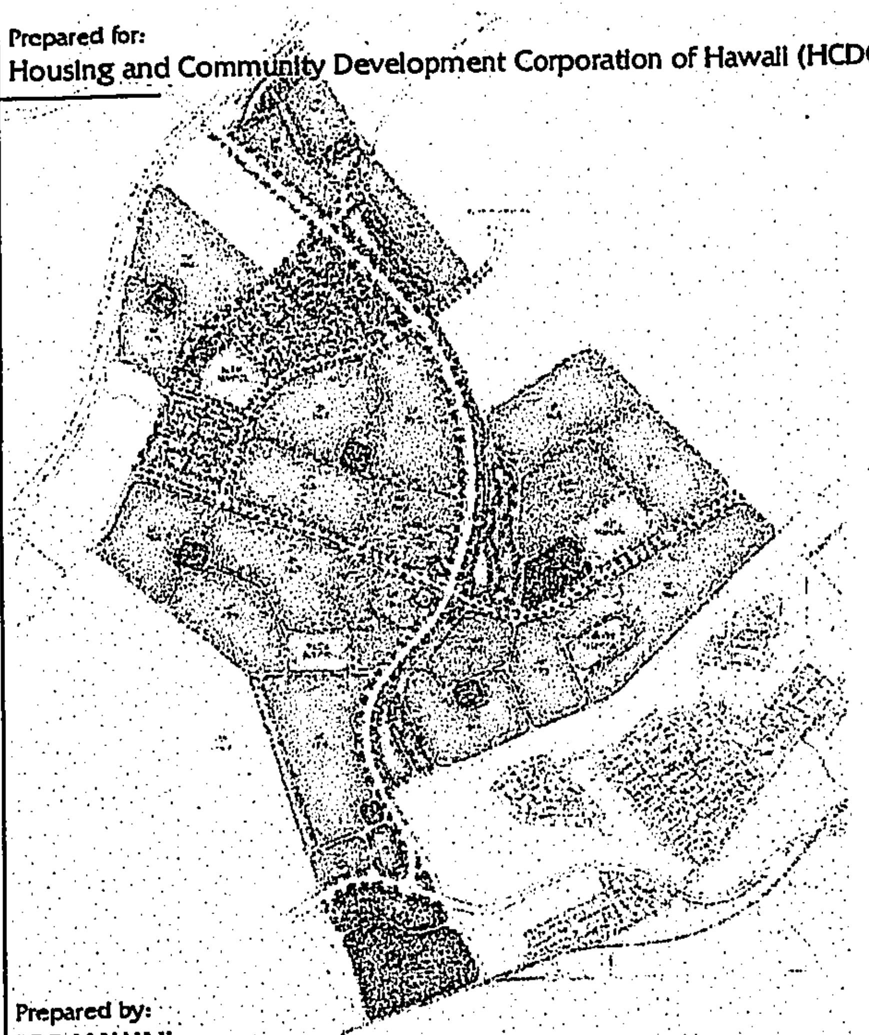
1998- Oahu- [redacted] FEIS-
East Kapolei

FILE COPY

EAST KAPOLEI MASTER PLAN

Final Environmental Impact Statement

Prepared for:
Housing and Community Development Corporation of Hawaii (HCDCH)



Prepared by:
PBR HAWAII

July 1998

PBR HAWAII

EAST KAPOLEI MASTER PLAN

Final Environmental Impact Statement

Prepared for:
Housing and Community Development Corporation of Hawaii (HCDCH)

Submitted by:

Mr. Donald Lau, Executive Director
Housing and Community Development Corporation of Hawaii (HCDCH)

The statement and all ancillary documents were prepared under my direction or supervision and that the information submitted, to the best of my knowledge fully addresses document content requirements as set forth in sections 11-200-17 and 11-200-18 of the Department of Health Administrative Rules as appropriate.

July 1998

HCDCH EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT
FINAL ENVIRONMENTAL IMPACT STATEMENT

TABLE OF CONTENTS

FIGURES

APPENDICES

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

DESCRIPTION OF THE ACTION

This Final Environmental Impact Statement ("FEIS") has been prepared in support of the proposed East Kapolei Master Plan Development Project, a 1,300-acre master planned residential community at Ewa, Oahu.The project area includes lands owned and/or controlled by The Department of Hawaiian Home Lands (DHHL).

The East Kapolei Master Plan Development Project reflects a mixture of residential, commercial, public facility, and open space recreation land uses that will replace the existing fallow agricultural lands. In support of the development, major infrastructure facilities will be developed by the Housing ~~Finance~~ and Community Development Corporation of Hawaii (~~HFDC~~HCDCH) to include access and circulation roadways; pedestrian paths, drainage improvements, distribution lines for potable water, collection lines for wastewater, and communication/utility systems. At the same time, the State Department of Accounting and General Services (DAGS) is developing a major sports complex ~~and park-and-ride facility~~ on lands makai of the proposed Kapolei Parkway adjacent to Barbers Point Naval Air Station.

~~Once~~During the ~~major infrastructure is in place~~1997 session, ~~large lot development parcels will be sold by~~the Hawaii legislature consolidated all state housing functions administered and controlled by the Hawaii Housing Authority (HHA), Housing Finance and Development Corporation (HFDC), and the Rental Housing Trust Fund (RHTF) into the HCDCH by the adoption ~~to individual developers for construction~~of Act 350, codified ~~new homes and businesses in accordance with the project master plan~~as HRS Chapter 201G. This legislation, which took effect July 1, 1998, also provides that HCDCH will automatically succeed to the rights, and assume the obligations, of HHA and HFDC. Therefore, HCDCH will automatically succeed to all current agreements previously executed by HHA and HFDC. As such, this Final EIS will hereinafter refer to the applicant as HCDCH while HFDC was identified as the applicant in the Draft EIS.

Once the major infrastructure is in place, large lot development parcels will be sold by HCDCH to individual developers for construction of new homes and businesses in accordance with the project master plan.

This document presents the East Kapolei Master Plan Development Project and describes the improvements proposed to accommodate the public facility needs of the project. It also describes the existing natural environment of the project site and surrounding area, the potential impacts that might result from the proposed project and mitigation measures to minimize potential adverse impacts. Comments and responses addressing applicable concerns that were received from review of the Draft Environmental Impact Statement ~~Notice of Preparation (EISPN)~~ are also provided.

At the appropriate time in the planning and approval process, the State's Housing ~~Finance~~and Community Development Corporation of Hawaii will propose applicable amendments to the State Land Use District Boundary from the current State Agricultural District to the State Urban District. Upon approval by the State Land Use Commission, an amendment to the City's Land Use Ordinance (LUO) zoning designations will be submitted to the City to reflect the land uses envisioned by the plan and to permit its implementation.

SIGNIFICANT BENEFICIAL AND ADVERSE IMPACTS

Need for the proposed East Kapolei Master Plan Development Project was determined by several methods. A Market Study (Appendix A) and Socio-Economic Impact Assessment (Appendix K) were prepared to determine the ultimate demand for the large lot development parcels along with comparable costs and revenues that could be generated through their sale to private developers. Generally, the market study indicated that the project would be absorbed during a planning period of approximately twenty years. Interviews with residents of the area were also conducted. These interviews were undertaken to ascertain the perceived needs and desires of the community, and to evaluate the potential local and international demand for the proposed sports complex. Secondly, the adoption of the City's Ewa Development Plan in 1997 also calls for development of the planning area in accordance with a two phase development schedule. This commitment by the City to plan for development of the subject property as proposed, also reflects the City's determination that there is a need for additional housing, commercial enterprises, and recreational opportunities in Ewa during the twenty year planning horizon.

The development of the proposed East Kapolei Master Plan will impact the physical resources of the project area and (to a lesser extent) adjoining properties. However, many of the environmental impacts presently associated with the historical use of the property (agricultural production) will be eliminated with development of the proposed improvements. Major proposed facility improvements include installation of new potable and non-potable water systems, wastewater collection systems, major drainage improvements, on-site and off-site transportation facility improvements, and electrical/communication infrastructure. New public facilities will include three elementary school sites, an intermediate school site, and major public recreational areas.

Potential environmental impacts will occur primarily during the construction period from noise, soil erosion, increased construction machinery exhaust emissions, and temporary disruption of traffic. After project development and implementation of appropriate mitigation measures, no significant impacts affecting water quality will occur, surface drainage will be significantly improved, the diversity of plant and animal species will increase, and archaeological resources will not be impacted. Provisions have also been made to propagate and expand the population of an endangered plant species that was found on the property.

Traffic impacts will be mitigated with construction of project related infrastructure improvements and other off-site regional transportation improvements which are planned by the State and City (i.e. North-South Road, improvements to Farrington Highway, and Kapolei Parkway). Visually, the property will be altered from the existing vacant scrub vegetation to a landscaped urban master planned development. In its present vacant condition, the public generally has little or no access onto the subject property or other benefits from its use.

PROPOSED MITIGATIVE MEASURES

When implemented with appropriate mitigation measures, project development will maintain or enhance the existing environmental qualities associated with the property. The design of all major infrastructure and public facility improvements will incorporate the necessary engineering and design methods to ensure that the environmental resources of the region will not be damaged and that the basic public service needs of the community are provided with development of the project master plan.

Drainage/Flood Control/Water Quality/Soil Erosion - Drainage control of surface water will be provided by the use of on-site retention basins with outlet structures designed to control the quantities and discharge of off-site surface flows, and to provide for siltation of suspended materials. In addition, to protect water quality and mitigate potential soil erosion, grassing of graded areas, watering to reduce fugitive dust emissions, and installation of dust screens during and after construction will be employed in accordance with generally accepted Best Management Practices (BMP) for the property.

Implementation of the recommended soil erosion control measures and grading plans will require establishment of new plant materials, and temporary and permanent types of groundcover. As applicable, developers of the various large lot development parcels will be notified upon sale of the property to work with surrounding landowners in identifying appropriate dust mitigation measures prior to construction.

Flora and Fauna - No endangered fauna exist within the subject property and no mitigative measures are required. However, one endangered plant species was identified on the subject property during a field survey prepared for this EIS (Appendix E). However, a habitat conservation plan has been developed by the State Department of Land and Natural Resources and reviewed by the U.S. Fish and Wildlife Service to ensure that the species is protected and propagated in accordance with Federal and State requirements (Appendix F). As applicable, these plants will also be incorporated into project landscaping in accordance with the approved habitat conservation plan. Overall, the proposed urban landscaping will increase the diversity of both plant and animal communities compared to the existing scrub vegetation and vacant condition of the property.

Archaeological Resources - A review of previously prepared archaeological survey reports and a recent field inspection, identified no archaeological resources requiring preservation on the subject property. If any artifacts or human remains are discovered during construction activities, the contractor will be instructed to halt work and notify the State of Hawaii Historic Preservation Division in accordance with applicable laws and regulations.

Noise - The project is not expected to generate any significant long-term noise that cannot be mitigated (Appendix I). During construction, contractors will secure State Department of Health Community Noise Permits and equipment will be used in accordance with accepted standards during daylight hours to mitigate potential noise impacts. The master plan has also established generous open space/drainage buffers between heavily traveled roadways and residential areas to mitigate potential traffic noise. In areas where extensive setbacks are not feasible, buildings will be designed to mitigate potential noise emanating from off-site sources (i.e. H-1 Freeway).

Recreational facilities will be designed to minimize noise impacts on adjoining properties through landscaping and use of setbacks. The proposed sports complex has been sited in an area where no significant off-site residential development is planned for adjacent parcels. However, there will be periods when major tournaments and other events could generate temporary noise impacts associated with public address systems and periods of increased traffic noise. The architect currently designing the sports complex, has hired a noise consultant to evaluate noise impacts and determine mitigation measures based on building architecture, orientation of structures, and distance to surrounding land uses.

Air Quality - Air quality impact(s) will result from use of construction equipment, fugitive dust generated during construction, and increased vehicular emissions along new roadways constructed in support of project land uses. However, since development is planned over a 20-year period, impacts from construction equipment and fugitive dust will occur intermittently only during periods of major construction. These include the construction of primary infrastructure by ~~HFDC~~HCDCH and within each of the development parcels during construction of residential, commercial, and recreational improvements.

Because the length of the development period will limit the land area exposed to erosion from wind and runoff at any one time, potential dust emissions should be reduced compared to the erosion experienced during previous agricultural cultivation and burning on the property. Watering during construction and use of dust barriers will largely mitigate generation of fugitive dust. After project build-out, vehicular emissions may be mitigated by the increased efficiencies provided by development of off-site transportation improvements, such as the North-South Road, East-West Road, and improvements planned for Farrington Highway and H-1 Freeway.

Traffic - The main roadway improvements proposed for the project consist of construction of a portion of the East-West Road and a portion of Kapolei Parkway. Regional improvements that will be developed independent of the proposed project include widening of Farrington Highway and construction of the proposed North-South Road which will intersect with a new interchange at the H-1 Freeway. With implementation of the proposed on-site and off-site transportation improvements, all of the major roadways and intersections planned for the project should operate under their designated capacity.

