DRAFT

WATERSHED PLAN and ENVIRONMENTAL IMPACT STATEMENT

WAIMANALO WATERSHED

CITY AND COUNTY OF HONOLULU, HAWAII

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1981

JULY 1981

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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WAIMANALO WATERSHED

City and County of Honolulu, Hawaii

DRAFT

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July 1981

ABSTRACT

This document describes the formulation, implementation, and effects of a local-federal cost-shared project to solve problems with inefficient use of water and related resources and severe limitations on the production of crops in Waimanalo. The project also takes advantage of an opportunity to enhance the agricultural use of prime and important farmlands. Land treatment, improved irrigation water management, irrigation use of treated sewage effluent and rehabilitation and expansion of the existing irrigation system were investigated in formulating alternative plans including a no-action plan. Economic benefits exceed costs for the proposed plan. Sponsors will pay 52 percent of the $12.798 million installation costs. Environmental impacts include increased agricultural use of prime and important farmlands, reduced solid waste disposal problems, and protecting or preserving portions of the existing ditch determined to have historic value. This document is intended to fulfill requirements of the National Environmental Policy Act, and the Water Resources Council Principles and Standards for Water and Related Land Resources Planning. This document is to be considered for authorization of Public Law 83-566 funding.

Prepared under the authority of the Watershed Protection and Flood Prevention Act, Public Law 83-566, as amended (16 USC 1001-1008) and in accordance with Section 102(2)(C) of the National Environmental Policy Act of 1969, Public Law 91-190, as amended (42 USC 4321 et seq).

Prepared By:

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UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
(Lead Agency)

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COMMENTS MUST BE RECEIVED BY OCTOBER 17, 1981

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WATERSHED AGREEMENT
between the

STATE OF HAWAII, DEPARTMENT OF LAND AND NATURAL RESOURCES
(Referred to herein as DLNR)

WINDWARD OAHU SOIL AND WATER CONSERVATION DISTRICT
(Referred to herein jointly with DLNR as Sponsors)

STATE OF HAWAII

and the

SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE
(Referred to herein as SCS)

Whereas, application has heretofore been made to the Secretary of Agriculture by local organizations for assistance in preparing a plan for works of improvement for the Waimanalo Watershed, State of Hawaii, under the authority of the Watershed Protection and Flood Prevention Act (16 U.S.C. 1001-1008); and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Soil Conservation Service (SCS); and

Whereas, there has been developed through the cooperative efforts of the local organizations and the SCS a plan for works of improvement for the Waimanalo Watershed, State of Hawaii, hereinafter referred to as the watershed plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Secretary of Agriculture, through the SCS, and the Sponsors hereby agree on this plan and that the works of improvement for this project will be installed, operated, and maintained in accordance with the terms, conditions, and stipulations provided for in this watershed plan and including the following:

1. The Sponsors will provide or acquire, with other than P.L. 566 funds, such landrights as will be needed in connection with the works of improvement. (Estimated cost $740,000.)

2. The DLNR assures that comparable replacement dwellings will be available for individuals and persons displaced from dwellings, and will provide relocation assistance advisory services and relocation assistance, make the relocation payments to displaced persons, and otherwise comply with the real property acquisition policies contained in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894) effective as of January 2, 1971, and the Regulations issued by the Secretary

of Agriculture pursuant thereto. The costs of relocation payments will be shared by the Sponsors and SCS as follows:

	DLNR (percent)	SCS (percent)	Estimated Relocation Payment Costs (dollars)
Relocation Payments	52	48	$ 0 1/

3. The DLNR will acquire such water rights pursuant to State law as may be needed in the installation and operation of the works of improvement.

4. The percentage of construction costs to be paid by DLNR and by SCS are as follows:

Works of Improvement	DLNR (percent)	SCS (percent)	Estimated Construction Costs (dollars)
Irrigation Systems	50	50	$ 8,280,000
Solid Waste Collection Sites	50	50	$ 60,000
(Maunawili Collection System Improvements)	(100)	(0)	($1,500,000) 2/

5. The percentages of the engineering costs to be borne by DLNR and by SCS are as follows:

Works of Improvement	DLNR (percent)	SCS (percent)	Estimated Engineering Costs (dollars)
Irrigation Systems	0	100	$ 825,000
Solid Waste Collection Sites	0	100	$ 6,000
(Maunawili Collection System Improvements)	(100)	(0)	($100,000) 2/

1/ Investigation has disclosed that under present conditions the project measures will not result in the displacement of any person, business, or farm operation. However, if relocations become necessary, relocation payments will be cost-shared in accordance with the percentages shown.

2/ This is a project construction cost of $500,000 and engineering costs of $33,000 ineligible for assistance and required for water collection system improvements outside Waimanalo Watershed. An additional construction cost of $1,000,000 and $67,000 engineering costs are assumed in the future without-project for improvements by DLNR outside the watershed.

6. DLNR and SCS will each bear the costs of Project Administration which they incur, estimated to be $651,000 and $1,087,000, respectively.

7. The Sponsors will obtain agreements from owners of not less than 50 percent of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land, and insure that 50 percent of the land is adequately protected prior to construction of any dam.

8. The Sponsors will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed plan.

9. The Sponsors will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

10. DLNR will be responsible for the operation, maintenance, and replacement of the works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

11. The costs shown in this plan represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

12. This agreement is not a fund obligating document. Financial and other assistance to be furnished by SCS in carrying out the plan is contingent upon the fulfillment of applicable laws and regulations and the availability of appropriations for this purpose.

13. A separate agreement will be entered into between SCS and DLNR before either party initiates work involving funds of the other party. Such agreements will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

14. This plan may be amended or revised only by mutual agreement of the parties hereto except that SCS may deauthorize funding at any time it determines that the Sponsors have failed to comply with the conditions of this agreement. In this case, SCS shall promptly notify the Sponsors in writing of the determination and the reasons for the deauthorization of project funding, together with the effective date. Payments made to the Sponsors or recoveries by SCS shall be in accord with the legal rights and liabilities of the parties when project funding has been deauthorized. An amendment to incorporate changes affecting a specific measure may be made by mutual agreement between SCS and the Sponsors having specific responsibility for the measure involved.

15. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this plan, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

16. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964, as amended, and the regulations of the Secretary of Agriculture (7 CFR 15.1-15.12), which

provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be otherwise subject to discrimination under any activity receiving Federal financial assistance.

DEPARTMENT OF LAND AND
NATURAL RESOURCES
P.O. Box 621
Honolulu, HI 96809

By _____

Title _____

Date _____

The signing of this plan was authorized by a resolution of the Board of Land and Natural Resources adopted at a meeting held on _____

_____ P.O. Box 621, Honolulu, HI 96809
Clerk

Date _____

WINDWARD OAHU SOIL AND
WATER CONSERVATION DISTRICT
P.O. Box 402
Kaneohe, HI 96786

By _____

Title _____

Date _____

The signing of this plan was authorized by a resolution of the board of directors of the Windward Oahu Soil and Water Conservation District held on _____.

_____ P.O. Box 402, Kaneohe, HI 96786
Secretary

Date _____

SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE

Approved by: _____
Jack P. Kanalz, State Conservationist

Date: _____

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SUMMARY

Project Name:	Waimanalo Watershed, City and County of Honolulu, Hawaii
Sponsors:	Hawaii Department of Land and Natural Resources (DLNR) and Windward Oahu Soil and Water Conservation District
Description of Recommended Plan:	The recommended plan will irrigate a total of 1,252 acres. Waimanalo Irrigation System (WIS) will be replaced with a gravity-pressure, piped distribution system providing continuous service at full supply to 890 acres. A deep, off-channel reservoir will be used for storage, regulation and nematode control. A separate system will be used for irrigating 68 acres with treated sewage effluent. BWS service will continue to 294 acres. Accelerated technical assistance and solid waste collection sites will be provided.
Alternatives Considered:	34 alternative plans were considered covering the following: without project, nonstructural (improvements in the facilities and operation of the existing system), lined ditches, combining with the Board of Water Supply (BWS) domestic system, and various combinations of reservoir sizes, area served and water quality. Alternative structural and nonstructural flood prevention measures were also considered.
Resource Information:	
Size of Watershed -	6,132 acres (105 farm units)
Land Use -	3,029 acres agriculture 334 acres urban or residential 994 acres military 257 acres parks and recreation 1,518 acres in preservation
Land Ownership -	16 percent Federal 18 percent Private (fee simple) 66 percent State owned (31 percent of state land is leased to farmers)
Water Available for Irrigation - MG/YR -	548 - Maunawili, 128 - effluent, 71 - BWS
Wetlands -	56 acres secondary wetlands (Ref. 11 & 12)

Flood Plain (100 year) -	456 acres	agriculture
	26 acres	urban - residential
	77 acres	parks (and golf course)
	251 acres	military
	68 acres	beach

Endangered Species - Hawaiian Duck, Hawaiian Coot, Hawaiian Gallinule, and Hawaiian Stilt (Ref. 12)

Cultural Resources - There are 12 known archeological sites and one historical site under consideration for nomination to the National Register (Ref 17 & 18).

Problem Identifications: Because of the antiquated irrigation system and insufficient storage there is inefficient use of water and related resources and severe limitations on production of crops. Flooding and solid waste disposal are also problems.

Opportunity Identifications: Improve the use of prime and important farmlands for agriculture, and allow effective implementation of the Agricultural Park Plan. There is also an opportunity to preserve the historic features of the irrigation ditch.

Candidate Plans Considered: Four candidate plans and the without-project plan were chosen from the 34 alternatives considered. From these five the Sponsors could select the recommended plan:

(1) NED, the national economic development plan, similar to the recommended plan, but applying less than a full supply of water and thereby maximizing irrigated acres;
(2) EQ, the environmental quality plan, similar to the recommended plan but irrigating only prime farmland and providing solid waste collection sites;
(3) Nonstructural using repairs, some modification, and management techniques to improve the existing system; and
(4) the recommended plan.

The without-project plan was also considered and was the basis for comparison of the candidate plans.

Project Purpose:

NED — Agricultural water management-irrigation

EQ — Environmental enhancement by increasing agricultural use of prime and important farmlands and by alleviating solid waste problems.

(Flood prevention proved not viable.)

Project Cost: SUMMARY DATA FROM TABLE 1 1/

Principal Project Measures	PL-566 Funds ($1000)	PL-566 Funds Percent	Other Funds ($1000)	Other Funds Percent	Total ($1000)
Land Treatment		0	589	100	589
Technical Assistance	20	74	7	26	27
Construction Costs					
Water Collection System		0	500	100	500
Irrigation	4,140	50	4,140	50	8,280
Solid Waste Sites	30	50	30	50	60
Engineering Services	831	96	33	4	864
Landrights		0	740	100	740
Project Administration	1,087	63	651	37	1,738
TOTAL PROJECT	6,108	48	6,690	52	12,798

1/ Data are from Table 1 and do not include costs that would be incurred without a project.

Project Benefits:

Agricultural Irrigation - $916,000 annual net remaining benefits

Acres Benefited - 958 gross acres land treatment
0 gross acres nonstructural
958 gross acres structural

Impacts:

Land Use Changes -

From	To Land Irrigated by WIS Including Sewage with Full Supply
Nonirrigated cropland	308 acres
Irrigated - Board of Water Supply	79 acres
Undeveloped Agricultural land	122 acres
TOTAL	509 acres

Natural Resources Changed or Lost - With no loss of significant natural resources, 377 acres of prime and important farmland will be added to irrigated agricultural production. The new reservoirs will occupy 13.6 acres and the solid waste collection sites 0.2 acres.

Other Impacts - Major Conclusions - Implementation of the Waimanalo Watershed project will facilitate development of the State's proposed Waimanalo Agricultural Park and ensure the viability of diversified agriculture in Waimanalo. In agreement with county and state planning goals, this future generates a higher quality environment than the future without-project.

Areas of Potential -

Controversy may surface over future use of the agricultural lands in Waimanalo Watershed. Some interests may favor urban development, and therefore not support a modern, efficient irrigation system.

Transfer of water from Maunawili Watershed, where Kawainui Marsh is, to Waimanalo Watershed may be controversial even though this transfer has long been a source of irrigation water for Waimanalo.

Some objection may arise to the use of treated sewage effluent for crop irrigation.

Minor disagreements may surface between individual operators concerning pipeline alignment, etc.

Issues to be Resolved -

The State's decision to implement the Waimanalo Agricultural Park Plan is yet to be resolved. Realization of the Agricultural Park Plan is partly dependent on the installation of the irrigation measures included in the Waimanalo Watershed Plan. Prior to expenditure of P.L. 566 contruction funds, the State must acquire long-term water rights and make collection system improvements.

INTRODUCTION

GENERAL

The watershed plan and environmental impact statement (plan and EIS) for this project have been combined into a single document. The document describes plan formulation, discloses the expected environmental and economic impacts, and provides the basis for authorizing federal assistance for implementation.

The plan was prepared under the authority of the Watershed Protection and Flood Prevention Act, Public Law 83-566 as amended (16 USC 1001-1008). The EIS is in accordance with Section 102(2)(c) of the National Environmental Policy Act of 1969, Public Law 91-190, as amended (42 USC 4321 et seq.). Responsibility for compliance with the National Environmental Policy Act rests with the U.S. Department of Agriculture, Soil Conservation Service (SCS).

The sponsoring local organizations (Sponsors) which requested planning assistance are the Hawaii Department of Land and Natural Resources (DLNR) and the Windward Oahu Soil and Water Conservation District. The Sponsors participated in the development of the watershed plan and EIS. The SCS provided technical assistance to the Sponsors in the development of the plan. Other federal, state, and local agencies, groups, and individuals participated in the planning process.

This plan was prepared to integrate with the Waimanalo Agricultural Park Plan (Report R61), which was published by DLNR (Ref. 1). The specific purpose of the proposed Agricultural Park Plan is to preserve and expand diversified farming in Waimanalo.

READER'S GUIDE

The format of the plan and EIS is dictated by various regulations and guidelines. This reader's guide describes the planning process and guides the reader in finding items of particular interest. Appendix E contains the Project Map, Figure 1, which can be folded out for reference while the plan-EIS is being read.

Planning begins with the Sponsor's request for assistance in solving water and related land resource problems. Interagency and interdisciplinary planners then follow a process that involves six basic steps--identify problems and opportunities; inventory resources and forecast future conditions; formulate alternative plans; evaluate effects of the alternatives; compare the alternatives; and select a recommended plan.

The environmental evaluation and planning process continues through the publication of the Draft to the Final Plan-EIS, cycling back through the six steps and adding refinements in each cycle. This document summarizes the process and presents the results. The recommended plan is the result.

The Contents gives a complete listing of the principal topics covered in the document. The Watershed Agreement, although included in the front of the

document, is the culmination of the planning effort and serves as the formal agreement (not the fund obligating document) between the Sponsors and the SCS.

The Summary describes the finished plan in brief. It should not be used as the sole source of information if a complete understanding of the project is needed.

The Project Setting actually begins the presentation by describing the area and its resources. Problem and Opportunity Identification covers the reasons for initiating the plan and examines problems and opportunities uncovered during the planning process. Table A, Problems and Opportunities, is a detailed listing. The photos in Appendix B will aid in understanding these two sections.

The next section, Inventory and Forecasting, evaluates specific resources and the effect of various project actions on those resources. The future conditions of those resources in year 2000 and year 2020 are forecast for a future without the project. Table B, Inventory and Analysis of Resources and Forecasting, presents this information.

The heart of the planning process is in the next section, Formulation of Alternatives. This section covers the process of formulating alternative plans, how the plans were compared to one another and, finally, how the recommended plan was selected.

The next two sections, Recommended Plan and Effects of the Recommended Plan, describe in detail the plan proposed for implementation and its effects on the economy and the environment. These two sections should be read carefully for a thorough understanding of what is proposed and what the effects will be of installing the proposed project. In addition to the Project Map, Figure 1, several other maps and drawings are included in Apendices D and E.

Appendix C is a map showing the area that could be flooded in the extremely unlikely event that either the existing or proposed reservoir structures should fail.

The acreage figures presented in the plan and EIS are gross acres. Gross acres include the farmland occupied by the farmer's buildings, roads, ditches, ponds, etc. The supporting data for the plan and EIS were developed on a net acre basis considering only the acres actually growing a crop. In Waimanalo net acreage is about 73 percent of the gross acreage.

Any questions the reader may have should be referred to the State Conservationist, SCS, whose address and phone number are listed on the flysheet.

PROJECT SETTING

TOPOGRAPHY

Waimanalo Valley contains about 12 square miles, and it is the southernmost valley on the windward or northeast shore of the Island of Oahu. The valley is bounded on the south by the cliffs (pali) of the Koolau Mountains; on the west by Aniani Nui Ridge and Keolu Hills which separate it from Maunawili Valley; and on the east by Waimanalo Bay. Photo No. 1 and the Project Map, Figure 1, Appendix E, show the area.

The valley floor occupies about half the valley and has less than 12 percent slope (Photo No. 5). The foothill area has 12-20 percent slope and contains about 5 percent of the land. Slopes vary from 20 percent to vertical in the remaining upper watershed . The highest point is Puu O Kona peak with an elevation of 2,200 feet.

LAND USE AND SOILS

The watershed project area contains 6,132 acres of which 3,029 acres are agricultural; 334 acres are urban or residential; 994 acres are military reservation; 257 acres are parks and recreation; and 1,518 acres are preservation. See the Land Use Map, Figure 3, Appendix E. There are 105 farming units including nurseries with 822 acres irrigated (often only partially).

Soils in the valley include the Haleiwa, Hanalei, Pohakupu and Waialua Series. These soils are high-plastic silts, but they have the characteristics of silty clays, silty clay loam and clay. The soils are usually deep and moderately well drained, except for the Hanalei which is somewhat poorly drained. Erosion hazard is generally slight (Ref. 2). About 2,174 acres, excluding military and residential lands, are classified as prime and important farmlands and are shown in Figure 2, Appendix E. Approximately 56 acres on Bellows Air Force Station are classified as secondary wetlands in accordance with the classification system used in Hawaii (Ref. 11 and 12). Wetlands are shown in Figure 3, Appendix E.

CLIMATE

The climate in Waimanalo ranges from hot and dry along the shore to wet and cool at higher elevations. Temperatures in town range from 56°F to 89°F with an average annual of 73°F.

Prevailing winds are from the northeast, but southwest winds associated with Kona storms can damage crops. Average annual rainfall varies greatly across the valley from below 30 inches at the shore to over 80 inches in the Koolaus. The maximum storm of record occurred on March 5 and 6, 1958, with over 18 inches of rain in 30 hours on the valley floor (Ref. 3).

SOCIAL AND ECONOMIC CHARACTERISTICS

The population of Waimanalo Valley increased 13 percent from 6,777 in 1970 to 7,674 in 1980, according to the U.S. Census. The valley has one of the highest proportions of native Hawaiians and part Hawaiians of any community on Oahu. Relative proportions are 65 percent in Waimanalo to 15 percent for all Oahu. Residents of the valley generally have larger and younger families and lower per capita income than prevails for the rest of Oahu. Housing in Waimanalo is primarily single family, privately owned or being purchased--67 percent as compared to 44.3 percent for Oahu.

Many residents in Waimanalo Valley have a common goal--they have expressed a strong determination to retain the rural character of this valley, and they have an appreciation for the importance of a viable diversified agriculture in achieving their goal (Ref. 5).

Only 2.6 percent of the work force are employed in agriculture--nearly all of these in Waimanalo Valley. Honolulu is the source of most employment. There is very little commercial or service development in the valley, and most of the shopping is done either in neighboring Kailua or in Honolulu. Income from service and sales to tourists is relatively insignificant in the valley. Current annual gross value of agricultural production in the valley is estimated to exceed $12,000,000 (Ref. 4).

Hawaii has a goal of greater production of its consumed fruit and vegetables. At present over two thirds of this fresh produce is imported (Ref. 23 and 27).

HISTORY AND LAND OWNERSHIP (Ref. 3, 6, and 7.)

Some of the earliest habitation sites are located on Bellows Air Force Station. Twelve archeological sites, mostly religious temples (Heiaus), have been identified in the watershed. The Waimanalo Irrigation System ditches may have historic value, and they are under consideration for nomination to the National Register.

In the land division (great mahele) of King Kamehameha III during 1846 to 1848, the approximately 7,000 acre Waimanalo Valley (Ahupuaa) was reserved as "Crown lands." During 1846 and 1851 native Hawaiians were awarded fee simple patents for their homesites and cultivated lands (kuleanas).

Over the period 1850 to 1920 one family leased the King's land and acquired about 200 acres of fee simple kuleanas. They raised livestock and later developed a sugarcane plantation and the Waimanalo Sugar Company. The sugar company was liquidated in 1947. Leased land was sublet to local farmers, and fee simple lands were sold. The company leases on state land expired in 1953 and pressures for additional farmland led to the state selling 63 lots of about 9 acres each on the valley floor.

In 1921 the Hawaiian Homes Commission Act listed most of the valley floor as "available lands" but excluded military areas, cultivated cane lands, and beach lands. The first Hawaiian Homes Commission lots were made available in 1925. The Hawaiian Homes Commission assigned 30 lots in 1958.

Presently the land ownership is in three major categories: by the federal government for Bellows Air Force Station which was established in 1917 (994 acres); in fee simple (1089 acres); and by the state (4049 acres). State land is leased to Hawaiians in the Hawaiian Homes Commission developments, and to other farmers in the valley. Also a small amount of land is owned by public utility companies.

WATER

Irrigation

Irrigation water for Waimanalo sugar plantation came from three sources--Maunawili Valley springs and tunnels, Kawainui Marsh, and Waimanalo Lagoon. As Waimanalo Valley shifted from sugar to diversified agriculture, irrigation water requirements decreased and, eventually, only Maunawili Valley was retained as the source. Transfer of water from Maunawili through Aniani Nui Tunnel was measured by the U.S. Geological Survey from 1954 to 1968 and ranged from approximately 500 to 800 million gallons per year (Ref. 1 and 20).

Waimanalo Irrigation System (WIS), a part of DLNR, operates and maintains the Maunawili collection system and the distribution system in Waimanalo.

Irrigation water quality tests indicated the presence of plant-parasitic nematodes, suspended solids, and debris. These could have a significant effect on irrigated agriculture (Ref. 21 and 28).

Streams

Waimanalo watershed is drained by two major stream systems--Waimanalo is a gaged perennial stream with an average annual discharge of 1.17 billion gallons, and Inoaole Stream is intermittent. The estimated peak flows into Waimanalo Bay for the most severe storm likely to occur once in 100 years are 14,000 and 12,500 cubic feet per second, respectively (Ref. 19). Kailua Reservoir impounds flows on a portion of Waimanalo Stream.

A typical foothill channel is shown in Photo No. 7, and Photo No. 13 shows a typical valley-floor channel.

The quality of both streams was evaluated as part of a flood control study in 1976 and water quality was generally satisfactory (Ref. 19). These findings were confirmed by testing done for this plan-EIS (Ref. 28).

Some physical qualities of these streams are attributable to the "flashy" characteristics. High turbidity and suspended sediment concentrations occur during heavy rainfall, but storms are usually of short duration, and the streams revert to clear, base flow conditions within a few hours (Ref. 24).

Waimanalo stream is assigned Ecology Quality Status II (moderate to high quality) as a fish habitat (Ref. 29).

Ground Water

Ground water in Waimanalo occurs as brackish basal water, dike-impounded water, and perched (or alluvial) water. The dike-impounded ground water is in dike-intruded lava flows in the Koolau Mountains, and is high-quality water suitable for domestic use without treatment. The permeable rock containing the brackish basal water is overlain by caprock materials. Although not presently considered suitable for domestic use, brackish basal water may be important for future needs.

The alluvial ground water is generally lower quality than the dike-impounded water and also important primarily as a resource for future use (Ref. 19 and 24).

To protect ground water quality, the Board of Water Supply (BWS) has established a water conservation line that approximately parallels the Waimanalo Forest Reserve Boundary shown on the Project Map, Figure 1, Appendix E. The line is just downslope or towards the sea (makai) of the boundary. No cesspools are allowed uphill or toward the mountains (mauka) of the water conservation line.

Treated Sewage Effluent

The Waimanalo Sewage Treatment Plant currently discharges about 350,000 gallons per day of secondary treated effluent into three deep injection wells below the basal water. The plant is designed for 1.1 million gallons per day. Water quality tests indicate that this effluent would be suitable for irrigation (Ref. 22 and 28).

FISH AND WILDLIFE (Ref. 12)

Four endangered birds are found in the vicinity of the wetlands--Hawaiian Duck, Hawaiian Coot, Hawaiian Gallinule, and Hawaiian Stilt. Numerous other birds have been observed in the watershed including: Common Mynah, Barred Dove, Spotted Dove, Japanese White-eye, Red Crested Cardinal, Cardinal, Red-rented Bulbul, Spotted Munia, House Sparrow, and Cattle Egret.

Kailua Reservoir contains bullfrogs, Tilapia, and Mosquito fish. WIS does not authorize recreational use of the reservoir.

Waimanalo Stream contains Hawaiian Prawn, Tahitian Prawn, Goby, Guppy, and Green Swordtail (Ref. 29).

An interagency survey determined that the fish and wildlife habitat in the area is not unique, and the species observed, other than the endangered birds, are common introduced species. There is no critical habitat for the endangered species within the watershed.

Visual Resources

Waimanalo Watershed is a visually pleasing area, framed on the south by spectacular cliffs (Photo No. 3) and on the northwest by high foothills, Aniani Ridge and Olomana Peak (Photos No. 4 and No. 14).

The vertical rock cliffs are softened by channels cut deeply into the face and mosses growing in the continual dampness. The foothills have a mixture of trees, brush, and open grassy areas (Photo No. 3). The valley floor presents a pattern of fields with diverse plants--highlighted by the often colorful nursery crops. The WIS reservoirs and ditches, mostly tree-lined, break up the straight property lines. The beautiful white sand beach with a backdrop of trees is considered by many to be Oahu's finest (Ref. 3).

One serious visual blight, particularly along the foothill edge of the valley floor, is the refuse dumped along the rural roads (Photo No. 14).

PROBLEM AND OPPORTUNITY IDENTIFICATION

EARLY IDENTIFICATION

The identification of problems and opportunities is vital to successful development of a project plan. The process is dynamic and passes through several cycles as data are collected and alternatives are formulated. Early planning by the Territory and, later, the State addressed many of the problems and opportunities covered by the Waimanalo Watershed Plan (Ref. 3 & 8).

Problems were stated in the May 1978 application for planning assistance submitted by the Sponsors:

> Farm production is limited by irrigation water availability and quality, and the irrigation system is inefficient and unreliable. Also, flooding causes damages to residential and agricultural areas.

An interdisciplinary, interagency, field examination documented the problems stated in the application. A public meeting was also held to discuss water and related resource problems in Waimanalo (Ref. 9).

CURRENT PLANNING

After SCS planning assistance was authorized in Janaury 1979, a comprehensive study was undertaken to identify and evaluate problems as well as opportunities. Previous studies, interviews, interagency consultation, and public workshops and meetings were used.

Table A separates the broad categories of problems and opportunities into general headings (A through F) and more comprehensively describes specific problems or opportunities under these headings. This same method of presenting problems and opportunities is applied in the Formulation of Alternatives section.

OTHER PROBLEMS

Kailua Reservoir on Waimanalo Stream would be a hazard in the highly unlikely event of a sudden structural failure.

Several additional problems and opportunities were investigated and found to be comparatively insignificant. They included the problem of declining coral in Waimanalo Bay, reduced wildlife habitat associated with abandoning the irrigation ditches, limited recreation opportunities, erosion from croplands, and critical area erosion. With the exception of one small critically eroding site, these topics were not addressed in the plan formulation stage.

TABLE A - PROBLEMS AND OPPORTUNITIES

Waimanalo Watershed, Hawaii

Note: General problems and opportunities are lettered A through G below. Specific problems and opportunities are numbered.

A. GENERAL PROBLEM WITH INADEQUATE IRRIGATION SYSTEM - WAIMANALO IRRIGATION SYSTEM (WIS)

1. Specific Problem - Undependable supply and operation
   a. Problems with the collection system in Maunawili Watershed
      1) State purchases irrigation water annually from a private owner. The contract can be terminated on a 30-day notice.
      2) Collection system includes 20 wooden flume-trestle structures and 2.8 miles of open ditch which are in very poor condition and highly susceptible to storm damage and vandalism. Much of the system is not readily accessible by equipment for timely repairs and maintenance (Ref. 20).
   b. Problems with the distribution system in Waimanalo Watershed
      1) Distribution system includes two principal reservoirs, Maunawili and Kailua, and two smaller reservoirs with a combined regulation storage of 13 million gallons. As a result, irrigation deliveries can be made only 3 days out of 7 (Photo No. 4).
      2) Distribution system includes 32 wooden flume-trestle structures and 15 miles of open ditch in generally poor condition. The system is susceptible to storm damage and vandalism (Photo Nos. 2, 6, 7, and 8).

2. Specific Problem - Inadequate amount of water to irrigate 1,873 acres of irrigable Waimanalo farmlands
   a. Problems with the collection system in Maunawili Watershed
      1) 1.8 million gallons per day are purchased, but 2.4 million gallons per day could be available for collection.
      2) Flumes leak and ditches have seepage losses with high water use by ditch bank vegetation (Ref. 20). Losses are estimated to be 11 percent of the total amount collected.
   b. Problems with the distribution system in Waimanalo
      1) Flumes leak and ditches and reservoirs have seepage losses with high water use by vegetation (Ref. 20). Losses are estimated to be as high as 74 percent of the total amount collected (Photo Nos. 6 and 8). These maximum losses occur during peak-use months.
      2) The first hour or two of flow on each irrigation day is used to flush ditches and flumes of debris, and to ensure that there are no residual herbicides from WIS weed control.

