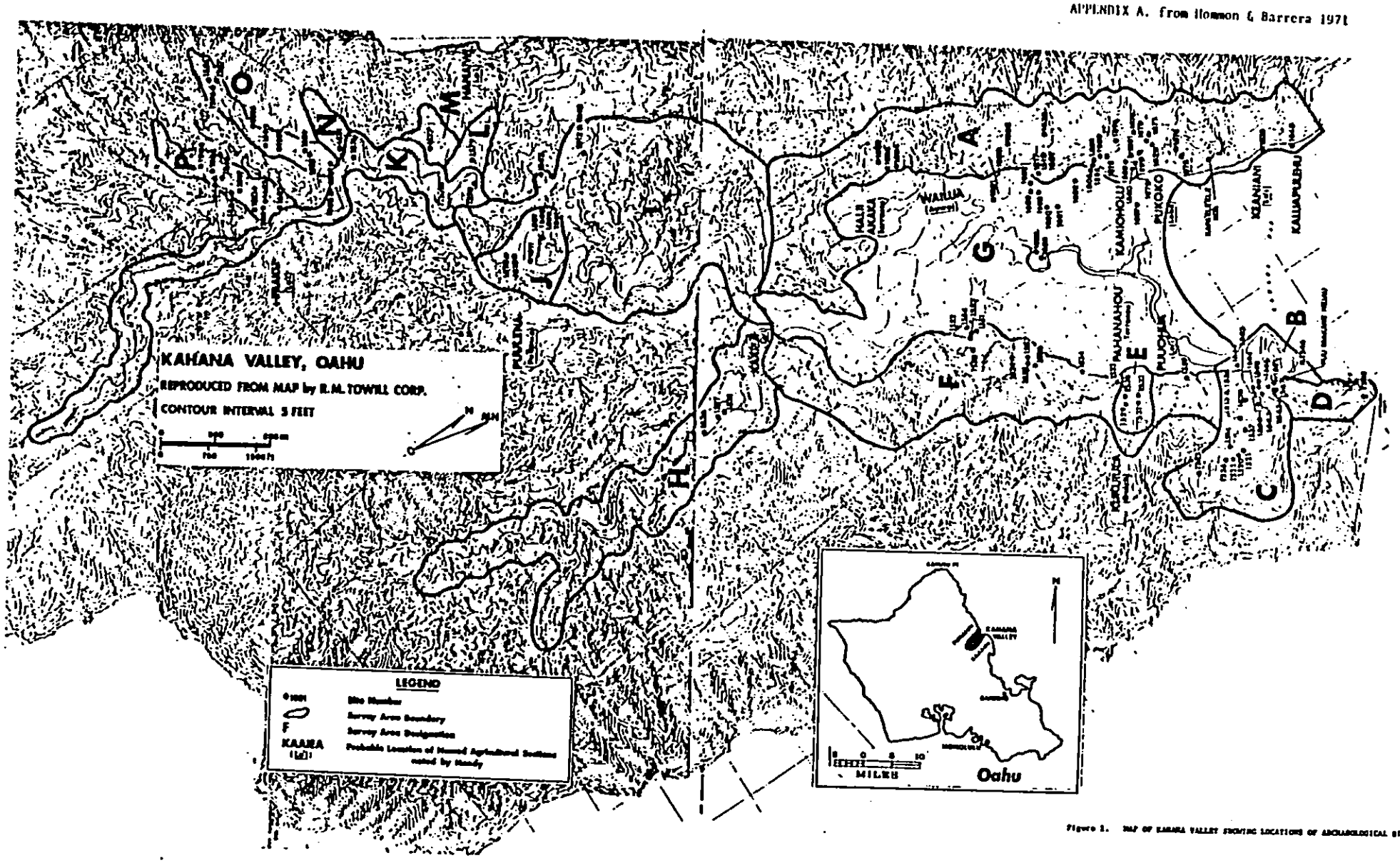


Figure 1. MAP OF KAHANA VALLEY SHOWING LOCATIONS OF ARCHAEOLOGICAL SITES.

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APPENDIX F

COMMENTS AND RESPONSES TO THE EIA AND EIS PREPARATION NOTICE

LIFE OF THE LAND
A GROUP FOR ENVIRONMENTAL RESEARCH AND ACTION

October 30, 1979

Mr. Lawrence Whang
Board of Water Supply
City and County of Honolulu
Honolulu, Hawaii 96813

Re: Kahana "300" Reservoir Project

Dear Mr. Whang:

Life of the Land would like to be a consulted party on the EIS being prepared for 2.0 MG reservoir and related improvements. Please send us a copy of the draft EIS when it becomes available.

Sincerely,

Doug Heller

Douglas Heller
Staff Supervisor

404 PIIKOI STREET HONOLULU HAWAII 96814 TELEPHONE 521 1300

November 8, 1979

Mr. Douglas Heller
Staff Supervisor
Life of the Land
404 Piikoi Street
Honolulu, Hawaii 96814

Dear Mr. Heller:

Subject: Your Letter of October 30, 1979, on the EIS for Kahana "300" Reservoir

We will add your organization to the consulted parties' list for the proposed reservoir and will send you a copy of the EIS when it becomes available.

Should you have questions or require additional information, please call Lawrence Whang at 548-5221.

Very truly yours,

Kazu Hayashida

KAZU HAYASHIDA
Manager and Chief Engineer

cc: R. M. Towill Corp.

FI:pvk
cc: K. Hayashida
L. Whang

79-4336

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

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

November 1, 1979

SUSUMU ONO, CHAIRMAN
BOARD OF LAND & NATURAL RESOURCES
EDGAR A. HAMASU
DEPUTY TO THE CHAIRMAN

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

Mr. Kazu Hayashida
Manager and Chief Engineer
Board of Water Supply
City and County of Honolulu
630 S. Beretania Street
Honolulu, Hawaii 96813

ATTENTION: Mr. Lawrence Whang

Dear Sir,

SUBJECT: EIS Preparation Notice, Kahana "300" Reservoir Project, Kahana Valley, Oahu.

Would you please provide us with a copy of the subject notice for the use of the Division of State Parks, Outdoor Recreation and Historic Sites. This is the agency within our Department charged with the responsibilities of planning and managing Kahana Valley as a State Park.

Thank you very much.

Very truly yours,

SUSUMU ONO
Chairman of the Board

cc: State Parks
DOWALD

November 15, 1979

Mr. Susumu Ono
Chairman of the Board
Department of Land and
Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

Subject: Your Letter of November 1, 1979, on Environmental Impact Assessment for the Kahana "300" Reservoir Project

We transmit a copy of the EIA for the proposed reservoir project as requested. We request that you submit your comments to us by December 16, 1979, on the preparation notice.

Should you have questions or require additional information, please call Lawrence Whang at 548-5221.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

Attach.

cc: R. M. Towill Corporation

FI:vc
cc: K. Hayashida
L. Whang

79-4417

Lawrence Wang
Board of Water Supply
City & County of Honolulu
630 Beretania Street
Honolulu, HI 96813

05NOV79

Dear Mr. Wang:

I wish to be a consulted party on the Kahana "300" Reservior Project.

Thank you for your kind attention in this matter.

Sincerely yours,

Dr. Evan C. Evans III
44-702 Kanamoana Place
Kaneohe, HI 96744

November 15, 1979

Dr. Evan C. Evans III
44-702 Nanamoana Place
Kaneohe, Hawaii 96744

Dear Dr. Evans:

Subject: Your Letter of November 5, 1979 on the Environmental Impact Statement for the Kahana "300" Reservoir Project

We transmit a copy of the EIS prenaration notice for the proposed Kahana Reservoir project and have added your name to our consulted parties' list as requested. Please submit your comments to us by December 16, 1979 on the preparation notice.

Should you have questions or require additional information, please call Lawrence Whang at 548-5221.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

Attach.

cc: R. M. Towill Corporation

FI/MHS/HHH:pvk
cc: K. Hayashida
L. Whang ✓

79-4421

GEORGE R. ARITOSHI
DEPUTY TO THE CHAIRMAN

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

SUSUMU ONO, CHAIRMAN
BOARD OF LAND & NATURAL RESOURCES
EDGAR A. HAMADA
DEPUTY TO THE CHAIRMAN

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

December 17, 1979

Mr. Kazu Hayashida
Manager and Chief Engineer
Board of Water Supply
630 S. Beretania Street
Honolulu, Hawaii 96813

Dear Mr. Hayashida,

Thank you for submitting a copy of the Environmental Impact Assessment for the Kahana "300" Reservoir Project as requested in our letter of November 1, 1979.

The selected reservoir site is a proposed viewpoint selected for its commanding view of the valley. It follows then, that a cut face and a structure at the proposed reservoir site would be in full view of the entire valley makai of the site, and much of it mauka, except where obscured by trees in the foreground of the viewer. It would be a disturbing, intrusive facility, seriously detrimental to the scenic preservation, environmental education and historical/cultural objectives of the park as described in the referenced EIS. We also note that the visual impact of the road and altitude control structure was not addressed.