Visual - The City's Land Use Ordinance controls the height, density, building setbacks, landscaping, and type of land uses permitted on all properties throughout Oahu. None of the subject property has been designated by the City's Coastal View Study as a significant visual resource. However, to mitigate the potential harshness of the urban environment, landscaping will be extensive and utilized to integrate the built environment with surrounding land uses while creating an attractive urban setting. ~~HFDC~~HCDCH will extensively landscape the major roadways, and the drainage/recreation corridor adjacent to the proposed North-South Road.

Public Services and Utilities - All new major backbone infrastructure will be sized in accordance with project requirements to service large lot development parcels which will be sold to private developers by ~~HFDC~~HCDCH. Within each of the large lot parcels, infrastructure will be provided by the respective developer in accordance with the needs established by the land uses envisioned by the project master plan. Treated non-potable wastewater effluent and brackish groundwater will be utilized for irrigation when available to the project area for urban landscaping. Electrical and communication improvements necessary to support the requirements of this project will be served from existing and proposed utility systems.

ALTERNATIVES CONSIDERED

In compliance with provisions of Title 11, Department of Health, Chapter 200, Environmental Impact Statement Rules, Section 11-200-17(f), the alternatives to the proposed project are limited to those that would allow the objectives of the project to be met, while minimizing potential adverse environmental impacts. Consequently, alternatives were considered based on densities, land use type, configuration of land uses, and circulation of major transportation infrastructure. Because the project site consists of contiguous state-owned land parcels and is adjacent to existing urban district lands, no other similar state-owned parcels exist on Oahu with these characteristics. Therefore, alternative sites for a project of this scale which could also be developed in support of the University of Hawaii West Oahu Campus and in conformance with the City's Development Plan for the area were not available.

UNRESOLVED ISSUES

All of the identified "Unresolved Issues" identified are in the process of being resolved by ~~HFDC~~HCDCH or other agencies with jurisdiction. None of the following Unresolved Issues, require acceptance of this Environmental Impact Statement prior to permit approval or construction. The identified "Unresolved Issues" are as follows:

Kaloi Gulch - U.S. Army Corps of Engineers permitting and approval to realign Kaloi Stream. According to their comments concerning the Environmental Impact Statement Notice of Preparation, the Corps of Engineers has determined that Kaloi gulch is a water of the United States and will, therefore, be subject to Section 404 of the Clean Water Act.

Abutilon Menziesii Habitat Conservation Plan - Approval and implementation. Coordination with the Department of Land and Natural Resources Division of Forestry and Wildlife, and the United States Fish and Wildlife Service has resulted in the preparation of a Habitat Conservation Plan (HCP) for *Abutilon menziesii* (Red Ilima), an endangered plant which occurs on the property. The HCP requires the final approval of the BLNR. Once approved, implementation of the plan can proceed with final concurrence of the U.S. Fish and Wildlife Service. Implementation of the plan is subject to the use of ~~HFDC~~HCDCH revolving funds and issuance of revenue bonds by ~~HFDC~~HCDCH.

~~Hawaii~~Kapolei Sports Complex - Program development, site plan preparation, and facility operation. The State Department of Accounting and General Services (DAGS) has been designated as the lead agency in preparing the development program, site plan, and coordination of facilities operations for the ~~Hawaii~~Kapolei Sports Complex. For the preparation of this Environmental Impact Statement, general program assumptions were utilized to calculate impacts to transportation systems, infrastructure, and drainage. Final program development, facility design, and determination of operational management alternatives are underway and are presently unresolved. However, these issues should be resolved by the fall of 1998.

COMPATIBILITY WITH LAND USE PLANS AND POLICIES

Throughout the planning process, the master plan was presented to the affected Neighborhood Boards, Legislators, and City officials. Generally, the plan was well received, however, revisions were made to increase the amount of recreation and drainage areas, ~~relocate and expand the size of~~develop the State's proposed park ~~and~~n' ride facility at a later date, and to incorporate the State's proposed sports complex into the master plan at a site makai of the proposed Kapolei Parkway and adjacent to Barbers Point Naval Air Station.

The project does not require an amendment to the City's General Plan or the Ewa Development Plan. This planning policy was recently reinforced by the City Council in their adoption of the Ewa Development Plan Update which permits development of the project master plan as proposed upon approval of the necessary zoning. As such, the master plan was designed to address future population growth needs on Oahu while providing logical extensions of infrastructure, while reflecting existing and planned land use patterns.

Inasmuch as the subject property is presently classified by the Land Use Commission as Agricultural District lands, ~~HFDC~~HCDCH will submit a petition to the Land Use Commission to amend the subject property from the State Agricultural District to the State Urban District.

LISTING OF PERMITS OR APPROVALS

The following is an approximate list of major approvals and permits required for the implementation of the proposed plan. From the earliest stages of the planning process, ~~HFDC~~HCDCH has worked with all affected agencies to obtain their comments and necessary approval of plans and specifications.

Permit or Approval	~~Authority~~Applicant	~~Environmental Impact Statement (EIS)~~Authority
~~Chapter 343, HRS, Governor~~Environmental Impact Statement (EIS)	~~State Land Use District Boundary Amendment~~HCDCH	~~Change of Zone~~Chapter 343, HRS, Governor
~~Department of~~State Land ~~Utilization/City Council~~Use District Boundary Amendment	~~Plant Mitigation Plan~~HCDCH	~~Alteration of Waters of the United States~~State Land Use Commission
~~US Army Corps~~Change of ~~Engineers/State Dept. of Health~~Zone	HCDCH	~~Subdivision Approval~~Department of Land Utilization/City Council
~~Department of Land Utilization~~Plant Mitigation Plan	~~Building/Grading Permits~~ HCDCH	~~Building Department/Department of Public Works~~Dept. Land and Natural Resources/US Fish and Wildlife
Alteration of Waters of the United States	HCDCH	US Army Corps of Engineers/State Dept. of Health
Subdivision Approval	HCDCH/Individual Developers	Department of Land Utilization
Building/Grading Permits	HCDCH/Individual Developers	Building Department/Department of Public Works
NPDES	HCDCH/Individual Developers	Department of Health

1.0 INTRODUCTION

1.0 INTRODUCTION

1.1 Project Summary

The following summary describes the existing entitlements and proposed actions:

Project Name:	East Kapolei Master Plan Development Project
Applicant:	Housing ~~Finance~~ and Community Development Corporation of Hawaii (~~"HFDC"~~ "HCDCH")
Land Area:	TMK: 9-1-16: 8, 108, and 109; TMK: 9-1-17: 4 (por.), 71, and; TMK: 9-1-18: 3 and 5 TOTAL: 1,300 Acres
Existing Use:	The subject parcels consist of fallow agricultural land previously used for sugar cane production and appurtenant infrastructure (i.e. cane haul roads). A small portion is used for diversified agriculture under short-term leases.
Proposed Use:	Single Family, multi-family, commercial, public facility, and open space recreation.
State Land Use District:	Agricultural District
Ewa Development Plan Land Use Map:	Residential, commercial, public facility, open space/recreation, transportation facilities
City and County of Honolulu Zoning:	AG-1 Restricted Agriculture
Action Requested:	Reclassification of approximately 1,300 acres from the State Agricultural to State Urban District
EIS Approving Agency:	Governor, State of Hawaii
Agencies Consulted:	Various City/State agencies, Neighborhood Boards, Legislators, and area landowners

1.2 Statement of Purpose

In accordance with Chapter 343, *Hawaii Revised Statutes* ("HRS") and Subchapter 4, Section 11-200-4, Hawaii Administrative Rules, "the governor, or an authorized representative, whenever an action proposes the use of state lands or the use of state funds, or, whenever a state agency proposes an action within section 11-200-6(b)" shall be the final authority to accept an environmental impact statement.

Since the proposed project will require the use of state owned land and funds, the project must comply with these provisions of Chapter 343, HRS. Therefore, the Governor will act as the Accepting Authority for the East Kapolei Master Plan Development Project Environmental Impact Statement.

1.3 Ownership

The land owner is currently the State of Hawaii Department of Land and Natural Resources (DLNR) and the agency preparing the master plan and acting as applicant for the applicable land use entitlements is the Housing ~~Finance~~ and Community Development Corporation of Hawaii (~~HFDC~~HCDCH). A Letter of Authorization from the landowner will *be provided in the State Land Use Petition which gives the* ~~HFDC~~HCDCH *the authority* to prepare the project master plan, environmental reports, and process the applicable land use entitlements through both State and City agencies.

The primary approval from the State will be acceptance of the environmental disclosure documents in accordance with Chapter 343, *Hawaii Revised Statutes* ("HRS") and processing of a State Land Use District Boundary Amendment by the State Land Use Commission from the Agricultural District to the Urban District for the entire 1,300 acre subject property. Appropriate zoning entitlement designations will also be required from the City and County of Honolulu in accordance with the recently updated Ewa Development Plan.

To identify the appropriate uses for the subject property, the Housing ~~Finance~~ and Community Development Corporation of Hawaii (the State's lead agency for the project), has authorized PBR HAWAII to prepare a Conceptual Master Plan and applicable environmental documents in compliance with Chapter 343, HRS. Therefore, in accordance with Chapter 343, HRS, the Housing ~~Finance~~ and Community Development Corporation of Hawaii is the proposing agency for the project. The HCDCH mailing address and primary contact person is as follows:

Mr. Donald Lau, Executive Director
State Housing and Community Development Corporation of Hawaii
677 Queen Street, Suite 300
Honolulu, Hawaii 96813

1.4 Background

The subject property consists of approximately 1,300 acres of land previously used for sugar cane production located in the District of Ewa in the ahupua'a of Honouliuli, Island of Oahu **(Figures 1 and 2)**. ~~The HFDC mailing address and primary contact person is as follows:~~

~~Mr. Roy S. Oshiro, Executive Director~~
~~State Housing Finance and Development Corporation~~
~~677 Queen Street, Suite 300~~
~~Honolulu, Hawaii 96813~~

~~**1.4 Background**~~

~~The subject property consists of approximately 1,300 acres of land previously used for sugar cane production located in the District of Ewa in the ahupua'a of Honouliuli, Island of Oahu **(Figures 1 and 2)**.~~

The Kapolei area, as shown in the Kapolei Area Long Range Master Plan prepared by the Estate of James Campbell **(Figure 3)**, is located on the Ewa Plain approximately 30 minutes from downtown Honolulu. The Ewa Plain encompasses approximately 32,000 acres or about 8 percent of the island of Oahu. The City of Kapolei and surrounding developments have been master-planned to provide for commercial, industrial, resort, recreational, and residential uses. Therefore, residents of the proposed development will have the opportunity to live, work, and play close to their homes and businesses without the long commute to Honolulu or Central Oahu.

To ensure that the proposed master plan is consistent with the intent of the Long-Range Master Plan, the Estate of James Campbell transferred the subject property to the State on the condition that it be developed primarily as a residential community with commercial and park uses sized in response to community needs. Revenues from the sale of a portion of the subject property are to be allocated toward the future development of the University of Hawaii West Oahu Campus at a site mauka of the H-1 Freeway and the East Kapolei Master Plan Development area.