3. Specific Problem - Poor water quality limits use and management opportunities
   a. Plant-parasitic nematodes are a serious problem in Waimanalo (Ref. 21).
      1) WIS water is susceptible to infestation by plant-parasitic nematodes, particularly, as a result of storm runoff from infested fields into the open ditches. The shallow reservoirs and ditches play a major role in the distribution of nematodes into and within the area (Ref. 21).
      2) Infestation of plant-parasitic nematodes reduces truck crop and banana production (Ref. 21).
      3) Nurseries that ship stock to California (a major market) have to be certified as nematode-free to meet the state's quarantine requirements.

TABLE A - PROBLEMS AND OPPORTUNITIES (Continued - 2)

Waimanalo Watershed, Hawaii

3. Specific Problem - Poor water quality limits use and management opportunities (Continued)

   b. Other water contamination problems associated with open ditches and reservoirs

      1) Farmers are concerned with potential for WIS water transporting herbicides, pesticides, and plant diseases onto their fields.

      2) Farmers are concerned with potential for weed seeds being transported throughout the valley by the WIS water.

      3) Solids in the water, particularly organic matter, severely limit the use of sprinkler and drip irrigation technologies (Ref. 28).

4. Specific Problem - Nonpressurized system requires energy for pumping for sprinkler or drip application.

B. GENERAL PROBLEM WITH LIMITATIONS OF IRRIGATION SYSTEM - BOARD OF WATER SUPPLY (BWS)

1. Specific Problem - Primarily a domestic water supply system

   a. BWS is operated by the City and County of Honolulu with top-quality ground water to meet the domestic and commercial needs of Oahu. BWS is not managed as an agricultural water supply system, and some farmers question BWS's ability to meet the needs of agriculture in Waimanalo in the future. Demand for potable domestic water is projected to exceed the rate of ground water recharge in the early 1990's (Ref. 14).

   b. Current rates are $0.76 per 1,000 gallons with periodic increases anticipated as energy and operation costs increase.

   c. New connections (or increases in meter size for existing users) are limited by the availability of water and facilities. Development costs are high.

C. GENERAL OPPORTUNITY TO UTILIZE TREATED SEWAGE EFFLUENT FOR IRRIGATION

1. Specific Opportunity - Approximately 128 million gallons per year of secondary treated sewage effluent is discharged into three deep injection wells at the Waimanalo Sewage Treatment Plant (Ref. 22 and 24).

   a. Treated effluent is discharged and serves no useful purpose.

   b. Three existing wells are nearing their capacity to accept effluent, although, the sewage plant is currently operating at only 1/3 of its design capacity.

2. Specific Opportunity - Irrigable state lands are close to the sewage plant (Ref. 24).

   a. Aproximately 120 acres of state-owned cropland suitable for surface irrigation (as required for sewage effluent) is located within approximately 1 mile of the sewage plant.

   b. Opportunity exists for experimental use of treated sewage effluent on the Waimanalo Experiment Station, University of Hawaii, College of Tropical Agriculture and Human Resources.

TABLE A - PROBLEMS AND OPPORTUNITIES (Continued - 3)

Waimanalo Watershed, Hawaii

D. GENERAL OPPORTUNITY TO RETAIN THE PRIME AND IMPORTANT FARMLAND IN WAIMANALO IN AGRICULTURE

1. Specific Opportunity - Privately owned land zoned for agriculture in Waimanalo includes 841 acres of prime and important farmland. Of that amount, only about 219 acres are currently under irrigation by WIS.

   a. Considerable pressures exist to allow additional subdivision on these lands (Ref. 23).

   b. A major factor limiting successful agricultural operations is the availability of good quality, dependable irrigation water (Ref. 23 and 24).

2. Specific Opportunity - State-owned land utilized for agriculture in Waimanalo includes 1,333 acres of prime and important farmland. Of that amount, only about 230 acres are currently under irrigation by WIS.

   a. The proposed State Agricultural Park Plan will play a major role in retaining prime and important farmlands in agriculture. The irrigation system proposed in the Waimanalo Watershed Plan is a key factor in the realization of the Agricultural Park Plan (Ref. 1 and 23).

E. GENERAL PROBLEM WITH FLOODING

1. Specific Problem - Flooding associated with frequent storm events

   a. Flooding is identified by residents as a problem (Ref. 5).

      1) Significant property damage is infrequent (Ref. 19).

      2) Nuisance flooding is widespread on the valley floor causing minor damages.

      3) Potential exists for public health problems associated with flooding.

      4) Land development opportunities are limited by zoned land use patterns. Zoning recognizes the 100-year floodplain of the existing channel systems.

   b. Farmers also identify flood problems (Ref. 9).

      1) Use of some fields is seasonally restricted by flooding.

      2) Nuisance flooding complicates or delays some cultural practices.

   c. Lack of maintenance is identified by residents anf farmers as a major contributor to flood problems (Photo No. 13).

      1) Citizens have difficulty in identifying the agency responsible for a particular ditch, stream, culvert, bridge, etc.

      2) Agencies are reportedly not clear on who is responsible.

      3) Obvious maintenance problems are not resolved in a timely or systematic manner.

TABLE A - PROBLEMS AND OPPORTUNITIES (Continued - 4)

Waimanalo Watershed, Hawaii

F. GENERAL PROBLEM WITH WASTE DISPOSAL

1. Specific Problem - Citizens have identified solid waste disposal as a problem in Waimanalo (Ref. 5 and Photo No. 14).
   a. Garbage is being dumped along rural roads in the area, particularly at certain intersections.
      1) Dumped garbage and abandoned cars are a visual blight on the community (Ref. 3 and 5).
      2) Dumped materials pose a potential health problem, and material is often washed into streams.
      3) Dumped materials restrict the capacity of drainages and plug culverts.

G. GENERAL OPPORTUNITY TO PRESERVE HISTORICAL SITES

1. Specific Opportunity - Identify portion of WIS ditch which may have historical value. Preserve or protect features determined to be historically significant.

INVENTORY AND FORECASTING

GENERAL

As a part of the planning process, an inventory was made to determine the quantity and quality of water resources and related land resources in Waimanalo. The inventory was also used to identify opportunities for protection and enhancement of these resources as discussed in the previous section, Problems and Opportunity Identification. The planning process also includes forecasting changes in the resource conditions that would occur without the project.

SCOPING OF CONCERNS

The inventory and analysis of resources included an interactive process termed "scoping" in which affected federal, state, and local agencies, and other interested groups or persons participated. Scoping was used in developing the Waimanalo Plan-EIS to ensure that all significant decisionmaking factors were addressed and that unneeded and extraneous studies were not undertaken. Through the scoping process such resources as wildlife habitat (other than wetlands and Kailua Reservoir), fish habitat, coral in Waimanalo Bay, minerals, and air quality were eliminated from the items that required discussion in this plan.

After early phases of inventory and analysis were accomplished and plan formulation proceeded, additional scoping and investigation revealed that some resources, although important, would not be significant to decisionmaking with the problems and alternatives being considered.

FORECASTING CONDITIONS

In order to forecast the most likely conditions to expect without the Waimanalo Watershed Project (future without plan), two scenarios were formulated. The worst-case scenario forecasts the eventual termination of Waimanalo Irrigation System (WIS) and results in extensive conversions from agricultural land use to other uses. The second case, determined to be the most likely, forecasts a continuation of present conditions. WIS would continue service to existing users, reliability would be improved by the acquisition of long-term water rights, and vital structural repairs would be made to the irrigation collection system in Maunawili Watershed.

One general assumption that influences forecast changes in a resource is the conflict between urbanization of Waimanalo and retaining and enhancing the area as a rural community. Although the future without project assumes WIS continues in operation and farming continues at the present rate, the idle farmland will be under increasing pressure to convert to residential-commercial use. The viability of an expanded, diversified agriculture community will be supported by the Agricultural Park Plan, the dependable high-quality irrigation water, and the related technical assistance provided by implementing the Waimanalo Watershed Plan.

Forecasting was done in full consideration of state and county forecasts, plans, concerns, policies, and regulations that would have an influence. The directors of the State Department of Agriculture and the State Department of Land and Natural Resources were consulted in developing the without-plan projections.

THE RESULTS

The results of the inventory of resources and forecasting are presented in Table B, Waimanalo Watershed, Inventory and Analysis of Resources and Forecasting. The table presents three aspects of a particular resource: 1) a list of important natural resources and the significance of the effects of various types of project actions on these resources; 2) baseline information on important resources; and 3) conditions forecast without installation of the Waimanalo Watershed Plan.

TABLE B - INVENTORY AND ANALYSIS OF RESOURCES AND FORECASTING

Waimanalo Watershed, Hawaii

RESOURCES	SIGNIFICANCE OF THE EFFECT OF PROJECT ACTIONS ON RESOURCES (L = LOW M = MEDIUM H = HIGH)						BASELINE DATA EXISTING RESOURCE		FORECAST CHANGES WITHOUT WAIMANALO WATERSHED PROJECT		
	PROJECT ACTIONS										
	REPAIR EXIST. DITCH & RES.	REPLACE DITCH WITH PIPE	NEW RESER-VOIR	IRRI-GATE MORE LAND	IRRI-GATE WITH SEWAGE	LINED FLOOD CHAN-NELS	UNITS	QUANT.	YR.2000 QUANT.	YR.2020 QUANT.	REMARKS
1. Coral Reefs - Waimanalo Bay	L	L	L	L	L	H	-	-	-	-	Increased peak flood discharges could affect coral reefs (Ref. 10).
2. Wetland - Bellows AFS	L	L	L	L	L	H	Acres	56	56	56	Area identified by federal and state as secondary (Ref. 11).
3. Threatened & Endangered Species (water birds)	L	L	L	L	L	M	No. of Species	3	Same	Same	No change in Bellows AFS wetland habitat (Ref. 12).
4. Floodplains	L	L	L	L	L	H	Acres	878	Less than present	Less than Yr.2000	Increased urbanization will tend to reduce floodplains (Ref. 19).
5. Prime & Important Farmlands	L	M	M	H	H	M	Acres Farmed	822	Less than present	Less than Yr.2000	Increased urbanization will tend to reduce prime and important farmlands in agriculture.
6. Waimanalo Stream -											
Flow Volume	L	L	L	L	L	H	MG/YR	1168	Same	Same	
1% Peak	L	L	L	L	L	H	cfs	7500	Increase	Increase	Increased urbanization will increase runoff peaks (Ref. 19).
7. Waimanalo Stream - Quality	L	M	L	L	L	M	Meets state std. for fresh water		Quality may decrease		Increased urbanization may reduce water quality.
8. Ground Water	L	M	L	M	M	L	-	-	Increased	importance	Alluvial water could be contaminated by poor irrigation water management.
9. Municipal (BWS) Water (Kaneohe Hydrologic Area II)			(See remarks)				Demand MG/D	(1975) 21	38	61	Oahu has a projected average year water deficit of 43 MG/D by 2020 for the total island (Ref. 14).
10. Municipal (BWS) Water Used for Ag. Crop Production in Waimanalo	L	M	M	M	M	L	MG/YR	71	Less than present	Less than present	Intensive agriculture will continue to demand BWS water, but domestic and commerical uses will probably prevail over agriculture.

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TABLE B - INVENTORY AND ANALYSIS OF RESOURCES AND FORECASTING (Continued - 2)

Waimanalo Watershed, Hawaii

RESOURCES	SIGNIFICANCE OF THE EFFECT OF PROJECT ACTIONS ON RESOURCES (L = LOW M = MEDIUM H = HIGH)						BASELINE DATA EXISTING RESOURCE		FORECAST CHANGES WITHOUT WAIMANALO WATERSHED PROJECT		
	PROJECT ACTIONS										
	REPAIR EXIST. DITCH & RES.	REPLACE DITCH WITH PIPE	NEW RESER-VOIR	IRRI-GATE MORE LAND	IRRI-GATE WITH SEWAGE	LINED FLOOD CHAN-NELS	UNITS	QUANT.	YR. 2000 QUANT.	YR. 2020 QUANT.	REMARKS
11. Irrigation (WIS) Water - Quantity Delivered	L	H	H	H	H	L	MG/YR	128	252	252	State's improvements to Maunawili collection system will improve reliability and reduce losses
12. Irrigation (WIS) Water - Quality	L	H	H	L	H	L	Poor quality		Remains poor		State's improvements to the collection system will not reduce suspended solids or nematodes.
13. Visual Resources on Valley Floor & Foothills											
Landscape Diversity	L	M	M	H	H	H	Acres in farms	822	Less	Less	Increased urbanization will reduce the land being farmed and change the appearance (Ref. 15).
Visible Structures	L	M	H	L	L	H	No.	0	0	0	No change in irrigation structures.
Visible Solid Waste	L	L	L	L	L	L	No. Dump areas	6	6	6	Continue to dump waste along roads.
14. Character of Human Environment	L	M	M	H	H	M	Farm units	105	Less	Less	Increased urbanization will reduce the number of farms and decreases the rural characteristics of the area.
15. Population - Waimanalo	L	L	L	M	M	M	No. (1980)	7674	9450	12,000	Projection is based on state baseline (E-2), adjusted for slower growth in Waimanalo than in Oahu. Regional plan recommends 10,000 maximum to maintain rural character.
16. Archeological Sites (Known)	L	M	L	H	M	M	No.	12	May Increase	May Increase	State policy is to promote preser-vation, protection, and enhancement of important sites (Ref. 6, 7, 17 & 26).
17. Historical Site - Existing WIS Ditch (Submitted for nomination to National Register)	M	H	L	L	L	L	Miles	15	Less	Less	Reduction of farming operations may result in sections of the ditch being abandoned (Ref. 18 & 26).

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FORMULATION OF ALTERNATIVES

GENERAL

At this step of the planning process alternative plans were formulated to make a net contribution to national economic development (NED) and to environmental quality (EQ). These alternative plans consisted of structural and nonstructural measures formulated to alleviate the specific problems or to take advantage of specific opportunities.

The scoping process described earlier was used in the initial conceptual phase of formulating alternatives to assure consideration of all measures, strategies and programs that might do the job. These alternatives were not limited to those directly implementable under Public Law 566. Consideration was also given to the cooperative role of local, county, state, federal, and nongovernment interests in implementation of alternatives.

Several alternative plans, including the without project condition, are required by the Water Resource Council Principles and Standards for Water and Related Land Resources Planning (18 CRF Part 711). These are the national economic development plan (NED), the environmental quality plan (EQ), and the primarily nonstructural plan. Also, land treatment and water conservation were fully integrated into plan formulation as a means of achieving NED and EQ objectives.

When the various alternative plans were evaluated and compared, certain plans were identified as candidate plans. Candidate plans are ones that could be selected as the recommended plan. The candidate plans were compared and the rationale established for selecting the recommended plan.

FORMULATION PROCESS

The major objective in formulating alternative plans was to alleviate the specific problems and to take advantage of the specific opportunities described in the Problem and Opportunity Identification section. To begin the formulation process, brainstorming and similar problem solving techniques were used to develop a list of measures and actions that address one or more of the problems or opportunities identified. These initial techniques involved the public, multidisciplinary planners, and various local, county, state, and federal agencies as well as special interest groups.

Next, the list of potential measures and actions was evaluated for the effectiveness of each item in alleviating each identified problem, or realizing identified opportunities. This evaluation is presented in Table C, Effectiveness of Measures and Actions.

Table C provided a planning tool for preliminary formulation of alternatives. As measures were combined to formulate an alternative for a specific consideration, the table provides an indication of the measure's effectiveness in solving a particular problem or realizing a particular opportunity.

TABLE C - EFFECTIVENESS OF MEASURES AND ACTIONS

Waimanalo Watershed, Hawaii

MEASURES AND ACTIONS: (+) FAVORABLE EFFECT (-) ADVERSE EFFECT (N) INSIGNIFICANT EFFECT

SPECIFIC PROBLEMS AND OPPORTUNITIES AS DESCRIBED IN TABLE A	LAND TREATMENT AND/OR TECHNICAL ASSISTANCE	WATER CONSERVATION MEASURES	NONSTRUCTURAL - IMPROVE EXIST. SYSTEM	LINE EXISTING DITCHES & RESERVOIRS	ALL PIPE SYSTEM	DEEP STORAGE RESERVOIR	BWS TAKES OVER WIS FUNCTION	TREATED SEWAGE EFFLUENT IRRIG. SYSTEM	FLOOD PREVENTION - CHANNEL SYSTEM	DESCRIBE & RANK FLOOD WORK NEEDED	ASSIGN WHO WILL DO FLOOD WORK - O&M	ESTABLISH SOLID WASTE COLLECTION SITES
A. Inadequate Irrigation System - WIS												
1.a. Problems with collection system	N	N	N	N	N	N	+	N	N	N	N	N
b. Problems with distribution system	N	N	N	+	+	+	+	N	N	N	N	N
2.a. Inadequate supply - collection system	N	N	N	N	N	N	-	N	N	N	N	N
b. Inadequate supply - distribution system	+	+	+	+	+	+	-	+	N	N	N	N
3.a. Plant-parasitic nematodes in system	+	N	N	N	+	+	+	N	N	N	N	N
b. Poor water quality	+	+	N	+	+	+	+	N	N	N	N	N
4. Nonpressurized system - energy requirements	N	N	N	N	+	+	+	N	N	N	N	N
B. Inadequate Irrigation System - BWS												
1.a. Domestic system - low farmer confidence	N	N	N	N	N	N	-	N	N	N	N	N
b. High water costs	N	N	N	N	N	N	-	N	N	N	N	N
c. Limited availability - high demand	N	N	N	N	+	+	-	+	-	N	N	N
C. Opportunity to Utilize Treated Sewage Effluent												
1.a. Effluent not being used	N	+	N	N	N	N	N	+	N	N	N	N
b. Well disposal system nearing capacity	N	N	N	N	N	N	N	+	N	N	N	N
2.a. Land available for irrigation	N	N	N	N	N	N	N	+	N	N	N	N
b. Experimental use by Univ. of Hawaii Station	N	+	N	N	N	N	N	+	N	N	N	N
D. Opportunity to Retain Prime-Important Farmlands												
1.2.a. Prime-important lands could be used for ag.	+	N	N	+	+	+	N	+	-	N	N	N
b. Irrigate more land	N	N	N	N	+	+	-	+	N	N	N	N
E. Problems With Flooding												
1.a. Residential flooding	N	N	N	N	N	N	N	N	+	+	+	N
b. Agricultural flooding	+	N	N	+	-	N	N	N	+	+	+	+
c. Lack of maintenance - who should do it?	N	N	N	N	N	N	N	N	+	+	+	N
F. Problem With Waste Disposal	N	N	N	N	N	N	N	N	N	N	N	+
G. Opportunity to Preserve Historical Site	+	N	+	-	N	N	N	N	N	+	+	N
NET SCORE: Number of (+) minus number of (-)	6	4	2	4	7	8	-1	8	2	4	4	2

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Irrigation Considerations

Table C shows a combination of measures effective in alleviating many of the problems associated with the existing irrigation systems: a deep storage reservoir, utilization of the sewage effluent, and a piped irrigation system. Consequently, these measures were viewed as a common foundation for several of the alternative plans.

While not particularly effective alone, accelerated technical assistance, land treatment, and water conservation measures were considered as vital elements in each irrigation alternative. Water conservation measures such as system management, measuring devices, and control of ditch bank vegetation, were particularly important in the nonstructural alternative. Land treatment measures and accelerated technical assistance were most important in those alternatives where previously irrigated cane land and new land were being brought into intensive diversified agriculture. Technical assistance was also important in those alternatives where water quality was improved to minimize its role in transporting nematodes into and within the watershed. This assistance would educate growers and demonstrate cultural practices designed to curtail nematode infestations.

Flood Prevention Considerations

Flood prevention problems and the related measures were, for the most part, not related to irrigation problems, and were treated as separate planning modules. Both a structural and a nonstructural flood prevention modular plan were developed for preliminary formulation. Because topography makes flood prevention dams unfeasible, the only structural alternative was a concrete channel system. However, this modular element was dropped from further consideration when a detailed report prepared for the Sponsors in 1976 (Ref. 19) was updated and projected costs of the channel system far exceeded benefits.

The nonstructural systems studied included flood zoning, flood warning, flood proofing, and land treatment. Modification of flood control policies, and management were also investigated. Flood zoning is not covered in an adopted ordinance, but the flood plain identified on the Flood Boundary and Floodway Map (Ref. 13) was used to prepare the proposed regional development plan (Ref. 24). This plan is used to regulate land use and, as such, it results in flood plain management. Flood warning was not considered practical or necessary for the short duration, rapid runoff storms common in Waimanalo. (A flood warning system is currently in use for tsunami hazards.) Elevating structures (or flood proofing) was determined to be practical for only seven residences in the flood damage area, but the measure is not economically feasible. Land treatment and technical assistance could help farmers in solving some of their individual and group onfarm flooding problems with measures such as diversions, waterways, and drains.

The most effective nonstructural measure identified was modification of flood control policies and management. This modification would be aimed at obtaining needed improvements to existing ditches, channels, culverts, bridges, etc., and, most importantly, would establish responsibility for accomplishing this work and for performing the operation and maintenance required. In order to determine what improvements and maintenance are needed, and to estimate the costs and environmental effects, a comprehensive study was undertaken by the Sponsors and SCS (under its ongoing program authority). As a result of the decision to make the comprehensive study, this nonstructural measure was dropped from further consideration in the plan.

NED Formulation

By definition, the NED alternative is the one that maximizes net benefits attributable to the project measures. As various alternatives were formulated and evaluated, it became apparent that maximizing the acreages irrigated and minimizing storage cost had the greatest effect on net remaining benefits. As a result, two incremental formulations were set up and evaluated.

The first started with the maximum practical storage and the acres that could be irrigated at full supply. The storage was held constant. By lowering the percent of full supply of critical season water that was applied to bananas, more acres of bananas could be grown. This lowering of percents and increasing of acreages was done by 10 percent increments from full supply down to 50 percent--identified as the low limit for banana production in Waimanalo. All changes in returns and costs were calculated to reflect each successive alternative. Acreages of nursery crops and truck crops were held constant throughout because of the extreme high investments and high short-season values that dictate either full water supply production or no production. In this first set of formulations, the 50 percent water supply and maximum acres produced the highest net remaining benefits.

The second set of incremental formulations started with the same maximum practical storage and acreage irrigated as in the first set. In the second set, the initial acreage was held constant and the volume of water storage was varied as percents of full water supply for critical months were varied by 10 percent increments. All changes in costs and returns were calculated to reflect each successive alternative. As costs of storage decreased, net remaining benefits increased for each increment down to 70 percent supply, but then started to decrease as production fell faster than structural cost savings were reduced. In the second set, maximum net remaining benefits were realized at the 70 percent supply, but they were not as high as net remaining benefits from the maximized acres at 50 percent supply for the large reservoir in the first set. Therefore, the first set formulation at the 50 percent water supply iteration is the NED alternative.

EQ Formulation

The Environmental Quality Plan (EQ) is formulated to reasonably maximize net contributions to the EQ objective--protection and enhancement of environmental quality. Contributions to environmental quality are favorable changes in the ecological, cultural, and aesthetic attributes of natural and cultural resources that sustain and enrich human life. An EQ plan is formulated to alleviate environmental problems and to take advantage of environmental opportunities that were identified in the early stages of the planning process.

The Waimanalo Watershed Plan-EIS identifies one significant EQ problem and two significant EQ opportunities. Problem F (described on Table A) covers local concerns with solid waste disposal in the rural areas of Waimanalo. Everything from tree trimmings to abandoned cars is dumped along country roads and in ditches degrading the appearance of the area, creating rodent and vector habitat, and the potential for both public health and water quality concerns. Debris dumped in the ditches tends to aggrevate flooding from storm runoff. The alleviation of Problem F was a major objective in formulating the EQ plan.

Opportunity D (described on Table A) covers the national, state, county, regional, and local dedication to retaining prime and important farmlands in agriculture. Hawaii is particularly aware of the finite quantity of this vital resource and

its importance to viable diversified agriculture (Ref. 23). The ecological, cultural, and aesthetic attributes of the resources that sustain and enrich rural life in Waimanalo--an area special to Hawaiians (and therefore to the rest of the country)-- are directly tied to the wise use of prime and important farmlands. The EQ plan was formulated to also take advantage of opportunity D.

Opportunity G (described on Table A) covers the potential to preserve and protect those portions of the Waimanalo Irrigation System ditch which may have historical significance. The ditch is under consideration for nomination to the National Register of Historical Places. This opportunity was considered in formulating the EQ plan.

EVALUATION OF ALTERNATIVES

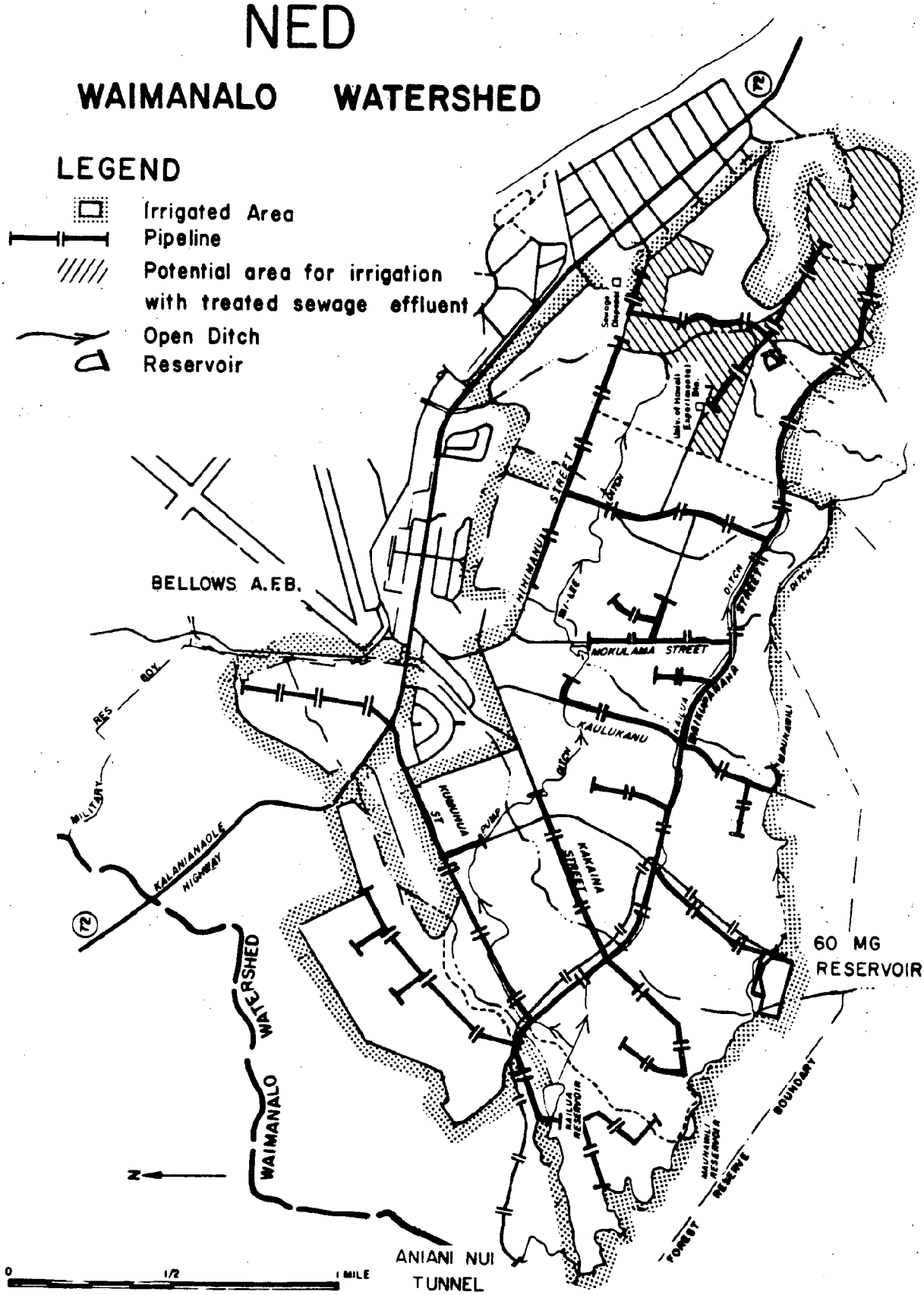
As a result of the plan formulation process described above, 34 plans were developed to the extent necessary to determine costs, benefits, and effects of each. Different opportunities to contribute to various mixes of the objectives were explored. These tentative plans were discussed with the sponsors and other agencies and at public meetings and workshops. The advantages, disadvantages, risk and uncertainty of each plan were considered. Generally viability of each alternative plan was determined by considerating four aspects:

Completeness	-	The extent to which an alternative plan accounts for all investments and actions necessary to realize planned results.
Effectiveness	-	The extent to which an alternative plan alleviates the problems and achieves the opportunities identified.
Efficiency	-	The extent to which an alternative plan is most cost effective.
Acceptability	-	The extent to which an alternative plan is accepted by the public and compatible with existing laws, regulations, and policies.

The application of this formulation process, including the four aspects described above, effectively identified the seven most successful in solving problems and taking advantage of opportunities. These seven alternatives and the future without are shown and discussed individually as follows:

NED

WAIMANALO WATERSHED



ALTERNATIVE 1 NED

Components: This alternative consists of accelerating assistance to all WIS irrigators, a storage reservoir, 15.7 miles of pipeline, a separate treated sewage effluent lift pump, reservoir, and pipeline. A change of emphasis would be made in the ongoing land treatment program from "maintenance" to improved irrigation systems. Accelerated technical assistance would be used to assist irrigators in their conversion to sprinkler and drip systems and to design cultural practices to minimize nematode problems. Bananas would be irrigated at 50 percent of the computed water requirement for June to September, and acres irrigated would be maximized.

Water from Maunawili Watershed would be taken from the tunnel outlet at Aniani Nui Ridge and piped to the reservoir near the mauka end of Mahailua Street. The reservoir would be a deep, off-channel, 60 million gallon excavated structure with an embankment 40 feet high. A gravity pressure pipeline (with some supplementary pumping required) would deliver water from the reservoir to the operators. The treated sewage effluent would be pumped from the Waimanalo sewage treatment plant to a storage reservoir at the site of the existing Wing-King Reservoir. The map on the opposite page shows the features discussed above.