Although Kahalu'u Valley is known to contain a great number of archaeological sites of importance to the study of past Hawaiian life ways, this environmental impact assessment has not addressed, in any way, the possible impact of their proposed development on these important cultural resources. It is therefore our recommendation that as archaeological reconnaissance, including a search of existing archaeological literature for both Punaluu and Kahana Valley, be conducted as a first step toward identifying possible cultural resources that might be impacted by the proposed development.

While the two identified alternative sites in Kahana Valley may be less intrusive to park values, we have serious reservations about these sites too. A perusal of available topographic maps indicates there are several sites in Punaluu and Kaaawa that

have attributes very similar to the sites considered in Kahana. It is our position that any such massive structure as this proposal is inappropriate in a State Park and should not be considered if viable alternatives exist. We suggest that any further water supply development of any kind in Kahana Valley be closely coordinated with the State Parks Division.

Thank you for the opportunity to review and comment on this environmental impact assessment.

Very truly yours,

SUSUMU ONO
Chairman of the Board

cc: OEQC

November 23, 1979

Mr. Walter L. Briant, Jr.
Manager and Chief Engineer
Department of Water
County of Kauai
P. O. Box 1706
Lihue, Kauai, Hawaii 96766

Attention Mr. Wayne H. Hinazumi

Dear Mr. Briant:

Subject: Environmental Impact Statement Preparation Notice for Kahana "300" Reservoir

Enclosed is a copy of the environmental assessment for our proposed reservoir project that you requested. We will send you a copy of our completed environmental impact statement when it becomes available.

Should you have questions or require additional information, please call Lawrence Whang at 548-5221.

Very truly yours,

Kazu Hayashida

KAZU HAYASHIDA
Manager and Chief Engineer

Encl.

MHS:vc
cc: K. Hayashida
L. Whang

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA
HONOLULU, HAWAII 96843

KAZU HAYASHIDA
Manager and Chief Engineer

January 8, 1980

Mr. Susumu Ono
Chairman
Board of Land and
Natural Resources
State of Hawaii
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

Subject: Your Letter of December 17, 1979, Commenting on our EIS Preparation Notice for the Kahana "300" Reservoir Project

Thank you for your comments on our EIS preparation notice.

We investigated other alternative reservoir sites, including those you mentioned, but found them costly to develop primarily because of their steep terrain. For example, the installation of a reservoir at two sites in Punaluu Valley is estimated to cost between $6,000,000 to $7,500,000. This can be compared with the estimated cost of $3,400,000 to install a reservoir at Kahana Valley.

To minimize the impact of the reservoir and to develop the site for our mutual benefit, we propose to architectually design and landscape the project to blend into the environment. The site can be graded and landscaped to incorporate your viewpoint. The proposed road can mutually provide access to the viewpoint and to the reservoir.

We will have our consultant prepare a rendering of the proposed reservoir which will be transmitted to you for review and comment. Our consultant will be instructed to work closely with your State Parks Division.

An archaeological reconaissance, including a search of existing archaeological literature, will be conducted as recommended and any impacts will be addressed in the EIS.

Should you have questions or require additional information, please call Lawrence Whang at 548-5221.

Very truly yours,

Kazu Hayashida

KAZU HAYASHIDA
Manager and Chief Engineer

cc: R. M. Towill Corporation

APPENDIX G

COMMENTS AND RESPONSES TO THE EIS

JAN 5 1983

GEORGE R. ARIYOSHI
Governor

ROY R. TAKEMOTO
Chairman

TELEPHONE NO.
(808) 548-6915

STATE OF HAWAII
ENVIRONMENTAL QUALITY COMMISSION
550 HALEKAUWILA ST.
ROOM 301
HONOLULU, HAWAII 96813

January 4, 1983

Dear Reviewer:

Attached for your review is an Environmental Impact Statement (EIS) that was prepared pursuant to Chapter 343, Hawaii Revised Statutes and the Rules and Regulations of the Environmental Quality Commission:

Title: Kahana "315" Reservoir Project

Location: Kahana Valley, Oahu

Classification: Agency Action

Your comments or acknowledgement of no comments on the EIS are welcomed. Please submit your reply to the accepting authority or approving agency:

Mayor Eileen Anderson
City and County of Honolulu
630 South King Street
Honolulu, Hawaii 96813

Please send a copy of your reply to the proposing party:

R.M. Towill Corporation AND Board of Water Supply
677 Ala Moana Boulevard, Suite 1016 City and County of Honolulu
Honolulu, Hawaii 96813 630 South Beretania Street
Honolulu, Hawaii 96843

Your comments must be received or postmarked by: February 7, 1983.

If you have no further use for this EIS, please return it to the Commission.

Thank you for your participation in the EIS process.

Jan. 5, 1983
No comments
L. Yamabiraa
Energy Program Administrator

DEPARTMENT OF PUBLIC WORKS
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

EILEEN R. ANDERSON
MAYOR

MICHAEL J. CHUN, Ph.D.
DIRECTOR AND CHIEF ENGINEER

WILLIAM A. BONNET
DEPUTY DIRECTOR

ENV 83-8

January 12, 1983

MEMORANDUM

TO: HONORABLE EILEEN R. ANDERSON, MAYOR
CITY AND COUNTY OF HONOLULU

VIA: MR. ANDREW I. T. CHANG, MANAGING DIRECTOR

FROM: MICHAEL J. CHUN, DIRECTOR AND CHIEF ENGINEER

SUBJECT: EIS FOR KAHANA "315" RESERVOIR PROJECT
KAHANA VALLEY, OAHU, HAWAII

The proposed project will not affect any municipal facilities under our control. Construction plans for the Board of Water Supply's facility should be submitted to the Division of Engineering for approval.

William A. Bonnet
MICHAEL J. CHUN
Director and Chief Engineer

cc: Board of Water Supply
R. M. Towill Corporation

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

January 14, 1983

TO: MICHAEL J. CHUN, DIRECTOR AND CHIEF ENGINEER
DEPARTMENT OF PUBLIC WORKS

FROM: KAZU HAYASHIDA
BOARD OF WATER SUPPLY

SUBJECT: YOUR MEMORANDUM OF JANUARY 12, 1983, ON THE ENVIRONMENTAL IMPACT STATEMENT (EIS) FOR KAHANA "315" RESERVOIR PROJECT

Thank you for reviewing the Draft EIS for our proposed reservoir project. Your memorandum will be appended to the Final EIS.

The construction plans will be submitted to the Division of Engineering for approval.

If you have any questions, please contact Lawrence Whang at 548-5221.

Kazu Hayashida
KAZU HAYASHIDA
Manager and Chief Engineer

cc: R. M. Towill Corporation

United States Department of the Interior

FISH AND WILDLIFE SERVICE
300 ALA MOANA BOULEVARD
P O BOX 50167
HONOLULU, HAWAII 96850

IN REPLY REFER TO:

ES
Room 6307

01/13/83

Mayor Eileen Anderson
City and County of Honolulu
630 South King Street
Honolulu, Hawaii 96813

Dear Mayor Anderson:

The Fish and Wildlife Service has reviewed the Environmental Impact Statement (EIS) for the Kahana "315" Reservoir project. The EIS adequately discusses the natural resources within our area of responsibility. Should this project be approved for construction, we recommend that clearcutting of riparian vegetation be avoided. Grading should be carefully performed to prevent excessive erosion of sediment into the adjacent stream.

We appreciate this opportunity to comment.

Sincerely,

Ernest Kosaka
Ernest Kosaka,
Project Leader for
Environmental Services

cc: R.M. Towill Corp.
Board of Water Supply
USFWS,RO(1)

CONSERVE AMERICA'S ENERGY

Save Energy and You Serve America!

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

January 24, 1983

Mr. Ernest Kosaka
Fish and Wildlife Service
U. S. Department of the Interior
P. O. Box 50167
Honolulu, Hawaii 96850

Dear Mr. Kosaka:

Subject: Your Letter of January 13, 1983, on the Draft Environmental Impact Statement (EIS) for the Kahana "315" Reservoir

Thank you for reviewing the Draft EIS of our proposed reservoir project. Your letter to the Mayor, which will be appended to the revised environmental document, has been referred to us for direct reply.

We shall avoid clearcutting of riparian vegetation and will carefully perform our grading operations to prevent excessive erosion of sediment into Kahana Stream. All grading work will conform to the City's Grading Ordinance and requirements of the Department of Land and Natural Resources.

If you have any questions, please contact Lawrence Whang at 548-5221.

Very truly yours,

Kazu Hayashida
KAZU HAYASHIDA
Manager and Chief Engineer

cc: R. M. Towill

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF HEALTH
P.O. BOX 3378
HONOLULU, HAWAII 96801

830130

CHARLES G. CLARK
DIRECTOR OF HEALTH

JOHN F. CHALMERS, M.D.
DEPUTY DIRECTOR OF HEALTH

HENRY H. THOMPSON, M.A.
DEPUTY DIRECTOR OF HEALTH

ALVIN H. GOTTLIEB
DEPUTY DIRECTOR OF HEALTH

ABELINA MADRID SHAW, M.A., J.D.
DEPUTY DIRECTOR OF HEALTH

In reply, please refer to:
File: EPHS-SS

January 14, 1983

MEMORANDUM

To: Honorable Eileen Anderson
Mayor, City & County of Honolulu

From: Director of Health

Subject: Environmental Impact Statement (EIS) for Kahana "315" Reservoir Project, Kahana Valley, Oahu

Thank you for allowing us to review and comment on the subject EIS. On the basis that the project will comply with all applicable Public Health Regulations, please be informed that we do not have any objections to this project.