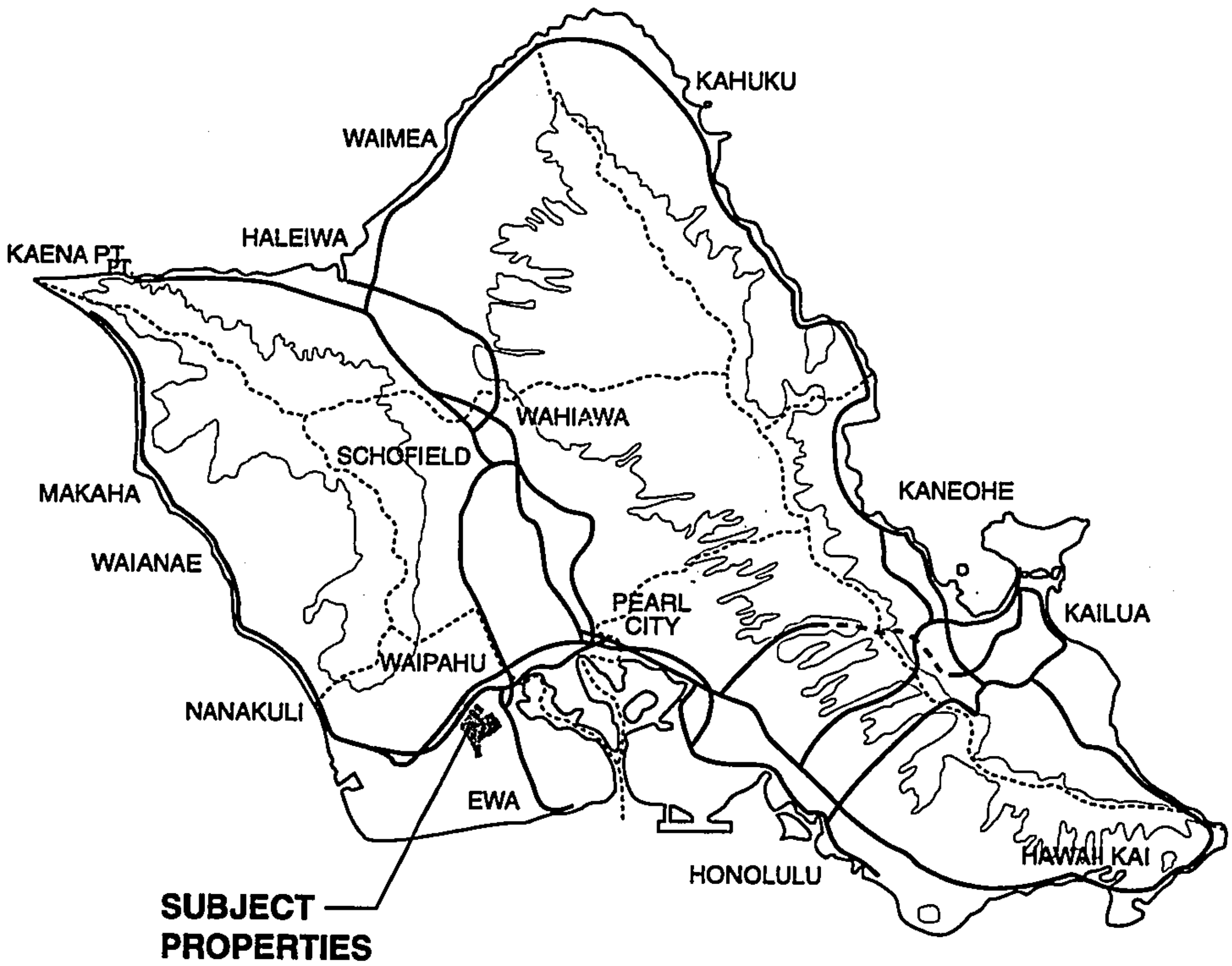


FIGURE 1
LOCATION MAP
HCDHC EAST KAPOLEI
ISLAND OF OAHU

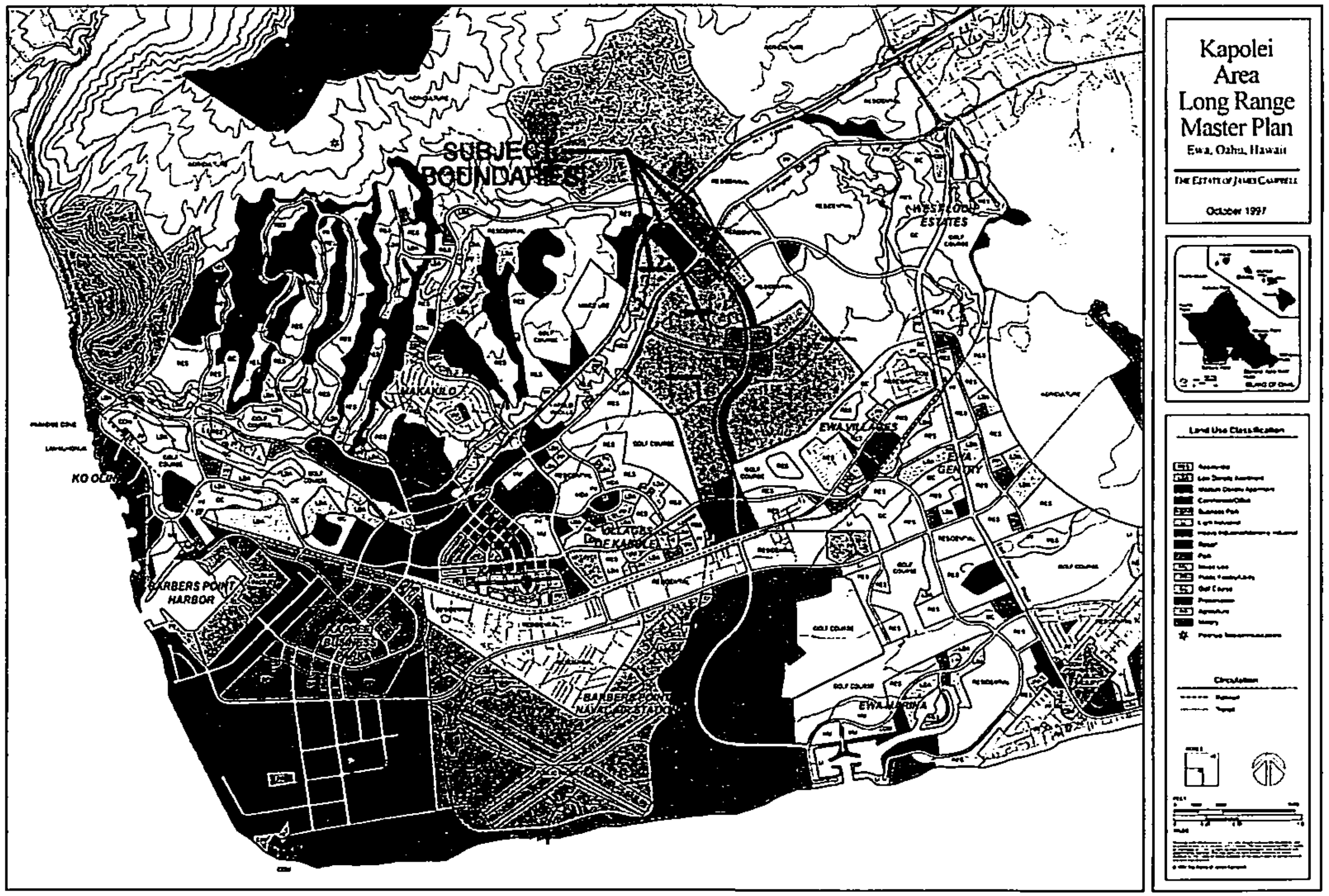


FIGURE 3
KAPOLEI AREA LONG RANGE
MASTER PLAN

HCDCH EAST KAPOLEI

ISLAND OF OAHU

PBR HAWAII

DATE: 2/98

1.5 Need for the Proposed Action

According to a Market Study prepared for the project (Appendix A), approximately 1,000 to 1,500 new single-family home sales occur each year with a similar sales level for multi-family units.

To determine the future residential sales absorption for the project, the Market Study assumed that the residential component of the project master plan could capture approximately 18 percent of the Oahu's single family market and 12 percent of the multi-family market (based on historic trends at the Villages of Kapolei). Consequently, project developers are expected to average approximately 225 single family unit sales and 150 multi-family unit sales per year over the 20 year development period. Although actual absorption will fluctuate, this average rate of absorption is projected based on historic trends. The residential densities envisioned by the East Kapolei Master Plan would permit a total of between 4,300 and 5,800 single family units and 2,100 and 2,600 multi-family units.

Average prices will be determined by project developers in accordance with market demand and the City's affordable housing policy, but prices are generally assumed at $250,000 for single family units and $125,000 for multi-family units. An appreciation rate of 2 percent per year is also assumed by the Market Study.

1.6 Description of the Property

The subject property is mostly vacant agricultural land which was previously leased for many years by Oahu Sugar Company, Limited ("OSCo") for the production of sugar cane. These leases have since expired, however, and no plans exist to convert the subject property to other types of agricultural land uses. Some small scale mellon production is presently being cultivated near the H-1 Freeway under short-term leases, however, these agricultural activities can be relocated to other available lands in Central Oahu once construction activities are initiated in this area.

Other current uses on the property include overhead electrical transmission lines and an old storage building associated with the prior sugarcane production. The subject property is generally flat to slightly sloping with the shallow Kaloi Gulch presently bisecting a portion of the property.

1.7 Surrounding Land Uses

The subject property is bounded on the north by Farrington Highway and H-1 Freeway, to the west by the Villages of Kapolei and Kapolei Golf Course, to the south and southeast by Barbers Point Naval Air Station ("NASBP") and Ewa Villages, and to the east by fallowed agricultural land. Two separate parcels located between the H-1 Freeway and Farrington Highway consisting of 76 acres and 66 acres (**Figures 1 and 3**) are also included in the 1,300 acre project area. All of the subject property is located within the State Land Use Commission Agricultural District (**Figure 2**).