Costs: 1/ Total project cost = $13,981,000; P.L. 566 share = $6,467,000; other = $7,514,000; average annual cost = $1,225,000.

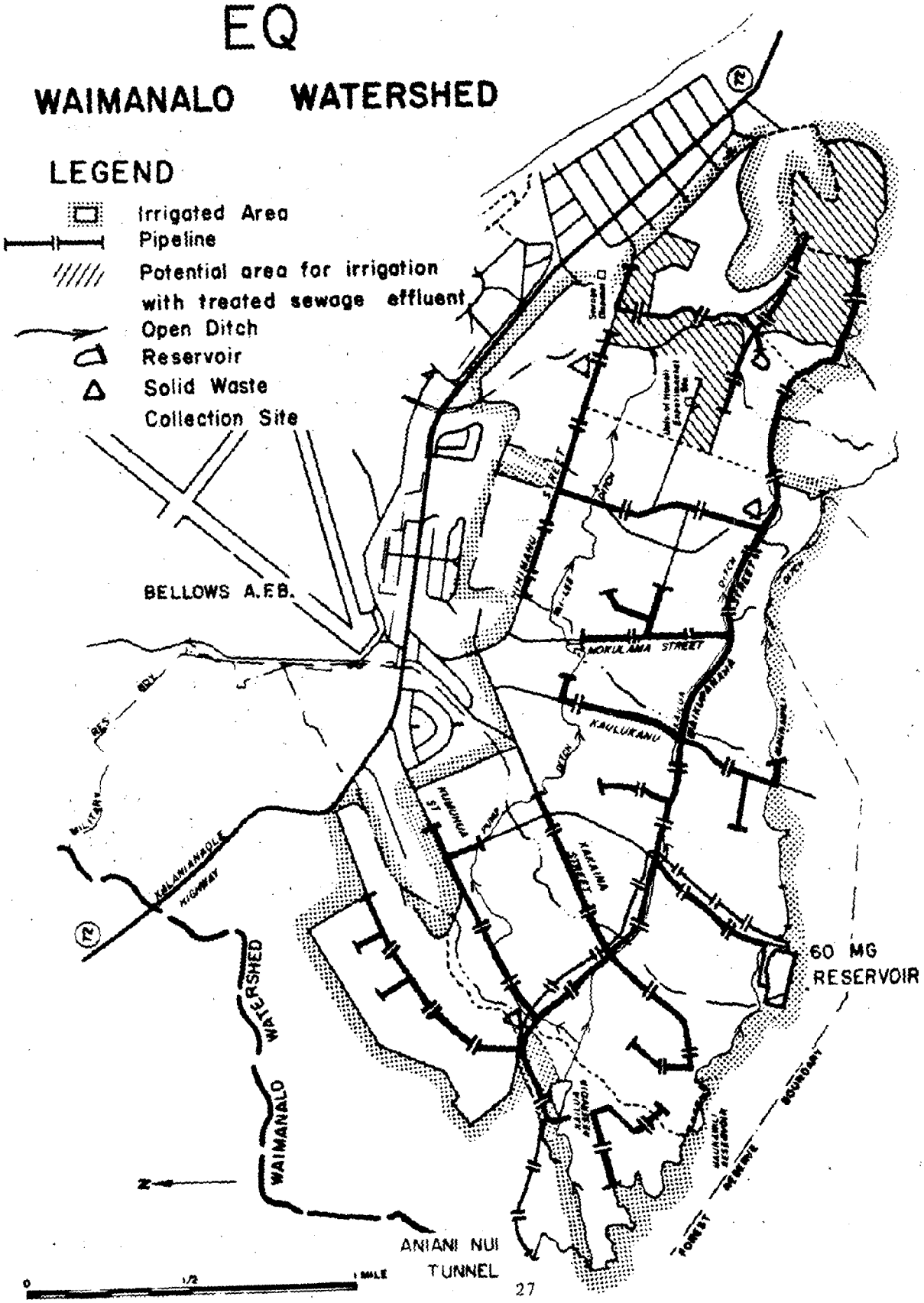
Benefits: 1/ Installation of this alternative would provide high quality WIS irrigation water under pressure to 1,134 acres including 79 acres previously irrigated with domestic water. An additional 68 acres would be supplied with treated sewage effluent. Average annual benefits of $2,312,000 would accrue.

Effects: The proposed Waimanalo Agricultural Park Plan could be implemented with the irrigation system proposed in this alternative. As a result, the agricultural productivity and the rural character of Waimanalo Valley could be strengthened. The agricultural use of prime and important farmland irrigated by WIS would increase to 1,076 acres with an additional 68 acres irrigated with treated sewage effluent. Problems with solid waste disposal would continue.

1/ Values shown do not include costs and benefits associated with the without-project condition.

EQ

WAIMANALO WATERSHED



ALTERNATIVE 2 EQ

Components: This alternative consists of accelerating assistance to all WIS irrigators, a storage reservoir, 14.1 miles of pipeline, a separate treated sewage effluent lift pump, reservoir, and pipeline. A change of emphasis would be made in the ongoing land treatment program from "maintenance" to improved irrigation systems. Accelerated technical assistance would be used to assist irrigators in their conversion to sprinkler and drip systems and to design cultural practices to minimize nematode problems. All crops would receive full irrigation water supply. Irrigation would be directed to prime and important farmlands.

The structural facilities are identical to Alternative 1 except that irrigation is not provided for the steeper lands in Area A and the Ag. Park Subdivision. Instead, irrigation is provided for additional prime and important farmlands within and adjacent to the irrigation service area. Three solid waste collection stations would be provided.

A plan for preservation or protection would be developed with the State Historical Preservation Officer for those portions of WIS ditch which may be determined to have historic value. Other portions of the ditch would be operated by the Sponsors for storm drainage, or they would be abandoned.

The map on the opposite page shows the features discussed above.

Costs: 1/ Total project cost = $12,896,000; P.L. 566 share = $6,153,000; other = $6,743,000; average annual cost = $1,141,000.

Benefits: 1/ Installation of this alternative would provide high quality WIS irrigation water under pressure to 890 acres including 79 acres previously irrigated with domestic water. An additional 68 acres would be supplied with treated sewage effluent. All 958 acres irrigated are prime and important farmlands. Average annual benefits of $2,121,000 would accrue.

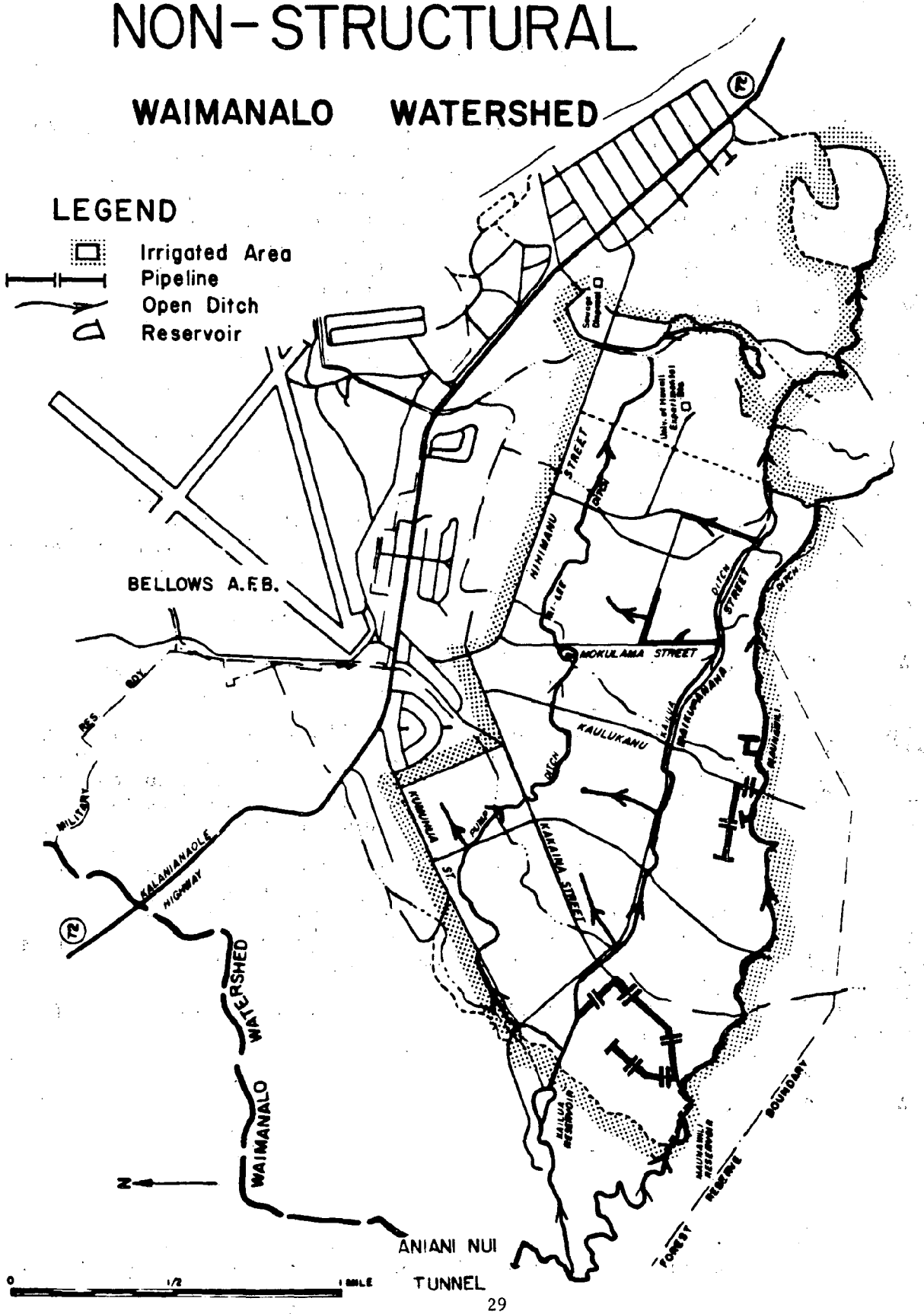
Effects: The proposed Waimanalo Agricultural Park Plan could be modified and implemented with the irrigation system proposed in this alternative. As a result the rural character of Waimanalo Valley would be strengthened. The agricultural use of prime and important farmland irrigated by WIS would increase to 958 acres. Problems with solid waste disposal would be reduced.

Those portions of the WIS ditch which may be determined to have historic value would be preserved or protected.

1/ Values shown do not include costs and benefits associated with the without-project condition.

NON-STRUCTURAL

WAIMANALO WATERSHED



ALTERNATIVE 3 NONSTRUCTURAL

Components: This alternative consists of repairing the existing distribution system to reduce leakage. The system would be improved to facilitate measurement, improve irrigation scheduling, and improve management. The current rate of technical assistance and land treatment would be adequate for the estimated needs.

Ditch bank vegetation would be removed along the entire 15 miles of ditch and approximately 0.5 miles would be lined where seepage is greatest. Pipe crossings would replace 4 flume-trestle stream crossings, and 5 ditch structures would be replaced. Flowmeters would be installed at 36 locations.

The map on the opposite page shows the features discussed above.

Costs: 1/ Total project cost = $497,000; P.L. 566 share = $279,000; other = $218,000; average annual cost = $166,000.

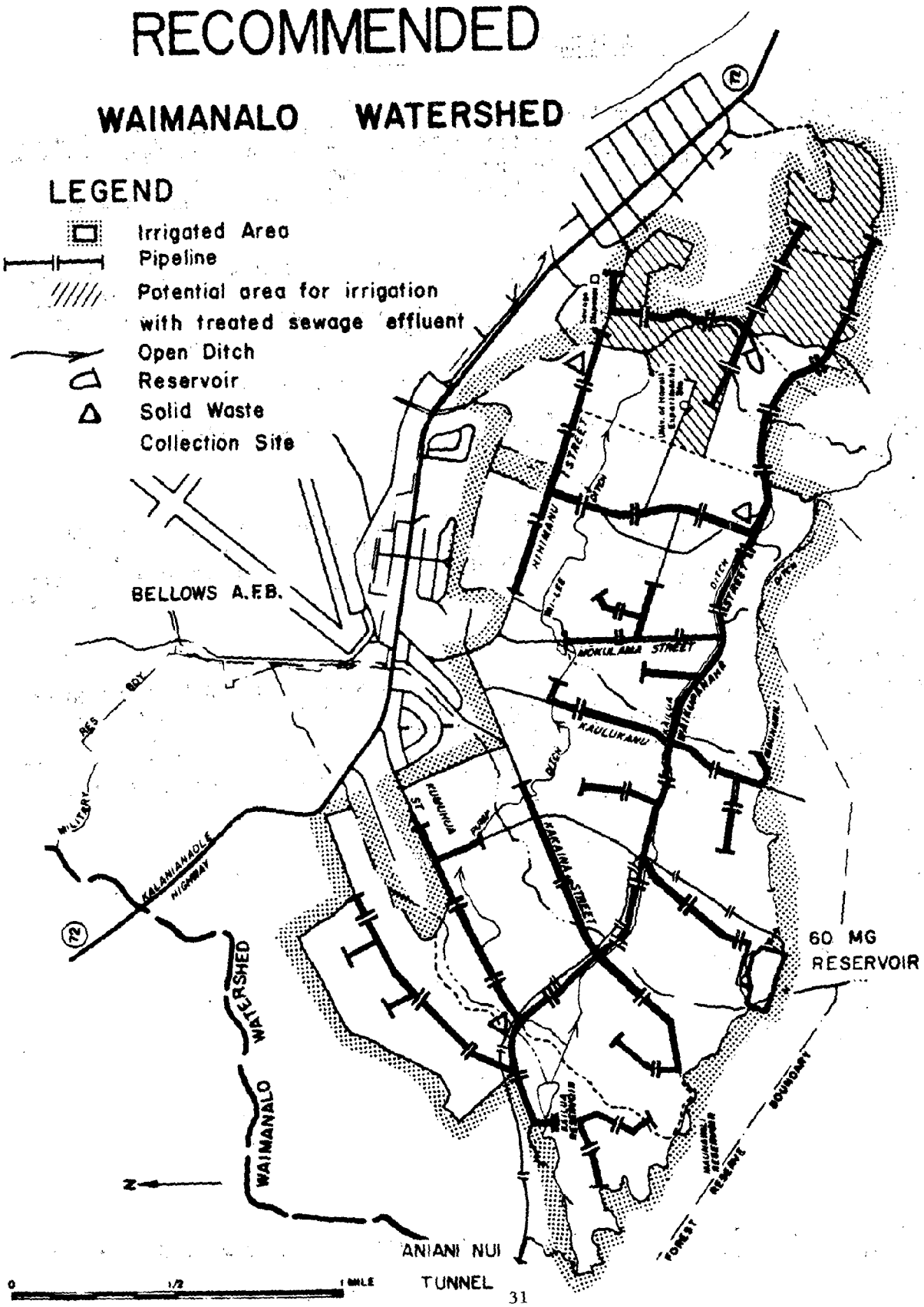
Benefits: 1/ Installation of this alternative would provide essentially the same quality water and service to the area currently irrigated. Reliability would be improved, and the savings in water would be used to supplement inadequate supplies available for lands currently irrigated. Average annual benefits of $382,000 would accrue.

Effects: The proposed Waimanalo Agricultural Park Plan could not be implemented with the irrigation system proposed in this alternative. As a result, the conditions similar to the future without project would prevail. With the exception of the proposed lining and the proposed flume and structure replacement, any historic value of the ditch system would not be changed. Problems with solid waste disposal would continue.

1/ Values shown do not include costs and benefits associated with the without-project condition.

RECOMMENDED

WAIMANALO WATERSHED



ALTERNATIVE 4 RECOMMENDED

Components: This alternative consists of accelerating assistance to all WIS irrigators, a storage reservoir, 12.7 miles of pipeline, and a separate treated sewage effluent lift pump, reservoir, and 1.4 miles of pipeline. A change of emphasis would be made in the ongoing land treatment program from "maintenance" to improved irrigation systems. Accelerated technical assistance would be used to assist irrigators in their conversion to sprinkler and drip systems and to design cultural practices to minimize nematode problems. All crops would receive full irrigation water supply.

The structural facilities are identical to Alternative 1 except that less pipe is required to service fewer acres, and three solid waste collection stations are provided.

A plan for preservation or protection would be developed with the State Historical Preservation Officer for those portions of WIS ditch which may be determined to have historic value. Other portions of the ditch would be operated by the Sponsors for storm drainage or they would be abandoned.

The map on the opposite page and Appendix E, Figure 1, the Project Map, show the features discussed above.

Costs: 1/ Total project cost = $12,798,000; P.L. 566 share = $6,108,000; other = $6,690,000; average annual cost = $1,205,000.

Benefits: 1/ Installation of this alternative would provide high quality WIS irrigation water under pressure to 890 acres, including 79 acres previously irrigated with domestic water. An additional 68 acres would be supplied with treated sewage effluent. Average annual benefits of $2,121,000 would accrue.

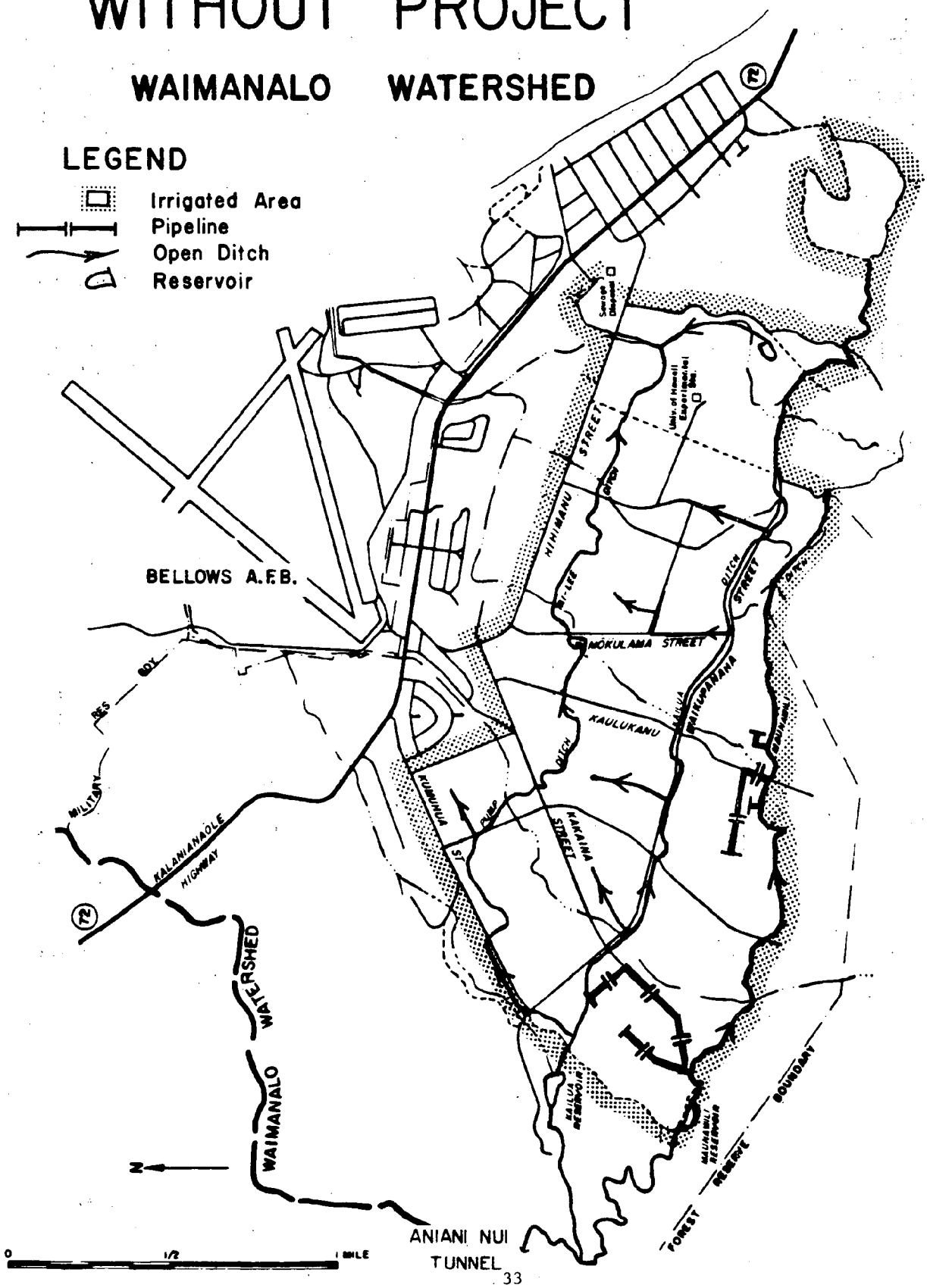
Effects: The proposed Waimanalo Agricultural Park Plan could be implemented with the irrigation system proposed in this alternative. As a result, the agricultural productivity and the rural character of Waimanalo Valley would be strengthened. The agricultural use of prime and important farmlands irrigated by WIS would increase to 905 acres. Problems with solid waste disposal would be reduced.

Those portions of the WIS ditch which may be determined to have historic value will be preserved or protected.

1/ Values shown do not include costs and benefits associated with the without-project condition.

WITHOUT PROJECT

WAIMANALO WATERSHED



ALTERNATIVE 5 WITHOUT PROJECT

Components: This alternative is basically a continuation of present conditions. It consists of foregoing implementation of the project. It does include some local costs to the Sponsors for obtaining long-term water rights, for improvements over present conditions to the irrigation water collection system in Maunawili Watershed, and for operation and maintenance of WIS. As a result of these improvements, additional water is available to supplement inadequate supplies available for lands currently irrigated.

The without-project alternative serves as the basis for comparison of the other alternatives.

The map on the opposite page shows the without-project alternative.

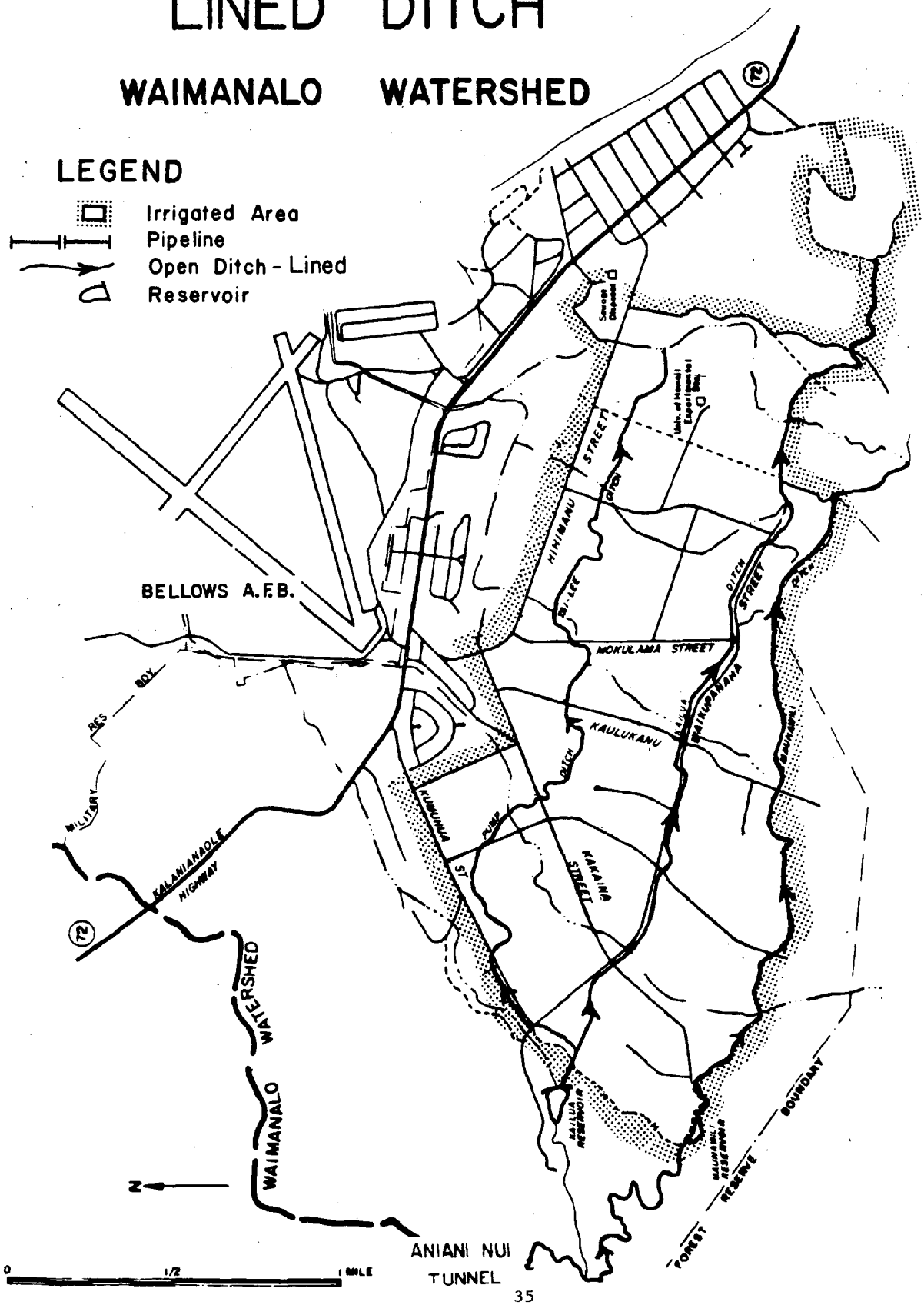
Cost: Total without-project cost = $2,522,000 which is funded 100 percent by other than P.L. 566; average annual cost = $316,000.

Benefits: This alternative would continue essentially the same quality water and service to the area currently irrigated. Reliability would be improved.

Effects: The proposed Waimanalo Agricultural Park Plan could not be implemented with the no-action alternative. The viability of diversified agriculture would decline while pressures to urbanize prime and important farmlands would increase. Problems with solid waste disposal would continue. The existing WIS ditch would remain in service.

LINED DITCH

WAIMANALO WATERSHED



ALTERNATIVE 6 LINED DITCH

Components: This alternative consists of concrete lining the existing ditches and reservoirs to reduce leakage and water losses to vegetation. Measurement, optimization of irrigation scheduling, and other management facilities and techniques would be installed. The current rate of technical assistance and land treatment would be adequate for the estimated needs.

Maunawili and Kailua Reservoirs would be reconstructed to modern safety and operational standards. The storage capacity would remain at approximately 13 million gallons. About 10.2 miles of ditch lining would be installed generally on the present alignments. Water measuring and control facilities would be provided. Improvements affecting those portions of the ditch which may be determined to have historic value would have to be concurred in by the State Historical Preservation Officer.

The map on the opposite page shows the features discussed above.

Costs: 1/ Total project cost = $4,105,000; P.L. 566 share = $2,550,000; other = $1,555,000; average annual cost = $440,000.

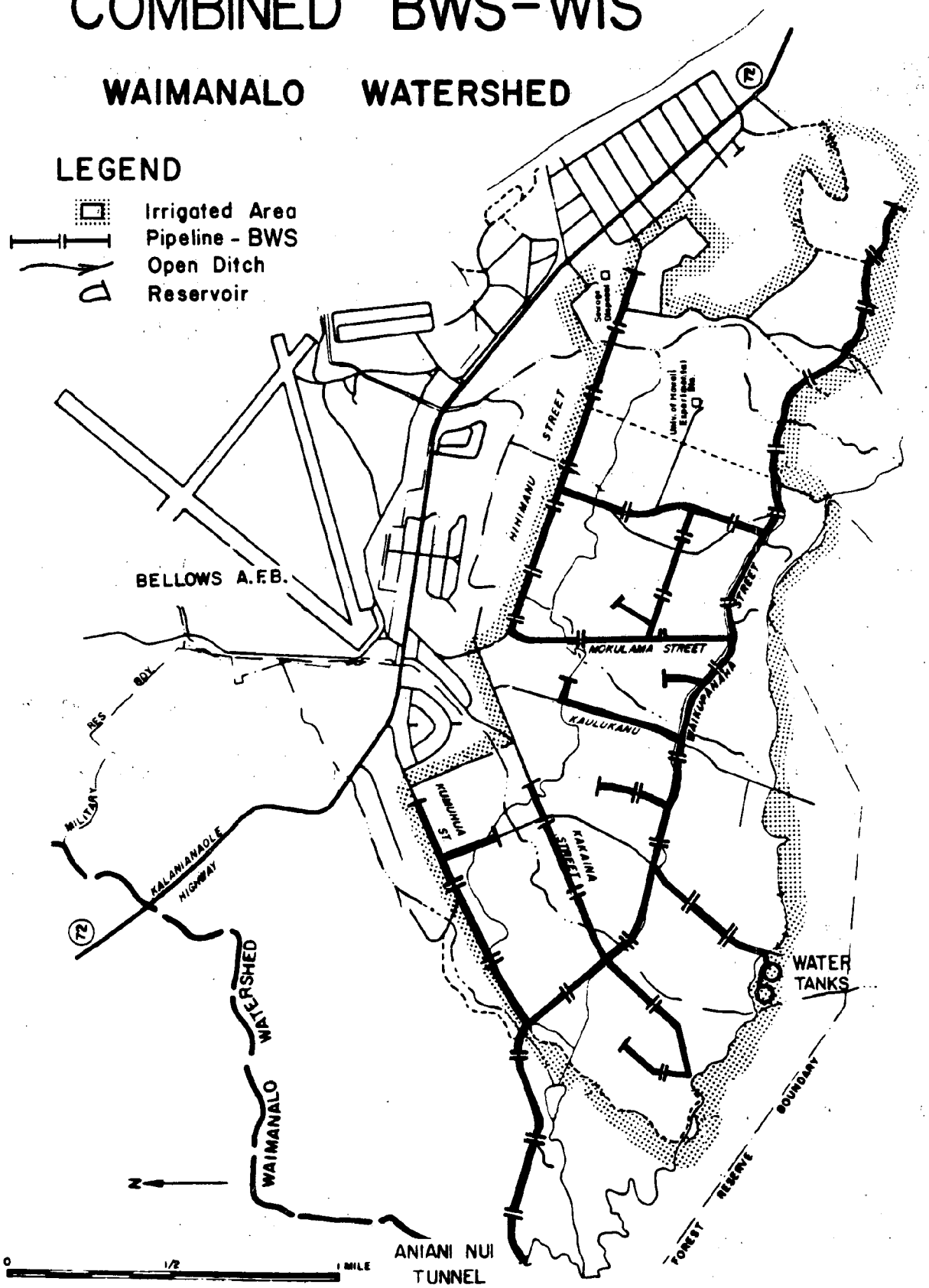
Benefits: 1/ Installation of this alternative would provide moderately improved water quality and service to 449 acres of cropland within the area currently irrigated. Full irrigation water supply would be provided. Average annual benefits of $775,000 would accrue.