We realize that the statements are general in nature due to preliminary plans being the sole source of discussion. We, therefore, reserve the right to impose future environmental restrictions on the project at the time final plans are submitted to this office for review.

CHARLES G. CLARK

cc: OEQC
R.M. Towill Corp.
Board of Water Supply

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

January 26, 1983

Mr. Charles G. Clark, Director
Department of Health
State of Hawaii
P. O. Box 3378
Honolulu, Hawaii 96801

Dear Mr. Clark:

Subject: Your Letter of January 14, 1983, On The Draft Environmental Impact Statement (EIS) for Kahana "315" Reservoir

Thank you for reviewing the Draft EIS of our proposed reservoir project. Your letter to the Mayor, which will be appended to the revised environmental document, has been referred to us for direct reply.

The final construction plans will be submitted for your review.

If you have any questions, please contact Lawrence Whang at 548-5221.

Very truly yours,

Kazu Hayashida

KAZU HAYASHIDA
Manager and Chief Engineer

cc: R. M. Towill

R.M.Towill

ARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

EILEEN R. ANDERSON
MAYOR

EMIKO I. KUDO
DIRECTOR

SAM L. CARL
DEPUTY DIRECTOR

OSCAR K. ABAMINA
EXECUTIVE ASSISTANT

January 14, ~~1983~~

TO: HONORABLE EILEEN R. ANDERSON, MAYOR

VIA: ANDREW I. T. CHANG, MANAGING DIRECTOR

FROM: EMIKO I. KUDO

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT FOR THE KAHANA "315" RESERVOIR PROJECT

The proposed reservoir improvements will not have any impact on recreation facilities in proximity to the project site.

Emiko I. Kudo

(Mrs.) EMIKO I. KUDO, Director

FORWARDED:

Andrew I. T. Chang

ANDREW I. T. CHANG
Managing Director

EIK:vc

cc: R. M. Towill
BWS

JAN 17 1983

Honorable Eileen Anderson
Mayor
City and County of Honolulu
630 South King Street
Honolulu, Hawaii 96813

Dear Mayor Anderson:

Subject: EIS for Kahana "315" Reservoir Project
Kahana Valley, Oahu

We have reviewed the subject matter and have no comments to offer.

Respectfully,

HIDEO MURAKAMI
State Comptroller

ET:jl

cc: R. M. Towill Corporation
Board of Water Supply

GEORGE R. ARIYOSHI
GOVERNOR

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

RYOKICHI HIGASHIONNA, Ph.D.
DIRECTOR

DEPUTY DIRECTORS
WAYNE J. YAMASAKI
JAMES B. McCORMICK
JONATHAN K. SHIMADA, Ph.D.

IN REPLY REFER TO:
HWY-PS
2.73409

January 18, 1983

The Honorable Eileen Anderson
Mayor
City and County of Honolulu
630 South King Street
Honolulu, Hawaii 96813

Dear Mayor Anderson:

Environmental Impact Statement for
Kahana "315" Reservoir Project;
TMK: 5-2-01, 02, 03 & 06

Thank you for the opportunity to comment on the subject document.

Our transportation program is not affected by your proposal. Therefore, we have no substantive comments to offer which could improve the EIS.

Very truly yours,

Ryokichi Higashionna
Director of Transportation

cc: Board of Wter Supply
R. M. Towill Corporation

R.M. TOWILL CORPORATION

TE 1/83-053

January 21, 1983

MEMORANDUM

TO: HONORABLE EILEEN R. ANDERSON, MAYOR

VIA: ANDREW I.T. CHANG, MANAGING DIRECTOR

FROM: WILLIAM A. BONNET, DIRECTOR (DTS)

SUBJECT: EIS FOR THE KAHANA "315" RESERVOIR PROJECT

We have reviewed the EIS and have no comments.

WILLIAM A. BONNET

cc: R.M. Towill Corporation
Board of Water Supply

DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813
PHONE 523-4191

FEB 1 10 51

EILEEN R. ANDERSON
MAYOR

JOSEPH K. CONANT
DIRECTOR

CHARLES K. TORIGOE
DEPUTY DIRECTOR

January 28, 1983

MEMORANDUM

TO: Honorable Eileen R. Anderson, Mayor

FROM: Joseph K. Conant

SUBJECT: Kahana "315" Reservoir Project
Kahana Valley, Oahu

We appreciate the opportunity to review the subject proposal at Kahana Valley, Oahu. We note that the proposed project will improve the water service to the communities along the Windward side of Oahu from Punaluu to Waimanalo.

Additionally, the planned facility will encourage the development of additional residential areas for low- and moderate-income families in the Windward areas. The Department of Housing and Community Development looks forward to assisting in the development of low- and moderate-income housing units in the area.

We will retain the EIS in our files.

JOSEPH K. CONANT

cc: R.M. Towill Corporation
Board of Water Supply

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

February 4, 1983

TO: JOSEPH K. CONANT, DIRECTOR
DEPARTMENT OF HOUSING AND
COMMUNITY DEVELOPMENT

FROM: KAZU HAYASHIDA
BOARD OF WATER SUPPLY

SUBJECT: YOUR MEMORANDUM OF JANUARY 28, 1983, ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT (EIS) OF KAHANA "315" RESERVOIR PROJECT

Thank you for reviewing the draft EIS of our proposed reservoir project. Your memorandum to the Mayor, which will be appended to the revised environmental document, has been referred to us for direct reply.

The reservoir project is intended primarily to alleviate our water transmission problem in the Windward area by reducing surge pressures in the system.

If you have any questions, please contact Lawrence Whang at 548-5221.

KAZU HAYASHIDA
Manager and Chief Engineer

cc: R. M. Towill

DEPARTMENT OF THE ARMY
PACIFIC OCEAN DIVISION, CORPS OF ENGINEERS
FT SHAFTER, HAWAII 96858

January 31, 1983

Honorable Eileen Anderson
Mayor, City and County of Honolulu
630 South King Street
Honolulu, Hawaii 96813

Dear Mayor Anderson:

Thank you for the opportunity to review and comment on the Environmental Impact Statement (EIS) for the Kahana "315" Reservoir Project, Kahana Valley, Oahu, sent to us on 7 January 1983.

The project will not require a Department of the Army Permit from the Corps of Engineers, nor will it have an impact on the possible harbor of refuge at Kahana Bay being studied by the Corps. The project is located in an area classified as flood zone D, an area having undetermined but possible flood hazards, as stated in the EIS.

Sincerely,

Kisuk Cheung
Chief, Engineering Division

Copy furnished:
R.M. Towill Corporation
677 Ala Moana Boulevard, Suite 1016
Honolulu, Hawaii 96813

Board of Water Supply
City and County of Honolulu
630 South Beretania Street
Honolulu, Hawaii 96813

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

February 15, 1983

Mr. Kisuk Cheung
Chief, Engineering Division
Pacific Ocean Division, Corps of Engineers
Department of the Army
Fort Shafter, Hawaii 96858

Dear Mr. Cheung:

Subject: Your Letter of January 31, 1983 on the Draft Environmental Impact Statement for the Kahana "315" Reservoir Project

Thank you for reviewing the draft environmental impact statement for the proposed reservoir project. Your letter to the Mayor, which will be appended to the revised environmental document, has been referred to us for direct reply.

We shall note in the revised environmental document that the project will have no impact on your study of a possible harbor of refuge at Kahana Bay.

If you have any questions, please contact Lawrence Whang at 548-5221.

Very truly yours,
Kazu Hayashida

KAZU HAYASHIDA
Manager and Chief Engineer

cc: R. M. Towill Corp.

GEORGE R. ARIYOSHI
GOVERNOR

JACK K. SUWA
CHAIRMAN, BOARD OF AGRICULTURE

State of Hawaii
DEPARTMENT OF AGRICULTURE
1428 So. King Street
P. O. Box 22159
Honolulu, Hawaii 96822

January 31, 1983

MEMORANDUM

TO: Honorable Eileen Anderson
Mayor
City and County of Honolulu

SUBJECT: Environmental Impact Statement
Kahana "315" Reservoir Project

The Department of Agriculture has reviewed the subject statement and does not have any comments to offer.

Thank you for the opportunity to comment.