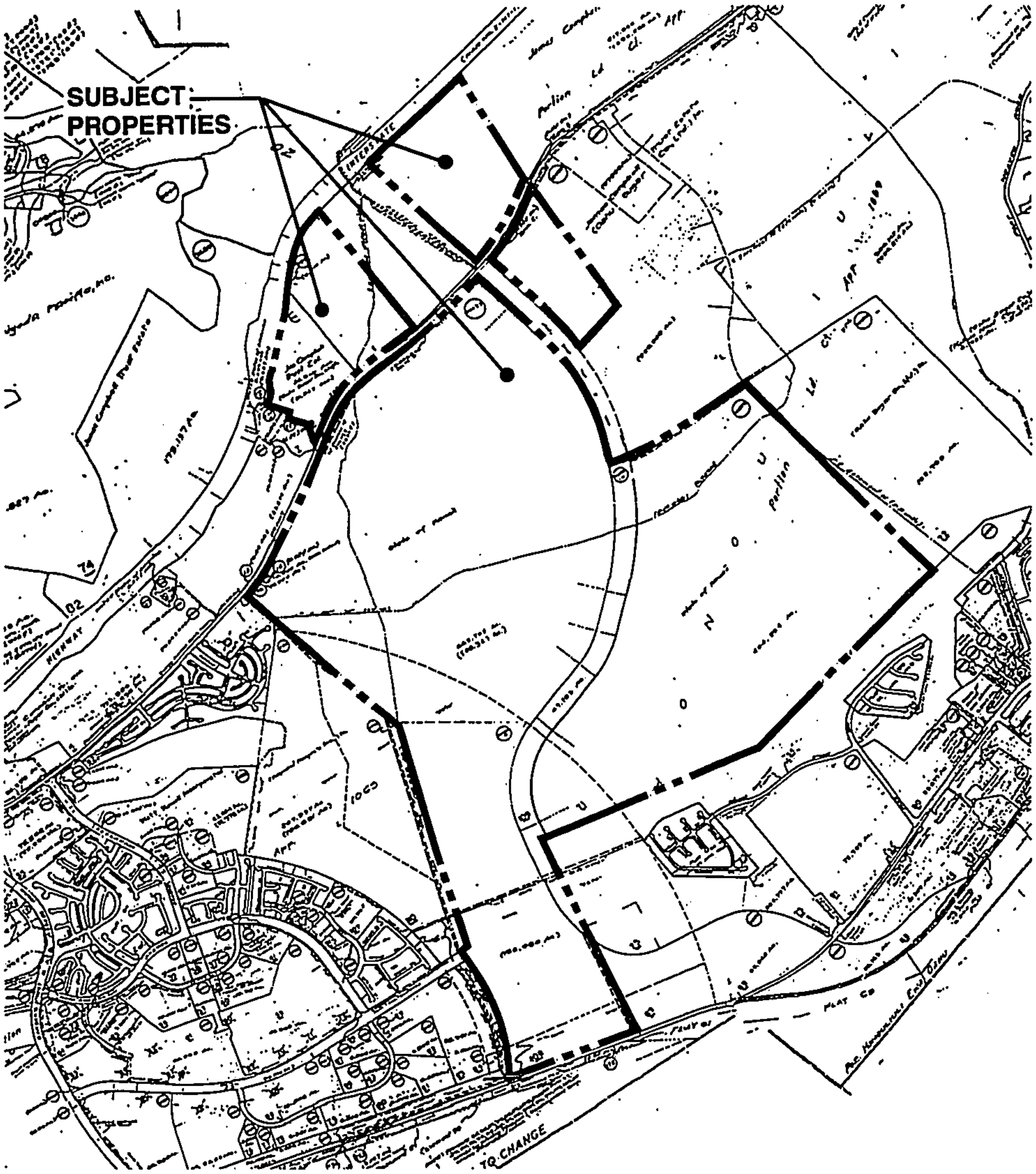


FIGURE 2
TAX MAP KEY
HCDCH EAST KAPOLEI
ISLAND OF OAHU

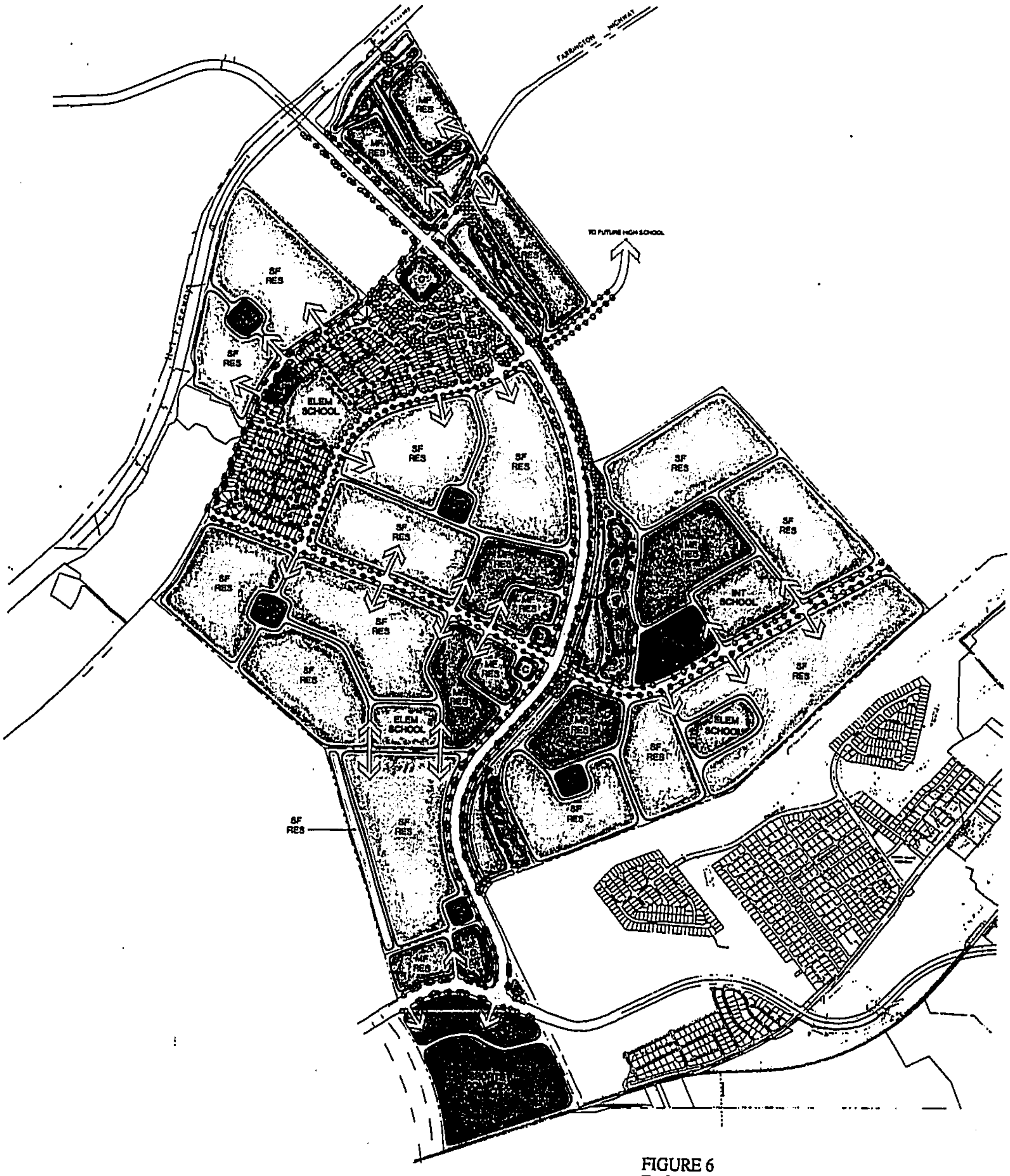


FIGURE 6
EAST KAPOLEI CONCEPTUAL DEVELOPMENT PLAN

HCDCH EAST KAPOLEI

ISLAND OF OAHU

NORTH

LINEAL SCALE (FEET)
400 0 400 800 1600

PBR HAWAII

DATE: 2/96

2.0 Description of the project

2.0 DESCRIPTION OF THE PROJECT

2.1 Project Goals and Objectives

The overall project goals and objectives established by the State Legislature and the State of Hawaii Housing ~~Finance~~ and Community Development Corporation of Hawaii (~~HFDC~~HCDCH) are essentially two fold:

1) to create more housing, recreational, and support facilities in the Ewa Development Plan area for residents of Hawaii, and;

2) to generate income from State-owned land in support of a new West Oahu Campus for the University of Hawaii which is planned mauka of the H-1 Freeway.

To achieve the stated objectives, large-lot development parcels would be developed with required major infrastructure and sold by ~~HFDC~~HCDCH to individual developers. None of the proposed land uses (i.e. residential, commercial) will be developed by ~~HFDC~~HCDCH. Rather, dwelling units and small neighborhood commercial parcels will be developed by the private sector in accordance with the East Kapolei Master Plan. The number of actual units developed, their type, and pricing will be dependent on market conditions at the time of development and applicable zoning restrictions. However, all developers will be required to comply with applicable City zoning regulations and the City's affordable housing policy.

2.2 Need for the Project

According to a Market Study prepared for the project (Appendix A), approximately 1,000 to 1,500 new single-family home sales occur each year on Oahu with a similar sales level for multi-family units. However, because ~~HFDC~~HCDCH will only sell large-lot development parcels to private developers and not construct new housing, the market demand for residential and commercial property was use only as a basis for determining the demand and pricing of large-lot development parcels.

Based on similar project sales in the region and the physical attributes and amenities of the proposed project, the Market Study assumed that the residential component of the project master plan could capture approximately 18 percent of the Oahu's single family market and 12 percent of the multi-family market (based on historic trends at the Villages of Kapolei). Demand for commercial space was also tied to the production of residential units at 188 square feet of land area/residential unit.

Consequently, project developers are expected to average approximately 225 single family unit sales and 150 multi-family unit sales per year over the 20 year development period.

Although actual absorption will fluctuate, this average rate of absorption is projected based on historic trends. The residential densities envisioned by the East Kapolei Master Plan would permit a total of between 4,300 and 5,800 single family units and 2,100 and 2,600 multi-family units.

Commercial land areas requirements are estimated at 24.3 acres over the development period which would exceed the 18 acres of commercial land area allocated by the East Kapolei Master Plan.

Average prices will be determined by project developers in accordance with market demand and the City's affordable housing policy, but prices are generally assumed at $250,000 for single family units and $125,000 for multi-family units. An appreciation rate of 2 percent per year is also assumed by the Market Study.

Based on the assumptions described above, the Market Study estimated a bulk sales price of $347,000/acre for improved property with all necessary land use entitlements in place. This price would likely be discounted based on the size of the bulk sale. For example, the estimated price/acre range for bulk sales (Table VIII-5, Appendix A) is estimated as follows: 1-90 acres at $347,000, 90 - 135 acres at $340,000, and 135 - 180 acres at $329,650.

Recognizing that real estate values have generally fallen in recent years, the values for the low range estimate were reduced in the Socio-Economic Assessment from $347,000 to $300,000 per acre for residential land, and from $1,300,000 to $1,000,000 for commercial land. This reduction was utilized to ensure that the net revenue projections for ~~HFDC~~HCDCH were based on more "conservative" assumptions. It was also assumed, after discussion with ~~HFDC~~HCDCH staff, that pricing at these levels could accelerate sales of the large-lots.

The Socio-Economic Assessment (Appendix K) estimates that by 2022, the net balance of revenues over costs of the project is estimated as $193 million to $245 million (1997 dollars). The net present value of ~~HFDC~~HCDCH cash flows is estimated well over $60 million (with a discount rate of 8 percent). The net present value of ~~HFDC~~HCDCH and State general fund spending and income associated with the project (not including DHHL investment) is estimated as about $90 million to $120 million through 2022. Eventually, after all residential and commercial land sales are complete and funds are transferred to the University of Hawaii West Oahu Campus, ~~HFDC~~HCDCH is expected to net some $34 million to $54 million (constant 1997 dollars).

2.3 Key Elements of the Master Plan

The concept for the East Kapolei Master Plan Development Project includes a mix of single-family, multi-family, commercial, public facility, (i.e., school parcels), parks, open space, and recreational land uses. A major sports complex is also planned for a ~~63~~64.3 acre parcel makai of Kapolei Parkway. The East Kapolei Conceptual Development Plan is depicted as **Figure 46**. These land uses are all planned to be within easy walking distance of one another and from other adjoining vacant land areas which will likely be developed in the future.

Large lot improved development parcels will be reclassified to the Urban District (Figure 64) and sold by ~~HFDCH~~HCDCH to individual developers for construction of the proposed land uses in accordance with the East Kapolei Master Plan, the City's Ewa Development Plan, and applicable zoning classifications. Backbone infrastructure consisting of major roadways, a large ~~park-and-ride facility, a~~ sports complex with parking, implementation of a drainage system, water and wastewater system master plans, expansion of electrical and communication systems, and development of open space recreation areas will be provided by ~~HFDCH~~HCDCH. All infrastructure improvements will be designed and sized to accommodate future regional land uses including the new University of Hawaii West Oahu Campus ("UHWOC") located mauka of the H-1 Freeway. All other applicable site plans and development programs for the area will be implemented by future developers.

A brief description of the major land use elements of the East Kapolei Conceptual Development Plan (**Figures 45 and 6**) are presented below:

2.4 Single Family Residential

The single family residential component of the plan, calls for approximately 722 acres of the subject property to be used for residential building sites. Current plans assume that the residential subdivisions will be designed in accordance with applicable provisions of the City's R-5 Residential zoning district (minimum lot sizes of 5,000 square feet) at densities ranging from 6-8 units per acre (4,300 to 5,800 units). Architecture of individual units will be designed by developers and sold in fee as house and lot packages to home buyers. Units will be sold in accordance with the City's applicable housing policy at both market and affordable prices. Average prices determined by the Market Study should be approximately $275,000 in 2001-2002.

2.5 Multi-Family Residential

The multi-family units will be designed, built, and sold in the same manner as the single family real estate product, but consisting of approximately 211 acres of the project site. Presently, densities are estimated to average approximately 10-12 dwelling units per acre which could yield approximately 2,100 to 2,600 units. Preliminary zoning designations for the multi-family areas will be A-1 Apartment. Units will be designed by developers and sold in fee as condominiums. Average prices determined by the Market Study should be approximately $138,000 in 2001-2002.

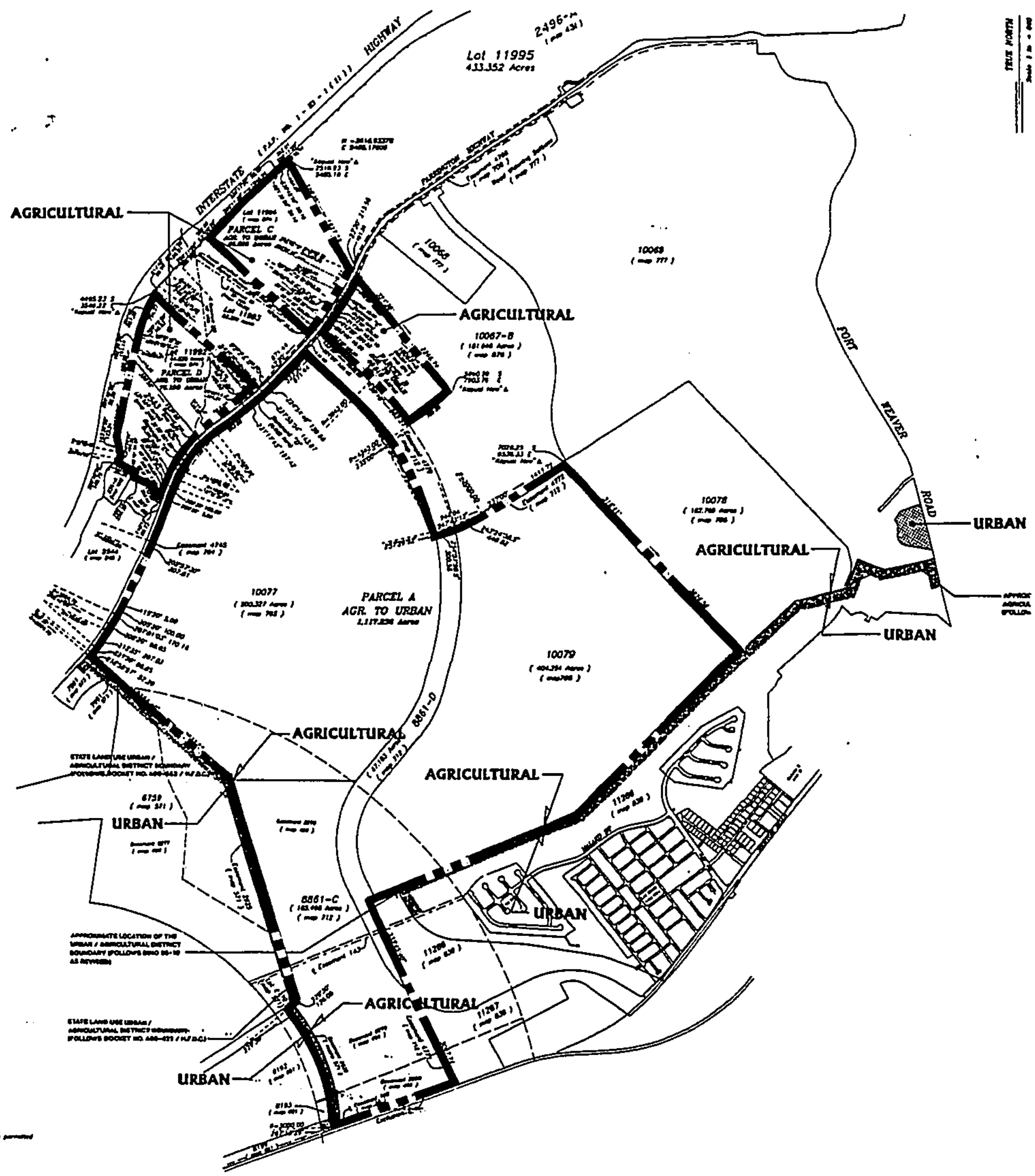


FIGURE 4
EXISTING STATE LAND USE
DISTRICT BOUNDARY INTERPRETATION

HCDCH EAST KAPOLEI

ISLAND OF OAHU

NORTH

LINEAL SCALE (FEET)