Effects: The proposed Waimanalo Agricultural Park Plan could not be implemented without extensive modification to reduce its scope. As a result, the future without-project conditions would tend to prevail. Problems with solid waste disposal would continue. The appearance of the existing ditch system would be changed.

1/ Values shown do not include costs and benefits associated with the without-project condition.

COMBINED BWS-WIS

WAIMANALO WATERSHED



ALTERNATIVE 7 COMBINED WITH BWS

Components: This alternative consists of the complete transfer of all water rights and collection and distribution facilities from WIS to the City and County of Honolulu, Board of Water Supply (BWS), the domestic water supply agency for Oahu. The current rate of technical assistance and land treatment would be adequate for the estimated needs.

Only ground water would be utilized in this totally enclosed system. About 2 million gallons of regulation storage would be provided by tanks. All facilities would be installed to meet standards and requirements for potable water. The existing ditch system would be abandoned except where the Sponsors preserve or protect those portions which may be determined to have historic value.

The map on the opposite page shows the features discussed above.

Costs: 1/ Total project cost = $13,895,000; P.L. 566 cost = $6,395,000; other = $7,500,000; average annual cost = $1,235,000.

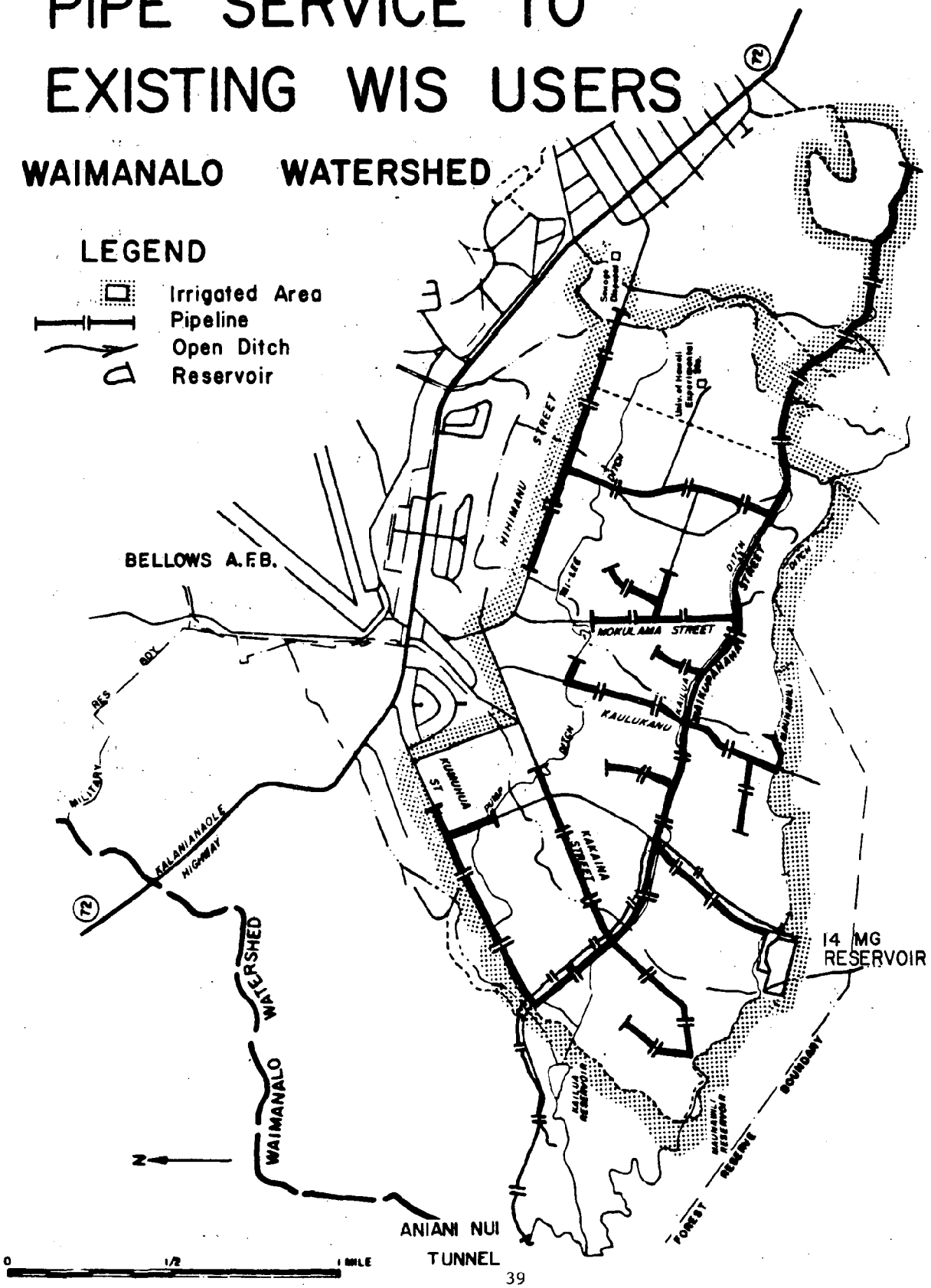
Benefits: 1/ Installation of this alternative would provide top quality water and continuous service to the area currently irrigated. Acreage irrigated would remain the same, limited by the capability of the small storage capacity to handle peak irrigation demands. Average annual benefits of $585,000 would accrue.

Effects: The proposed Waimanalo Agricultural Park Plan could not be implemented with the combined irrigation-potable water system proposed in this alternative. Urbanization of the prime and important farmlands would be facilitated by the expanded potable water supply and distribution system. Problems with solid waste disposal would continue. Portions of the ditch which may be determined to have historic value would be preserved or protected.

1/ Values shown do not include costs and benefits associated with the without-project condition.

PIPE SERVICE TO EXISTING WIS USERS

WAIMANALO WATERSHED



ALTERNATIVE 8 PIPE SERVICE TO EXISTING USERS

Components: This alternative consists of installing a reservoir and 10.2 miles of gravity pressure pipe system to irrigate the area now served by WIS. A change of emphasis would be made in the ongoing land treatment program from "maintenance" to improved irrigation systems. Accelerated technical assistance would be used to assist irrigators in their conversion to sprinkler and drip systems. All crops would receive full irrigation water supply.

This system would require a 14 million gallon excavated reservoir near the mauka end of Mahailua Street. A gravity pressure pipeline (with some supplementary pumping required) would deliver water from the reservoir to the operators.

A plan for preservation or protection would be developed with the State Historical Preservation Officer for those portions of WIS ditch which may be determined to have historic value. Other portions of the ditch would be operated by the Sponsors for storm drainage or they would be abandoned.

The map on the opposite page shows the features discussed above.

Costs: 1/ Total project cost = $4,970,000; P.L. 566 share = $2,880,000; other = $2,090,000; average annual cost = $515,000.

Benefits: 1/ Installation of this alternative would provide high quality WIS irrigation water under pressure to 528 acres including 79 acres previously irrigated with domestic water. Average annual benefits of $1,635,000 would accrue.

Effects: The proposed Waimanalo Agricultural Park Plan could not be implemented without extensive modification to reduce its scope. Viability of current agricultural operations would be enhanced, and the future would be an improvement over the future without-project condition. Problems with solid waste disposal would continue. Those portions of the WIS ditch which may be determined to have historic value would be preserved or protected.

1/ Values shown do not include costs and benefits associated with the without-project condition.

CANDIDATE PLANS

The next step, after formulating alternative plans, was to identify the alternative plans that could be considered as candidates for a recommended plan. The NED, EQ, and nonstructural plans as well as the future without-project are required to be included as candidate plans.

The alternative plans described as Lined Ditch, Combined With BWS, and Piped Service to Existing Users were not designated candidate plans because they did not adequately alleviate identified problems or take advantage of identified opportunities. Evaluation focused on four aspects of an alternative plan--completeness, effectiveness, efficiency, and acceptability. The evaluation also considered the risk and uncertainty involved with each plan. Each of the the three plans failed to allow implementation of the State's Waimanalo Agricultural Park Plan. The small storage capacities proposed increased the risk of crop damages from droughts. The Lined Ditch alternative failed to solve the problems with water quality and quantity. Combined With BWS provided top quality water exceeding the quality requirements for most crops, but a high degree of uncertainty exists for many irrigators concerning agriculture's long range access to a potable water system. The proposal is the least cost-effective of all plans considered. Piped Service to Existing Users is essentially a scaled-down version of the recommended plan, and it was unacceptable because did not adequately alleviate the problems and take advantage of the opportunities.

The candidate plans continued to be refined and are displayed on the following table, Summary Comparison of Candidate Plans, Table D.

TABLE D - SUMMARY COMPARISON OF CANDIDATE PLANS

Waimanalo Watershed, Hawaii

COMPARISON FACTORS / ALTERNATIVES	ALTERNATIVE 1 - NATIONAL ECONOMIC DEVELOPMENT (NED)	ALTERNATIVE 2 - ENVIRONMENTAL QUALITY (EQ)	ALTERNATIVE 3 - NONSTRUCTURAL	ALTERNATIVE 4 - RECOMMENDED
Project Investment	$13,982,000	$12,896,000	$ 497,000	$12,798,000
NED ACCOUNT				
Adverse, Annualized	$ 1,225,000	$ 1,140,000	$ 166,000	$ 1,205,000
Beneficial, Annualized	2,312,000	$ 2,121,000	$ 382,000	$ 2,121,000
Net Beneficial	$ 1,087,000	$ 981,000	$ 216,000	$ 916,000
RED ACCOUNT				
Positive Effect, Annualized				
Region	$ 4,150,000	$ 4,089,000	$ 460,000	$ 4,089,000
Rest of Nation	- $ 520,000	- $ 509,000	- $ 55,000	- $ 509,000
Negative Effect, Annualized				
Region	$ 699,000	$ 647,000	$ 144,000	$ 714,000
Rest of Nation	$ 526,000	$ 493,000	$ 22,000	$ 498,000
EQ ACCOUNT				
Beneficial				
Ag. Use of Prime and Important Farmlands	Add 616 acres.	Add 430 acres.	No change.	Add 377 acres.
Visual Attribute - Appearance of Valley Floor	No change in visible garbage. Addition of 674 acres of irrigated diversified agriculture will increase variety and visual contrast.	3 solid waste collection sites will reduce visible garbage. Addition of 430 acres of irrigated diversified agriculture will increase variety and visual constrast.	No change in visible garbage. No change in irrigated diversified agriculture.	3 solid waste collection sites will reduce visible garbage. Addition of 430 acres of irrigated diversified agriculture will increase variety and visual constrast.

JULY 1981

TABLE D - SUMMARY COMPARISON OF CANDIDATE PLANS (Continued - 2)

Waimanalo Watershed, Hawaii

COMPARISON FACTORS / ALTERNATIVES	ALTERNATIVE 1 - NATIONAL ECONOMIC DEVELOPMENT (NED)	ALTERNATIVE 2 - ENVIRONMENTAL QUALITY (EQ)	ALTERNATIVE 3 - NONSTRUCTURAL	ALTERNATIVE 4 - RECOMMENDED
EQ ACCOUNT (conti.)				
Beneficial				
Historical Sites - WIS Ditch	Retain historically significant reaches of abandoned ditches.	Retain historically significant reaches of abandoned ditches.	Entire ditch system retained.	Retain historically significant reaches of abandoned ditches.
Waimanalo Stream Water Quality	Minor improvement.	Minor improvement.	No effect.	Minor improvement.
Adverse				
12 Known Archeological Sites	1 may be affected.	1 may be affected.	None affected.	1 may be affected.
Visual Attribute - Appearance of Foothills	Reservoir will be major contrast in viewshed.	Reservoir will be major contrast in viewshed.	No change.	Reservoir will be major contrast in viewshed.
OSE ACCOUNT				
Beneficial				
Preserve the Rural Character of Waimanalo	Will add 62 farming units.	Will add 40 farming units.	No change in number of farming units.	Will add 40 farming units.
Population Estimates for Year 2000 and Year 2020	9,450 and 12,000 - Ag. Park Plan may encourage 10,000 for Year 2020.	9,450 and 12,000 - Ag. Park Plan may encourage 10,000 for Year 2020.	9,450 and 12,000 - No Ag. Park Plan.	9,450 and 12,000 - Ag. Park Plan may encourage 10,000 for Year 2020.
Adverse				
Low - Probability Hazard Resulting from Structural Failure of Embankment	New reservoir - 77 residences could be inundated.	New reservoir - 77 residences could be inundated.	Existing reservoirs - 21 residences could be inundated.	New reservoir - 77 residences could be inundated.
Energy Required to Operate the System (Pumping)	150,000 KwHr/YR	135,000 KwHr/YR	Minor	150,000 KwHr/YR
Energy Required to Build the System	700 billion BTU's.	668 billion BTU's.	29 billion BTU's.	660 billion BTU's.

NOTES: Interest rates - all plans evaluated at 7 3/8 percent interest.
Period of analysis - all plans evaluated over 50 years.
Price levels - current 1980 price levels except for crops where average 1977-1979 prices were used. Dollars values shown do not include cost, and benefits associated with the without-project condition.

JULY 1981

PROJECT INTERACTION

The following table displays the relationship of the candidate plans to existing or expected Federal and non-Federal projects where significant economic, environmental, or physical interactions exist.

TABLE E - INTERACTION WITH OTHER PROJECTS
WAIMANALO WATERSHED, HAWAII

WAIMANALO WATERSHED	OTHER FEDERAL AND NONFEDERAL PROJECTS	
	Sewage Plant	CE Flood Control
CANDIDATE PLANS	Waimanalo Sewage Treatment Plant - effluent disposal system uses 3 wells - 128 MG/YR current rate - wells nearing capacity	U.S. Army CE Kaneohe - Kailua Flood Control and Allied Purposes - construction displaced 45 acres of bananas - State Dept. of Ag. considered this a serious economic and social impact upon growers.
Alt. 1 - NED	78 MG/YR effluent used for irrigation	Irrigated bananas in Waimanalo increased by 402 acres. Irrigation at 50% of full water requirements.
Alt. 2 - EQ	78 MG/YR effluent used for irrigation	Irrigated bananas in Waimanalo increased by 159 acres. Irrigation at 100% of full water requirements.
Alt. 3 - NONSTRUCTURAL	No interaction	No interaction
Alt. 4 - RECOMMENDED	78 MG/YR effluent used for irrigation	Irrigated bananas in Waimanalo increased by 159 acres. Irrigation at 100% of full water requirements.
Alt. 5 - WITHOUT PROJECT	No interaction	No interaction

RISK AND UNCERTAINTY

The degree of risk and uncertainty involved in each alternative plan was considered throughout the planning process and adjustments were made in the plans to reduce risk and uncertainty. Risk in alternative plans for Waimanalo Watershed includes the severity and frequency of droughts, the hazards associated with a sudden structural failure of the reservoir embankment, and the likelihood of reinfestations by plant-parasitic nematodes. Uncertainty includes the unknown future in the choice of crops planted, the economics of producing and selling those crops, and the timing of damaging natural disasters.

The drought risk would be lowest for Alternatives 1, 2, and 4 where large storage capacities are included to provide dry season water. Many years of hydrological data were used to accurately predict specific frequencies of water supply levels.

In the highly unlikely event of a structural failure, hazards would be greatest with Alternatives 1, 2, and 4 because of the 60 million gallon storage reservoir. The risk of failure occurring probably would be greatest with the existing Kailua Reservoir used in Alternatives 3 and 5, but the resulting damage would be less than for the 60 million gallon reservoir. The large storage reservoir would be designed as a class (c) hazard structure which is the most conservative design criteria used by SCS. It would be an off-channel structure not significantly affected by storm runoff.

The risk of nematode reinfestation by irrigation water is greatest with Alternative 3. The deep reservoir used in Alternatives 1, 2, and 4 would kill most plant-parasitic nematodes by denying them oxygen. The piped distribution system would reduce the risk for contamination of the irrigation water (Ref. 21).

Although, in a free society, some uncertainty will always exist in the choice of crops to be planted, the cropping patterns predicted were based on extensive farmer interviews and consultations with interested agencies. Current normalized prices of commodities and production impacts are used to minimize uncertainty in agricultural benefits. The State is committed to increased production of the fruit and vegetables consumed in Hawaii. They are presently meeting only one-third of their requirement and importing the remainder (Ref. 23 and 27).

COMPARISON OF CANDIDATE PLANS

The Sponsors selected Alternative No. 4 as the recommended plan. The selection was based on the various evaluations described previously--effects on problems, opportunities and environmental factors; completeness, effectiveness, efficiency, and acceptability; risk and uncertainty; and input from individuals, groups, and agencies as described in the Consultation and Public Participation section.

Alternative No. 1 NED would do an excellent job in facilitating implementation of the proposed Waimanalo Agricultural Park Plan. The major fault with this plan is its unacceptability to farmers and the Sponsors and, as such, it may not be implementable. It would require providing the banana growers only 50 percent of the full water supply required during the high-demand period (summer). The water saved would be used to bring additional acreage and operators into production. This would result in reduced income to existing banana growers. The reduced supply distributed over more acres would have a higher risk of drought damage to bananas than the recommended plan.

A detailed explanation of the incremental analysis used in formulating the NED plan can be found under the subtitle, "NED Formulation" in the Formulation of Alternatives section.

Alternative No. 2 EQ would do an excellent job in meeting the environmental objectives of Waimanalo, but it is not in direct agreement with the proposed Agricultural Park Plan. This alternative irrigates different areas than the Agricultural Park Plan proposed. The emphasis is placed on irrigating prime and important farmlands and does not support irrigating other lands.

Alternative No. 3 Nonstructural would fail to adequately alleviate the identified problems with WIS. The irrigation system remains basically the same as it would be in the future without project. Management opportunities, water quantity, system reliability, and water quality would be only slightly improved . This alternative also would fail to take advantage of the identified opportunities. No increase would be made in the agricultural use of prime and important farmlands.

Alternative No. 4 Recommended would do the best job in alleviating identified problems and in taking advantage of identified opportunities. Irrigation water quantity, quality, and system reliability would not be exceeded by any other candidate plan. There are 244 acres less irrigated cropland than in Alternative No. 1, but every acre would receive a full supply, and the risk of drought damage would be less. There are only 53 acres less prime and important farmlands in agriculture than in Alternative No. 2, and that EQ opportunity is 94 percent realized. The EQ problem with solid waste disposal would be alleviated in this alternative. The EQ opportunity to preserve those sections of the ditch which may be determined to have historic value would be the same as in Alternative No. 2.

RECOMMENDED PLAN

GENERAL

The recommended plan, Alternative 4, includes features of both the NED plan and the EQ plan. This plan is closely integrated with the State's proposed Waimanalo Agricultural Park Plan and recognizes certain actions by DLNR to acquire long term water rights and upgrade the water collection system in Maunawili Watershed as absolutely essential to the accomplishment of both plans. The P.L. 566 part of the watershed plan is limited to actions within Waimanalo Watershed and includes the following:

Waimanalo Irrigation System (WIS) improvement,
sewage effluent irrigation system,
solid waste collection sites,
land treatment, and
technical assistance.

PURPOSE

The purposes of this plan are improvement of agricultural water management through modernizing an antiquated irrigation system; use of treated sewage effluent for irrigation; preserving and enhancing environmental quality by retaining prime and important farmland in agricultural use; protecting and preserving portions of the WIS ditch which may be determined to have historic value; and improving health and aesthetics by providing adequate solid waste collection sites.

PLAN ELEMENTS

Waimanalo Irrigation System improvement starts at the east portal of the Aniani Nui Ridge Tunnel where water from Maunawili Watershed is picked up in a 16-inch pipe and carried 1.8 miles under gravity pressure to a fenced 60 million gallon, reinforced concrete lined reservoir at the mauka end of Mahailua Street (Plates 1 and 2, Appendix D and Photo 15). Visual treatment will be applied to the reservoir site to minimize adverse visual effects. Flow into the reservoir will be screened and discharged to minimize aeration. Releases will be from near the bottom of the reservoir. This arrangement will tend to control plant-parasitic nematodes by reducing the available oxygen. The delivery system below the reservoir will be a closed, pressurized pipe system, 10.9 miles long, ranging from 24 inches to 6 inches in diameter (Table 3B). There will be a metered outlet at each irrigation turnout. At certain critical locations along the upper mainline there will be booster pumps to provide sufficient sprinkler pressure to users with land above the gravity pressure contours.

Treated Sewage Effluent Irrigation System will consist of a separate pump-reservoir-pipeline system 1.4 miles long operated by WIS to use treated sewage effluent to irrigate crops allowed by health regulations, such as bananas, orchard crops, and certain nursery crops. A pump station at the Waimanalo Sewage Treatment Plant will pump the effluent through a 12-inch pipeline to a two-cell 3.0 million gallon effluent storage reservoir to be constructed at

the Wing-King Reservoir site. A relift pump at the reservoir will deliver effluent to lands above the reservoir. All delivery lines will be 12-inch pipe (Plate 4, Appendix D). All effluent will be applied by furrow irrigation on farmlands shown on Figure 1, Appendix E.

Solid Waste Collection Sites will be graded and surfaced to facilitate all weather use and maintenance, and they will be screened from view. The three sites will be equipped with heavy-duty dumpsters (Plate 5, Appendix D).

The general location of the sites is shown in Figure 1, Appendix E.

Land Treatment includes planning and application of resource management systems by individual farmers to protect the resource base and achieve project benefits. The SCS provides planning and application assistance to farmers through the Windward Oahu Soil and Water Conservation District.

Conservation plans are recorded decisions made by the land users combining the technical information available from the SCS with the farmers' desires and knowledge of the land and crops. Such plans are useful when several related practices are to be applied and the sequence and/or timing are related. Plans are also useful to the farmers in budgeting and scheduling the application of practices and to the SCS in scheduling technical assistance. Conservation practices needed to apply the resource management systems are listed on Table 1.

Land which has not been farmed in the last few years will be cleared.

Surface water removal systems carry rainwater from the land without erosion or damage using such practices as diversions and waterways. Irrigation systems will use the most practical and efficient application methods--sprinklers, drip, and surface sytems. Irrigation water management systems are irrigation methods the farmer uses to apply water needed by the crop without waste or erosion and consider such factors as water holding capacity of the soil, moisture requirements of the crop, and rainfall. Soil management systems will assure that the physical condition of the soil does not deteriorate from cultivation, compaction due to traffic, and applying water to supplement natural rainfall. This combination of practices is know as a conservation cropping system.

Technical Assistance is provided through the Windward Oahu Soil and Water Conservation District to farmers in the project area. SCS assistance under the present program is 1.4 person-years per year. It is estimated that 1.7 person-years per year SCS assistance will be needed to assist farmers plan and apply the needed conservation practices during the four-year project installation period. The accelerated technical assistance needed is 0.3 person-year per year over the ongoing program.

P.L. 566 funds for accelerated technical assistance by the University of Hawaii and the Cooperative Extension Service are directed to the control of nematodes by providing onfarm assistance coupled with an intense information program.

Landrights needed for installation of both reservoirs are owned by the State and include 11 acres for the 60 million gallon reservoir and 2.6 acres for the sewage effluent reservoir. Landrights for the pipeline systems are owned by the State or the City and County where pipelines will be in road rights-of-way. Solid waste collection sites will be developed on approximately 0.2 acre State or City and County land.

RESERVOIR SAFETY

The location of the proposed 60 million gallon reservoir near the mauka end of Mahailua Street is upslope from residences and various other facilities. The SCS has taken two courses of action to minimize the risks to public safety associated with the reservoir.

The first step was to assign the earth embankment (or dam) the most severe hazard classification--Hazard Class (c). Class (c) dams receive rigorous and thorough foundation and soils investigations. They are designed using the safest procedures and in accordance with the most rigid criteria. Construction will be inspected continuously and various quality indicators such as material strengths, densities, and internal pressures in the foundation and embankment will be monitored.

The most likely causes of a sudden structural failure were considered. The reservoir embankment will not be constructed across a stream. Consequently, the operation of the reservoir is largely independent of storm activity and related stream flooding, and it is not subject to overtopping. However, a concrete emergency spillway structure is included in the design of the reservoir to safely pass flows that would be generated by the probable maximum precipitation (44 inches in 24 hours) if it occurred over the approximately 6 acres occupied by the reservoir.

Operational problems with the reservoir structure could involve negligent operation, malfunctioning valves or gates, or vandalism. These problems would not pose a significant hazard to public safety. Pipe flow into the reservoir can be diverted into Waimanalo Stream, and the reservoir can be drained using the gravity pipe system.

A catastrophic natural event--an earthquake--was determined to be the most likely cause of a sudden structural failure although the possibility of such a failure is extremely remote. To evaluate earthquake hazards a seismic assessment was conducted for this structure which is in Seismic Zone 1 (moderately low). It was determined that there have been 2 earthquakes with Richter magnitude 4 or greater (4.0 and 4.1) since 1900 within a 60 mile radius of the reservoir. All structural elements will be designed for the earthquake forces required in Seismic Zone 1.

The second step to minimize the risks to public safety was to evaluate the adverse effects of a sudden structural failure. The major hazard would result from the sudden, rapid and uncontrolled release of water associated with a breach of the structure. A breach analysis identified the courses a flood wave would follow and its depth.

Elevations of specific residences and streets were checked. The water depth would be about 7 feet above street level at the stream crossing on Waikupanaha Street near Kakaina Street, the first crossing downslope from the reservoir. As the flood wave moves downslope and widens, the depth decreases to about 2 feet above street level at the intersection of Kakaina and Mekia Streets. The area flooded by the wave is shown in Appendix C, Area Subject to Flooding in the Event of Structural Failure. Table F presents the findings of the evaluation. Table F also presents the finding of a similar evaluation for the existing Kailua Reservoir which is retained in the future without-project alternative. Kailua Reservoir will no longer be a part of the irrigation system under the recommended plan, and the Sponsors will modify it to reduce the hazard.

TABLE F - RESIDENCES AND AREAS SUBJECT TO FLOODING
IN THE EVENT OF A STRUCTURAL FAILURE
Waimanalo Watershed, Hawaii

Item	Without Project (Kailua Reservoir, Existing)	Recommended Plan (Proposed Reservoir)
Residences Flooded (Number) 1/	21	77
Area Flooded		
Residential Zone	0 acres	17.9 acres
Commercial Zone	0 acres	0.9 acres
Agricultural Zone	31.6 acres	212.4 acres
Parks	3.5 acres	54.2 acres

1/ The number of residences with water above the first floor is based on a June 1981 field examination of the flooded area. Few, if any, additional residences are anticipated within the area flooded over the 50-year life of the project. Population increases will be in the residential areas planned for growth.

MITIGATION

No losses of wildlife habitat will occur as a result of implementing this plan, and therefore no mitigation has been included. The U.S. Fish and Wildlife Service and the State Division of Forestry and Wildlife participated with SCS in this determination.

PERMITS AND COMPLIANCE

All activities related to the construction and operation of the facilities described in the Recommended Plan section will be accomplished in full compliance with all county, state and federal requirements. County (City and County of Honolulu) requirements are as follows:

GRADING AND GRUBBING City and County of Honolulu Ordinance No. 3968 (Bill No. 101, Draft 3:1972)	DPW 1/

State requirements are as follows:

1.	HISTORIC PROPERTY Hawaii Sessions Laws, Act 104, 1976.	DLNR 2/
2.	SEWAGE EFFLUENT HRS Chapter 342, Environmental Quality, Part III: Water Pollution, and Dept. of Health Regulations, Chapter 38: Sewage Treatment and Disposal Systems.	DOH 3/
3.	SOLID WASTE HRS Chapter 343, Environmental Quality, Part V: Solid Waste Pollution, and Dept. of Health Regulations, Chapter 46, Solid Waste Management Control.	DOH 3/

Federal requirements for permits and other entitlements are shown on Table G on the following page.

1/ City and County of Honolulu, Department of Public Works
2/ State of Hawaii, Department of Land and Natural Resources
3/ State of Hawaii, Department of Health

TABLE G - COMPLIANCE OF THE RECOMMENDED PLAN WITH WRC-DESIGNATED ENVIRONMENTAL STATUTES
Waimanalo Watershed, Hawaii

	FEDERAL POLICY	COMPLIANCE 1/
1.	Archeological and Historic Preservation Act, 16 U.S.C. 469, et seq.	Full compliance
2.	Clean Air Act, as amended, 42 U.S.C. 1857h-7, et seq.	Not applicable
3.	Clean Water Act (Federal Water Pollution Control Act), 33 U.S.C. 1251, et seq.	Full compliance
4.	Coastal Zone Management Act, 16 U.S.C. 1451, et seq.	Full compliance
5.	Endangered Species Act, 16 U.S.C. 1531, et seq.	Full compliance
6.	Estuary Protection Act, 16 U.S.C. 1221, et seq.	Not applicable
7.	Federal Water Project Recreation Act, 16 U.S.C. 460-1(12), et seq.	Not applicable
8.	Fish and Wildlife Coordination Act, 16 U.S.C. 661, et seq.	Not applicable
9.	Land and Water Conservation Fund Act, 16 U.S.C. 4601-4601-11, et seq.	Not applicable
10.	Marine Protection, Research and Sanctuary Act, 33 U.S.C. 1401, et seq.	Not applicable
11.	National Environmental Policy Act, 42 U.S.C. 4321, et seq.	Full compliance
12.	National Historic Preservation Act, 16 U.S.C. 470a, et seq.	Full compliance
13.	Rivers and Harbors Act, 33 U.S.C. 403, et seq.	Not applicable
14.	Watershed Protection and Flood Prevention Act, 16 U.S.C. 1001, et seq.	Full compliance
15.	Wild and Scenic Rivers Act, 16 U.S.C. 1271, et seq.	Not applicable

1/ NOTES:
- Full Compliance - Having met all requirements.
- Partial Compliance - Not having met some of the requirements that normally are met.
- Noncompliance - Violation of a requirement of the statute.
- Not Applicable - This plan does not involve elements that require compliance.