JACK K. SUWA, CHAIRMAN
BOARD OF AGRICULTURE

cc: R.H. Towill Corporation
Board of Water Supply
City and County of Honolulu

"Support Hawaiian Agricultural Products"

DEPARTMENT OF PLANNING AND ECONOMIC DEVELOPMENT

GEORGE R. ARIYOSHI
HIDETO KONO
FRANK SUENAGA

February 3, 1983

C
O
Y

The Honorable Eileen Anderson
Mayor
City and County of Honolulu
Honolulu, Hawaii 96813

Dear Mayor Anderson:

Subject: Environmental Impact Statement for Kahana "315" Reservoir, Kahana Valley, Oahu

We have reviewed the subject EIS and offer the following comments with respect to the relevant objectives and policies of the Hawaii Coastal Zone Management (CZM) Program.

Coastal Ecosystems: Minimize disruption or degradation of coastal water ecosystems by effective regulation of stream diversions, channelization, and similar land and water uses, recognizing competing water needs.

Construction of the proposed 6 MG reservoir tank will require extensive excavation and grading in the upper reaches of Kahana Valley. Given the relatively steep terrain and estimated annual rainfall of more than 100 inches, we are concerned with potential impacts on the Kahana stream and adjacent class AA receiving waters at Kahana Bay from runoff and siltation during and following construction. As such, the probable impacts of the tank's construction and any proposed mitigating measures should be discussed as part of the EIS. We would like the Kahana stream to be continued in the U.S. Department of the Interior, National Park Services Nationwide Rivers Inventory as one of Oahu's streams of high natural quality.

With respect to other potential impacts that are relevant to CZM objectives and policies, we note that surface archaeological surveys have been conducted and provisions made for sub-surface monitoring during construction. We further note that filled and excavated slopes and benches will be landscaped and planted to address impacts on viewplanes and scenic values that would result from proposed construction.

The EIS states at the top of page IV-12 that the (population) figure of 1,039,000 for the year 2000 and the corresponding distribution of the population to the various areas (of Oahu) will be revised as the State Department of Planning and Economic Development revised its population projections. Our agency made a revised population projection of 917,400 for Oahu in the year 2000 to supersede the population figure of 1,039,000. The

917,400 projection was issued on March 1, 1978, in our publication: Revised Population and Economic Projections, 1975-2000, and it is officially recommended by our agency for planning purposes. Please make the correction in your population section pages IV-10 to 12 in the EIS. Also, your estimated 1982's population at 989,000 on page III-12 is too high.

Thank you for the opportunity to comment. Should any questions arise, please feel free to contact us at any time.

Sincerely,

Hideto Kono

cc: R.M. Towill Corp.
Board of Water Supply

CORRECTION

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

GEORGE R. ARIYOSHI
GOVERNOR

JACK K. SUWA
CHAIRMAN, BOARD OF AGRICULTURE

State of Hawaii
DEPARTMENT OF AGRICULTURE
1428 So. King Street
P. O. Box 22159
Honolulu, Hawaii 96822

January 31, 1983

MEMORANDUM

TO: Honorable Eileen Anderson
Mayor
City and County of Honolulu

SUBJECT: Environmental Impact Statement
Kahana "315" Reservoir Project

The Department of Agriculture has reviewed the subject statement and does not have any comments to offer.

Thank you for the opportunity to comment.

JACK K. SUWA, CHAIRMAN
BOARD OF AGRICULTURE

cc: R.H. Towill Corporation
Board of Water Supply
City and County of Honolulu

"Support Hawaiian Agricultural Products"

State of Hawaii
DEPARTMENT OF DEFENSE
OFFICE OF THE ADJUTANT GENERAL
3949 Diamond Head Road
Honolulu, Hawaii 96816

HIENG

Mayor Eileen Anderson
City and County of Honolulu
630 South King Street
Honolulu, Hawaii 96813

Dear Mayor Anderson:

Kahana "315" Reservoir Project

Thank you for providing us the opportunity to review the proposed project, "Kahana "315" Reservoir Project" Environmental Impact Statement.

We have completed our review and have no comments to offer at this time.

Yours truly,

HENRY M. HATSUDA
Captain, HANG
Contr & Engr Officer

cc: K.H. Towill Corp
Board of Water Supply
Env Quality Commission w/EIS

DEPARTMENT OF PLANNING AND ECONOMIC DEVELOPMENT

GEORGE R. ARIYOSHI
Governor
HIDETO KONO
Director
FRANK SUENAGA
Deputy Director

February 3, 1983

COPY

The Honorable Eileen Anderson
Mayor
City and County of Honolulu
Honolulu, Hawaii 96813

Dear Mayor Anderson:

Subject: Environmental Impact Statement for Kahana "315" Reservoir, Kahana Valley, Oahu

We have reviewed the subject EIS and offer the following comments with respect to the relevant objectives and policies of the Hawaii Coastal Zone Management (CZM) Program.

Coastal Ecosystems: Minimize disruption or degradation of coastal water ecosystems by effective regulation of stream diversions, channelization, and similar land and water uses, recognizing competing water needs.

Construction of the proposed 6 MG reservoir tank will require extensive excavation and grading in the upper reaches of Kahana Valley. Given the relatively steep terrain and estimated annual rainfall of more than 100 inches, we are concerned with potential impacts on the Kahana stream and adjacent class AA receiving waters at Kahana Bay from runoff and siltation during and following construction. As such, the probable impacts of the tank's construction and any proposed mitigating measures should be discussed as part of the EIS. We would like the Kahana stream to be continued in the U.S. Department of the Interior, National Park Services Nationwide Rivers Inventory as one of Oahu's streams of high natural quality.

With respect to other potential impacts that are relevant to CZM objectives and policies, we note that surface archaeological surveys have been conducted and provisions made for sub-surface monitoring during construction. We further note that filled and excavated slopes and benches will be landscaped and planted to address impacts on viewplanes and scenic values that would result from proposed construction.

The EIS states at the top of page IV-12 that the (population) figure of 1,039,000 for the year 2000 and the corresponding distribution of the population to the various areas (of Oahu) will be revised as the State Department of Planning and Economic Development revised its population projections. Our agency made a revised population projection of 917,400 for Oahu in the year 2000 to supersede the population figure of 1,039,000. The

917,400 projection was issued on March 1, 1978, in our publication: Revised Population and Economic Projections, 1975-2000, and it is officially recommended by our agency for planning purposes. Please make the correction in your population section pages IV-10 to 12 in the EIS. Also, your estimated 1982's population at 989,000 on page III-12 is too high.

Thank you for the opportunity to comment. Should any questions arise, please feel free to contact us at any time.

Sincerely,

Hideto Kono

cc: R.M. Towill Corp.
Board of Water Supply

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

February 14, 1983

Mr. Hideto Kono, Director
Department of Planning and
Economic Development
State of Hawaii
P. O. Box 2359
Honolulu, Hawaii 96804

Dear Mr. Kono:

Subject: Your Letter of February 3, 1983
on the Draft Environmental Impact
Statement (DEIS) for the Kahana
"315" Reservoir Project

Thank you for reviewing the DEIS for the proposed reservoir project. Your letter to the Mayor, which will be appended to the revised environmental document, has been referred to us for direct reply.

We offer the following information in response to your comments:

1. The coastal ecosystem objective will be included in the discussion on the Hawaii Coastal Zone Management Program.

2. All grading work will be in accordance with the City's Grading Ordinance and construction techniques to minimize erosion and siltation of Kahana Stream will be used as required. Plans for the project are being coordinated with the State Parks Division to avoid any conflicts with park plans, especially those related to Kahana Stream.

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

3. The DEIS will be corrected to reflect the latest population projection from your department. ✓

If you have any questions, please contact Lawrence Whang at 548-5221.

Very truly yours,

Kazu Hayashida

KAZU HAYASHIDA
Manager and Chief Engineer

cc: R. M. Towill

DEPARTMENT OF LAND UTILIZATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813 • [illegible] 523-4432

EILEEN R. ANDERSON
MAYOR

MICHAEL M. McELROY
DIRECTOR

ROBERT B. JONES
DEPUTY DIRECTOR

83/EC-5(JDN)
JU1/83-61

FEB - 3 1983

Mr. Roy R. Takemoto, Chairman
Environmental Quality Commission
State of Hawaii
550 Halekauwila Street, Room 301
Honolulu, Hawaii 96813

Dear Mr. Takemoto:

Environmental Impact Statement (EIS)
for Kahana "315" Reservoir Project
Tax Map Key: 5-2-01, 02, 03 and 06

We have reviewed the subject EIS and have the following comments:

Re: Special Management Area (SMA)

A major portion of the Kahana Valley State Park (all of Tax Map Key 5-2-02) is within the SMA. The EIS indicates that the 42-inch influent - effluent line will be in the SMA. Therefore, a Special Management Area Use Permit (SMP) will be required.

The proposed new service road may also require an SMP if any portion of it falls within the SMA. Repair or maintenance of the existing service road is exempt from SMA provisions.

If there are any questions, please contact John Nakagawa of our staff at 523-4077.