PBR

DATE: 2/98

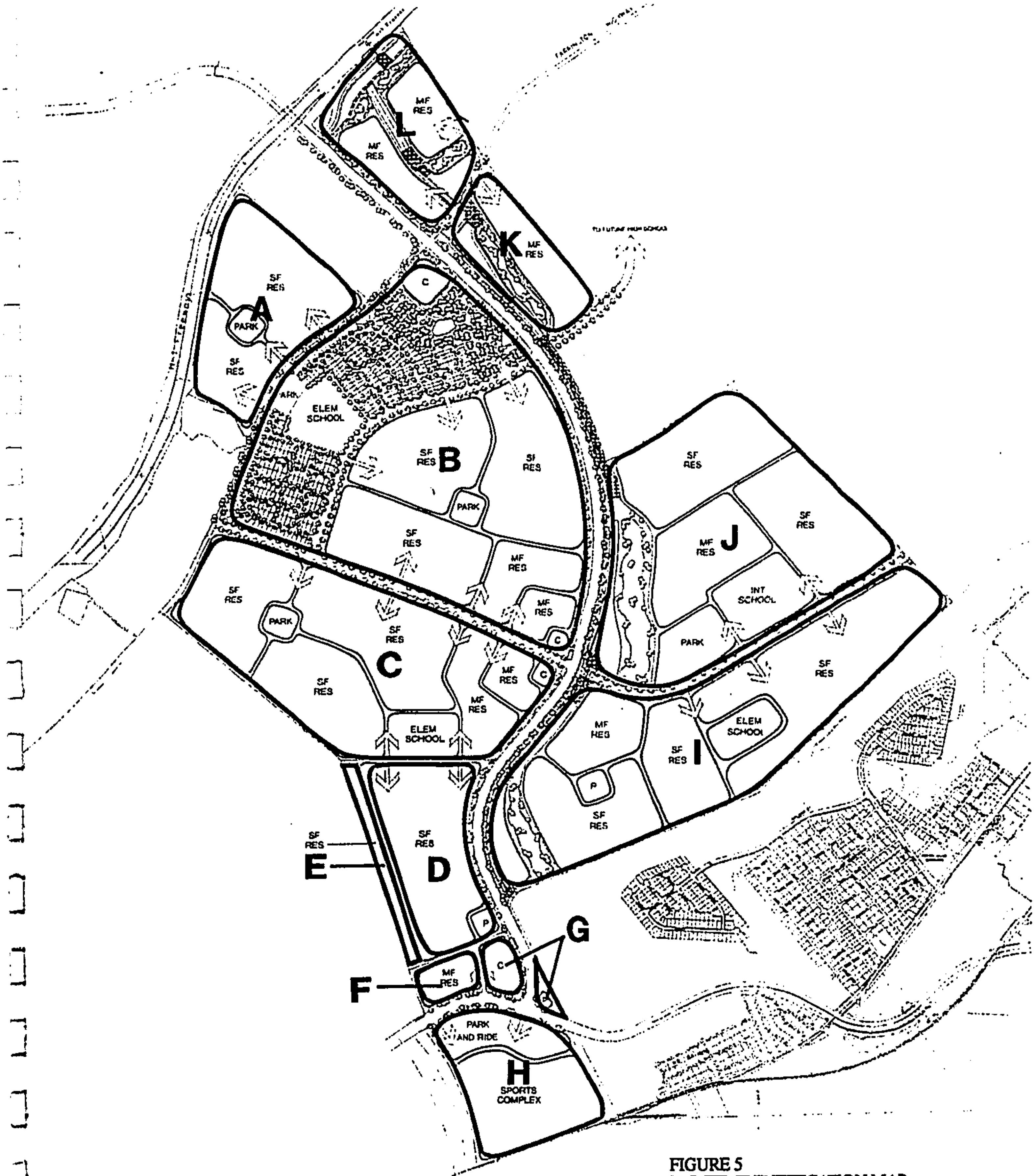


FIGURE 5
PARCEL IDENTIFICATION MAP

HCDCH EAST KAPOLEI

ISLAND OF OAHU

NORTH

LINEAL SCALE (FEET)

PBR

DATE: 2/98

To minimize the need for vehicular transportation, most multi-family parcels have been located in the master plan at locations proximate to major transportation facilities, commercial facilities, school sites, and parks to minimize the need to drive to project amenities and public facilities. Pedestrian walkways and bicycle facilities will be encouraged to enhance internal circulation between major trip generation centers and residential areas, and will be incorporated within the proposed park/open space corridor.

2.6 Park/Open Space Corridor

The project master plan envisions the establishment of a network of six neighborhood parks (each approximately 3 acres), a 15-acre district park, and an open space recreational/drainage corridor. The corridor will run roughly parallel to the proposed North-South Road which will be developed by the State Department of Transportation and City Department of Transportation Services. The open space/drainage corridor element of the plan will function as:

- collector for surface runoff,
- retention/detention facility,
- open space recreational corridor; and,
- open space buffer adjacent to heavily traveled roadways and higher density land uses.
- to be used as a passive open space recreational and aesthetic amenity eventually extending from the University of Hawaii West Oahu Campus (UHWOC) to off-site open space corridors at Barbers Point designed with a similar drainage and open space recreational/drainage function may also connect to the East Kapolei corridor system.

By placing the open space/drainage corridor adjacent to this major roadway, the proposed drainage facilities will establish an open space buffer between this major transportation corridor and other future residential development planned for the area. On-site retention basins within the drainageway are also planned to serve as an aesthetic and functional drainage element. The drainage basins and adjoining open space areas, will offer extensive grassed and landscaped recreation land available to the community. The drainage function of the open space corridor will be utilized approximately once every 100 years during periods of intense rainfall.

Master planning and development of new parks will be provided in accordance with the requirements of the City's Park Dedication Ordinance as administered by the City and County Department of Parks and Recreation. Private parks will likely be developed in association with multi-family residential development projects.

2.7 Sports Complex

The proposed sports complex is planned for a ~~63-acre~~64.3-acre site located makai of Kapolei Parkway and mauka of the property boundary with Barbers Point (**Figures 7a, 7b, and 7c**). ~~A proposed~~The sports complex was also designed to permit the possible future development of elevated parking to accommodate a park ~~and~~'n ride facility ~~would be located~~ toward the mauka side of the facility and adjacent to the Kapolei Parkway. The ~~park-and-ride is planned to~~park 'n ride could potentially encourage ridership on TheBus and other transportation alternatives as they become available. This ~~and to~~facility could serve the public and as a potential parking area for State employees at the State Civic Center. (According to the Department of Accounting and General Services, there will be adequate parking provided for public employees and others at the Kapolei Civic Center in accordance with City parking requirements). ~~This facility~~In addition, ~~plus an internal system of pedestrian walkways and bike facilities,~~the Sports Complex will ~~encourage students and parents~~utilize an internal system of pedestrian walkways and bike facilities to encourage alternative modes of transportation to and from the facility.

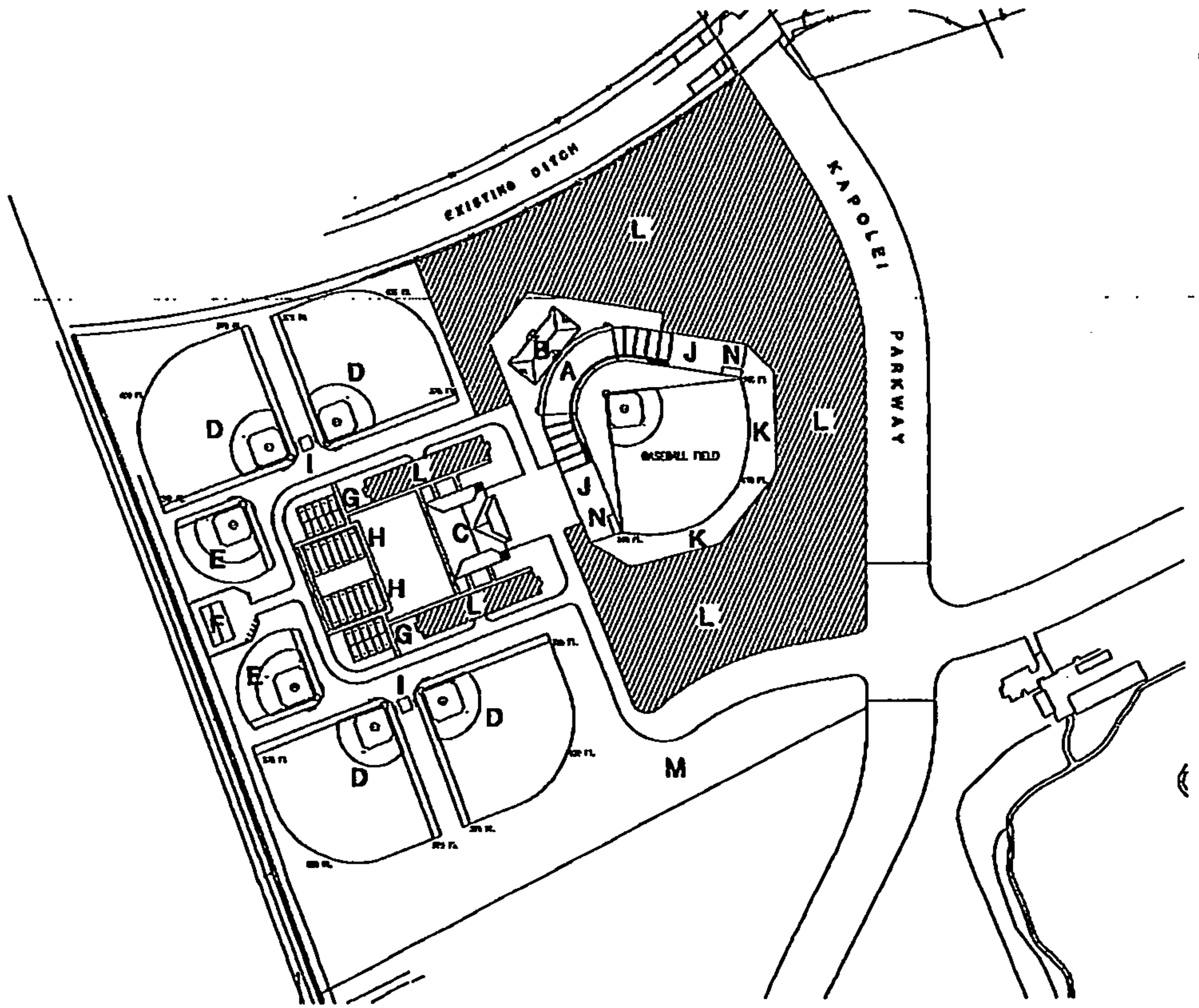
A conceptual layout of the sports complex ~~and park-and-ride facility~~ has been designed to support up to two professional baseball teams simultaneously. Approximately 2,000 parking stalls would be provided initially. This design was based on discussions with local teams, mainland operators, and international sports teams (Appendix K).

The proposed facility will be developed by the Department of Accounting and General Services and owned by the State of Hawaii. According to the feasibility study prepared for the sports complex, the facility could be made available to both American and foreign professional baseball teams for their spring training period. Japanese baseball teams have conducted some spring training in Hawaii, but have been restricted by the inadequate facilities available.

Benefits to the State of Hawaii could accrue from several sources, including the publicity and possible broadcasting that the operations could generate, the attraction of tourists to the facility and to the State in general, and the expenditures in Hawaii associated with the professional teams, tourists, and media. By providing revenue during the training season, the goal of the project is to be self supporting through revenues generated by professional teams or the sports complex operator.

Program Assumptions

- Aloha Stadium Authority would likely manage the facility. The goal is to become self supporting with revenues from practice teams, concessions, and ticket sales to cover maintenance and operation.