COSTS

Installation costs for the Recommended Plan include: cost of accelerated land treatment needed to achieve the irrigation benefits; cost of construction (base year 1980) including 10 percent contingency costs; engineering services for design; land and water rights needed for installation and operation of project measures; associated land clearing and land building cost; and project administration costs for construction supervision and inspection (Tables 1, 2, and 2A).

Annualized costs include amortization of installation costs at 7-3/8 percent for the 50-year life of project period or for shorter periods for certain land treatment items; and operation, maintenance, and replacement (OM&R) costs for structural measures. OM&R costs for land treatment are accounted for in costs and returns for irrigated crops. Annualized costs of $1,205,000 attributable to irrigation improvements and $7,000 attributable to solid waste collection sites are shown as adverse effects under the NED part of Table 4.

Land treatment costs include installation and technical assistance costs of conservation cropping systems, storm runoff diversions, grassed waterways, irrigation systems, onfarm irrigation pipelines, irrigation water management, and land clearing necessary to achieve the benefits from improved quantity and quality of irrigation water. Table 1 shows costs to be incurred during the four-year installation period in excess of the ongoing rate of that type of land treatment in the watershed. Land treatment costs include $20,000 P.L. 566 funds for accelerated technical assistance and $596,000 other funds under ongoing programs.

Construction costs include engineer's estimates plus contingency costs for the following: water collection system improvement outside the watershed--no P.L. 566 funds and $500,000 other funds; irrigation storage reservoir--$2,485,000 P.L. 566 funds and $2,485,000 other funds; irrigation pipeline system--$1,425,000 P.L. 566 funds and $1,425,000 other funds; modification of the WIS ditch for surface runoff disposal--$25,000 P.L. 566 funds and $25,000 other funds; sewage effluent pumps, storage reservoir, and pipelines--$205,000 P.L. 566 funds and $205,000 other funds; solid waste collection sites--$30,000 P.L. 566 funds and $30,000 other funds; for a total of $4,170,000 P.L. funds and $4,670,000 other funds.

Engineering services costs include the direct costs of engineers and others required for design-level investigations, engineering design and construction specifications. Total engineering services are estimated to cost $831,000 in P.L. 566 funds and $33,000 in other funds.

Landrights costs include the value of the land resources used for project installations and any costs of public utility protection or relocation. Total landrights costs are estimated at $740,000 other funds (no P.L. 566 funds).

Water rights will be secured by the Sponsors and are considered as existing under the future without-project condition.

Project administration costs include the costs of preparing invitations to bids, administering contracts, inspection, and overhead costs of project installation including legal opinions where needed. Project administration costs are estimated at $1,087,000 P.L. 566 funds and $651,000 other funds.

Total installation of structural measures is estimated to cost $6,088,000 P.L. 566 funds and $6,094,000 other funds for a total of $12,182,000.

INSTALLATION AND FINANCING

The planned sequence for installing the structural improvements during the first year includes: design and construction of the pipeline from Aniani Nui Ridge Tunnel to the 60 million gallon storage reservoir, construction of that reservoir, construction of the 1.5 million gallon sewage effluent reservoir, and a start on the delivery systems. Construction during the second year will include the delivery systems and the solid waste disposal sites.

The planned sequence for installing land treatment would be phased over four years with the first two years concentrating on preparation of those lands in the Agricultural Park Subdivision and Area "A." The conversion of sprinkler irrigation to drip and development of contour furrow irrigation for the sewage effluent will be delayed until the new delivery systems are nearing completion. This sequence should provide the least disruption of the cropping operations and farm production. Table H presents the planned expenditure of funds during the project installation.

TABLE H - SCHEDULE OF OBLIGATIONS
Waimanalo Watershed, Hawaii

Year	Measure	P.L. 566 Funds	Other Funds	Total Funds
1	Reservoirs & Pipelines -	$3,040,000	$ 2,800,000	$ 5,840,000
	Water Collection System -	--	500,000	500,000
	Land Treatment -	--	160,000	160,000
2	Complete Reservoirs, Pipelines & Solid Waste Sites -	3,048,000	2,757,000	5,805,000
	Land Treatment -	--	160,000	160,000
3	Contracted Technical Assistance -	20,000	--	20,000
	Land Treatment -	--	160,000	160,000
4	Land Treatment -		153,000	153,000
	TOTAL	$6,108,000	$6,690,000	$12,798,000

Responsibilities

DLNR is responsible for the installation of all structural measures, obtaining landrights and water rights, protection of public utilities, and coordination with other state and county agencies. The Windward Oahu Soil and Water Conservation District will assume the leadership in the installation and maintenance of land treatment measures, using agreements with individual farmers. Final decisions on land treatment measures rests with the landowner or operator. Technical assistance will be provided by SCS under the ongoing program and with P.L. 566 funds.

Landrights and Utilities

Acquisition of all lands, easements, or rights-of-way shall be made in compliance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, P.L. 91-646, and appropriate USDA and federal regulations. These provide that in cases where landrights are not obtained by donation or land exchange, every reasonable effort will be made to acquire real property rights by negotiation. Prior to the initiation of negotiations, an appraisal of the fair market value of the real property interest will be made by a qualified land appraiser. Most, if not all, landrights are already state or city and county property.

Several public utilities both buried and above ground exist within the planned project. At the 60 million gallon storage reservoir, an overhead, double-pole supported, electric powerline crosses the mauka edge of the construction site. Work near this line will require extreme caution and must be coordinated with the utility company.

Throughout the delivery system, numerous pipeline crossings of buried and above-ground utilities will be encountered. These include rural electric powerlines and telephone cables; BWS delivery lines, existing WIS ditches, pipelines, and water control structures; Waimanalo Sewage Collection System; and roads, streets, culverts, and bridges.

Changes of existing utilities or protection inplace which are made necessary by the works of improvement will be the responsibility of DLNR. Costs of these changes or protection shall be considered landrights costs.

Costs of changes or protection to existing irrigation facilities made necessary by the works of improvement shall be considered construction costs and be cost-shared at the same rate as the works of improvement.

Contracting

Installation of the structural works of improvement will be under a locally awarded contract. Contracts for the construction of structural measures will be let on competitive bids. SCS will prepare all contract documents. DLNR will be responsible for all contracting and for coordinating with the SCS during installation. DLNR is also responsible for establishing a financial management system, including financial reporting requirements, meeting the requirements listed in the Federal Management Record 74-7.

SCS will contract for the P.L. 566 funded technical assistance described in this plan.

Financing

Federal assistance for installing the structural works of improvement as described in this plan will be provided under the authority of the Watershed Protection and Flood Prevention Act, Public Law 566, 83rd Congress, 68 Stat. 666, as amended (P.L. 566). Under this authority SCS will provide: (1) engineering services, including surveys, site investigations, designs, and preparation of plans and specifications; (2) project administration, including review of engineering plans prepared by others, government representatives, construction surveys, necessary inspection services during construction, and contract administration; and (3) technical assistance to farmers and others.

The Department of Land and Natural Resources (DLNR) is a legally constituted department of the Hawaii State government. As such, DLNR has the power to

borrow money for financing the installation of this project, the power of eminent domain, and the power to charge fees for repayment of borrowed funds and payment of operating expenses. Structural installation costs other than those allocated to Public Law 566 funds will be the responsibility of DLNR. State appropriated funds will be used to pay the local share of structural installation costs. Donations of land, easements, labor, material, equipment, services, or money by the Sponsors or others may, as eligible, be used to reduce the local share of project installation costs.

Conditions for Providing Assistance

The following conditions shall be met before issuance of invitations to bid on any portion of construction:

1. The necessary landrights and water rights will be acquired by DLNR which agrees to use its authority to litigate if necessary.

2. DLNR will ensure that all necessary permits required for project construction are obtained. Contractors will be required to follow regulations to prevent sedimentation and pollution of stream waters during construction. Dust control during construction will be required. Contractors will also be required to provide protection against the effects of excessive noise exposure. All SCS safety requirements for construction will be strictly observed.

3. Mutual agreement shall be reached between DLNR and SCS on the schedule for construction and on plans and specifications. Contracts for works of improvement shall be mutually satisfactory and in accordance with requirements of the DLNR and in agreement with SCS technical and administrative requirements.

4. DLNR will ensure full conformance with city and county, state, and federal laws and regulations. Reasonable evidence of such conformity shall be provided to the mutual satisfaction of all parties.

5. Agreements for the operation and maintenance of all reservoirs, pipeline systems, and solid waste collection sites shall be agreed to in writing by DLNR and SCS.

6. Structural improvements on the WIS collection system in Maunawili Watershed are required for the proper functioning of the total WIS system and shall be completed, or they shall be under construction and scheduled for completion prior to completing installation of the structural elements in this plan.

Cultural Resources

One archeological site is in the vicinity of the Agricultural Park Subdivision. An environmental impact statement (EIS) is being prepared by the State covering development of the subdivision in the proposed Waimanalo Agricultural Park. It will consider the effects and disposition of this site.

SCS and the State Historic Preservation Officer have submitted the Waimanalo Ditch System for nomination to the National Register of Historic Places and are awaiting a formal determination of eligibility. SCS will follow the procedure found at 7 CFR 656 regarding the future of the ditch system.

If cultural resources are discovered during construction, appropriate notice will be made to the Secretary of Interior and the Hawaii State Historic Preservation Officer and SCS procedures found at 7 CFR 656 will be followed.

OPERATION, MAINTENANCE, AND REPLACEMENT

General

The operation, maintenance, and replacement of structural measures will be the responsibility of DLNR. An operation and maintenance agreement will be executed prior to signing a project agreement in accordance with the SCS publication, "Hawaii Watershed Operation and Maintenance Handbook." The operation and maintenance agreement will include specific provisions for retention and disposal of property acquired or improved with Public Law 566 financial assistance. An operation and maintenance plan will be prepared for all structural measures. The total annual cost for operation, maintenance and replacement is $148,000.

Operation

Reservoir inflow and releases will be monitored and adjusted by WIS to meet project demands for irrigation water. In the 60 million gallon storage reservoir, water depth will be generally maintained greater than 10 feet above the outlet to assist in controlling plant-parasitic nematodes that may have entered the reservoir. Outflow from the reservoir into the irrigation delivery system will be monitored for nematode content periodically throughout the irrigation season. The drain valve assembly at the intersection of Waimanalo Stream and Waikupanaha Street is available for disposal of reservoir inflow as well as a drainage facility for the reservoir itself.

The sewage effluent storage reservoir will be operated to meet project demands for irrigation water without overflow into the adjacent stream under routine operating conditions. Close coordination with the Waimanalo Sewage Treatment Plant will be required. Backflow for the sewage effluent storage reservoir is provided at the sewage plant pump sump with a manually controlled valving system. The gated outlet facility at the reservoir will allow storage water to be drained into the existing injection wells at the sewage plant.

Special attention will be required for the operation of both reservoirs to ensure that the full supply of planned water storage will be available during the irrigation season (critical water-short months are June through September).

DLNR will operate or arrange for the operation of the solid waste collection sites.

Maintenance

The 60 million gallon storage reservoir and the sewage effluent reservoir will be maintained by WIS. The principal routine work items are servicing and maintaining slide gates, maintaining reinforced concrete structures, maintaining structural backfill, removing debris, cleaning debris and algae from trashracks, repairing fencing, maintaining the reservoir lining and drainage system.

WIS will also maintain the distribution system keeping all pipeline structures, pumps, irrigation turnout structure, meters, valves, screens, and pipe protection devices in serviceable condition by maintenance or repairs as needed during the life of the project.

WIS will maintain the capacity of the reservoir diversion channels and spillways by clearing debris and undesirable vegetative growth. Poor stands of vegetation or areas destroyed by erosion, will be reestablished and, if necessary, eroded areas will be restored before reseeding. Particular emphasis will be placed on the condition of landscaping vegetation, the vegetation at the two reservoirs, on the immediate small areas upstream, and within the diversion channels.

A reasonable vegetation establishment period (not to exceed one year) will be allowed after initial plantings. The need for maintenance will be determined by inspections.

Inspection

An inspection to determine operation, maintenance, and replacement needs will be conducted during or immediately after the initial filling of the reservoirs. There will be an inspection annually and after any major storm or earthquake. An SCS engineer will assist in conducting structural measure inspections. A qualified SCS employee will assist in conducting inspections of land treatment and vegetation.

DLNR will maintain a record of all maintenance inspections, any maintenance required together with the schedule for completing it, and when completed, the cost of the maintenance. A copy will be submitted to SCS.

Replacement

Major repair as a result of severe storms or other causes, and replacement of worn or deteriorated items with a useful life shorter than the 50-year life of the project, will be provided by the DLNR.

The following items have an estimated useful life of approximately 25 years:

Slide gates on the reservoir and the control structures
Pump and motors
Trashracks and debris racks
Traveling screen at the reservoir inlet
Valves, vents, pressure relief valves, etc.
Meters, flow control valves

TABLE 1 - ESTIMATED INSTALLATION COST

Waimanalo Watershed, Hawaii

Installation Cost Item	Unit	Number	Estimated Cost (Dollars) 1/ Total P.L. 566 Funds (SCS)	Total Other Funds	Total
LAND TREATMENT:					
Conservation Cropping System	Acres	314		0	0
Diversion	Feet	20,000		40,000	40,000
Grassed Waterway	Acres	12		6,000	6,000
Irrigation System	No.	52		127,000	127,000
Irrigation Pipeline (On-farm)	Feet	26,000		288,000	288,000
Irrigation Water Management	Acres	450		0	0
Land Clearing	Acres	314		128,000	128,000
Technical Assistance 3/	Man/Years	0.3	20,000	7,000	27,000
Subtotal Land Treatment			20,000	596,000	616,000
STRUCTURAL MEASURES:					
CONSTRUCTION:					
Water Collection System Improvements	All	All	0	500,000	500,000
Irrigation Storage Reservoir	No.	1	2,485,000	2,485,000	4,970,000
Irrigation Pipeline System	Miles	14.1	1,425,000	1,425,000	2,850,000
Old Irrigation Ditch Modification	All	All	25,000	25,000	50,000
Sewage Effluent Pumps, Pipeline System and Storage Reservoir	All	All	205,000	205,000	410,000
Solid Waste Collection Sites	No.	3	30,000	30,000	60,000
Subtotal Construction			4,170,000	4,670,000	8,840,000
ENGINEERING SERVICES:					
Subtotal Engineering	All	All	831,000	33,000	864,000
LAND AND WATER RIGHTS:					
Subtotal Land Rights	All	All	0	740,000	740,000
PROJECT ADMINISTRATION	All	All	1,087,000	651,000	1,738,000
TOTAL STRUCTURAL			6,088,000	6,094,000	12,182,000
TOTAL PROJECT			6,108,000	6,690,000	12,798,000

1/ Price base 1980
2/ Federal agency responsible for assisting in installation of works of improvement
3/ Includes contracted technical services in nematode control and trickle irrigation

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TABLE 2 - ESTIMATED COST DISTRIBUTION

IRRIGATION AND ENVIRONMENTAL ENHANCEMENT STRUCTURAL MEASURES

Waimanalo Watershed, Hawaii

(Dollars) 1/

Item	Installation Costs - PL-566 Funds				Installation Cost - Other Funds						Total Installed Cost
	Construction	Engineering	Project Admin.	Total PL-566	Construction	Engineering	Land Rights 2/	Water Rights	Project Admin.	Total Other	
STRUCTURAL MEASURES											
Water Collection System Improvements: 3/ 4/	-	-	-	-	500,000 (1,000,000)	33,000 (67,000)		(400,000)	67,000 (133,000)	600,000 (1,600,000)	600,000 (1,600,000)
Irrigation Storage Reservoir:	2,485,000	500,000	650,000	3,735,000	2,485,000		550,000		350,000	3,385,000	7,020,000
Irrigation Pipeline System:	1,425,000	280,000	370,000	2,145,000	1,425,000		50,000		200,000	1,675,000	3,750,000
Old Irrigation Ditch Modification For Surface Runoff Disposal:	25,000	5,000	10,000	40,000	25,000					25,000	65,000
Sewage Effluent Pumps, Pipeline System and Storage Reservoir:	205,000	40,000	50,000	295,000	205,000		130,000		30,000	365,000	660,000
Solid Waste Collection Sites:	30,000	6,000	7,000	43,000	30,000		10,000		4,000	44,000	87,000
TOTAL STRUCTURAL MEASURES	4,170,000	831,000	1,087,000	6,088,000	4,670,000	33,000	740,000		651,000	6,094,000	12,182,000
GRAND TOTAL				6,088,000						6,094,000	12,182,000

1/ Price base 1980.
2/ Opportunity cost value of land rights owned by local sponsors or acquired for project plus protection of utilities.
3/ Associated cost necessary to the project but not cost-shared because they occur outside the watershed boundary.
4/ Item in parenthesis will be installed in the future even without the project and are not added to project costs. Water rights costs are annual costs of $30,000 capitalized at 7-3/8% for 50 years.

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TABLE 2A - COST ALLOCATION AND COST-SHARING SUMMARY

IRRIGATION AND ENVIRONMENTAL ENHANCEMENT STRUCTURAL MEASURES

Waimanalo Watershed, Hawaii

(Dollars) 1/

Item	Cost Allocation			Cost-Sharing 2/					
	Purpose			PL-566			Other		
	Irrigation	Environ. Enhance.	Total	Irrigation	Environ. Enhance.	Total	Irrigation	Environ. Enhance.	Total
Water Collection System Improvements: 3/									
Construction	500,000		500,000				500,000		500,000
Engineering	33,000		33,000				33,000		33,000
Project Admin.	67,000		67,000				67,000		67,000
Subtotal	600,000		600,000				600,000		600,000
Irrigation Storage Reservoir:									
Construction	4,970,000		4,970,000	2,485,000		2,485,000	2,485,000		2,485,000
Engineering	500,000		500,000	500,000		500,000			
Land Rights 4/	550,000		550,000				550,000		550,000
Project Admin.	1,000,000		1,000,000	650,000		650,000	350,000		350,000
Subtotal	7,020,000		7,020,000	3,635,000		3,635,000	3,385,000		3,385,000
Irrigation Pipeline System:									
Construction	2,850,000		2,850,000	1,425,000		1,425,000	1,425,000		1,425,000
Engineering	280,000		280,000	280,000		280,000			
Land Rights 4/	50,000		50,000				50,000		50,000
Project Admin.	570,000		570,000	370,000		370,000	200,000		200,000
Subtotal	3,750,000		3,750,000	2,075,000		2,075,000	1,675,000		1,675,000
Old Irrigation Ditch Modification:									
Construction	50,000		50,000	25,000		25,000	25,000		25,000
Engineering	5,000		5,000	5,000		5,000			
Project Admin.	10,000		10,000	10,000		10,000			
Subtotal	65,000		65,000	40,000		40,000	25,000		25,000
Sewage Effluent Pumps, Pipeline System and Storage Reservoir:									
Construction	410,000		410,000	205,000		205,000	205,000		205,000
Engineering	40,000		40,000	40,000		40,000			
Land Rights 4/	130,000		130,000				130,000		130,000
Project Admin.	80,000		80,000	50,000		50,000			30,000
Subtotal	660,000		660,000	295,000		295,000	365,000		365,000
Solid Waste Collection Sites:									
Construction		60,000	60,000		30,000	30,000		30,000	30,000
Engineering		6,000	6,000		6,000	6,000			
Land Rights 4/		10,000	10,000					10,000	10,000
Project Admin.		11,000	11,000		7,000	7,000		4,000	4,000
Subtotal		87,000	87,000		43,000	43,000		44,000	44,000
TOTAL	12,095,000	87,000	12,182,000	6,045,000	43,000	6,088,000	6,050,000	44,000	6,094,000

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1/ Price base 1980
2/ Cost-sharing: Construction items 50-50; engineering and administration about 5/6-1/6, PL-566 and other funds respectively
3/ Associated costs necessary to the project but not cost-shared because they occur outside the watershed boundary
4/ Opportunity cost value of land rights owned by local sponsors or acquired for project plus protection of utilities

TABLE 3A - STRUCTURAL DATA

EXCAVATED RESERVOIRS WITH PLANNED STORAGE CAPACITY

Waimanalo Watershed, Hawaii

Item	Unit	Storage & Regulating	Sewage Effluent Ponds
Class of Structure	-	C	NA
Seismic Zone	-	1	NA
Controlled Drainage Area (Reservoir Surface)	ac.	5.2	0.8
Elevation Crest Inflow (Submerged)	ft.(msl)	242.0	87.0 Assumed Elev.
Elevation Top of Dam	ft.(msl)	311.7	96.5 " "
Elevation - Irrigation Storage Pool	ft.(msl)	308.7	94.5 " "
Elevation Crest of Ungated Spillway	ft.(msl)	308.7	95.5 " "
Maximum Height of Fill (Top of Dam to Original Ground)	ft.	40	3
Volume of Fill	cu. yd.	197,600	3,358
Maximum Depth of Excavation	ft.	37	17.5
Volume of Excavation	cu. yd.	230,400	29,341
Reservoir Capacity -			
Irrigation Pool	$\bar{M}G$	60	2 @ 1.5 ea.
	ac. ft.	184.1	4.6
Surface Area -			
Irrigation Pool	ac.	5.2	2 @ 0.8 ea.
Inlet Pipeline System Design	$\bar{M}G/D$	4.7	2.6
Ungated Spillway Design -			
Freeboard Design -			
Rainfall Volume (FH)	in.	44 (PMP)	12 (P_{25})
Runoff Volume (FH)	in.	44	12
Storm Duration	hr.	24	24
Maximum Reservoir W.S. Elevation	ft.(msl)	309.9	95.5 Assumed Elev.
Type -			
Drop Spillway -			
Crest Length	ft.	12.5	12-in.diameter
Capacity at Top of Dam Elev.	cfs	200	3.3
Routed Flow @ Maximum Res. W.S. Elev.	cfs	52	0.4
Diversion for Outside Reservoir Drainage Area -			
Drainage Area	ac.	6.3	9.8
Frequency - Design	%	PMP	4
Storm Duration	hr.	24	24
Runoff Peak Flow	cfs	200	13

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TABLE 3A - STRUCTURAL DATA (Continued - 2)

EXCAVATED RESERVOIRS WITH PLANNED STORAGE CAPACITY

Waimanalo Watershed, Hawaii

Item	Unit	Storage & Regulating	Sewage Effluent Ponds
Type -		Rocky Alluvium Material	
Bottom Width	ft.	10	2
Velocity of Flow	fps	5.9	3.8
Slope of Channel	ft./ft.	.005	.01
Irrigation & Drain Outlet Pipe			
Elevation Crest Outlet	ft.(msl)	245	pump
Conduit Diameter	in.	24	12

TABLE 3B - STRUCTURAL DATA

PIPELINE SYSTEM

Waimanalo Watershed, Hawaii

Pipeline Location	Type	Length ft.	Diameter in.	Design Flow[3/] gpm	Max. Static Pressure[1/] @ Max. W.S. psi	Minimum Irrigation Outlet Pressure[4/] @ Probable Max. Flow psi	Booster Pumps Required For Sprinkler Pressure no.
RESERVOIR SUPPLY							
Tunnel to reservoir	AC	9,700	16	3,250 4.7 MG/D	94	NA	NA
IRRIGATION DISTRIBUTION							
On Mahailua St. from reservoir to Waikupanaha St.	AC	2,680	24	3,250	82	39	1
On Waikupanaha St. from Mahailua St. to Kakaina St.	PVC	1,660	14	2,230	82	50	-
On Waikupanaha St. from Kakaina St. to Kumuhau St.	PVC	1,600	14	1,300	94	48	-
On Waikupanaha St. from Kumuhau to outlets of Area "A" and Ag. Park Subdivision	PVC	675	12	1,010	94	NA	-
On Waikupanaha St. from Mahailua St. to Kaulukanu St.	PVC	1,960	14	1,875	84	50	2
On Waikupanaha St. from Kaulukanu St. to Mokulama St.	PVC	1,840	14	1,375	80	47	2
On Waikupanaha St. from Mokulama St. to Ahiki St.	PVC	1,760	14	1,760	83	48	1
On Waikupanaha St. from Ahiki St. to end of line	PVC PVC	940 4,800	10 8	460 220	83 95	48 57	- -

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TABLE 3B - STRUCTURAL DATA (Continued - 2)

PIPELINE SYSTEM

Waimanalo Watershed, Hawaii

Pipeline Location	Type	Length ft.	Diameter in.	Design Flow[3/] gpm	Max. Static Pressure[1/] @ Max. W.S. psi	Minimum Irrigation Outlet Pressure[4/] @ Probable Max. Flow psi	Booster Pumps Required For Sprinkler Pressure no.
IRRIGATION DISTRIBUTION (conti.)							
On Kakaina St. makai from Waikupanaha St. to Mahailua St.	PVC	2,420	8	200	104	57	-
On Kakaina St. from Mahailua St. to end of line	PVC	800	6	150	115	74	-
On Kakaina St. mauka from Waikupanaha St. to end of line	PVC PVC	2,320 1,020	12 8	150 150	78 50	0 -	1 -
On Kumuhau St. makai from Waikupanaha St. to Mahailua St.	PVC	2,940	8	150	112	64	-
On Kumuhau St. from Mahailua St. to end of line	PVC	860	6	150	117	81	-
On Mahailua St. from Kumuhau St. to end of line	PVC	960	6	150	114	78	-
Area "A" - mauka of Waikupanaha St.	PVC PVC	1,800 2,400	12 8	300 150	80 55	0 -	1 -
Ag. Park Subdivision	PVC PVC	1,725 2,775	10 6	460 150	90 115	44 44	3 -
On Mooiki St. makai from Waikupanaha St. to end of line	PVC	1,240	6	150	101	92	-
On Kaulukanu St. makai from Waikupanaha St. to end of line	PVC	2,460	6	150	112	60	-

TABLE 3B - STRUCTURAL DATA (Continued - 3)

PIPELINE SYSTEM

Waimanalo Watershed, Hawaii

Pipeline Location	Type	Length ft.	Diameter in.	Design Flow[3/] gpm	Max. Static Pressure[1/] @ Max. W.S. psi	Minimum Irrigation Outlet Pressure[4/] @ Probable Max. Flow psi	Booster Pumps Required For Sprinkler Pressure no.
IRRIGATION DISTRIBUTION (conti.)							
On Kaulukanu St. mauka from Waikupanaha St. to end of all lines	PVC PVC PVC	1,650 800 540	12 8 6	218 150 150	75 54 33	2 3 5	1 - -
Lateral makai from Waikupanaha St. between Kaulukanu St. and Mokulama St.	PVC	950	6	150	78	59	-
On Mokulama St. from Waikupanaha St. makai to end of line	PVC	2,320	6	150	112	65	-
On Makakalo St. from Mokulama St. to end of line	PVC	1,050	6	150	108	72	-
From Makakalo St. makai to end of line	PVC	950	6	150	111	75	-
On Ahiki St. from Waikupanaha St. to Hihimanu St.	PVC	3,440	10	415	122	82	-
On Hihimanu St.	PVC PVC	1,500 2,500	8 8	150 290	123 129	84 90	- -
SEWAGE USE AREA							
From pump at sewage plant to reservoir	PVC	3,450	12	1,150	25	NA	1
From reservoir to areas irrigated with treated sewage effluent	PVC	4,000	12	450	15	0	1[2/]

1/ With maximum water surface in reservoir at elevation 317.0

2/ To pump from sewage reservoir to "on-farm" outlet for surface irrigation

3/ @ 5 gpm/ac or 150 gpm (min.), whichever is greater

4/ With minimum water surface in reservoir at elevation 260.0

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TABLE 4 - PROJECT EFFECTS

Waimanalo Watershed, Hawaii

NATIONAL ECONOMIC DEVELOPMENT

Beneficial Effects

Components	Measure of Effects (Average Annual)1/
A. Value to users of increased outputs of goods and services:	
1. Irrigation	$1,996,000
2. OM&R foregone 3/	$ 125,000
Total Beneficial Effects	$2,121,000
Net Beneficial Effects	$ 916,000
B:C = 1.8:1.0	

Adverse Effects

Components	Measure of Effects (Average Annual)2/
A. The value of resources required for the project:	
1. Project outlays	
a. Irrigation reservoirs and pipeline systems -	
Project installation	$918,000
OM&R	$148,000
b. Accelerated land treatment	47,000
c. EQ construction 4/ components	($ 7,000)
2. Other project costs	
a. Interest during construction 5/	49,000
b. Water collection system improvements occurring outside of watershed -	
Installation cost	$ 38,000
OM&R	$ 5,000
Total Adverse Effects	$1,205,000

1/ Price base - 1980 current normalized.
2/ Amortized over 50 years @ 7 3/8 percent interest.
3/ OM&R no longer needed because of project action.
4/ Solid waste collection sites related to surface drainage, aesthetics, and health. Costs not charged against NED beneficial effects.
5/ Construction period of 2 years with approximately equal investment in each year and quarter year. Compounded interest @ 7 3/8 percent ($648,000) is then amortized over 50 years.