Very truly yours,

for Lorrie Chee
MICHAEL M. McELROY
Director of Land Utilization

MMM:sl

cc: R.M. Towill Corp.
BWS

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

February 8, 1983

TO: MICHAEL M. McELROY, DIRECTOR
DEPARTMENT OF LAND UTILIZATION

FROM: KAZU HAYASHIDA
BOARD OF WATER SUPPLY

SUBJECT: YOUR LETTER OF FEBRUARY 3, 1983, ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT (EIS) FOR THE KAHANA "315" RESERVOIR PROJECT, KAHANA VALLEY, TMK: 5-2-01, 02, 03, and 06

Thank you for reviewing the Draft (EIS) of the proposed reservoir project. Your letter to Mr. Roy Takemoto, Chairman of the Environmental Quality Commission, will be appended to the revised environmental document.

We shall apply for a Special Management Area (SMA) Permit for all construction related activities in the SMA including installation of the 42-inch influent-effluent pipeline and any new service roads.

If you have any questions, please contact Lawrence Whang at 548-5221.

Kazu Hayashida

KAZU HAYASHIDA
Manager and Chief Engineer

cc: R. Takemoto, EQC
R. M. Towill

DEPARTMENT OF GENERAL PLANNING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU HAWAII 96813

EILEEN R. ANDERSON
MAYOR

WILLARD T. CHOW
CHIEF PLANNING OFFICER

RALPH PORTMORE
DEPUTY CHIEF PLANNING OFFICER

DGP1/83-4480

February 4, 1983

R. M. Towill Corporation
677 Ala Moana Boulevard, Suite 1016
Honolulu, Hawaii 96813

Gentlemen:

Kahana "315" Reservoir Project
Environmental Impact Statement

We have reviewed the subject EIS and have no comments. Thank you for including us in the review process.

Sincerely,

Ralph Kawamoto

RALPH KAWAMOTO
Planner

APPROVED:

W. J. Chow

WILLARD T. CHOW

cc: Board of Water Supply

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
550 HALEKAUWILA ST.
ROOM 301
HONOLULU, HAWAII 96813

Jacqueline Parnell
DIRECTOR
TELEPHONE NO.
548-6915

February 7, 1983

Mr. Kazu Hayashida
Manager and Chief Engineer
Board of Water Supply
City and County of Honolulu
630 South Beretania Street
Honolulu, Hawaii 96843

Dear Mr. Hayashida:

Subject: Draft EIS for the Kahana "315" Reservoir Project

Thank you for the opportunity to review your draft EIS. At the present time, we have no substantive comments to make.

Sincerely,

Jacqueline Parnell

Jacqueline Parnell
Director

cc: Office of the Mayor
R.M. Towill Corporation

GEORGE R. ARIYOSHI
Governor of Hawaii

PROJECT OFFICES

HILO OFFICE
P. O. BOX 936
HILO, HAWAII 96720

KEAUHOU OFFICE
P. O. BOX 833
KEAAU, HAWAII 96749

STATE OF HAWAII
DEPARTMENT OF HAWAIIAN HOME LANDS
P. O. BOX 1879
HONOLULU, HAWAII 96805

February 7, 1983

PROJECT OFFICES

MAUI OFFICE
P. O. BOX 77
KAMUELA, MAUI 96743

MOLOKAI OFFICE
P. O. BOX 198
KAUNAKAKAI, MOLOKAI 96748

KAUAI OFFICE
P. O. BOX 339
LIHUE, KAUAI 96766

The Honorable Eileen Anderson,
Mayor
City and County of Honolulu
630 South King Street
Honolulu, Hawaii 96813

Dear Mayor Anderson:

SUBJECT: Environmental Impact Statement
Kahana "315" Reservoir Project
TMK: 5-2-01, 02, 03 and 06

Thank you for the opportunity to comment on the Environmental Impact Statement (EIS) for the subject project.

We have no comments to offer on the Environmental Impact Statement for the Kahana "315" Reservoir Project.

Sincerely yours,

Georgiana K. Padeken
Chairman

GKP:RF:CW:jm

cc: R. M. Towill Corporation
Board of Water Supply, City and County of Honolulu

University of Hawaii at Manoa

Water Resources Research Center
Holmes Hall 283 • 2540 Dole Street
Honolulu, Hawaii 96822

7 February 1983

Mayor Eileen Anderson
City and County of Honolulu
630 South King Street
Honolulu, Hawaii 96813

Dear Mayor Anderson:

Subject: Environmental Impact Statement for Kahana "315" Reservoir Project, TMK: 5-2-01, 02, 03, and 06 December 1983

We have reviewed the subject EIS and have no comment to offer at this time. Thank you for the opportunity to comment. This material was reviewed by WRRC personnel.

Sincerely,

Edwin T. Murabayashi
EIS Coordinator

ETM:jm

cc: R.M. Towill
BWS

SIERRA CLUB, HAWAI'I CHAPTER
P.O. BOX 22897 HONOLULU, HAWAI'I 96822
(808) 946-8494

February 8, 1983

Mayor Eileen Anderson
City and County of Honolulu
630 South King Street
Honolulu, Hawaii 96813

Re: Kahana "315" Reservoir Project

Dear Mayor Anderson:

Sierra Club, Hawaii Chapter, seriously objects to this reservoir being located in the Kahana Valley State Park. We do not contest the project nor the need for it, but since there are alternative location sites, we feel strongly that such a project does not belong in a State Park. Our communication with State Parks indicates that they agree with us, but there is apparently some difference within the Department of Land and Natural Resources.

We would have chosen to be a consulted party and feel that a new Preparation Notice should have been published, since the one prepared and published was in October, 1979 and was for a 2.0 Mg. Reservoir at Kahana Site 1, essentially a different project.

In describing the affected environment, the EIS states (I-3), "Kahana Valley and Kahana Stream are natural resources of great value. To preserve the scenic beauty of the valley, the DLNR plans to develop the valley into a State Park. (implementation underway). The Kahana marsh and stream are classified as areas of secondary importance to endangered water bird species and have been proposed as a wildlife refuge. Kahana Stream has also been identified as one of two streams on Oahu still of high natural quality and has been included in the U.S. Department of the Interior, National Park Services Nationwide Rivers Inventory." With this description we heartily agree. The Valley is a favorite place to hike because of the beauty of the streams and is much more accessible than the other valuable stream system on Oahu. Certainly a project of the magnitude of almost 8 million dollars will be most disruptive to the beauty of the valley. The roadwork alone, with the laying of the influent-effluent Main will greatly alter the present hiking trail and will cause a good deal of silting below the

SIERRA CLUB, HAWAI'I CHAPTER
P.O. BOX 22897 HONOLULU, HAWAI'I 96822
(808) 946-8494

project and into the bay and into the marsh, regardless of mitigating measures. This is the wettest valley on Oahu. On water quality, the EIS states (III-7,5) that Kahana Bay is one of few coastal embayments designated as Class AA. This classification also applies to the estuarine sector.

We refer you to described, long-term impacts in V-4,2 and VI-1 and to the description of the access road on V-7. As stated, this access road also serves as the trail into the valley. No hiker ever chooses to hike on a road nor to compete with vehicle use of that road. We are losing hiking trails (enclosure) and access to forestry trails on Oahu. Can the County and the State possibly condone loss of a trail in a State Park? This comes at a time when there is a greater interest in this type of recreation among both residents and visitors. The fact that there is an access road on the opposite side of the valley does not act as a mitigating factor. This road has also had imposed upon it man-made structures and doesn't offer the same hiking experience.

This reservoir does not have to be sited in Kahana Valley. No doubt it is more convenient because this is State land. The reservoir can serve its purpose sited anywhere along the stretch of mountain from Kahana to Punaluu. Two Punaluu sites are briefly described and rejected, because, (VII-2), "while physically possible, will further aggravate the adverse environmental impact". We disagree with this analysis. How can adverse environmental impact be more aggravated than it is on a State Park where the stream and the marsh are natural resources of great value? We feel that the concern is not for these resources, but for hiding the facility from main-highway view. We note that the estimated total project costs for both of these alternatives are less than the cost in Kahana Valley.

Thank you for allowing us to comment.

Aloha

Lola Mench
Legislative Chair

cc. R.M. Towill Corporation
Board of Water Supply
Hui Malama Aina O'Koolau

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

February 16, 1983

Ms. Lola Mench
Sierra Club, Hawaii Chapter
P. O. Box 22897
Honolulu, Hawaii 96822

Dear Ms. Mench:

Subject: Your Letter of February 7, 1983 On The Draft Environmental Impact Statement (EIS) for the Kahana "315" Reservoir Project

Thank you for reviewing the Draft EIS for the proposed reservoir project. Your letter to the Mayor, which will be appended to the revised environmental document, has been referred to us for direct reply.

We will coordinate our plans with the Department of Land and Natural Resources, State Park Division, to retain the recreational value of the valley, including the reuse of hiking trails that may be temporarily affected by our construction work. We have investigated other sites and due to the steepness of the mountain slopes, we would have to make extensive cuts in the mountain sides to accommodate the reservoir.

Our consultant will also be responding directly to your comments and address the issues in the revised environmental document.

If you have any questions, please contact Lawrence Whang at 548-5221.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: R. M. Towill Corporation

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA
HONOLULU, HAWAII 96843

May 17, 1983

Ms. Lola Mench
Sierra Club, Hawaii Chapter
P. O. Box 22897
Honolulu, Hawaii 96822

Dear Ms. Mench:

Subject: Your Letter of February 7, 1983 on the Draft Environmental Impact Statement (DEIS) for Kahana "315" Reservoir Project

This is a follow-up of our interim reply of February 16, 1983 to your comments on the proposed reservoir in Kahana Valley.