ARCHITECTURAL SITE PLAN

LEGEND:

- **A** 4,000 SEATING CAPACITY BASEBALL STADIUM
- **B** PRESS LOUNGE
- **C** TEAM CLUBHOUSE/MULTI-PURPOSE BUILDING
- **D** FULL SIZE BASEBALL PRACTICE FIELD (90 FEET BASE PATHS)
- **E** INFIELDER AND PITCHER'S PRACTICE FIELD (90 FEET BASE PATHS)
- **F** GENERAL FIELD MAINTENANCE AND STORAGE BUILDING
- **G** BATTING CAGES
- **H** PITCHER'S MOUND
- **I** CONCESSION/RESTROOM AND OBSERVATION TOWER BUILDING
- **J** FUTURE STADIUM EXPANSION (2,000 CAPACITY ADDITION SEATING ON BOTH SIDES)
- **K** OUTFIELD LAWN SEATING AREA (2,000 CAPACITY ADDITION SEATING)
- **L** PARKING – STANDARD: XXXX; COMPACT: XXXX; HANDICAP: XXXX; TOTAL: XXXX
- **M** NURSERY
- **N** BULL-PEN

FIGURE 7A
SPORTS COMPLEX SITE PLAN

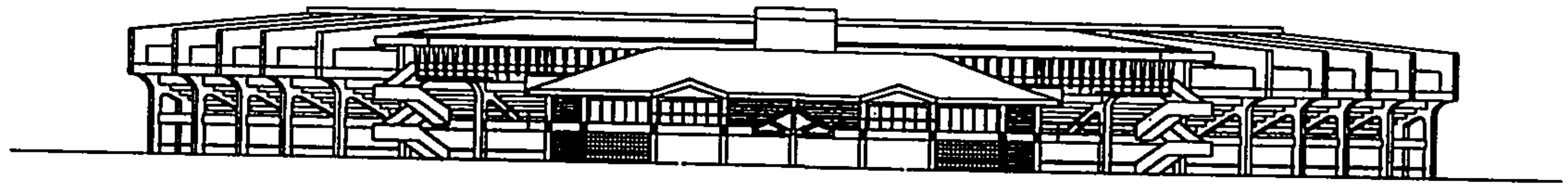
HCDCH EAST KAPOLEI

ISLAND OF OAHU

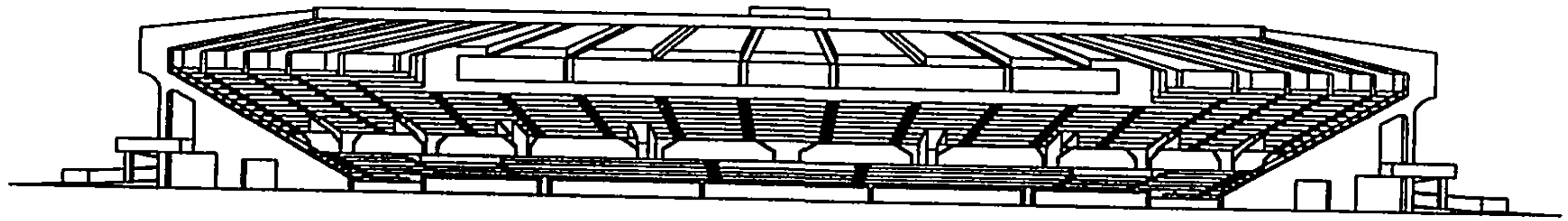
NORTH

PBR HAWAII

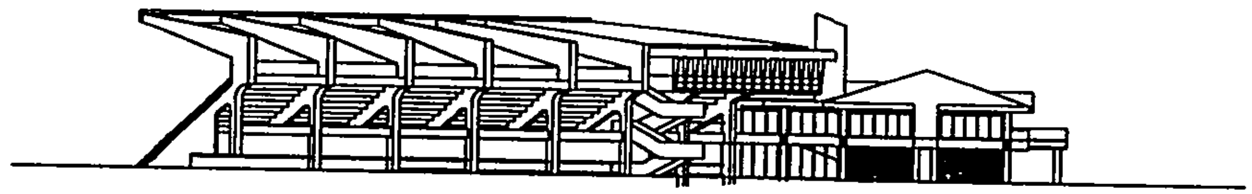
DATE: 7/98



FRONT ELEVATION



FIELD ELEVATION



SIDE ELEVATION

FIGURE 7B
SPORTS COMPLEX MULTI-PURPOSE
BUILDING ELEVATIONS

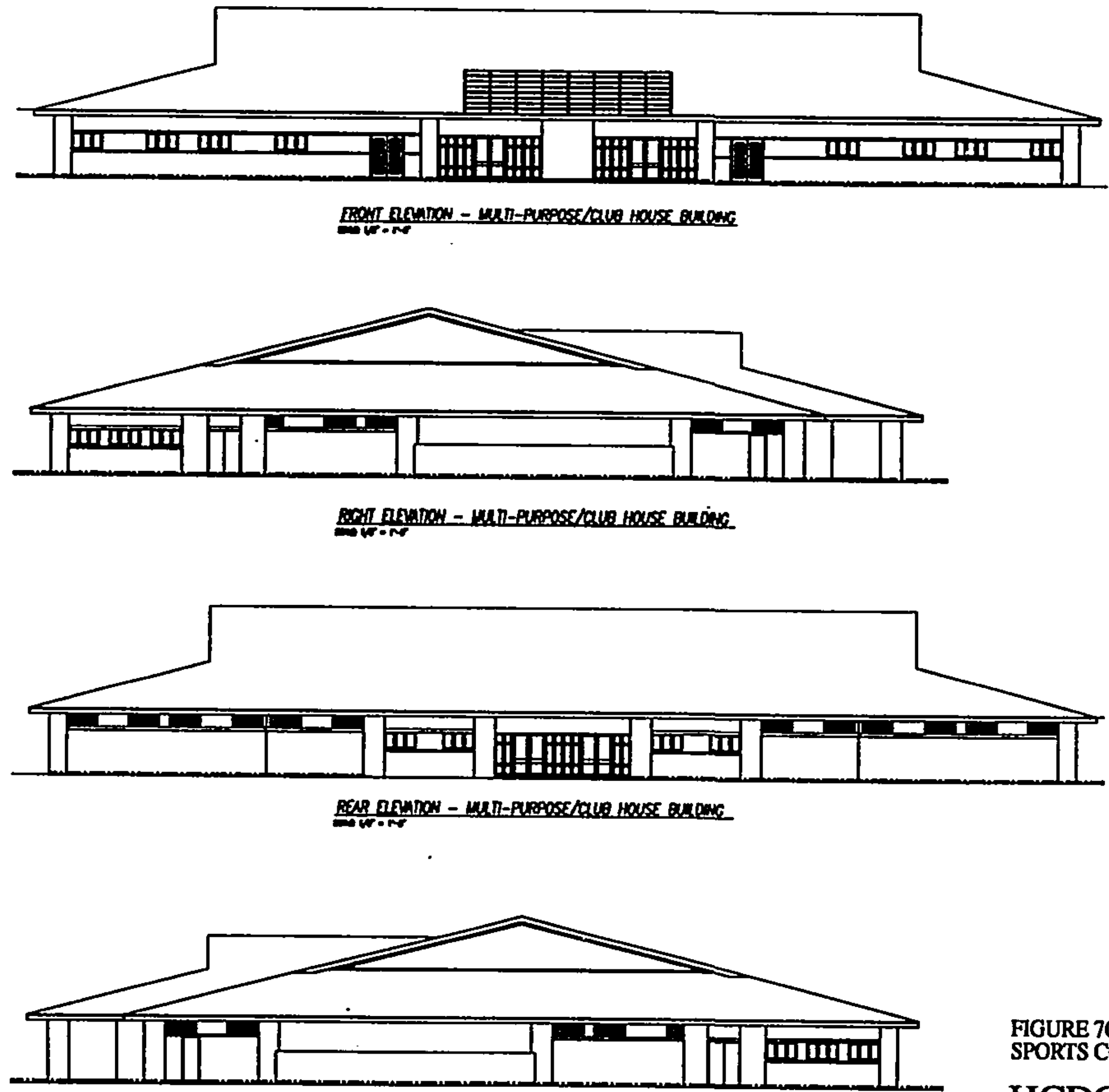
HCDCH EAST KAPOLEI

ISLAND OF OAHU

NORTH

PBR HAWAII

DATE: 7/98



FRONT ELEVATION - MULTI-PURPOSE/CLUB HOUSE BUILDING

RIGHT ELEVATION - MULTI-PURPOSE/CLUB HOUSE BUILDING

REAR ELEVATION - MULTI-PURPOSE/CLUB HOUSE BUILDING

LEFT ELEVATION - MULTI-PURPOSE/CLUB HOUSE BUILDING

FIGURE 7C
SPORTS COMPLEX STADIUM ELEVATIONS

HCDCH EAST KAPOLEI

ISLAND OF OAHU

NORTH

PBR

DATE: 7/98

- Top trainers, potential sports medicine, training, and conditioning facilities could be available.
- Public/Private partnerships may be available to contribute equipment and facilities.
- Facilities for summer instructional league would be provided including training and class rooms.

~~*Youth leagues including little leagues from communities in the region could also be accommodated.*~~
Facilities

- The first phase of stadium development would accommodate a 4,000 seat stadium to be expandable to 10,000 seats and be designed for AAA league play. Four practice fields and two practice infields, pitchers' mounds for 2 teams would also be developed.
- The stadium would be fully lighted.
- Sports facilities at the stadium would also include concessions, public restrooms, a press box area and press lounge area, home and visitor dugouts, ticket offices and bullpens.
- A multi-purpose building of approximately 23,000 square feet with locker rooms, concessions, weight training, and meeting rooms available for team conferences, training, and classes. This facility would be designed to accommodate two teams at one time. Other facilities include administration offices, hydrotherapy rooms, equipment storage, covered dining lanai, and miscellaneous accessory facilities (i.e. mechanical and electrical rooms, lobbies, etc.)
- Scoreboards and viewing area for officials and concession area with additional storage at ground level.

~~Near the intersection of the North-South Road and makai of Kapolei Parkway, a park and ride facility is planned to integrate the project into the development of new transportation facilities as they become available in the future. This facility will also serve as the primary parking lot for employees of the new Civic Center located within the City of Kapolei.~~

- A portion of the sports complex's 2,000 parking stalls can serve as a park n' ride facility to integrate the project into the development of new transportation facilities as they become available in the future.

2.8 Commercial/Retail

The Ewa Development Plan calls for the establishment of neighborhood commercial nodes to service the residential components of the master plan and to be located proximate to major transportation nodes. The commercial parcels are located at the intersection of Farrington Highway and the proposed North-South.Road, a second commercial area at the intersection of the Kapolei Parkway and the North-South Road, and two small commercial parcels at the intersection of the North-South Road and East-West Road. Neighborhood commercial parcels total approximately 18 acres within the project area.

As shown, these nodes are also adjacent to major intersections, proposed transit facilities, and the higher density multi-family land uses located primarily along the North-South Road. Landscaping would be used to integrate the neighborhood commercial facilities into the future transportation facilities identified in the Ewa Development Plan for this area. The commercial elements of the master plan would also supplement retail activity at the City of Kapolei to create a critical mass of retail space to draw customers from a wider geographic area.

2.9 Schools

A total of four school sites (three elementary and one intermediate school) are located throughout the East Kapolei Master Plan area. Acreage allotments for proposed school sites include three elementary school sites of 12 acres each and an intermediate school site of 20 acres. Each of the school sites will also contain extensive recreational facilities to be jointly used by the school and community.

2.10 Land Use Summary

According to a preliminary market analysis prepared for this project and an assessment of other development projects planned for Ewa, a wide range of land uses as reflected in the proposed East Kapolei Master Plan will be in demand. Projections prepared by the market study indicate that the project can achieve build-out in approximately 20 years after major infrastructure and zoning entitlements are in place.

Therefore, based on the economic feasibility of potential land uses, the following land use program was developed as described in the East Kapolei Conceptual Development Plan above **(Figure 46)** and the Parcel Identification Map **(Figure 5)** is summarized as follows:

LAND USE SUMMARY FOR HCDCH EAST KAPOLEI DEVELOPMENT PROJECT										UNITS CALC			
										LOW RANGE		HIGH RANGE	
							OTHER			SF	MF	SF	MF
PARCEL		ACREAGES					OS/PF	subtotal	density	6	10	8	12
		SF	MF	COMM	SCHOOL	PARK							
	A	73.1	-	-	-	3.0	-	76.1		439	-	585	-
DHHL	B	211.6	56.4	8.0	12.0	6.0	-	294.0		1,270	564	1,693	677
	C	132.0	32.1	2.0	12.0	3.0	-	181.1		792	321	1,056	385
DHHL	D	61.0	-	-	-	3.0	-	64.0		366	-	488	-
	E	9.2	-	-	-	-	-	9.2		55	-	74	-
	F	-	10.5	-	-	-	-	10.5			105		126
	G	-	-	8.0	-	2.5	-	10.5		-	-	-	-
	H	-	-	-	-	64.3	-	64.3		-	-	-	-
	I	106.9	-	-	12.0	-	27.8	146.7		641	-	855	-
DHHL	I	34.2	22.7	-	-	3.0	-	59.9		205	227	274	272
	J	94.5	34.0	-	20.0	15.4	39.2	203.1		567	340	756	408
	K	-	22.8	-	-	-	20.7	43.5		-	228	-	274
	L	-	32.4	-	-	-	31.2	63.6			324		389
		-	-	-	-	-	-	-		-	-	-	-
		-	-	-	-	-	-	-		-	-	-	-
		-	-	-	-	-	-	-		-	-	-	-
	MAJOR ROADS	-	-	-	-		73.5	73.5					
SUBTOTALS		722.5	210.9	18.0	56.0	100.2	192.4	1,300.0		4,335	2,109	5,780	2,531
MINUS DHHL										1010	227	1347	272
UNITS ON LAND SOLD BY HFDC TO DEVELOPERS										3,325	1,882	4,433	2,259
RANGE TOTALS													
	TOTAL UNITS ON SITE, INCLUDING DHHL									6,444		8,311	
	TOTAL, EXCLUDING DHHL									5,207		6,692	

Final determination of land use types, densities, number of units, pricing, development timetable, and projected improvement costs will be identified during the entitlement review process and as market conditions evolve in the future. The market study (Appendix A) and Socio-Economic Impact Assessment (Appendix K) best describe project phasing and the net affect of the project on State and City revenues and expenditures.

2.11 Infrastructure Improvements

Construction of the proposed project master plan will begin with development of the major backbone infrastructure after the applicable grading permits are issued. It is anticipated that construction of the major infrastructure components of the plan will be initiated by ~~HFDC~~HCDCH as funding becomes available. Improvements to Kapolei Parkway and the start of construction for the proposed sports complex are planned for 1998.