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TABLE 4 - PROJECT EFFECTS (Continued - 2)

Waimanalo Watershed, Hawaii

REGIONAL ECONOMIC DEVELOPMENT

Beneficial Effects

Components	Measure of Effects: State of Hawaii (Average Annual) 1/	Measure of Effects: Rest of Nation (Average Annual) 1/
A. Value of increased output of goods and services to users residing in the region:		
1. Irrigation	$3,580,000	0
2. Additional wages to agricultural workers	$ 500,000	-$500,000
3. Additional OM&R wages	$ 9,000	-$ 9,000
B. External economies from supplying agricultural production inputs	nil	
Total Beneficial Effects	$4,089,000	-$509,000

Adverse Effects

Components	Measure of Effects: State of Hawaii (Average Annual) 2/	Measure of Effects: Rest of Nation (Average Annual) 2/
A. Value of resources contributed from within the region to achieve the outputs:		
1. Project outlays		
a. Irrigation reservoirs and pipeline systems -		
Project installation	$463,000	$462,000
OM&R	$148,000	0
b. Accelerated land treatment	$ 34,000	$ 13,000
2. Other project costs		
a. Interest during construction	$ 26,000	$ 23,000
b. Water collection systems improvements occurring outside of watershed -		
Installation costs	$ 38,000	0
OM&R	$ 5,000	
c. External diseconomies		
Total Adverse Effects	$714,000	$498,000

1/ Price base - 1980 current normalized.
2/ Amortized over 50 years @ 7 3/8 percent interest.
3/ Estimated by WRC Guideline 5 Regional Multipliers, January 1977, "Direct Effect" components for fruits, vegetables, and nursery products.

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TABLE 4 - PROJECT EFFECTS (Continued - 3)

Waimanalo Watershed, Hawaii

ENVIRONMENTAL QUALITY

Beneficial Effects

Components	Measure of Effects
A. Aesthetics	1. Project output will make available regional funds and resources that can be used to enhance the rural appearance of 145 farms on 1,252 acres.
	2. Provide irrigation water to an additional 430 acres of diversified agriculture, creating more color contrast on the landscape.
	3. Create 2 reservoirs with total surface area of 7 acres which diversify the landscape from viewpoints above the valley.
	4. Improve the appearance of the landscape by providing solid waste sites which are screened from view.

Adverse Effects

Components	Measure of Effects
A. Aesthetics	1. Removal of vegetation causing a temporary unsightly landscape during construction.
	2. Removal of surface irrigation system removes visibility of water on the landscape.
	3. Irrigation reservoir and associated works will be a major contrast in the viewshed.

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TABLE 4 - PROJECT EFFECTS (Continued - 4)

Waimanalo Watershed, Hawaii

ENVIRONMENTAL QUALITY

Beneficial Effects		Adverse Effects	
Components	Measure of Effects	Components	Measure of Effects
B. Ecological Attributes	1. Improves fish and wildlife habitat and food by freeing spring water to flow down Waimanalo Stream. 2. Orderly solid waste collection sites will reduce chance of stream pollution.	B. Ecological Attributes	1. Forty additional farm units may introduce additional dogs and cats into the area which will have an adverse effect on the present wild animals.
C. Cultural Attributes	1. Identifies and protects archeological and historical sites.	C. Cultural Attributes	1. Unknown buried archeological sites may be disturbed during construction before their significance is realized.

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TABLE 4 - PROJECT EFFECTS (Continued - 5)

Waimanalo Watershed, Hawaii

OTHER SOCIAL EFFECTS

Beneficial Effects

Components	Measure of Effects
A. Urban and Community Impacts	1. Create 100 low to medium income jobs in agriculture.
	2. Create regional income benefits of $4,089,000 distributed by family income costs as follows:

Family Income Class	Percent of Population in Class	Estimated Percent of Benefits to Class
Less than $10,000	36.6%	20%
$10,000-$20,000	37.3%	25%
More than $20,000	26.1%	55%

Components	Measure of Effects
B. Life, Health, and Safety	1. Reduces safety hazards to WIS maintenance employees.
	2. Reduces flood hazard to 21 houses and about 95 people from sudden failure of Kailua Reservoir.
	3. Reduces potential health hazards by improved facilities for solid waste.
C. Long-Term Productivity	1. Encourages maintenance of 1,199 acres of important farmland in ag. use.
D. Energy Requirements	1. Makes use of gravity pressures to save pumping energy.

Adverse Effects

Components	Measure of Effects
A. Urban and Community Impacts	1. Annualized local costs of project total $714,000 These costs are borne by family income classes as follows:

Family Income Class	Percent of Population in Class	Estimated Percent of Benefits to Class
Less than $10,000	36.6%	5%
$10,000-$20,000	37.3%	20%
More than $20,000	26.1%	75%

Components	Measure of Effects
B. Life, Health, and Safety	1. Creates flood hazard to 77 houses and about 350 people from sudden failure of off-stream reservoir.
C. Long-Term Productivity	1. Commits 13.6 acres to the two reservoirs.
	2. Commits 0.2 acre to solid waste collection sites.
D. Energy Requirements	1. Installation: 660 billion BTU's.
	2. Operation: 150,000 KwHr/YR.

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EFFECTS OF RECOMMENDED PLAN

GENERAL

This section describes the economic, environmental, and social effects of the planned project and discusses four aspects of these effects. The first aspect covers features determined to have significant effect on specific resources and resource attributes. Table B - Inventory and Analysis of Resources and Forecasting lists the significant items as determined by the scoping process.

The second aspect expands on comments made in Table 4, Project Effects. The third explains the degree or extent to which the recommended plan alleviates the problems and takes advantage of the opportunities listed in Table A, Problems and Opportunities.

The last aspect deals with specific resources that are recognized by federal policies. Table H - Effects of the Recommended Plan on Resources of Principal National Recognition lists the types of resources, the specific policy, and the measurement of effects.

SIGNIFICANT EFFECTS

The recommended plan involves four of the six project actions covered by Table B: pipelines in place of ditches; new reservoir; irrigation with sewage effluent; and irrigation of more land. These project actions have a medium to high significance to decisionmaking for 11 of the 17 resources listed in the table as follows:

Prime and important farmlands under irrigation are increased by 377 acres.

Waimanalo stream quality will tend to be improved by no longer using Kailua Reservoir in the irrigation system. Spring water generated on upper Waimanalo Stream will now flow unimpeded. The replacement of open ditches by pipelines will eliminate ditch flushings as a source of temporary stream contamination.

Ground water quantity in the alluvial zone may tend to be reduced as leaking ditches and reservoirs are replaced and irrigation efficiencies increase. Irrigation with treated sewage effluent introduces the opportunity for effluent to move into the alluvial ground water.

Municipal water (BWS) used for agricultural production is estimated to decrease from 71 to 56 million gallons per year.

Irrigation water quantity (WIS) delivered to the farm will increase from 128 to 548 million gallons per year. This increase will deliver a full water supply to the 449 acres presently irrigated (often with less than full supply) and to an additional 441 acres (actually 430 acres when BWS and sewage are considered).

Irrigation water quality will be improved by the reduction of mineral and organic matter transported, reduction of the opportunity for contamination by agricultural chemicals, and the almost complete elimination of plant-parasitic nematodes.

Visual resources will be improved by utilizing the solid waste collection sites, the increased number of farming operations from 105 to 145, and by the additional 430 acres in irrigated farmland. There will be a loss in visual quality when some portions of the ditch are abandoned.

Character of human environment is enhanced as desired in state and local plans by the strengthening of agriculture in Waimanalo. The 40 new farms will involve approximately 100 additional people in agriculture.

Population is forecast to expand to 12,000 by the year 2020. By strengthening agriculture, the recommended plan will tend to encourage a 2020 population of approximately 10,000 (Ref. 1).

One Archeological site in the vicinity of the proposed Ag Park Subdivision may be directly affected by the implementation of the State's proposed Agricultural Park Plan. It will be evaluated and covered by the State's EIS for the Ag Park Subdivision. Sites that may be uncovered by project construction operations will be handled in accordance with SCS procedures as detailed at 7 CFR 656.

Historical sites may include portions of the antiquated WIS ditch system. It has been proposed for nomination to the National Register of Historic Sites and appropriate actions will be taken in accordance with SCS procedures (7 CFR 656).

PROJECT EFFECTS SHOWN IN TABLE 4

Table 4 separates the beneficial and adverse effects of the recommended plan into four separate accounts--National Economic Development, Regional Economic Development, Environmental Quality, and Other Social Effects.

National Economic Development (NED)

All beneficial effects in the NED account stem from improved irrigated crop production as a result of structural and land treatment measures. These measures provide a more dependable and higher quality irrigation water supply. WIS will have an improved pressurized pipeline delivery system that accommodates highly efficient drip or sprinkler application. WIS will have a separate system for furrow irrigation with treated sewage effluent. The beneficial effects of the project are the increases in net returns above production costs (over and above net returns that would accrue under the future without-project condition) and are estimated at $2,121,000 per year.

Adverse effects in the NED account attributable to irrigation include the annualized costs of reservoirs, pipeline systems, and land treatment that would be greater with the project than under the future without-project condition. Annualized costs include amortization of installation costs plus increases in operation and maintenance costs. Adverse effects of solid waste collection sites as shown in parentheses are the amortized costs of those installations and are not charged against NED beneficial effects. Total adverse effects are estimated at $1,205,000 per year.

Total beneficial effects of $2,121,000 minus total adverse effects of $1,205,000 provide net beneficial effects of $916,000 per year. Beneficial effects divided by adverse effects provide a B:C ratio of 1.8:1.0.

Regional Economic Development (RED)

Beneficial effects in the RED account recognize that the annual net benefits to the national economy will actually accrue to the resident economy of Hawaii and not to the rest of the nation. There will be additional benefits to the region in the form of income to agricultural workers and to WIS operation and maintenance workers who might be working in other states if not employed in Hawaii (transfer or displacement benefits).

Adverse RED effects include the annualized local share of structural installation and land treatment; operation, maintenance and replacement costs borne by Hawaii; and the annualized costs of structural measures and land treatment borne by the rest of the nation. Emphasis is on the relative subsidy of the project by the rest of the nation and the benefit accrual to Hawaii.

Environmental Quality (EQ)

Beneficial effects in the EQ account will occur with project installation. The appearance of the area will be enhanced by several features of the recommended plan. There will be improvements to houses, barns, yards, and fields as a result of increased net incomes to the farmers. The additional 430 acres of irrigated land in diversified crops such as bananas, truck crops, and nursery stock will increase color contrast resulting in a more pleasing visual impression. The new reservoirs will create diversity from the surrounding lands when viewed from the mountains or from aircraft. The recommended plan provides for three containerized solid waste disposal sites located off the roads and screened by vegetation. Use of these sites will improve the appearance of the area by reducing the present practice of discarding waste materials along rural roads and in ditches.

Spring water flowing into Kailua Reservoir is now stored with ditch water from Aniani Nui Tunnel. Water is released down the Waimanalo Stream for scheduled irrigations or when the reservoir fills from heavy rainfall. These flows tend to reduce stream water quality by flushing debris from the ditches into the stream. The recommended plan would not divert ditch water into Kailua Reservoir and as a result the occasional reductions in quality would not occur.

The recommended plan provides for the identification of significant historical and archeological resources. Those that are identified will be preserved or protected according to plans that will be developed with the State Historical Preservation Officer in accordance with SCS procedures (7 CFR 656).

Adverse environmental quality effects from the installation of the project include removal of natural vegetation in construction areas, causing a temporary visual scar on the landscape, movement of construction equipment through the rural area--temporarily disrupting tranquility.

The present irrigation system presents fleeting glimpses of water in the ditches on irrigation days, creating an interesting visual impression. The recommended plan eliminates the use of ditches to transport irrigation water and thus loses this visual asset. Removal of vegetation along abandoned portions of the WIS ditch will cause some reduction in visual diversity on the valley floor.

The increase in irrigated land will result in 40 additional farm units with some increase in dogs and cats. These domestic animals will have an adverse effect on wildlife.

Construction activities, such as pipe installation, may disturb unidentified buried archeological sites.

Other Social Effects

Beneficial effects (to urban and community impacts) include the creation of 100 new jobs in agriculture that probably would be filled from the Waimanalo community. The regional gross income benefits of $4,089,000 would largely be distributed among family income classes in proportion to those involved in agriculture. Though Waimanalo farms are small, family net income level is often quite good because of high-value crops and family labor in highly intensive cropping. Over half of the benefits from irrigation will accrue to families with income over $20,000 per year.

Benefits to life, health, and safety include an important reduction of safety hazards by replacing unsafe antiquated wooden flumes with buried pipe siphons, and replacing open ditches with closed pipe systems eliminating the need for continual herbicide application. Kailua Reservoir will no longer be a part of the irrigation system, and the remote threat of damage to 21 houses by the flood from a structural failure would be reduced. Health hazards will be reduced by improved solid waste collection sites that encourage more orderly garbage disposal.

Benefits to long-term productivity will accrue from the project encouraging the maintenance of 1,199 acres of prime and important farmland in agricultural use. This occurs because profitable irrigated farming is better able to compete against urbanization for the use of land than is marginal farming or dry pasture.

Benefits from energy conservation will be realized by replacing onfarm sprinkler pumps with gravity pressures for most lands now irrigated. Booster pump energy to irrigate some of the additional acres at higher elevations and pump energy to use the sewage effluent will be required.

Adverse effects to the community include the annualized local costs of the project which will be borne by local residents in proportion to the user fees and income taxes paid. This concentrates the payment of the local costs on families with higher incomes.

Adverse effects to life, health and safety include the hazard to 77 houses from the remote threat of a sudden failure of the 60 million gallon reservoir on the mauka end of Mahailua Street. Massive earthquake damage would be the most likely event that might create such failure.

Adverse effects to long-term productivity would occur from the commitment of approximately 13.6 acres for the reservoirs and approximately 0.2 acre for solid waste collection sites.

Adverse energy effects include the consumption of 660 billion BTU's to fabricate and install the project measures and 150,000 kWh/yr for operation.

EFFECTIVENESS OF THE RECOMMENDED PLAN

Table A describes 7 general and 13 specific problems or opportunities with water and related land resources in Waimanalo Watershed. The following

discussion relates directly to the lettered general problems or opportunities and the numbered specific problems or opportunities in Table A:

A.1. Undependable supply and operation

The sponsors have agreed that as a part of the future without-project condition they will acquire long-term water rights and make structural improvements in the Maunawili Watershed collection system. They also agreed, as a condition to implementing this plan, to make improvements in Maunawili to enhance water quality. The recommended plan will alleviate the physical and operational problems with the distribution system in Waimanalo Watershed.

A.2. Inadequate amount of water to irrigate 1,873 acres of irrigable Waimanalo farmland

The recommended plan will irrigate a total of 1,252 acres at full supply.

A.3. Poor water quality limits use and management opportunities

The replacement of the open ditch distribution system with pressure pipelines and collection system improvements eliminate the major sources of contamination to irrigation water. The deep storage reservoir will serve as a control to any plant-parasitic nematodes in the system by restricting their oxygen supply. The water as delivered to the farm will be sprinkler quality, and the nematode problem will be greatly reduced to easily manageable levels. Drip systems will require standard onfarm filtering. The treated sewage effluent will be satisfactory for surface irrigation of crops allowed by health regulations such as bananas, orchards, and certain nursery crops.

B.1. BWS primarily a domestic water supply system

The dependence on BWS for irrigation is reduced from 71 to 56 million gallons per year. The new WIS facilities provided by the recommended plan will meet Waimanalo's agricultural water needs although some users may choose to use domestic water for irrigation if it is available.

C.1. Opportunity to use 128 $\bar{M}$G/YR of treated sewage effluent

The recommended plan will use 78 million gallons per year of treated sewage effluent for irrigation.

C.2. Irrigable state lands close to the sewage treatment plant

Treated sewage effluent will be conveyed to approximately 68 acres of state controlled land including the University of Hawaii, College of Tropical Agriculture, Waimanalo Experiment Station. In addition to partially meeting the station's irrigation water requirements, the treated sewage effluent provides an opportunity for experimentation with its use on various crops.

D.1. and 2. WIS service to 449 acres of prime and important farmlands out of 2,174 acres available

The recommended plan will irrigate 837 acres of prime and important farmlands with WIS water and an additional 68 acres with sewage effluent. (BWS will irrigate 294 acres for a total of 1,199 acres.)

E.1. Flooding problems from frequent storm events

The recommended plan does not significantly alleviate the nuisance flooding. The recommended plan will make minor unevaluated improvements by providing facilities for solid waste collection. Solid waste discarded along the roads clogs ditches and culverts. The abandoned WIS ditch system will be modified and maintained as necessary to continue to operate as a storm runoff drainage system.

During plan formulation, the Sponsors requested that SCS make a study and prepare a report addressing the need for improvements and modifications in the existing drainage system. Costs and potential environmental effects will be included and needs will be ranked. This report will be used by the Sponsors to request changes in policies or laws as necessary to alleviate specific problem E.1.c. Lack of Maintenance. . . .

F.1 Solid waste disposal problems

The recommended plan provides facilities, which the Sponsors will operate and maintain, for solid waste collection sites. The Sponsors will work with local groups to encourage use of the sites rather than roadside dumping.

G.1 Opportunity to preserve or protect historically significant portion of WIS ditches

If portions of the WIS ditches submitted for nomination to the National Register are determined to have historic value, those portions will be preserved or protected in accordance with a plan developed with the State Historical Preservation Office (SCS procedures are at 7 CFR 656).

EFFECTS ON NATIONALLY RECOGNIZED RESOURCES

Certain federal policies and laws recognize specific types of resources. These policies and laws impose specific requirements for analysis of the effects of a recommended plan as shown in Table I. In addition to the ten "Types of Resources" shown in Table I, there may be some localized reduction in quality of alluvial ground water as a result of irrigation with treated sewage effluent. Ground water resources are recognized nationally in the Safe Drinking Water Act, as amended (42 U.S.C. 300f et seq.).

TABLE I - EFFECTS OF THE RECOMMENDED PLAN ON RESOURCES OF PRINCIPAL NATIONAL RECOGNITION

Waimanalo Watershed, Hawaii

Types of Resources	Principal Sources of National Recognition	Measurement of Effects
1. Air quality	Clean Air Act, as amended (42 U.S.C. 1857h-7 et seq.)	No effect
2. Areas of particular concern within the coastal zone	Coastal Zone Management Act OF 1972, as amended (16 U.S.C. 1451 et seq.)	No effect
3. Endangered and threatened species	Endangered Species Act of 1973, as amended (16 U.S.C. 1451 et seq.)	No effect
4. Fish and wildlife habitat	Fish and Wildlife Coordination Act (16 U.S.C. Sec. 661 et seq.)	No effects on wildlife habitat
5. Flood plains	Executive Order 11988, Flood plain Management	No effect
6. Historic and cultural properties	National Historic Preservation Act of 1966, as amended (16 U.S.C. Sec. 470 et seq.)	One historic site submitted for nomination to National Register. One archeological site covered by State Plan and EIS.
7. Prime and unique farmland 1/	CEQ Memorandum of August 1, 1980: Analysis of Impacts on Prime or Unique Agricultural Lands in Implementing the National Environmental Policy Act	Gain 377 acres prime and important farmland
8. Water Quality	Clean Water Act of 1977 (33 U.S.C. 1251 et seq.)	Reduce suspended solids and debris on Waimanalo Stream.
9. Wetlands	Executive Order 11990, Protection of Wetlands Clean Water Act of 1977 (42 U.S.C. 1857h-7 et seq.)	No effect
10. Wild and scenic rivers	Wild and Scenic River Act, as amended (16 U.S.C. 1271 et seq.)	Not present in planning area

1/ This plan-EIS addresses Agricultural Lands of Importance to the State of Hawaii which include prime, unique and other important agricultural lands.

RELATIONSHIP TO OTHER PLANS AND POLICIES

Installation of the recommended plan irrigation system will facilitate the implementation of the State's proposed Waimanalo Agricultural Park Plan (Ref. 1). The State plan aimed at irrigating approximately 1,800 acres, but it was based on preliminary estimates of how much irrigable land and water were available and the peak crop water requirements. Subsequent investigations, during the development of the Waimanalo Watershed Plan, resulted in a firm water supply of 2.4 million gallons per day and 60 million gallons storage which will fully irrigate approximately 1,252 acres. Some modification of the State's plan will be necessary, but it will accomplish the basic purpose of sustaining and enhancing diversified farming in Waimanalo Valley.

Water Resources Regional Study

The Hawaii Water Resources Regional Study presents 105 recommendations and specific actions for the balanced conservation, development, and use of Hawaii's water and related land resources (Ref. 14). From among these recommendations, 38 were selected in the Regional Plan as deserving priority implementation. The Waimanalo Watershed recommended plan, together with the State's proposed Agricultural Park Plan, are responsive to seven priority recommendations as follows:

10-2 (in part) Recycle wastewater and exchange for high quality irrigation water (1975-2000).

11-1 (in part) Encourage agricultural operations to locate near existing sewage treatment plants where feasible (1975-2000).

14-1 Use more efficient irrigation methods--convert to drip or sprinkler irrigation where feasible and reduce storage and transmission losses (1975-2000).

14-2 Provide additional irrigation water--improve diversion, storage, and transmission systems; develop more surface water . . .; and study the reuse of treated domestic wastewater for irrigating diversified crops . . . (1975-2000).

15-3 (in part) Apply land treatment practices to cropland and pastures . . . (1975-1990).

20-5 (in part) Maintain sanitary conditions in streams and drains by litter controls . . . and implement improved soil conservation practices on croplands and grazing lands (1975-2000).

21-4 (in part) Preserve and enhance wetlands . . . (1975-2000).

Coastal Zone Management Plan

The Waimanalo Watershed Plan is consistent with Hawaii's Coastal Zone Management Program, policies, and guidelines.

State Functional Plans - Hawaii State Plan

Both the watershed plan and the proposed agricultural park plan are in agreement with the State functional plans for agriculture and for water resources development (Ref. 23 and 24). The 12 functional plans--still to be

approved by the State Legislature--are key elements of the Hawaii State Plan which is the comprehensive planning document for the entire state (Chapter 226, Hawaii Revised Statutes). The governor has directed State departments to use the functional plans as the basis for all planning (Ref. 30).

The State Agriculture Plan has as one of its two fundamental objectives continued growth and development of diversified agriculture throughout the State. In addition the plan emphasizes two specific objectives:

> achievement of productive agricultural use of lands most suitable and needed for agriculture; and
>
> achievement of efficient and equitable provision of adequate water for agricultural use.

Key objectives from the State Water Resources Development Plan are:

1. Improve the quality, efficiency, service, and storage capabilities of system supplying agricultural water;
2. Increase the use of treated sewage effluent for irrigation purposes;
3. Promote agricultural water conservation; and
4. Provide adequate, reasonably priced water supplies for agricultural production.

County General Plan

The functional plans are part of a statewide planning system to execute and coordinate State and County planning. Waimanalo Watershed is in the Koolaupoko District of the City and County of Honolulu. The district is covered by the Development Plan Ordinance published in October 1980 which designates ten land use categories. All irrigated agricultural production proposed in the recommended plan is on land designated "agricultural."

Both the watershed plan and the State's proposed agricultural park plan are responsive to the Statements of General Principles in the ordinance as follows:

> Waimanalo will remain a rural area having extensive acreage devoted to diversified agricultural pursuits and a small low-density residential community.
>
> To promote pleasing and attractive living environments, panoramic mauka and makai views and views of major landmarks should be protected.

CONSULTATION AND PUBLIC PARTICIPATION

GENERAL

Agency consultation and public participation were an integral part in all phases of planning and environmental evaluation conducted by the Sponsors and SCS. All contacts were noted and the results reported and evaluated in the documentation.

AGENCY CONSULTATION

Agency consultation began with the March 9, 1978, notification by Windward Oahu Soil and Water Conservation District to the Governor that it was applying for federal assistance under Public Law 83-566. This initiated the Project Notification and Review System required by the Office of Management and Budget (Circular No. A-95). Several agencies then participated with the Sponsors and SCS on August 9, 1978, in a field examination of the area to identify water and related land resource problems and related environmental considerations.

Based on the results of the field examination, SCS requested planning authorization from the SCS Chief in Washington, D.C. This authorization was granted January 19, 1979, and agencies and the public were notified.

Intensive planning and environmental evaluation began in the summer of 1980 under the direction of the SCS. Federal, state and county agencies participated in the "scoping process" described in the section, Inventory and Forecasting. The multidisciplinary planning staff and associated SCS specialists consulted with various federal, state, and county agencies and group representatives on specific items as necessary, and periodically on an informational basis, and to provide appropriate opportunities for participation. The environmental evaluation required by the National Environmental Policy Act (NEPA) was conducted in conjunction with planning. A Notice of Intent to Prepare an Environmental Impact Statement was made to meet both Federal NEPA and State requirements. Similar consultation continued throughout the environmental evaluation. Often one meeting or contact served both planning and evaluation purposes.

The U.S. Fish and Wildlife Service (USFWS) was consulted in accordance with Section 7 of the Endangered Species Act, as amended, concerning threatened and endangered species that may be present in Waimanalo Watershed. USFWS also participated, together with State Division of Forestry and Wildlife, in an evaluation of the wildlife habitat.

The State Historic Preservation Officer and the Heritage Conservation and Recreation Service were consulted concerning sites for possible nomination to the National Register of Historic Places and the likely effects of project actions on historical and archeological sites.

The notice of availability of this draft plan-environmental impact statement for Waimanalo Watershed was published in the Federal Register, the Hawaii Office of Environmental Quality Control Bulletins, and local newspapers. Notices were mailed to all Waimanalo residents and to interested agencies. The Plan-EIS was distributed for review and comment to the agencies and groups shown on the following list:

U.S. Government

- Advisory Council on Historic Preservation
- Department of the Air Force
- Department of Agriculture
  - Agricultural Stabilization and Conservation Service
  - Animal & Plant Health Inspection Service
  - Forest Service
  - Office of Equal Opportunity
- Department of the Army - Corps of Engineers
- Department of Commerce
  - Office of Coastal Zone Management
  - Marine Fishery Service
- Department of Housing and Urban Development
- Department of Health and Human Services
- Department of the Interior
  - Fish and Wildlife Service
  - Heritage Conservation and Recreation Service
- Department of Transportation - Coast Guard
- Environmental Protection Agency
- Federal Power Commission

State of Hawaii

- Department of Agriculture
- Department of Land and Natural Resources
  - Coastal Zone Management
  - Division of Forestry and Wildlife
  - Division of Water and Land Development
  - State Historic Preservation Officer
- Department of Planning and Economic Development
- Office of Environmental Quality Control
- University of Hawaii
  - Institute of Marine Biology
  - Water Resources Research Center
  - College of Tropical Agriculture and Human Resources

City and County of Honolulu

- Board of Water Supply
- Department of General Planning
- Department of Public Works
  - Division of Wastewater Management

Groups

- Ad Hoc Committee for Kawainui
- Congress of Hawaiian Peoples
- Environmental Defense Fund
- Friends of the Earth
- Lani-Kailua Outdoor Circle
- League of Women Voters of Hawaii
- National Audubon Society
  - Hawaii Audubon Society
- National Wildlife Federation
- Natural Resources Defense Council, Inc.
- Sierra Club (National)
  - Hawaii Chapter - Sierra Club
- Waimanalo Council of Community Organizations
- Waimanalo Farm Bureau Federation
- Waimanalo Neighborhood Board
- Waimanalo Planning Committee

PUBLIC PARTICIPATION

A major consideration in the development of the plan and environmental impact statement was to provide interested and affected groups and individuals opportunity to participate. The Sponsors and SCS developed a public participation program to achieve a high level of participation.

Many individual contacts were made with farmers and other interested persons to gather data and, most importantly, to solicit participation in planning and environmental evaluation. Forms used to record information included Flood Damage, OMB No. 40-R3805 for flood damages and Irrigation Questionnaire, OMB No. 40-R3807 for irrigation.

A mailing list was prepared and maintained to ensure timely notification of meetings and distribution of materials. A newsletter, Waimanalo Watershed Up-Date, was distributed to all Waimanalo postal patrons at important points in the planning process (October 1979, September 1980, January 1981, April 1981, and August 1981). The newsletter was also used to advise local residents of meetings and the availability of information for their review.

Upcoming meetings and the availability of information were announced in newspaper notices and articles, media spots, posters, and at meetings of interested groups. Newspaper articles and media coverage also informed people of general progress during planning.

Public meetings were held beginning early in the preauthorization phase of planning with the meeting held August 29, 1978, to discuss the Field Examination Report. A public workshop was held on election day, Saturday, September 20, 1980. Participation was enthusiastic and opinions were expressed on various charts listing problems, opportunities, possible measures for alleviating problems or realizing opportunities, and the effects of those measures. Another large public meeting held on Saturday, January 24, 1981, presented the identified problems and opportunities and the preliminary alternative plans that were under consideration. (NED, EQ, Primarily Nonstructural, and Without Project plans were included in the irrigation improvement proposals.) The meeting also covered both structural and nonstructural solutions to some of the flooding problems. An extensive discussion followed the presentation, and several suggestions were made by attendees for areas needing additional study.

An edition of Waimanalo Watershed Up-Date and a letter from the Sponsors to each January 24, 1981, meeting attendee informed interested parties on modification and completion of the planning alternatives.

Next a technical review copy of the plan-environmental impact statement was given informal local distribution. This preliminary version is circulated within SCS for technical review and, at the same time, copies are made available for interested groups, individuals, and local agencies (including local offices of federal agencies) for an informal review.

After revision, the plan-environmental impact statement has now been published as a draft and officially distributed for formal, interagency review. Public participation in this review is encouraged. All comments from this review will be considered in preparing the final plan-environmental impact statement. Responses to all comments received on the draft, will be included in the final.