We have reviewed your comments for the proposed reservoir in Kahana Valley and will address the issues in the revised environmental document.

When the Board of Water Supply determined that a 6.0 MG reservoir was needed rather than a 2.0 MG one, the Kahana Reservoir Site 1 ridge was not wide enough at the desired elevation. A review of the previous four sites was made.

Kahana Reservoir Site 3, although 3,000 feet further into the valley requiring a longer influent-effluent main, has the physical characteristics needed for a 6.0 MG reservoir and possesses other features that lessens its environmental impact when compared with the other five sites. These are:

1. The proposed site would be excavated into a "sunken bowl" shape, completely obscuring the reservoir from sight anywhere along the valley floor.

2. The cost would be less than any of the other sites. Note: The DEIS presents cost comparisons for 2.0 MG reservoirs. Siting 6.0 MG reservoirs at those other sites would be 2-3 times more costly than the estimated costs shown on page VII-5.

3. The proposed site was adjacent to and had the same elevation as the abandoned jeep road that is planned for rehabilitation (with coral) as a maintenance road. Therefore, only a short access road with minimum excavation would be needed from the jeep road to the site with little "scarring" of the hillside occurring.

4. The shape of the ridge at the proposed site presented a smaller cut face than the other sites.

It should also be noted that by reusing the jeep road for a maintenance road, a minimum of excavation and vegetative destruction would be experienced. By siting the influent-effluent main along this jeep road, the need for a construction road would be eliminated. By trenching in dry weather and in short segments and backfilling immediately, silting to Kahana Stream and Bay would be minimized. Road culverts will be placed in the stream crossings at the invert elevations of the stream to maintain as close as possible the present conditions. The need to establish new hiking trails parallel to the jeep road for the satisfaction of the hiking purists will be coordinated with the State Department of Land and Natural Resources.

In summary, the recommended Kahana Reservoir Site 3 exhibits all of the best features when compared to the other five sites studied in detail. (Please note that many other sites along the ridge between Punaluu and Kahana Valleys were studied but were rejected for more detailed study

because the 6.0 MG reservoir could not be placed at those sites.) Site 3 is the least costly, will not be visible from the State park activity areas, and disturbs the natural terrain the least both at the site and along the access road.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

Attach.

cc: R. M. Towill Corp.

University of Hawaii at Manoa

Environmental Center
Crawford 317 • 2550 Campus Road
Honolulu, Hawaii 96822
Telephone (808) 948-7361

February 7, 1983

RE:0365

Mayor Eileen Anderson
City and County of Honolulu
630 South King Street
Honolulu, Hawaii 96813

Draft Environmental Impact Statement
for Kahana "315" Reservior Project
TMK: 5-2-01, 02, 03 & 06
Kahana Valley, Oahu, Hawaii

Dear Mayor Anderson:

Thank you for the opportunity to review the above cited plan. Our Environmental Center review has been prepared with the assistance of Matthew Spriggs, Anthropology; James Parrish, Hawaii Co-operative Fishery Research Unit; Ruth Gay, Botany; Paul Ekern, Soils; Jacquelin Miller and Mark Ingoglia, Environmental Center.

The Kahana stream, Kahana Valley and Bay constitute a valuable natural resource. The Department of Land and Natural Resources plans to retain the valley as a State "Living Park". The stream has been included by the U. S. Department of the Interior in a Nationwide Rivers Inventory. The Department of Health has clarified the waters of the bay as class AA in which natural quality is to be researched. It is, therefore, questionable whether a reservoir can appropriately be located in the valley.

We have noted that all the alternative sites for the reservoirs were initiately proposed on the basis of the 2 mg reservoir plan and were found to be inadequate. No alternative sites were considered for the 6 mg reservoir. Furthermore, it appears that much of the survey work done for the 2 mg, "300" reservoir has been used for the "315" reservoir site some 3000 feet away. The application of these previous surveys to the new "315" site location will be discussed according to each of the following specific topics.

Archaeology

The Archaeology Reconnaissance Survey, Appendix D, addresses Reservoir Sites 1, 2A and 2B. As presented in the document, it does not address Reservoir Site Number 3 ("315"). Therefore, comments regarding archaeological impact as noted on pages I-9, 5 and V-3 may not be valid. Will an intensive archaeological survey with subsurface testing where applicable, be conducted in areas expected to be impacted - especially in Reservoir Area #3, and the 'new coral access road'?

As noted in the document extensive excavation will be a required part of the construction (V-5), therefore the archaeological survey should include areas which are expected to be impacted secondarily. These areas include locations for vehicle and equipment storage, areas used for storage of soils during construction, areas where excavated materials will be stored during road construction, building supply storage areas, equipment turn around areas, etc.

Recent botanical and archaeological research suggest that cultural resources may be present in grassland areas at the juncture of the Jeep road and the 'hunter's access road'. This area should be examined for archaeological resources, prior to being impacted by construction or associated activities.

Archaeological monitoring has been mentioned in several contexts in the document. It is unclear, however, exactly what is meant by this phrase. When, where and how often will this 'monitoring' be done? What does 'selective monitoring' mean (V-3)? If archaeological resources are found during monitoring will the archaeologists have the authority to stop construction?

No information regarding possible impact to archaeological resources has been furnished for the 'new coral access road' (II-4, II-7). This road is described as being 12' wide and 200' long from the Jeep Road to the reservoir perimeter. The statement in the document that the, "access road . . . will only impact the affected area to a limited extent" (V-7) seems unjustified.

The addendum to the archaeological report, Appendix D, addresses Well Sites 1, 2, and 3, not Reservoir Site 3. Although, this addendum addresses archaeological sites, "in the vicinity" (III-16) it is not possible to extrapolate data from one area to another in an archaeological survey. Therefore, it is not valid to assume that other areas 'in the vicinity' are devoid of sites.

Socio-cultural

Have the Kahana Valley residents been apprised of the proposed development/, and do they have any specific areas of concern?

Stream Fauna

The potential impact on stream fauna will occur primarily during the initial contruction process. Erosion may create a short term siltation problem. Clarification is needed of the procedures to be followed to assure that erosion will be minimized. What parameters will determine if the turbidity is excessive (V-4)? Given the high rainfall associated with this area, the instability of the soils present in Kahana Valley and the high priority that Kahana Park has as a natural resource, has consideration been given to requiring grading and construction to be limited to the drier months of the year?

During the construction, where will excess excavated materials be placed? What mitigative measures are being considered to minimize erosion during the extensive road grading. The three streams to be crossed by the road should have adequate culverts that maintain a consistant grade for the stream so that stream fauna will not be impeded while traveling up-stream.

The last sentence on page III-11 is unclear. Where is Kawa stream? What is the basis for comparing its fauna to Kahana stream. A minor point, o'opu nopili is misspelled.

The following references provide information pertinent to the stream biology and should be included in the revised EIS:

Archer, K. M., A. S. Timbol, J. P. Parrish
1980 Biological Survey of Kahana Stream System.
Contract 9817 Final Report to Hawaii Div. of State Parks

Timbol, A. S.
1972 Tropic Ecology and Macro Fauna of Kahana Estuary, Oahu
PhD Thesis University of Hawaii.

Kubota, W. T.
1972 The Biology of an Introduced Prawn: Macrobrachium lar. (fabricius) in Kahana Stream. PhD Thesis University of Hawaii.

Flora-Botanical

The survey used for the flora and botanical analysis of Kahana Valley has been updated by a more recent work by Negnah Wirawan. This work provides site specific data as to what, if any, endangered species are present in the Valley, and background information on flood control and soil-water regimens.

Wirawan, Nengah
1978 Vegetation and Soil-Water Regimens in a Tropical Rainforest Valley on Oahu, Hawaiian Islands: Phd dissertation, Botany Dept. University of Hawaii

The botanical survey should include the reservoir site, roadway, excavated materials storage sites and any other areas subject to construction or excavation.

Soils

The soil reconnaissance conducted by Walter Lum Associates, Inc. in Appendix B addresses the soils at sites 1, 2B and 2A only. It doesn't include Site 3. The report clearly states that "soil formations are commonly erratic and rarely uniform or regular .... and may not represent conditions at other locations, or at other dates". Given these conclusions it appears essential to perform another soil survey for Site 3. Will such a survey be included in the final EIS? The following reference should be considered in evaluating the impacts related to soil types at the reservoir site:

Soil Survey of Island Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii United States Dept. of Agriculture, Soil Conservation Service Washington D. C. 1972

Roadway

No specific provisions for maintenance of the roadway have been mentioned in

the document. Deterioration of similar roadways in the area has been quite rapid due to the soil-types and heavy rains of Kahana Valley. What procedures have been considered to address road maintenance requirements and what agency will be delegated with this responsibility?

Miscellaneous

Presently pig hunters have access to the area slated for construction. The document should address the possible impact the development will have on the hunters and any safety measures to be undertaken to assure that workmen will not be endangered.