Onsite infrastructure required to accommodate the residential dwellings within each large lot development parcel will be provided by the individual developers during the construction period. Wind patterns will also be considered during the development phases to minimize impacts on down-wind residential areas from fugitive dust emissions.

2.11.1 Wastewater Collection and Transmission

East Kapolei is located within the City and County of Honolulu's Honouliuli Wastewater Treatment Plant ("WWTP") service area. The WWTP is located adjacent to Barbers Point Naval Air Station ("NASBP") approximately 4,000 feet makai of the subject property. The only major trunk sewer line near the subject property is the 30-inch Makakilo Interceptor which runs from Makakilo, along Ft. Barrette Road and Renton Road (parallel to the OR&L Railroad right-of-way) to the Honouliuli WWTP.

Design capacity of the Honouliuli Wastewater Treatment Plant is adequate for the East Kapolei project (Appendix B).

Maximum design flow generated by the East Kapolei project is projected at 14.6 mgd and 19.5 mgd if the University of Hawaii West Oahu Campus is included. However, the design average flow based on the sewage generated on-site is estimated at 3.338 mgd and design average flow including the UHWOC is 5.258 mgd.

The major streets and utilities required for the East Kapolei Master Plan will be provided by ~~HFDC~~HCDCH including the wastewater collection system. The East Kapolei "backbone" sewer system will be comprised of a major trunk line along the North-South Road with size varying from 18-inches to 36-inches, and 12-inch and 15-inch branch lines along connecting collector roads. All pipe sizes range from a minimum diameter of 12-inches to a maximum of 36-inches.

2.11.2 Water Supply and Distribution

Presently, there is no potable water system servicing the subject property. The East Kapolei project spans two Board of Water Supply service pressure zones, 215-feet and 440-feet. The portion of the project below the planned East-West Road is primarily within the 215-foot service elevation zone. Most of the remaining portion is within the 440-foot service elevation zone. Maximum daily potable water demand generated by the East Kapolei is estimated at 6.8 mgd and 7.5 mgd which includes water demand for the University of Hawaii West Oahu Campus.

Non-potable water will also be used to supplement the potable water system in meeting the total water demand for East Kapolei. This non-potable system will utilize brackish water and/or reclaimed water for irrigation purposes primarily within road right-of-ways, parks, sports complex, and the 15-acre district park. The average daily non-potable water demand for the East Kapolei development is estimated at 0.95 mgd. The East Kapolei potable and non-potable water systems will be completely separate and fully comply with all applicable State Department of Health regulations.

When East Kapolei is fully developed, the total storage requirement is calculated at 6.8 mgd. Therefore, a new 4.0 mg reservoir for the 215' system and a 4.0 mg reservoir for the 440' system will be developed which will surpass the storage requirement for the proposed East Kapolei project. To provide water to the higher elevation system, a booster pump at the 215' elevation will pump water to the 440' reservoir. The system will be connected to the 36" water main along Farrington Highway.

New distribution lines include 12-inch and 16-inch lines along the North-South Road and East-West Road and a 16-inch along Farrington Highway. A 12-inch line will also be located within Kapolei Parkway.

Presently, the Board of Water Supply is requesting a water reservation from the State Commission on Water Resource Management to convert agricultural water allocations from the Waiawa-Waipahu aquifer to urban use. This is needed to serve the needs of the projects (including the East Kapolei Project) envisioned by the Ewa Development Plan.

2.11.3 Drainage Facilities

The impact from developing the subject property will be an increase in storm runoff generated from the impermeable surfaces established by the on-site roadways, parking areas, and buildings. These increases in surface runoff could cause downstream flooding if on-site drainage improvements are not made or if downstream drainage facilities cannot accommodate the additional flows. As previously described, the existing Kaloi Gulch drainage system is inadequate and significant drainage impacts will be realized if appropriate mitigation measures are not implemented.

The future development of the East Kapolei Master Plan will include drainage improvements such as detention/retention basins in order to maintain off-site storm runoff at existing levels. A complete engineering assessment of drainage system improvements necessary to accommodate the proposed project is provided in Appendix B.

All storm water entering the subject property must ultimately flow through the property and discharge into the ocean or infiltrate into the ground. Consequently, all development downstream of the subject property must also accommodate Kaloi Gulch drainage. Therefore, a drainage corridor is planned within the 300-foot wide utility, drainage and access corridor along the proposed North-South Road. This corridor provides for a realigned and channelized Kaloi Gulch with appropriate detention basins. By promoting on-site infiltration of surface water with the retention basins, the groundwater recharge lost when irrigation for sugar cane was terminated would be partially mitigated.

2.11.4 Traffic and Roadway Improvements

Presently the only existing public roadway through the subject property is the Farrington Highway which carries an estimated 6,000 to 10,000 vehicles per day (Appendix H). However, most of the regional traffic between Kapaolei and Kunia Road is carried on the H-1 Freeway which averages approximately 68,040 vehicles per day in 1995 and 72,800 vehicles per day in 1996. In the future, a new roadway (not part of the East Kapolei project) identified as the "North-South Road" will be constructed through the middle of the subject property.

Based on the existing and future traffic conditions projected for the East Kapolei Project, forecasts of transportation demand were made for the future year 2020, including estimates of turning movements at major intersections. According to the Traffic Report (Appendix H), "intersection approach laneage and signalization have been identified and acceptable conditions are expected at all intersections except one unsignalized intersection (Parcel K and L intersection) where long delays may occur but traffic signals do not appear warranted." The traffic report also identified recommendations for the length of storage turn lanes and other improvements as applicable.

2.12 Design Guidelines

As the master developer for the major infrastructure, ~~HFDC~~HCDCH will provide consistent use of materials and design elements to ensure a uniform design character for the project, especially along major roadways and drainage features. A prime contractor will be selected to construct the major infrastructure and roadways under the direction of ~~HFDC's~~HCDCH's engineering and architectural consultants.

As such, Design Guidelines will not be prepared by ~~HFDC~~HCDCH for their portion of the project development. Design guidelines and preparation and enforcement of restrictive covenants for the large lot development parcels will be the responsibility of the individual developers to ensure that future architecture and landscape architecture design is consistent with the overall design theme established by ~~HFDC~~HCDCH during construction of the major infrastructure.

2.13 Phasing and Timing of Action

Upon completion of the major infrastructure by ~~HFDC~~HCDCH, construction phasing of the proposed land uses will likely respond to market demand and logical extensions of required infrastructure. Some developers may choose to purchase the large lot parcels early in the development process and hold the property undeveloped until future market conditions improve. Consequently, it is difficult to determine the actual phasing of project completion, however, the project Market Study (Appendix A) has projected large lot and unit absorption over the 20 year development period.

In addition to the Market Study absorption phasing, the City's Ewa Development Plan also provides for project phasing with 4,000 units permitted for development between 1997 and 2005 and 3,700 units after 2006. Although preliminary market indicators project a final build out of approximately 20 years, the major infrastructure would likely be in place within the first 1 to 2 year period following approval of all applicable land use entitlements and permits.

Development of major infrastructure such as drainage improvements and roadways, and public facilities such as the sports complex ~~and park-and-ride facility~~, can take place under the present agricultural zoning classification. However, the large lot parcels could not be developed as envisioned by the master plan until the appropriate zoning is approved by the City Council.

2.14 Approximate Infrastructure Costs

Preliminary estimates for the planning, design, and construction of residential, commercial, parks, and open space infrastructure is approximately $95,841,200 in 1997 dollars. A detailed assessment of estimated costs and Socio-Economic Impact Assessment of the project is provided in Appendix K, Exhibit 4-C. Costs incurred by individual developers cannot be determined at this stage in the planning process, however, estimates based on similar projects indicate that infrastructure will cost approximately $12,000 - $16,000 per single family unit and $8,000 - $9,000 per multi-family unit depending on the total number of units ultimately constructed. The budget for the Sports Complex is $27.5 million provided by State Capital Improvement Program funding.

3.0 REQUIRED APPROVALS AND PERMITS

3.0 REQUIRED APPROVALS AND PERMITS

3.1 Chapter 343, Hawaii Revised Statutes

This EIS is prepared pursuant to Chapter 343, *Hawaii Revised Statutes* ("HRS") and Subchapter 4, Section 11-200-4, Hawaii Administrative Rules which states that, "the governor, or an authorized representative, whenever an action proposes the use of state lands or the use of state funds, or, whenever a state agency proposes an action within section 11-200-6(b)" shall be the final authority to accept an environmental impact statement."

Since the proposed project will require the use of state owned land and funds, the project must comply with the applicable provisions of Chapter 343, HRS. Therefore, the Governor or designated representative will act as the Accepting Authority for the East Kapolei Master Plan Development Project Environmental Impact Statement.

Comments which were received during the 45-day review period for regarding the Draft EIS have been provided in the Final EIS.~~Comments which were received during the 30-day East Kapolei Master Plan Development Project Environmental Impact Statement Notice of Preparation (EISNOP) comment period and the applicable responses have been reproduced in their entirety in Section 14.0. Upon publication of this Draft EIS in the OEQC Bulletin, an additional 45-day review period will commence for comments regarding the Draft EIS. All comments and applicable responses will be provided in the Final EIS.~~

3.2 City and County of Honolulu

3.2.1 Ewa Development Plan Land Use Map

According to comments of April 22, 1997, the consistency of the master plan with the Ewa Development Plan land use designations were confirmed by comments received from the Planning Department regarding the East Kapolei Master Plan Development Project Environmental Impact Statement Notice of Preparation (EISPN).

The subject area on the conceptual Ewa Development Plan Land Use Map includes: both low and medium residential areas, neighborhood commercial centers, and open space/recreation areas~~(Figure 7)~~. Public facilities include planned transit nodes and corridor along the proposed North-South Road, and a grade-separated interchange at the H-1 Freeway. Open space facilities such as various landscaped boulevards/greenways, a north-south oriented natural drainageway and bike path are identified in the Open Space Map. During the recent Ewa Development Plan update, the proposed land uses reflected by the East Kapolei Conceptual Development Plan were considered ~~(Figure 5)~~ and incorporated into the project master plan (Also see Section 7.7).

The planning and development process within the Ewa Development Plan Area has been and continues to be a joint effort of the community, the State of Hawaii, the City & County of Honolulu, area developers, and the Estate of James Campbell.

3.2.2 Development Plan Public Facilities Map Designation

According to the Ewa Development Plan Public Facilities Map, major proposed infrastructure and public facilities impacting the subject property include:

- a transit corridor parallel to Kapolei Parkway and the proposed North-South Road
- Transit Nodes at the intersection of Farrington Highway and the North-South Road, Kapolei Parkway, and another transit node mid-way between the Farrington Highway and Kapolei Parkway transit nodes,
- ~~a Park and Ride Facility at the intersection of the North-South Road and Kapolei Parkway; and,~~Symbols for an Intermediate School and High School in the area.

All of these proposed public facility improvements have been incorporated into the project master plan. In addition, a 20-acre site for the proposed intermediate school has been determined within the subject property as depicted on the project master plan. A proposed high school site is located just outside of the project boundary makai of Farrington Highway and east of the project's boundary on the Ewa side of the project area (Also see Section 7.7.4).

3.2.3 Land Use Ordinance Designation - Zoning

The subject property is presently zoned Ag-1 Restricted Agriculture by the City and County of Honolulu Land Use Ordinance. As such, a Change of Zone Application will be submitted by ~~HFDC~~HCDCH after the Final Environmental Impact Statement and the processing a State Land Use District Boundary Amendment before the State Land Use Commission is complete. This is consistent with the recently adopted Ewa Development Plan which requires completion of an Environmental Assessment for significant Change of Zone Applications for urban uses that are 25 acres or more.

Tentative processing milestones include approval of the State Land Use District Boundary Amendment by the fall of 1998 and approval of the Change of Zone Application in ~~toward the end of~~late 1998 or early 1999 (Also see Section 7.8).

3.3 State Land Use Districts

According to the State Land Use Commission, the entire subject property is located within the State Agricultural District (**Figure 64**). Therefore, ~~HFDCH~~HCDCH will submit a State Land Use District Boundary Amendment (SLUDBA) Petition to the State Land Use Commission upon publication of this ~~Draft~~Final EIS in the OEQC Bulletin.

3.4 Other Required Permits and Approvals

The following is an approximate list of major approvals and permits required for the implementation of the proposed plan. From the earliest stages of the planning process, ~~HFDCH~~HCDCH has worked with all affected agencies to obtain their comments and necessary approval of plans and specifications.