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APPENDIX D ENGINEERING DRAWINGS

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Plate 2 - Details - Regulating and Storage Reservoir

Plate 3 - Structure Details

Plate 4 - Details - Treated Sewage Effluent Use

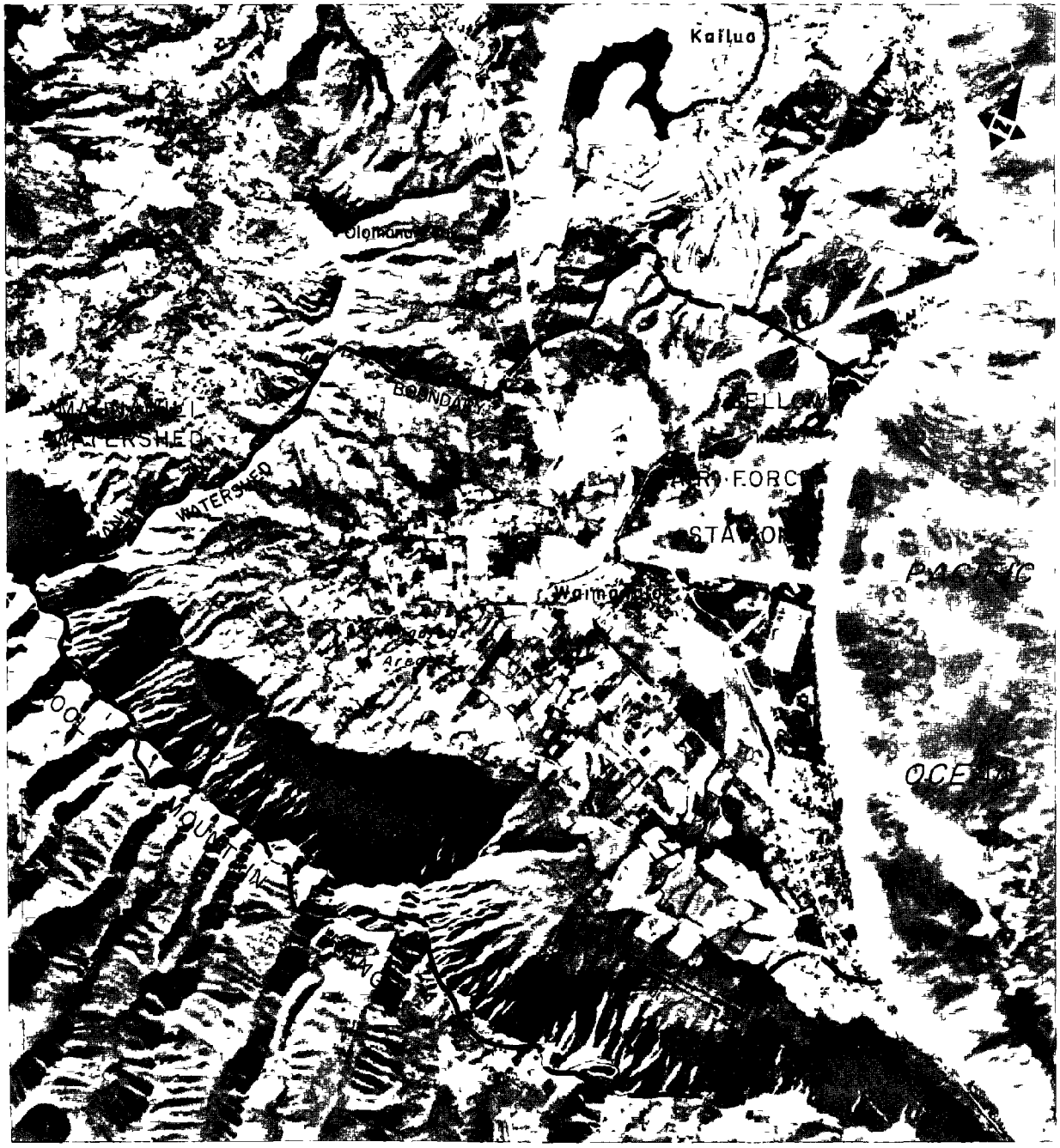
Plate 5 - Solid Waste Collection Sites

APPENDIX E PROJECT MAP AND OTHER MAPS

Figure 1 - Project Map

Figure 2 - Agricultural Lands Important to the State of Hawaii

Figure 3 - Land Use and Flood Plain



SCALE 1" = 4000 Feet

PHOTO NO. 1 - *Aerial photo of Waimanalo Watershed and adjacent areas.*

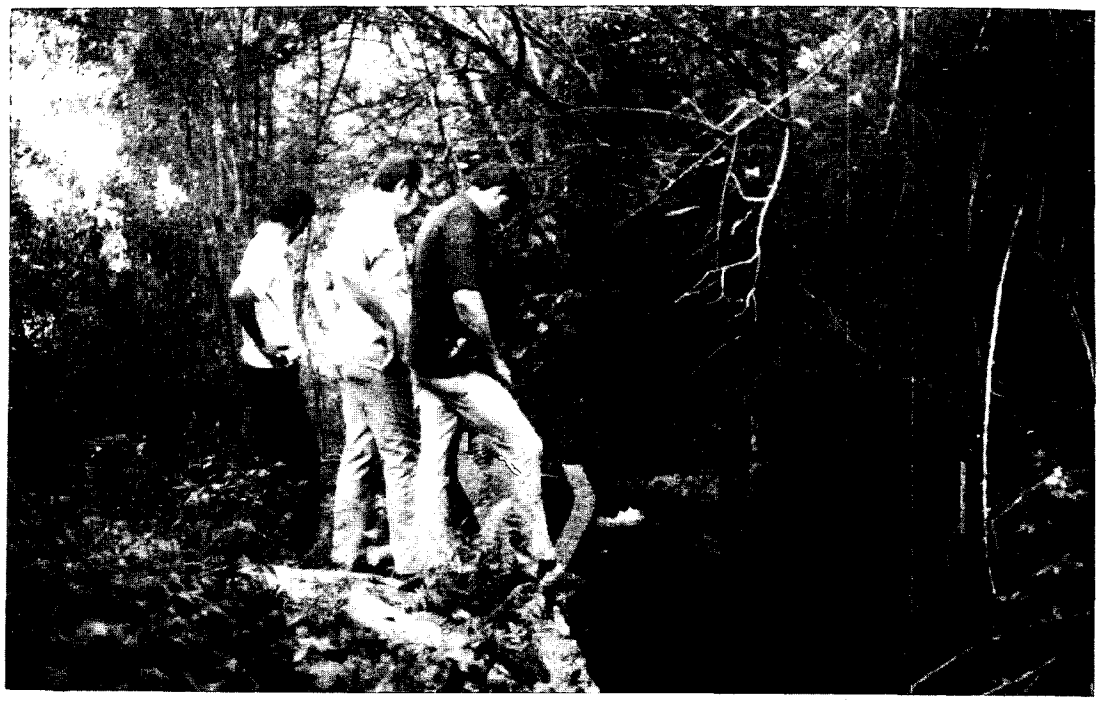


PHOTO NO. 2 - *The Waimanalo Irrigation System ditch below the tunnel outlet on Aniani Nui Ridge.*

PHOTO NO. 3 - *Waimanalo Valley from Aniani Nui Ridge. Cliffs (pali) of the Koolau Mountain Range are in the background.*

PHOTO NO. 4 - *Kailua Reservoir with Aniani Nui Ridge in the background.*

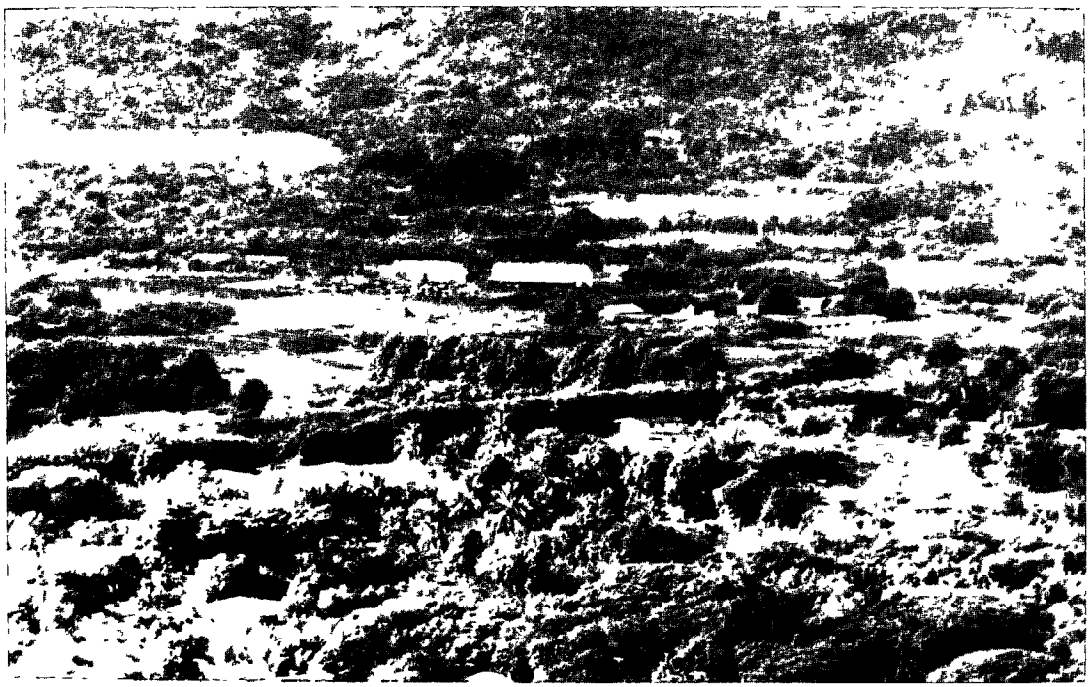


PHOTO NO. 5 - *Small farms on Waimanalo Valley floor.*

PHOTO NO. 6 - *Waimanalo Irrigation System flume and trestle in the irrigated area.*

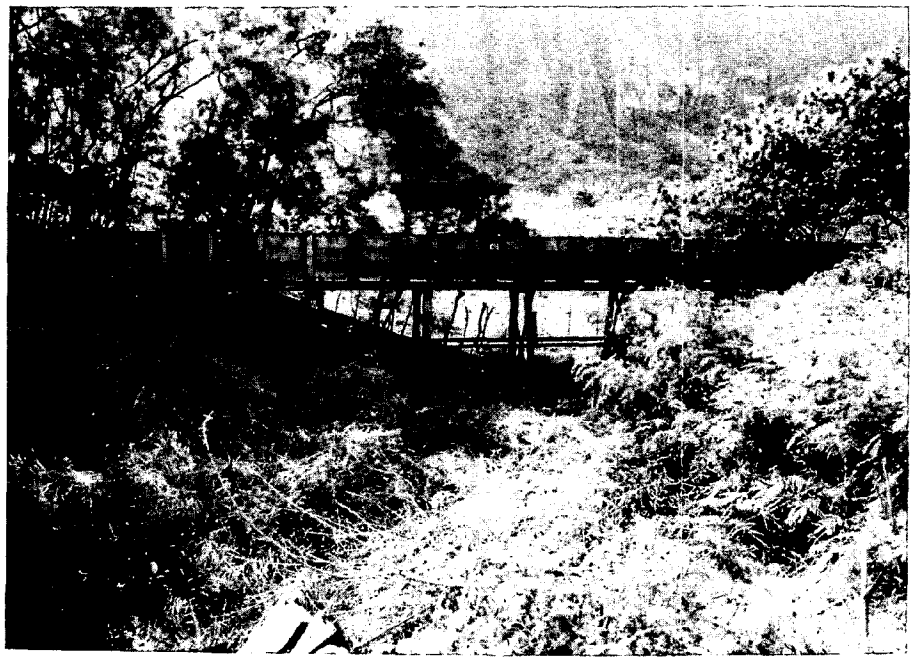


PHOTO NO. 7 - *Waimanalo Irrigation System flume and trestle at a typical foothill stream crossing in the irrigated area.*

United States
Department of
Agriculture

Soil
Conservation
Service

P.O. Box 50004
Honolulu, HI
96850

August 19, 1981

In accordance with Section 5 of the Watershed Protection and Flood Prevention Act (Public Law 83-566), as amended, Section 2 of Executive Order 10913, and our responsibility as assigned by the Secretary of Agriculture, we are transmitting, for your review and comment, the draft watershed plan-environmental impact statement (EIS) for the Waimanalo Watershed, Hawaii. The final plan will require approval by the appropriate committees of the Senate and House of Representatives, before federal assistance is authorized.

The EIS was prepared in accordance with Section 102(2)(C) of the National Environmental Policy Act of 1969 (Public Law 91-190). We are requesting that comments on this document be received by this office on or before October 17, 1981. If your comments are not received by the due date, we will assume you do not wish to comment.

Sincerely,

JACK P. KANALZ
State Conservationist

Enclosure

PHOTO NO. 8 - *Waimanalo Irrigation System distribution ditch.*

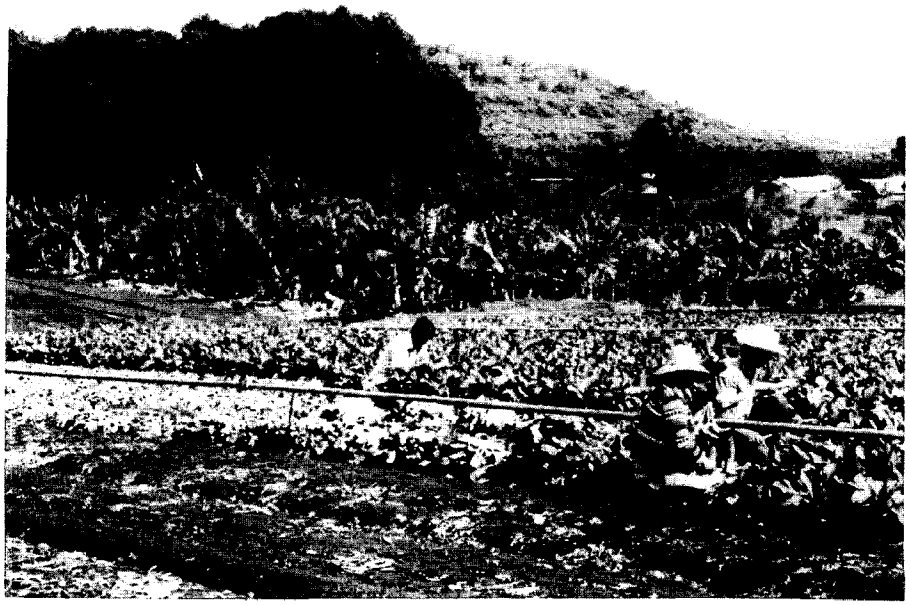


PHOTO NO. 9 - *Irrigated truck crops in the foreground and bananas in the background.*

PHOTO NO. 10 - *Nursery crops in the irrigated area growing under shade.*

PHOTO NO. 11 - *Landscape nursery crop being prepared for transplanting.*

PHOTO NO. 12 - *Typical banana pad showing different generations.*

PHOTO NO. 13 - *Typical drainageway on the valley floor.*

PHOTO NO. 14 - *Garbage and orchard debris dumped along roadside blocking drainageway. Olomana Peak in the background.*

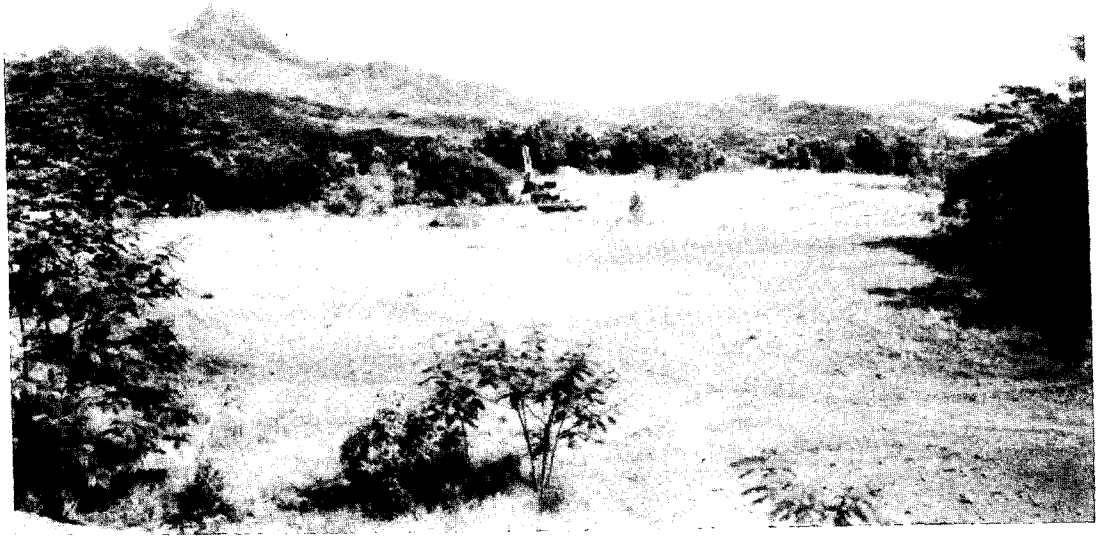
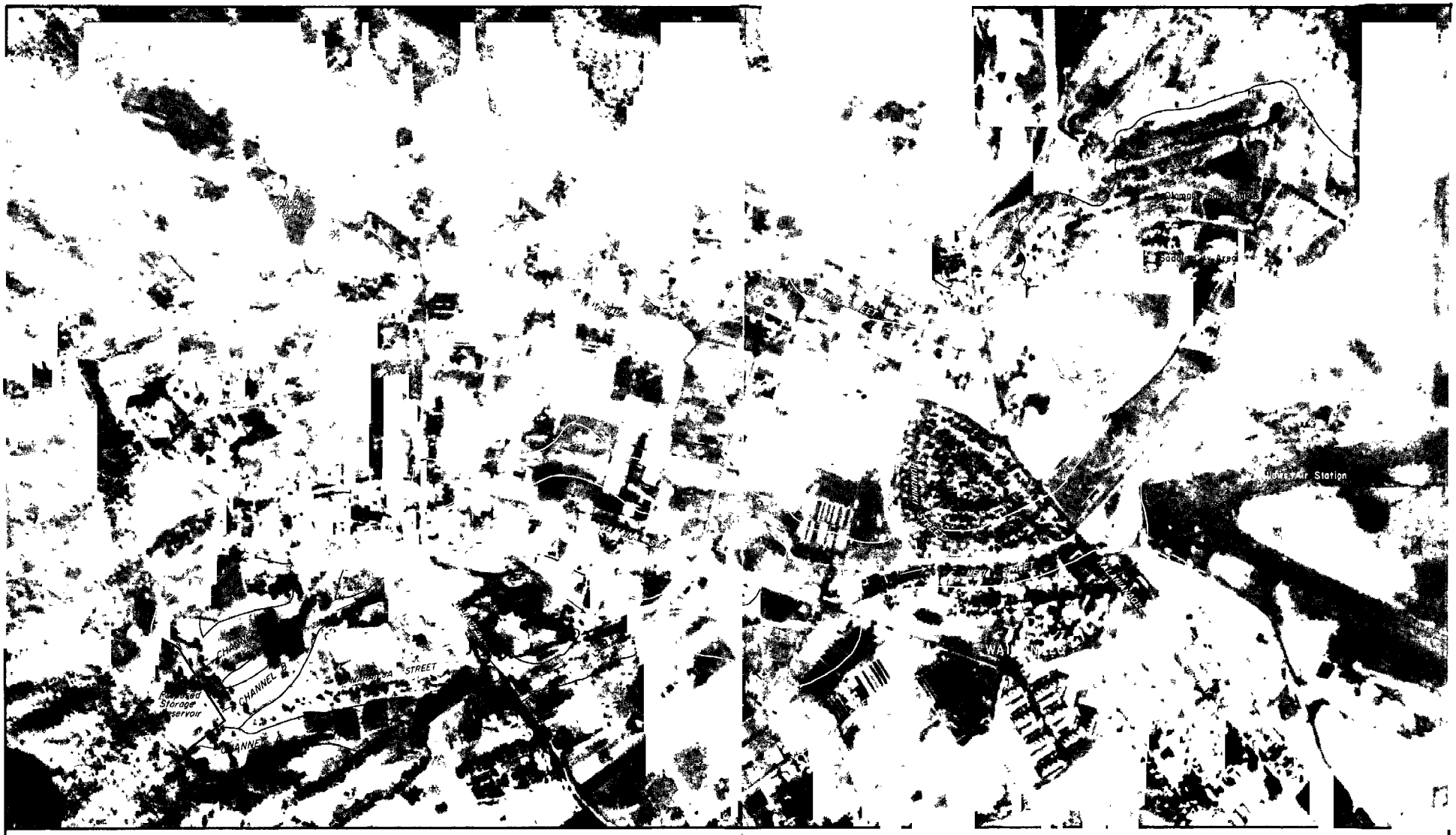


PHOTO NO. 15 - *Site of the planned irrigation reservoir with Olomana Peak in the background.*



Residences and Areas Subject to Flooding
in the Event of Structural Failure

Item	Without Project Existing Kailua Reservoir	Recommended Plan Proposed Reservoir
Residences With Water Above the First Floor	21	77
Area Flooded		
Residential Zone	0 ac	17 9 ac
Commercial Zone	0 ac	0 9 ac
Agriculture Zone	31 6 ac	212 4 ac
Parks	3 5 ac	54 1 ac

The area subject to flooding by a possible structural failure was analyzed through each channel adjacent to and downstream of the proposed storage reservoir Four channel areas (A, B C and D) were analyzed assuming that the possibility exists that a sudden structural failure could occur and produce a flood flow in either channel but probably not in all channels simultaneously The flooded areas below the convergence of two or more channels is the larger area of any one initial flow

Channel K represents the channel area subject to flooding by a possible structural failure of the existing Kailua Reservoir

AREA SUBJECT TO FLOODING IN THE EVENT OF STRUCTURAL FAILURE

WAIMANALO WATERSHED

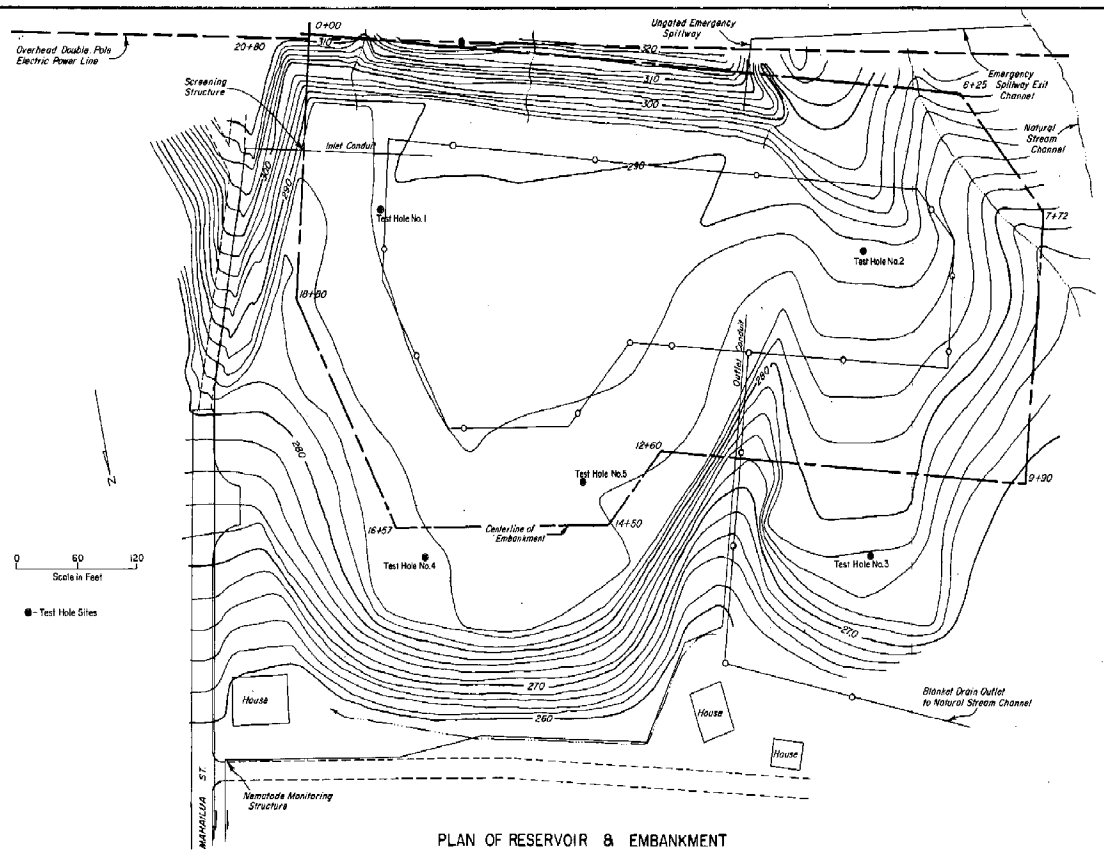
ISLAND OF OAHU, HAWAII

JULY 1981

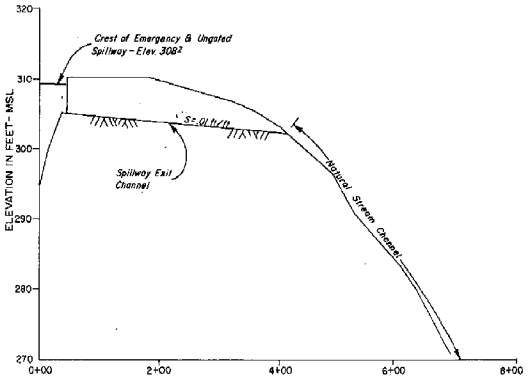
0 1/8 1/4 3/8 1/2 MILE

SCALE 1 9600

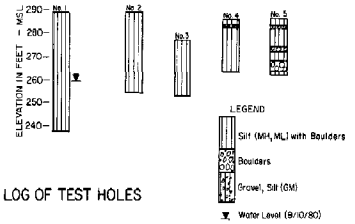
U S DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE USDA SCS PORTLAND OR 1981