We appreciate the opportunity to comment on the DEIS and look forward to your response.

Yours very truly,

Doak C. Cox
Director

cc: R. M. Towill Corp.
Board of Water Supply
Matthew Spriggs
James Parrish
Ruth Gay
Paul Eckern
Jacquelin Miller
Mark Ingoglia

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

February 15, 1983

Dr. Doak C. Cox, Director
Environmental Center
University of Hawaii at Manoa
2550 Campus Road, Crawford 317
Honolulu, Hawaii 96822

Dear Dr. Cox:

Subject: Your Letter of February 7, 1983 on the Draft Environmental Impact Statement (DEIS) for the Kahana "315" Reservoir Project

Thank you for reviewing the DEIS for the proposed reservoir project. Your letter to the Mayor, which will be appended to the revised environmental document, has been referred to us for direct reply.

Because your comments relate primarily to the inadequacy of the DEIS to address certain technical and environmental issues, we have instructed our consultant to work directly with you. The consultant will incorporate any pertinent information into the revised environmental document and prepare a response to your comments.

We shall be working closely with the State Department of Land and Natural Resources to ensure that the environmental and recreational values of the valley are maintained.

Very truly yours,

Kazu Hayashida

KAZU HAYASHIDA
Manager and Chief Engineer

cc: R. M. Towill Corporation

May 16, 1983

Dr. Doak C. Cox, Director
Environmental Center
University of Hawaii at Manoa
2550 Campus Road, Crawford 317
Honolulu, Hawaii 96822

Dear Dr. Cox:

Subject: Your Letter of February 7, 1983 on the Draft Environmental Impact Statement (DEIS) for the Kahana "315" Reservoir Project

This is a follow-up of our interim reply of February 15, 1983 to your comments on the proposed reservoir in Kahana Valley. We will address the issues in the revised environmental document.

Archaeology

On May 21 and 22, 1980, Susan Dobyns and Ken Shun of Bishop Museum conducted additional archaeological reconnaissance of three well fields and the access trail in Kahana Valley (Appendix D: Addendum). The well sites were in the same general vicinity of the proposed 6.0 MG reservoir. Based on surface reconnaissance, no archaeological features were observed.

During construction of the proposed reservoir and reservoir access road, and improvement to the existing jeep trail, a requirement will be made to have all clearing and grading work monitored by an archaeologist. This monitoring by the archaeologist is referred to in the DEIS as "archaeological monitoring."

We will be deleting the term "selective monitoring" appearing on page V-3 of the DEIS. The basis for the deletion is that an archaeologist will be required to monitor all clearing and grading work, including the excavation for the pipeline. The archaeologist monitoring the construction work will be given the authority to stop work should any

archaeological or historical artifact be encountered. The archaeologist will coordinate any mitigative action with the State Historic Sites Office.

On your concern regarding the lack of information relating to archaeological features in the vicinity of the reservoir access road, a field reconnaissance of the proposed 6.0 MG reservoir site and well fields was made by archaeologists of the State's Historic Sites Office. They found no archaeological features within 200 feet of the reservoir site or well fields. To further mitigate any impacts, as mentioned previously, an archaeologist will monitor all clearing, grading, and excavation work.

Socio-Cultural

The Board will be meeting with the Kahana Valley residents to discuss the project.

Stream Fauna

To control siltation, erosion control measures will be provided during construction as required by the grading permit. Considerations will be given to do mass grading operations during the drier months of the year. Excess excavated materials may be used by the State Parks for improvements to their planned developments within Kahana Valley. Location of storage areas during construction would be at the direction of State Parks. This question will be coordinated with State Parks before a construction contract is finalized.

The use of silting ponds and cut-off trenches are other alternatives that will be considered to minimize siltation of the stream from the construction activities.

Determination of excessive turbidity can be made on a visual basis only. The accumulation of sediment at Huilua Pond indicates that natural siltation already occurs in the stream. Only by implementing one or several of the mitigative measures mentioned earlier can siltation from the construction activities be minimized.

The abandoned jeep trail will be rehabilitated to follow the existing profile as closely as possible in plan and elevation to minimize grading. Likewise, the influent-effluent main will follow this proposed maintenance road thereby eliminating the need to build a new construction road. By shortening the pipe trench segments and back-filling immediately, minimal siltation is anticipated. Road culverts are planned to be placed in the stream with inverts to maintain the stream grades at their present elevations. Note: Kawa Stream is a tributary to Kahana Stream.

The spelling for oopu nopili will be corrected in the revised environmental document.

The following references are pertinent to the stream biology and will be included in the revised EIS.

Archer, K. M., A. S. Timbol, J. P. Parrish
1980 Biological Survey of Kahana Stream System. Contract 9817 Final Report to Hawaii Div. of State Parks

Timbol, A. S.
1972 Tropic Ecology and Macro Fauna of Kahana Estuary, Oahu.
PhD Thesis University of Hawaii

Kubota, W. T.
1972 The Biology of an Introduced Prawn: Macrobrachium lar. (fabricius) in Kahana Stream.
PhD Thesis University of Hawaii

Flora-Botanical

The reference listed:

Wirawan, Nengah
1978 Vegetation and Soil-Water Regimens in a Tropical Rainforest Valley on Oahu, Hawaiian Islands: PhD dissertation, Botany Dept. University of Hawaii

will be used to update the flora and botanical analysis of Kahana Valley.

Soils

A soils report, "Foundation Investigation Kahana 315 Reservoir Kahana Valley State Park, Kahana Valley, Oahu, Hawaii" by Ernest K. Hirota & Associates, Inc., dated April 15, 1982 will be included in the revised EIS.

Also, the following reference:

Soil Survey of Island Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii United States Dept. of Agriculture, Soil Conservation Service Washington D.C. 1972

has been considered and referred to in the text in evaluating the impacts relating to soil types.

Roadway

The Board of Water Supply will maintain the coral roadway to the reservoir site using their maintenance crews to replace and compact additional coral as needed.

Miscellaneous

Pig hunting will not be allowed in Kahana Valley once the "Living Park" concept is implemented. During construction of the Kahana Reservoir, pig hunters may be permitted to hunt by the State Park Rangers in specific areas that would not endanger construction workers or hikers.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

Kazu Hayashida

KAZU HAYASHIDA
Manager and Chief Engineer

cc: R. M. Towill Corp.

KAHALUU NEIGHBORHOOD BOARD NO. 29
c/o KAHALUU COMMUNITY CENTER
47-232 WAIHEE ROAD
KANEOHE HAWAII 96744

"Let us not ever have an unhappy community"

February 7, 1983

Honor Eileen Anderson
City & County of Honolulu
530 South King Steet
Honolulu, Hawai'i 96813

Comments on Final Environmental Impact Statement
Kahana "315" Reservoir Project
Kahana, Ko'olaupoko, O'ahu, Hawai'i

Dear Mayor Anderson:

The Kahalu'u Neighborhood Board recognizes the importance of this project which is intended to provide a more stable water transmission system for Windward O'ahu.

The major concern of our Board is whether it is appropriate to place such a massive structure within the Kahana Valley State Park because of the resulting adverse visual impact and possible conflict with passive recreational uses. This concern is well stated in the Environmental Impact Statement itself under Section XI, SUMMARY OF UNRESOLVED ISSUES "The proposed project could affect the aesthetic quality of the Kahana Valley State Park. The steep cut slope and reservoir site will have to be revegetated and properly landscaped to minimize the visual impact to people utilizing the State Park."

We hope that our comments will be of help to you in making your decision on whether or not to accept this Environmental Impact Statement.

Sincerely,

Edwin B. Stevens, Chairman
Kahalu'u Neighborhood Board No. 29

Letter & Comments Authorized at
N.B.#29 Regular Meeting 1-26-83

Copies: Board of Water Supply
R.M. Towill Corp.
Councilman David Kahanu
Senator Charles Toguchi
Representative Robert Nakata
Department of Land & Natural Resources
Hui Malama Aina O Ko'olau
Ko'olauloa N.B.#28
Kahalu'u N.B.#29 - Chairman
- Water & Agriculture Committee
- Parks & Recreation Committee
Kahalu'u Community Resource Center
Neighborhood Commission

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

February 15, 1983

Mr. Edwin B. Stevens, Chairman
Kahaluu Neighborhood Board No. 29
c/o Kahaluu Community Center
47-232 Waihee Road
Kaneohe, Hawaii 96744

Dear Mr. Stevens:

Subject: Your Letter of February 7, 1983, on the Draft Environmental Impact Statement for the Kahana "315" Reservoir Project

Thank you for reviewing the draft environmental impact statement for the proposed reservoir project. Your letter to the Mayor, which will be appended to the revised environmental document, has been referred to us for direct reply.

Your concerns over the adverse visual impact and possible conflict with passive recreational uses of Kahana Valley State Park are being considered in the design of the facility. Our construction plans are being coordinated with the State Parks to avoid adverse impacts and potential conflicts with park plans. One of our proposals include burying half of the tank so that it would not extend above the trees.

If you have any questions, please contact Lawrence Whang at 548-5221.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: R. M. Towill Corp.

United States Department of Agriculture
Soil Conservation Service
P. O. Box 50004
Honolulu, Hawaii
96850

February 10, 1983

Honorable Eileen R. Anderson
Mayor, City and County of Honolulu
630 South King Street
Honolulu, HI 96813

Dear Mayor Anderson:

Subject: Environmental Impact Statement for Kahana "315" Reservoir Project - TMK: 5-2-01, 02, 03 & 06, Kahana Valley, Oahu

We have reviewed the subject environmental impact statement and have no comments.

Thank you for the opportunity to review this document.

Sincerely,

Herbert J. Fyford ACTING

FRANCIS C. H. LUM
State Conservationist

cc:
Board of Water Supply
City and County of Honolulu
630 South Beretania Street
Honolulu, HI 96813

R.M. Towill Corporation
677 Ala Moana Blvd., Suite 1016
Honolulu, HI 96813

MAR 8 1983

Honorable Eileen Anderson
Mayor
City and County of Honolulu
630 So. King Street
Honolulu, Hawaii 96813

Dear Mayor Anderson:

We appreciate the opportunity to comment on the draft statement of the environmental impact of the proposed Kahana "315" reservoir. We have a number of concerns to express.

Aquatic Resources

We believe that the project will have no significant adverse impacts on the water quality and biota of Kahana Stream. Temporary increases in stream water turbidity may occur occasionally as an aftermath of the construction, but such impacts should be minimal considering the location of the project site and the nature of the proposed access road.

There is, however, a source of confusion in Table 7 where the oopu nakea is listed as "depleted" for Kahana Stream and its tributaries. We note that the footnote indicates the oopu nakea is "Depleted on Oahu," and not specific for the Kahana Stream. Some explanation appears necessary to avoid confusion in this matter.

Another potential source of confusion is Table 7 itself, where the last column headed by the term "Listing," "None" is used to indicate that macrofauna found in the stream are not endangered, threatened, or depleted. Again, for clarification purposes, it should be explained directly in Table 7 that organisms found in Kahana Stream are not of threatened, endangered, or depleted status (rather than use a vague term such as "None").

Historic Sites

Kahana Valley is known to contain numerous archaeological sites that have not been added to our statewide inventory. An archaeological survey should be conducted in the project area and forwarded to our historic site office for review and evaluation, prior to making any final decisions regarding land use in the project area. The archaeological surveys contained in this EIS are not for the project area.

Recreation

The subject environmental impact statement is unacceptable for two main reasons:

1. The proposed project is a major intrusion into Kahana Valley State Park. This park was purchased in part for the need to preserve the natural environment, particularly in the upper portions of the valley, which includes the reservoir site.

   The environmental impact statement addresses our concern about the aesthetics of the reservoir. For example, the height of the reservoir will not exceed 15 feet, the approximate tree-line height. However, the statement does not identify areas of the valley from which the project would still be visible. If the proposed reservoir is built, this portion of the park including the access road will be "written off" for recreation purposes. A new trail would have to be built to avoid the area.

   The environmental impact statement assumes the improved access by a 12-foot wide coral road will be an asset to recreation interests. From the point of view of hikers seeking the natural environment of the valley, the road would actually be an unacceptable replacement for a trail and allow motor vehicle access into an area where they are considered a major intrusion.

2. We understand that other sites outside of Kahana Valley have been investigated which would result in greater environmental degradation in terms of hillside cuts. Furthermore, the cost of the site work would be extremely high.

   However, we believe there has not been adequate consideration of alternative sites. A reservoir for surge control could be located anywhere along the system from Punaluu to Waihee. To date, the only sites considered are two sites in Punaluu, plus the various sites in Kahana Valley. No mention is made of any potential sites in the extensive ridge and valley systems between Kahana and Waihee valleys.

   Nor have alternative grading plans been considered for each site. We note that one-half the proposed tank is to be buried, but no consideration was given to alternative degrees of burial at any of the alternative sites.

Sincerely,

SUSUMU ONO
Chairman of the Board
and
State Historic Preservation Officer

cc: ✓R. M. Towill
Board of Water Supply

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

May 17, 1983

Mr. Susumu Ono, Chairman
Board of Land and Natural
Resources
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

Subject: Your Letter of March 8, 1983
on the Draft Environmental
Impact Statement (EIS) for
Kahana "315" Reservoir Project

We forward the follow-up to our interim response dated March 22, 1983.

Your comments have been discussed with the staff of the State Parks Division and the Water and Land Development Division. Our response reflects these discussions:

1. Table 7 and its explanatory notes were extracted as is from Amadeo S. Timbol's 1979 report titled Limnological Survey of Kahana Stream, footnote (1). Footnote (1) shall be inserted next to Table 7 in the Revised EIS. Timbol's report also references Miller's 1972 report and includes Kahana Stream as having the oopu nakea depleted as is noted for Oahu by Miller.

2. Your archaeologists assigned to State parks have actually visited the proposed reservoir site and saw no archaeological features in the area. They acknowledged that no additional survey is needed. However, should we encounter archaeological features during construction, work will be halted and your Historic Sites Office will be contacted.

3. We are in consonance with your department's concern for retaining Kahana Valley State Park in as natural an environment as possible:

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

a. The reservoir may only be visible by hikers through screened vegetation on a portion of the proposed access road fronting the reservoir or by hikers on the ridgelines overlooking the valley.

b. Construction of the reservoir should not preclude the recreational use of the area. The reservoir would be setback from the trail-proposed roadway. The shoulders of the roadway should revert back to its natural state within a year or so. As to the use of the road by unauthorized motor vehicles, your State Parks Division has administrative control over all access in the park. We request that we be permitted access into the area for operational and maintenance purposes.

4. As part of our ongoing studies regarding system efficiencies, we determined that in the Windward area, a storage tank in the vicinity of Kahana would, (1) increase transmission capability on the narrow winding Kamehameha Highway, (2) reduce the need for high operating pressures to meet peak hour loads and the inherent increased risk of service disruptions due to main breaks as a result of high operating pressures and pressure surges, and (3) allow efficient operation of the 23 mgd existing and planned sources between Kahana and Laie, provided the tank could be sized large enough to allow more efficient pump operations through steadier, longer duration pumping. The proposed 6 mg reservoir in Kahana provides all of the operating advantages described.

During the preliminary planning phase of the study, alternative sites were considered between Kaaawa and Punaluu. However, except for the area around Hakipuu-Kaaawa and Kahana-Punaluu, the steep topography of the valleys between Punaluu and Kaaawa precluded constructing a reservoir without

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

astronomical construction costs. The huge cost arises from excavations requiring cuts 400 ft. to 600 ft. and ugly scarring of the area will result. There were potential sites in the Kaaawa-Hakipuu area but they were not selected previously because of the high cost of providing an additional pipeline between Kaaawa and Punaluu. The pipeline is not needed if the reservoir is built in Kahana Valley. In addition, except for a site at Hakipuu that had a high visual impact from Kamehameha Highway, the other Kaaawa sites could not accommodate a large reservoir to meet the hydraulic gradeline elevation requirements for gravity flow to Kailua.

Alternative grading plans are very limited in reservoir design because of topography, elevation, soil stability, allowable soil bearing, and construction considerations. Thus, costs were developed for the grading plan that would best fit the site. The cost figures were evaluated and where they appeared prohibitively high, we terminated further study and alternative sites were then investigated.

The Board prefers not to install buried reservoirs because burial increases construction and maintenance costs. However, the proposed reservoir in Kahana Valley is to be partially buried to ease its visual impact. The fifteen foot high reservoir would present a lower profile in relation to the height of the surrounding trees. This would soften the appearance of the reservoir, as the thickly vegetated terrain would shield it from view from almost all areas of the valley.

If you have any questions, please contact Lawrance Whang at 527-6138.

Very truly yours,

Kazu Hayashida

KAZU HAYASHIDA
Manager and Chief Engineer

cc: R. M. Towill Corp.

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

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

SUSUMU ONO, CHAIRMAN
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LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

MAY 23 1983

Mr. Lawrence Whang
Environmental Section
Board of Water Supply
630 South Beretania Street
Honolulu, Hawaii 96813

Dear Mr. Whang:

SUBJECT: EIS FOR KAHANA VALLEY RESERVOIR
KAHANA VALLEY, OAHU, TMK 5-2-01, 02, 03, 06

It has come to our attention that the State Parks archaeologists field inspected the reservoir site on January 28, 1982. At this time the hilltop reservoir site was overgrown with uluhe fern but there was no evidence of surface archaeological or historical sites. The site was visited again on February 19, 1983, when some clearing work had been performed. Again, there was no evidence of surface features in the reservoir vicinity.

Consequently, we do not feel that an archaeological survey of the reservoir site is needed. However, if reservoir construction should take place in the future, we recommend that the State Parks archaeologist be notified of the work schedule and be permitted to observe the slope cuts for any evidence of sub-surface cultural remains.

Sincerely yours,

Susumu Ono
Chairman and
State Historic Preservation
Officer