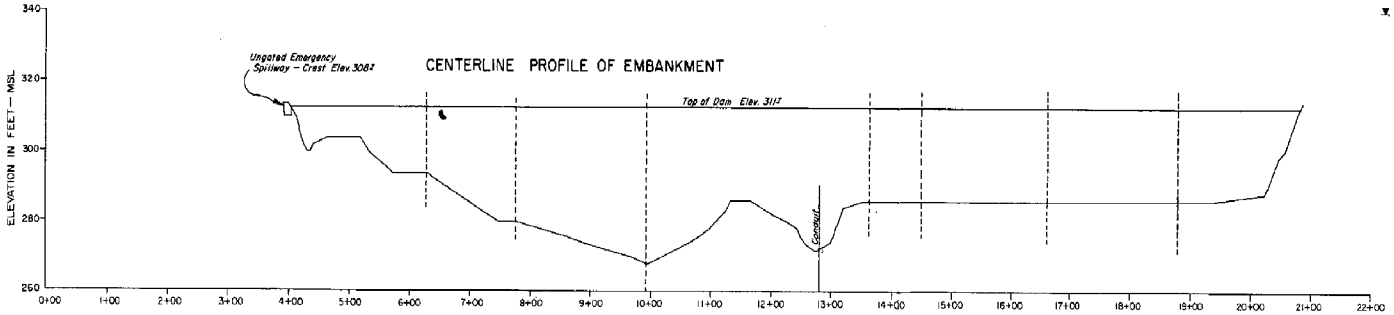
PLAN OF RESERVOIR & EMBANKMENT



PROFILE OF UNGATED EMERGENCY SPILLWAY



LOG OF TEST HOLES



CENTERLINE PROFILE OF EMBANKMENT

APPENDIX D: PLATE I

PLAN & PROFILE

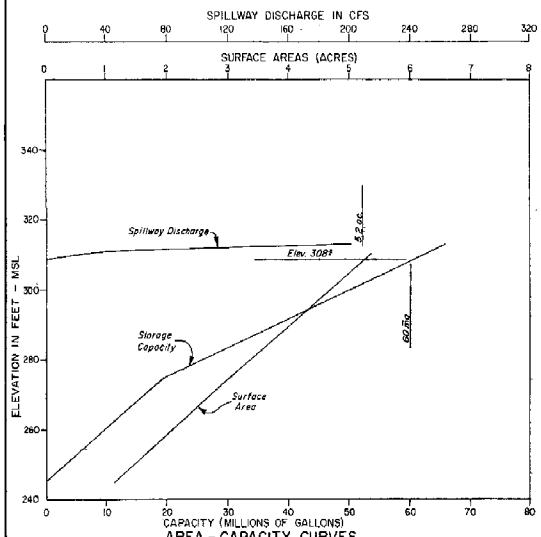
WAIMANALO RESERVOIR SITE

WAIMANALO WATERSHED

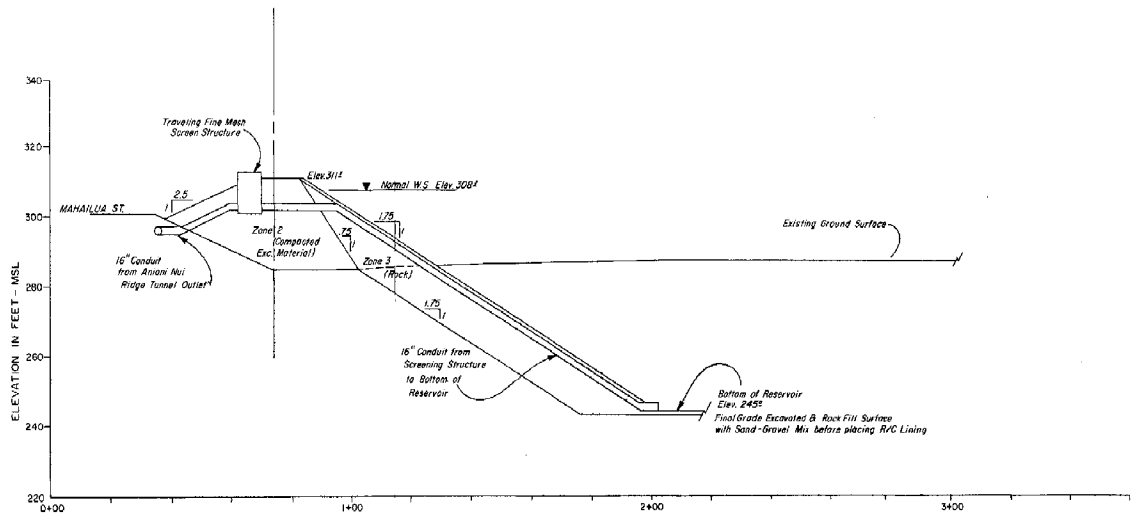
CITY AND COUNTY OF HONOLULU, HI

JULY 1981

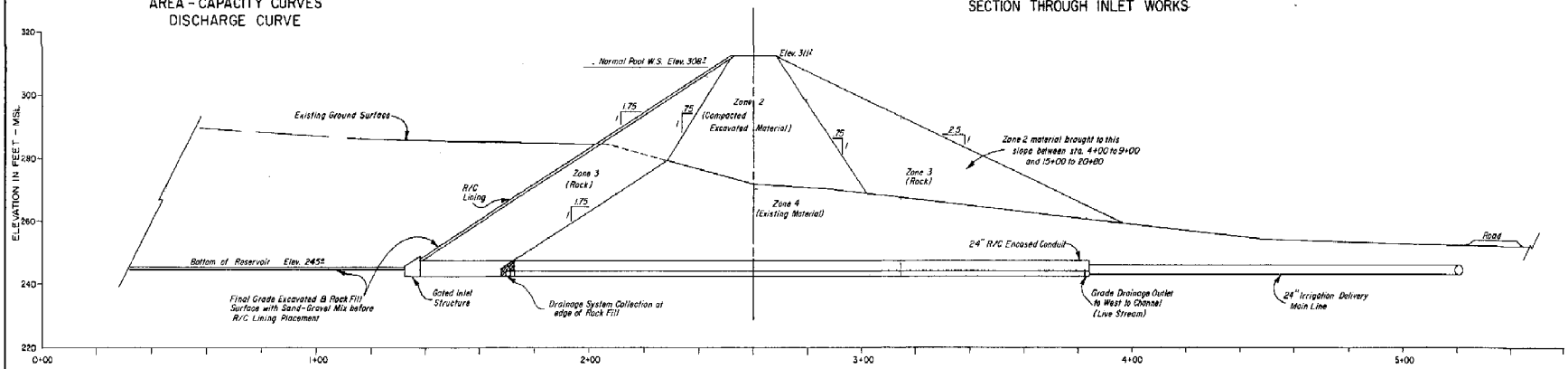
USDA-SCS-PORTLAND, OR. 1981



AREA - CAPACITY CURVES
DISCHARGE CURVE



SECTION THROUGH INLET WORKS



SECTION THROUGH OUTLET WORKS & TYPICAL SECTION

APPENDIX D: PLATE 2

DETAILS

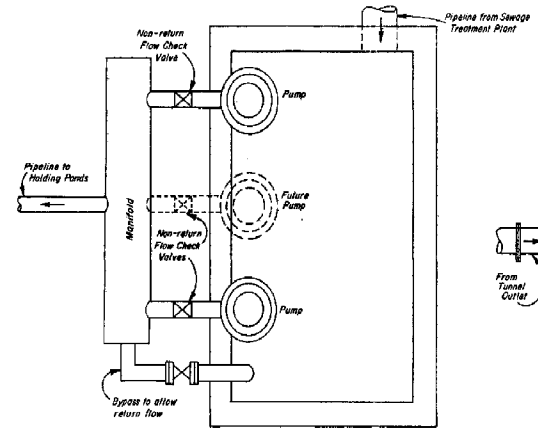
REGULATING & STORAGE RESERVOIR

WAIMANALO WATERSHED

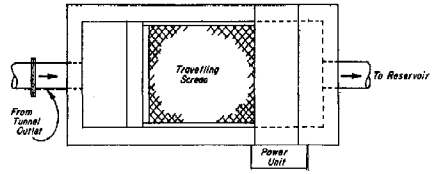
CITY & COUNTY OF HONOLULU, HI

JULY 1981

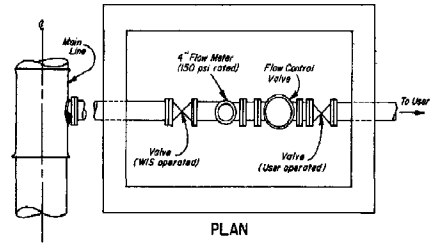
USDA-SCS-PORTLAND, OR. 1981



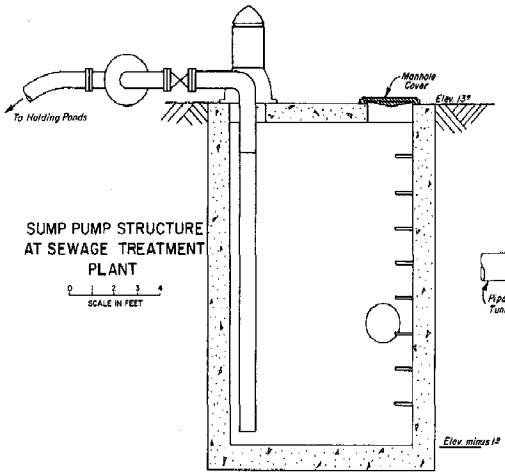
PLAN



PLAN



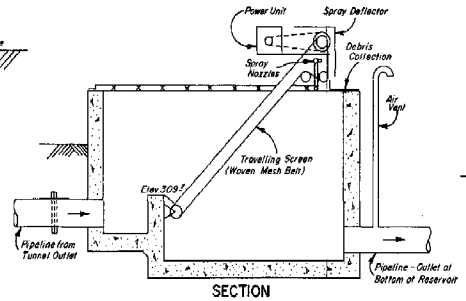
PLAN



SUMP PUMP STRUCTURE AT SEWAGE TREATMENT PLANT

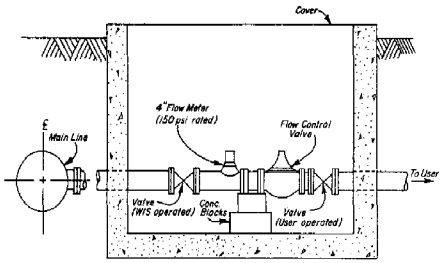
0 1 2 3 4
SCALE IN FEET

SECTION



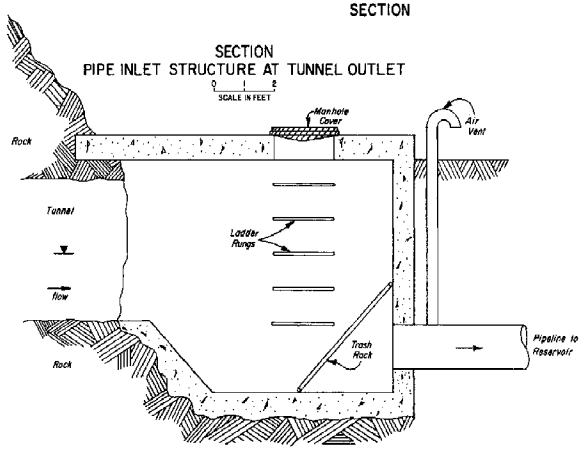
SECTION
STRUCTURE AT INLET TO RESERVOIR

0 1 2 3 4 5
SCALE IN FEET



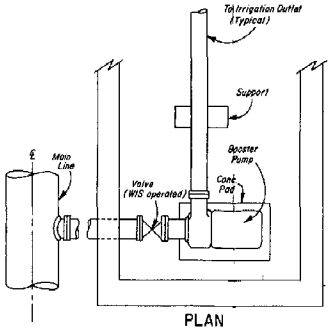
SECTION
IRRIGATION OUTLET DETAIL - TYPICAL

0 1 2 3
SCALE IN FEET



SECTION
PIPE INLET STRUCTURE AT TUNNEL OUTLET

0 1 2
SCALE IN FEET



PLAN
BOOSTER PUMP - TYPICAL

0 1 2 3
SCALE IN FEET

APPENDIX D: PLATE 3

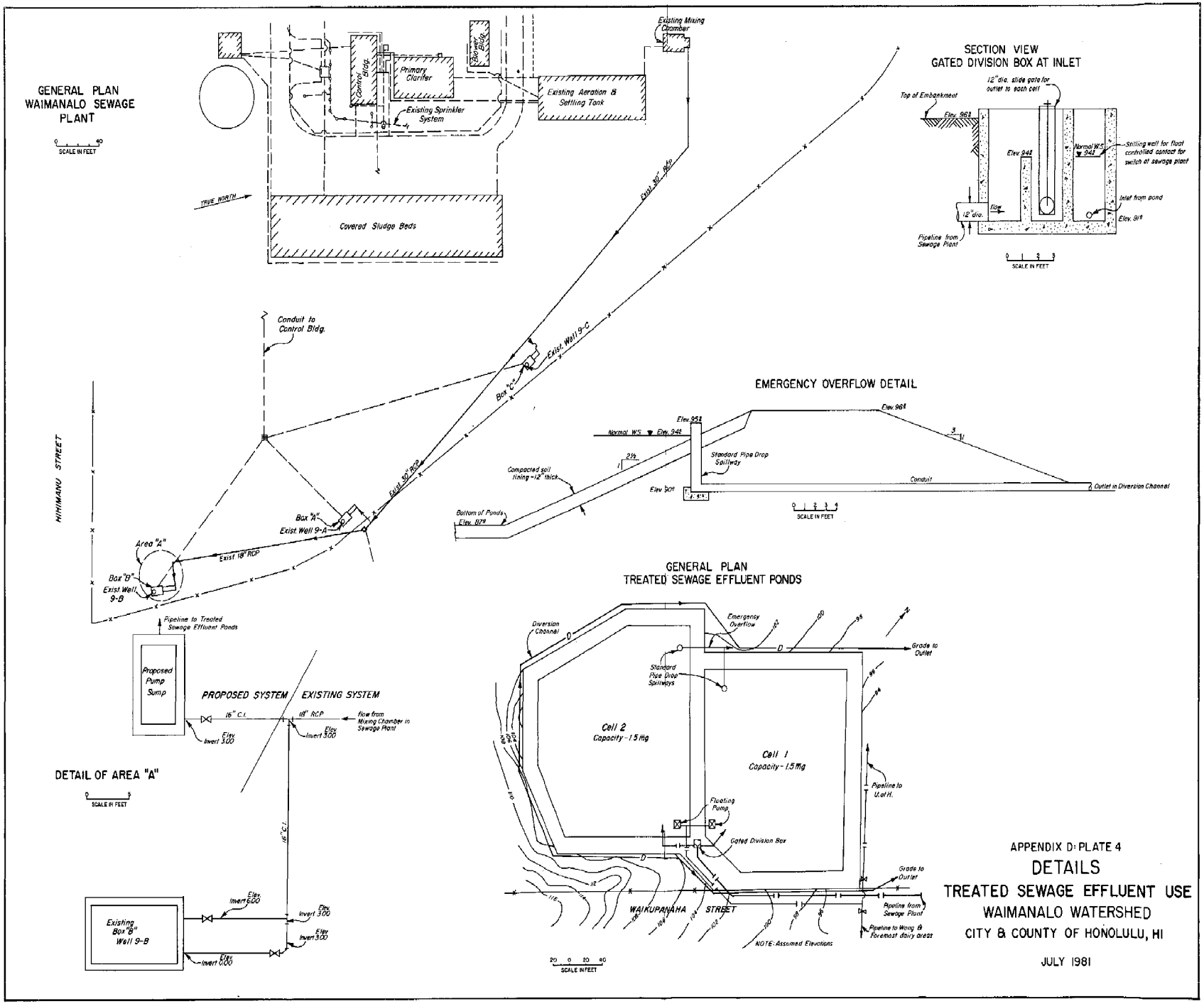
STRUCTURE DETAILS

WAIMANALO WATERSHED

CITY & COUNTY OF HONOLULU, HI

JULY 1981

USDA-SCS-PORTLAND, OR. 1981



APPENDIX D: PLATE 4

DETAILS

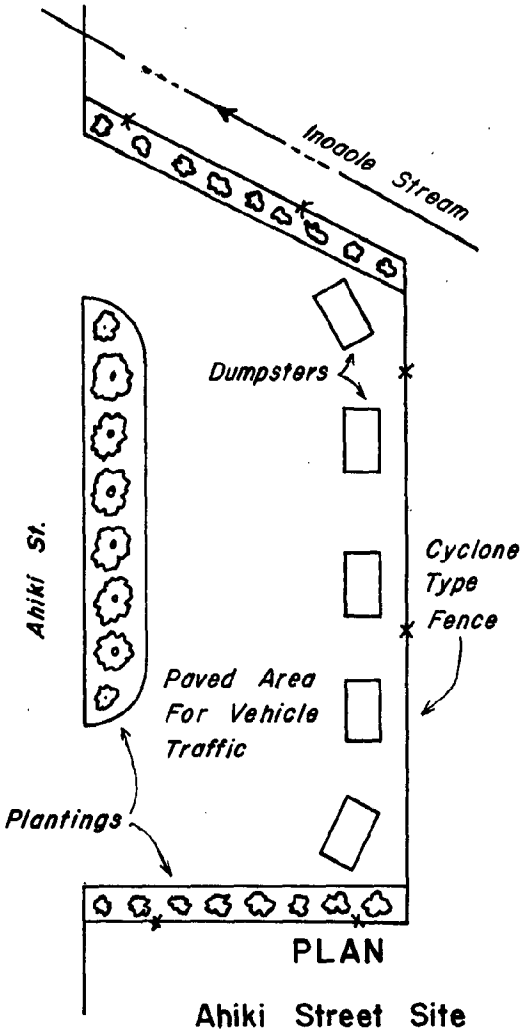
TREATED SEWAGE EFFLUENT USE

WAIMANALO WATERSHED

CITY & COUNTY OF HONOLULU, HI

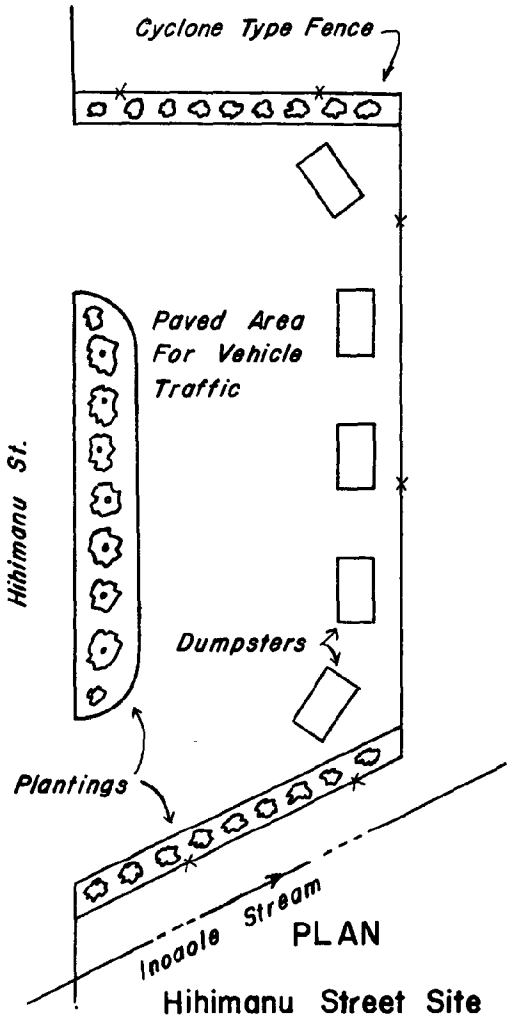
JULY 1981

USDA-SCS-PORTLAND, OR. 1983



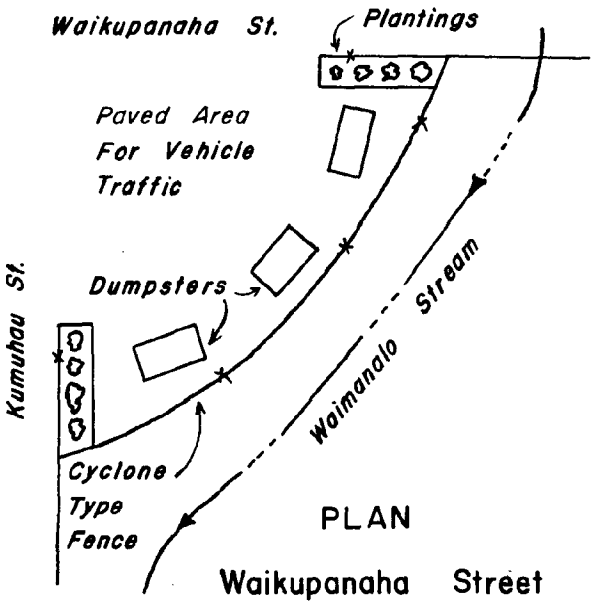
PLAN

Ahiki Street Site



PLAN

Hihimanu Street Site



PLAN

Waikupanaha Street Site

Appendix D Plate 5

Solid Waste Collection Sites

WAIMANALO WATERSHED

City and County of Honolulu

July 1981

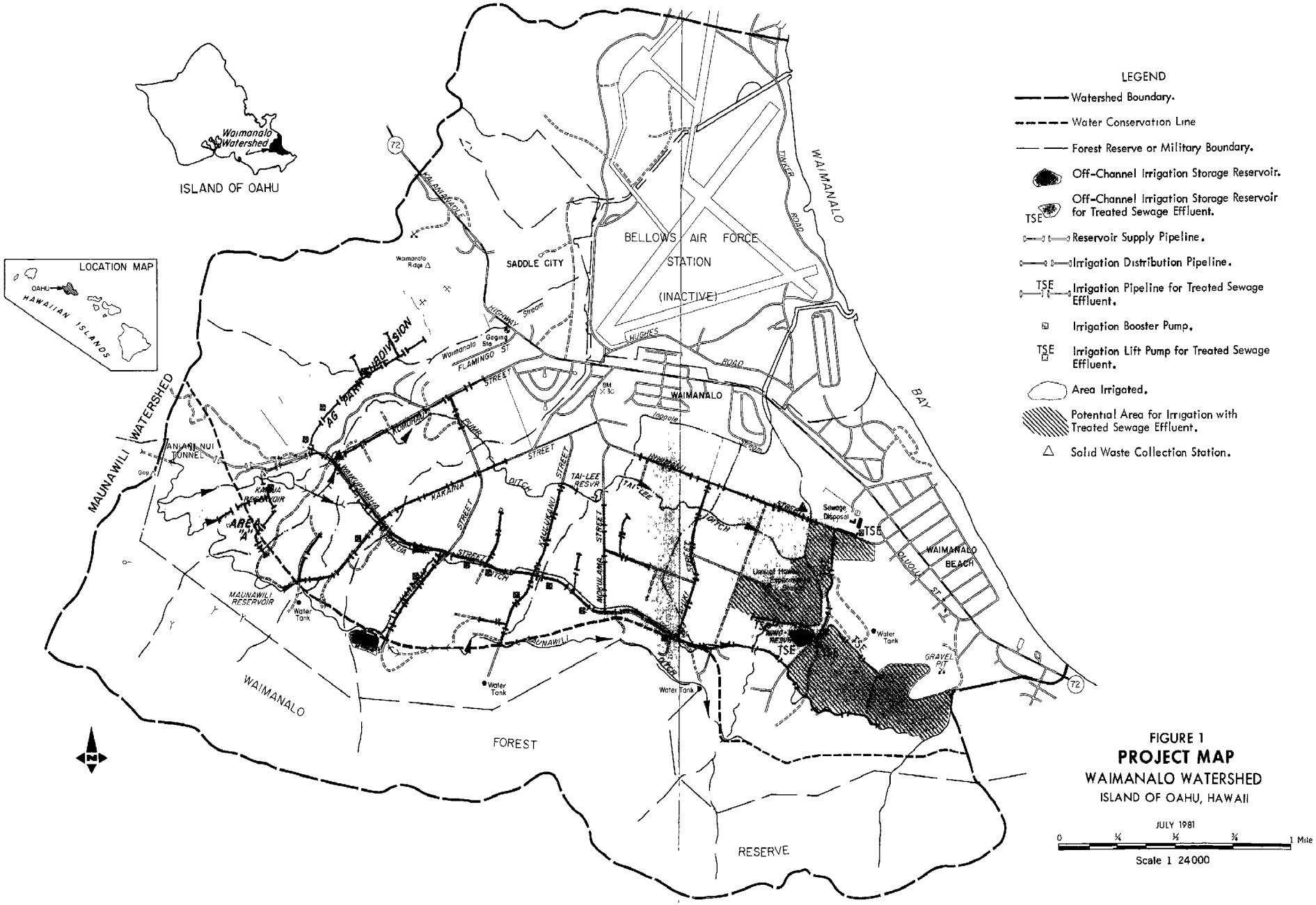


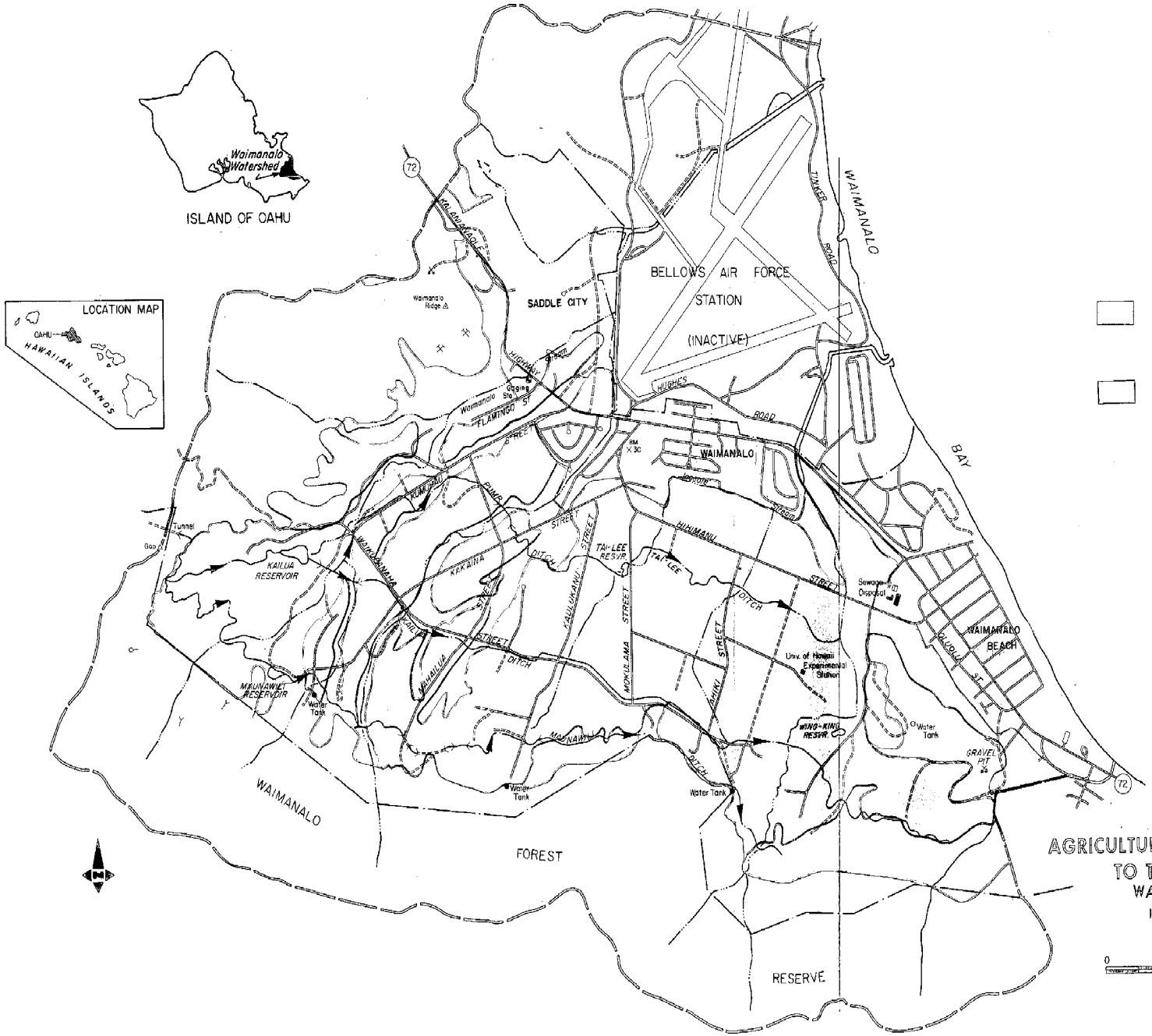
FIGURE 1
PROJECT MAP
WAIMANALO WATERSHED
ISLAND OF OAHU, HAWAII

JULY 1981

0 ¼ ½ ¾ 1 Mile

Scale 1 24000

Source
Base map prepared by SCS, WTSC Carto Unit from USGS 1 24,000 quads
Thematic detail compiled by Portland Multistate Planning Staff
U S DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE USDA SCS PORTLAND OR 1981



LEGEND

PRIME AGRICULTURAL LAND
Land which has the soil quality, growing moisture supply needed to produce sustai of crops economically when treated and according to modern farming methods.

OTHER IMPORTANT AGRICULTURAL L
Land other than Prime or Unique Agricul that is also of statewide or local importa agricultural use.

FIGURE 2
AGRICULTURAL LANDS OF IMPORTA
TO THE STATE OF HAWAII
WAIMANALO WATERSHED
ISLAND OF OAHU, HAWAII

JULY 1981

0 ¼ ½ ¾ 1 M

Scale 1:24000

Source:
Base map prepared by SCS, WTSC Carto Unit from USGS 1:24,000 quads.
Thematic detail compiled by Portland Multistate Planning Staff from Agricultural Lands of Importance to the State of Hawaii dated 1/77 adjusted to Development Plan Map for Koolaupoko, City and County of Honolulu dated 10/80.
U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OR. 1981

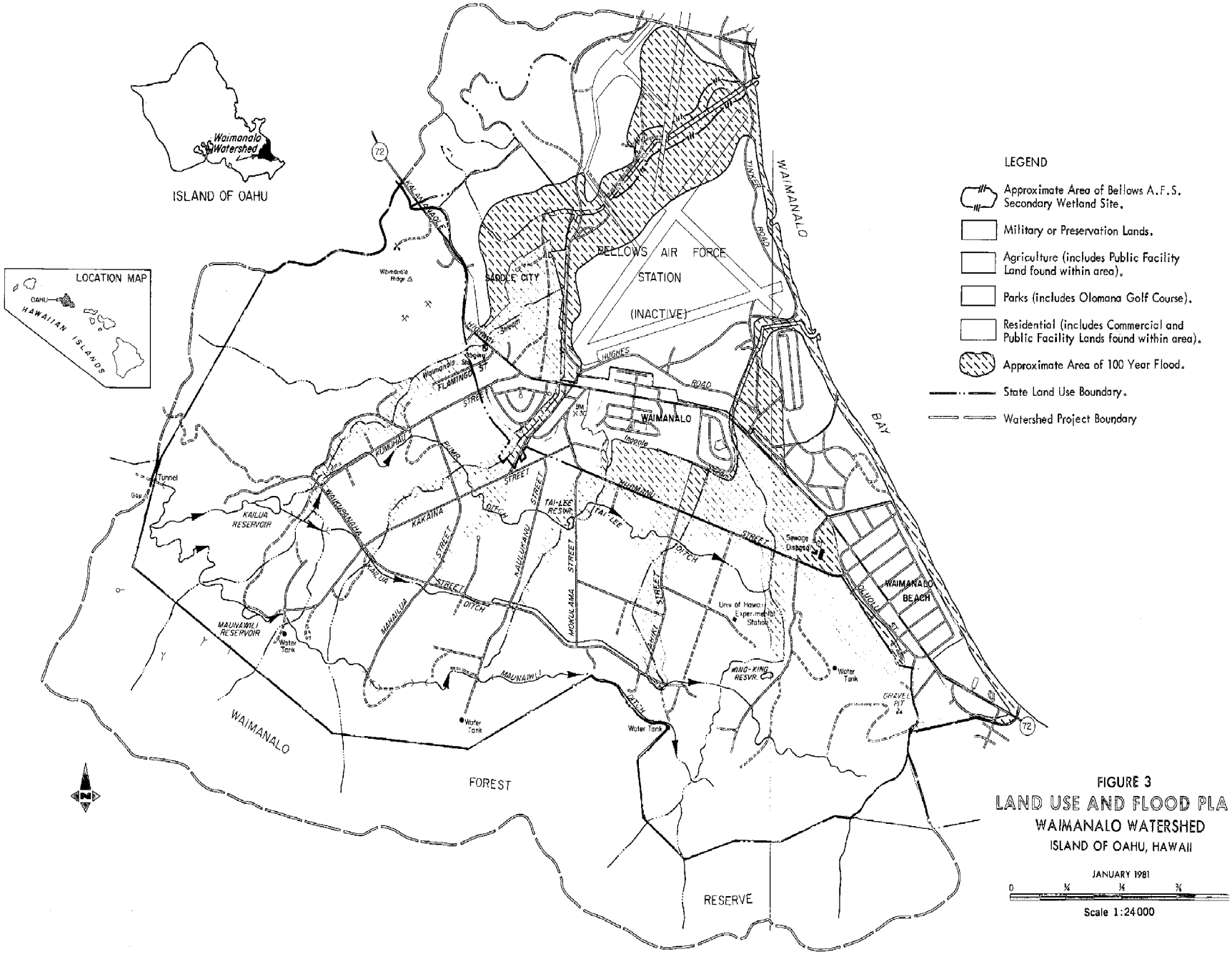


FIGURE 3
LAND USE AND FLOOD PLA
WAIMANALO WATERSHED
ISLAND OF OAHU, HAWAII

JANUARY 1981

0 ¼ ½ ¾ 1

Scale 1:24000

Source:
Base map prepared by SCS, WTSC Carto Unit from USGS 1:24,000 quads.
Thematic detail compiled by Portland Multistate Planning Staff.
Agriculture, Residential, and Park zones from October 1980 City and County of Honolulu Development Plan Map.
100 Year Flood boundary from FIA Floodway Map, Honolulu, HI, September 3, 1980.
U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE USDA SCS PORTLAND OR 1981

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