Permit or Approval	~~Authority~~Applicant	~~Environmental Impact Statement (EIS)~~Authority
~~Chapter 343, HRS, Governor~~Environmental Impact Statement (EIS)	HCDCH	~~State Land Use Commission~~Chapter 343, HRS, Governor
~~Change of Zone~~State Land Use District Boundary Amendment	~~Department of Land Utilization/City Council~~HCDCH	~~Dept.~~State Land Use Commission
Change of Zone	HCDCH	Department of Land Utilization/City Council
Plant Mitigation Plan	HCDCH	Dept. Land and Natural Resources/US Fish and Wildlife
Alteration of Waters of the United States	HCDCH	US Army Corps of Engineers/State Dept. ~~Land and Natural Resources/US Fish and Wildlife~~of Health
~~Alteration of Waters of the United States~~Subdivision Approval	~~US Army Corps of Engineers/State Dept. of Health~~HCDCH/Individual Developers	Department of Land Utilization
~~Subdivision Approval~~Building/Grading Permits	~~Department of Land Utilization~~HCDCH/Individual Developers	~~Building/Grading Permits~~ Building Department/Department of Public Works
~~Building Department/Department of Public Works~~NPDES	HCDCH/Individual Developers	Department of Health

4.0 ASSESSMENT OF THE EXISTING NATURAL ENVIRONMENT, POTENTIAL IMAPACTS, AND MITIGATION MEASURES

4.0 ASSESSMENT OF THE EXISTING NATURAL ENVIRONMENT, POTENTIAL IMPACTS, AND MITIGATIVE MEASURES

From a local and regional perspective, the subject property reflects a logical extension of existing and planned urban development on the Ewa Plain. Agriculture in the area is no longer economically viable due to the proximity of urban development and the high cost of required agricultural infrastructure. In addition, there are unique physical resources associated with the property. Consequently, the Ewa Plain has been determined by both the State and City as Oahu's "Second City".

The following describes the existing natural environment associated with the subject property and potential impacts that may result from project development. With the potential impacts identified, mitigative measures are also described as applicable for each section.

4.1 Climate

Existing Conditions

During the day and early evening hours, the site is relatively warm compared to other locations around Oahu and the state. Late night and early morning periods, however, are generally cooler than other locations. These conditions are a result of the site being on a downwind, or leeward, side of the island. Based on more than 50 years of data collected at the Ewa Plantation, average annual daily minimum and maximum temperatures in the project area are 65°F and 84°F, respectively. Extreme minimum and maximum temperatures were 47°F and 93°F. Under the current condition as fallow agricultural land, the relatively inconsequential levels of evapo-transpiration which occurs from scrub vegetation produces little cooling effect.

The most representative long-term wind data available for the subject property has been collected at the Naval Air Station Barbers Point ("NASBP"), located southwest of the subject property. Wind frequency data for NASBP show the annual prevailing wind direction for this area of Oahu is east northeast. The climate of the subject property is constant and relatively dry, with prevailing winds blowing from the northeast about 40 percent of the time, at approximately 10 knots (12 miles per hour). Winds from the south are infrequent, occurring only a few days during the year and mostly in winter in association with Kona storms. The Ewa Plain experiences light rainfall with a mean annual rainfall of about 20 inches per year, most of which occurs between the months of November and April.

Anticipated Impacts and Mitigative Measures

With project build out, there may be some localized increase in temperature as a result of paved surfaces, roofs, and reduced vegetation. However, extensive landscaping and establishment of water features associated with the proposed drainage system will mitigate some of the potential temperature increase. Shade trees will be incorporated into project landscaping where none currently exists. Therefore, landscaping and necessary irrigation will help mitigate any localized temperature increases from establishment of hard, heat absorbing surfaces.

4.2 Physical Characteristics

Existing Conditions

The island of Oahu is of volcanic origin and is characterized by underlying basaltic flows. The Ewa Plain is an emerged coral reef formed during the Pleistocene Period when the ocean level was at a higher elevation. For the most part, the Ewa Plain is flat with a few isolated bluffs eroded by Honouliuli Stream. It is underlain by material which has been modified over the millennia so that it is hard but extremely permeable. This hard, permeable caprock of sedimentary deposits forms a wedge which retards the seaward movement of fresh groundwater from the inland basaltic aquifer. At higher elevations the ground surface is made of alluvium and sedimentary deposits washed down slope over the millennia.

The study area is located in the mid-to-lower portion of the Kaloi Stream watershed, on the southern slopes of the Waianae Mountain Range. The uppermost portion of the watershed is over 2,200 feet above sea level. For the project site, the average elevation at the lower boundary is 65 feet MSL and rises to about 200 feet MSL at the upper boundary. The site is relatively flat with slopes varying between 0.7 and 2 percent. The slopes gradually increase to over 5 percent at the H-1 Freeway. Above the H-1 Freeway (beyond the subject project boundary), slopes increase considerably in mountainous terrain reaching well over 20 percent in the upper watershed areas.

Since much of the subject property has been historically utilized for sugar cane cultivation, the property has been extensively modified with cane haul roadways, a furrow irrigation system, and other appurtenant agricultural structures.

Anticipated Impacts and Mitigative Measures

The subject property will eventually be modified with new roadways, residential, commercial and recreational structures, landscaping, and improvements to the existing drainage system. Mitigation measures consist primarily of new construction of drainage improvements and urban landscaping. Compared to the present use as fallow agricultural land, the urban landscape after project construction will likely result in reduced erosion and better control and management of surface runoff during intense storms.

All grading operations will be conducted in full compliance with dust and erosion control and other requirements of the City and County of Honolulu Grading Ordinance, and all construction activities must comply with the provisions of Chapter 11-60.1, Hawaii Administrative rules, Section 11-60.1-33 on Fugitive Dust. A grading permit is a requirement to modify the topography. In addition, a National Pollutant Discharge Elimination System (NPDES) permit will also be required prior to construction to address non-point source discharges.

4.3 Drainage

A master plan report has been prepared which describes the drainage plan for the East Kapolei Master Plan Development Project (Appendix B). The master plan includes an assessment of existing drainage conditions, an assessment of developed drainage conditions, and calculations for sizing of regional and backbone drainage facilities.

Existing Conditions

A large portion of the site lies in the Kaloi Stream flood plain. Existing drainage conditions are poor due to the flat topography of the land and inadequate drainage swales, which were primarily used to drain the surrounding sugarcane fields.

Runoff from two primary drainage basins flow through the area; the Kaloi Gulch and the Hunehune Gulch. The Kaloi Gulch stream crosses the H-1 Freeway and Farrington Highway, each at one location. In the upper level watershed, Hunehune Gulch, a tributary to Kaloi, crosses the H-1 Freeway at six locations. These streams then combine and cross the Farrington Highway at two locations. After crossing Farrington Highway, the Hunehune Gulch stream combines with Kaloi to form one stream. The Kaloi Stream flows south through the Ewa Villages Golf Course and then through the Coral Creek Golf Course. The adjacent watershed to the east is the West Loch basin.

A small portion of the East Kapolei project is located in the West Loch basin. Another area of the project is located in the Kapolei basin to the west. A smaller portion of the project lies between Varona Village and the Villages of Kapolei, and runoff from this portion flows into both the Varona Village and Villages of Kapolei drainage system.

The flat topography over the broad plain between the northern boundary at Farrington Highway and the southern boundary adjacent to Ewa Villages make it difficult to determine a clear delineation between watersheds.

The Federal Emergency Management Agency classifies flood hazard zones as part of the Flood Insurance Program for the City and County of Honolulu. Most of the subject property has not been mapped in detail on the Flood Insurance Rate Map (FIRM), but the makai portion of the property is presently designated as Zone X (**Figure 11**). This zone has floods of undetermined depths calculated to occur once every 500 years.

Potential Impacts and Mitigative Measures

The intent of the East Kapolei Drainage Plan is to control flooding and provide adequate storm water disposal for on-site and off-site generated runoff.

The proposed North-South Road runs along the existing Kaloi Stream, down the middle of East Kapolei, and is planned to be incorporated into the regional drainage plan for the area.

To carry out the plan, "regional" facilities are proposed to address off-site runoff and mitigate flooding from Kaloi Stream. "Backbone" facilities are proposed to address the on-site generated runoff, and feed into the regional facilities. Project areas above Farrington Highway as well as areas west of the proposed North-South Road are planned to feed the regional drainage system. Due to existing topography constraints, project areas below Farrington Highway and east of the proposed North-South Road are not planned to contribute to the "regional" system. These areas are proposed to discharge runoff into the Ewa Villages Golf Course, as they currently do, via on-site backbone drainage facilities. "Backbone" facilities for these areas east of the North-South Road are left as subdivision design items and are not discussed in this master plan. Increase in runoff volume is primarily due to the increase in impermeable ground surface due to development of roofs and pavements. In this study, an increase in runoff is also due to the consolidation of drainage basins, which is the result of the North-South Road alignment.

Analyses were done for the existing conditions, developed conditions without storage and developed conditions with storage. With the proposed detention and storage basins considered, the total runoff volume discharged into Ewa Villages is reduced to less than the existing runoff volume. It is determined that the proposed detention and storage basins are adequate in controlling the increase in runoff due to the East Kapolei Development.

Detention basins along the Kaloi channel are planned to attenuate the peak flow due to the East Kapolei development. Due to the implementation of the detention basins, the total developed condition 100-year peak flow entering the Ewa Villages Golf Course is 13 cfs less than the existing condition 100-year peak flow. It is determined that the proposed detention basins are adequate in controlling the increase in peak flow due to the East Kapolei development.

4.4 Soils

Existing Conditions

4.4.1 Soil Suitability Studies

There have been three soil suitability studies prepared for Hawaii whose principal focus has been to describe the physical attributes of land and the relative productivity of different land types for agricultural production. These are (1) the Land Study Bureau Detailed Land Classification, (2) the U.S. Department of Agriculture Soil Conservation Service Soil Survey, and (3) the Agricultural Lands of Importance to the State of Hawaii (ALISH).

According to the "Impact on Agriculture" report (Appendix C) prepared for the project, the urbanization of these lands would cause loss of Land Study Bureau A- and B-rated lands as well as "Prime" and "Other Important" agricultural land. According to Appendix C, approximately 1,245 acres (95.4%) of the subject property is rated "prime" by ALISH and Class I and II by the Soil Conservation Service. Similarly, the Land Study Bureau designates 97.3 percent of the subject property as "A" or "B" rated lands.

4.4.1.1 Land Study Bureau Detailed Land Classification

The Detailed Land Classification (1965 through 1972) series was produced by the Land Study Bureau ("LSB") of the University of Hawaii for each island. The intent of this series of reports was to develop a land inventory and productivity evaluation based on statewide "standards" of crop yields and levels of management.

The LSB land classification is a synthesis of the information found in the 1955 Soil Survey for the Territory of Hawaii as well as several other sources for data on geology, topography, climate, water resources and crops. The LSB classification system groups lands into homogeneous units called Land Types, describes their condition and environment, delineates the areas on aerial photo base maps, rates the lands on their overall quality (productivity) in relation to other land, and appraises their performance under selected alternative agricultural crops. The productivity evaluations were based on statewide standards of crop yields and levels of management at the time the classification was made.

According to Section 205-4.5 of the *Hawaii Revised Statues*, the LSB studies define the areas in the State Agricultural District wherein specific agricultural uses are permitted and where restrictions relating to the disposition of the land are applicable.

A five-class productivity rating is applied using the letters A, B, C, D and E, with A representing the class of highest productivity and E the lowest. The soils on the subject property ~~(Figure 8)~~ are rated mostly A (A11i, A69i) and B (B16i), with a small portion in C (C17i), which reflects its present and past use for sugar cultivation under irrigated conditions **(Figure 8)**.

4.4.1.2 Soil Conservation Service Soil Survey

The site contains four general soil types **(Figure 9)** as classified by the Soil Conservation Service, now called the Natural Resource Conservation Service, NRCS. These include Honouliuli (HxA and HxB), Waialua (WkA), Waipahu (WzA and WzB), Mamala (Mcn), Ewa (EwC, EaB), Kunia (KyA), Kawaihapai (KlaB and KlbC), Molokai (MuB and MuC), Mahana (McD2 and MBL) and Stony Steep Land (rSY), with Honouliuli being the predominant type. These are clay soils with moderately low permeability and high shrink-swell potential (Reference 8).

This classification is somewhat similar to those of the Land Study Bureau except that they are patterned after a soil classification procedure adapted for nationwide, uniform application and are ranked according to their suitability for most kinds of crops. Also provided are listings of crops commonly grown on the soil types and their expected productivity under present management.

Most of the soils on site are of the Honouliuli Series (**Figure 9**). This series consists of well-drained soils on coastal plains. These materials developed in alluvium derived from basic igneous material. They are nearly level and gently sloping. Permeability is moderately slow (Honouliuli Clay, 0 to 2 percent slopes [HxA], capability classification I, if irrigated) to slow (Honouliuli Clay, 2 to 6 percent slopes [HxB], capability classification IIe, if irrigated) and the erosion hazard is no more than slight.

Honouliuli soils are geographically associated with the Ewa area (Ewa Silty Clay Loam, 3 to 6 percent slopes [EaB], capability classification IIe, if irrigated), Mamala (Mamala Stony Silty Clay Loam, 0 to 12 percent slopes [MnC], capability classification IIIs, if irrigated) and Waialua (Waialua Silty Clay, 0 to 3 percent slopes [WkA], capability classification I, if irrigated) soils which are also found within the Subject property. Other soils found within the Subject property include Kunia Silty Clay, 0 to 2 percent slopes (KyA, capability classification I, if irrigated) and Waipahu Silty Clays (WzA, 0 to 2 percent slopes, capability classification I, if irrigated; WzB, 2 to 6 percent slopes, capability classification IIe, if irrigated).

Except for the Mamala soils, the erosion hazard for all of the above soils is slight. The erosion hazard for the Mamala series is slight to moderate. In terms of capability classifications, Class I soils have few limitations that restrict their use; Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices; and Class III soils have severe limitations

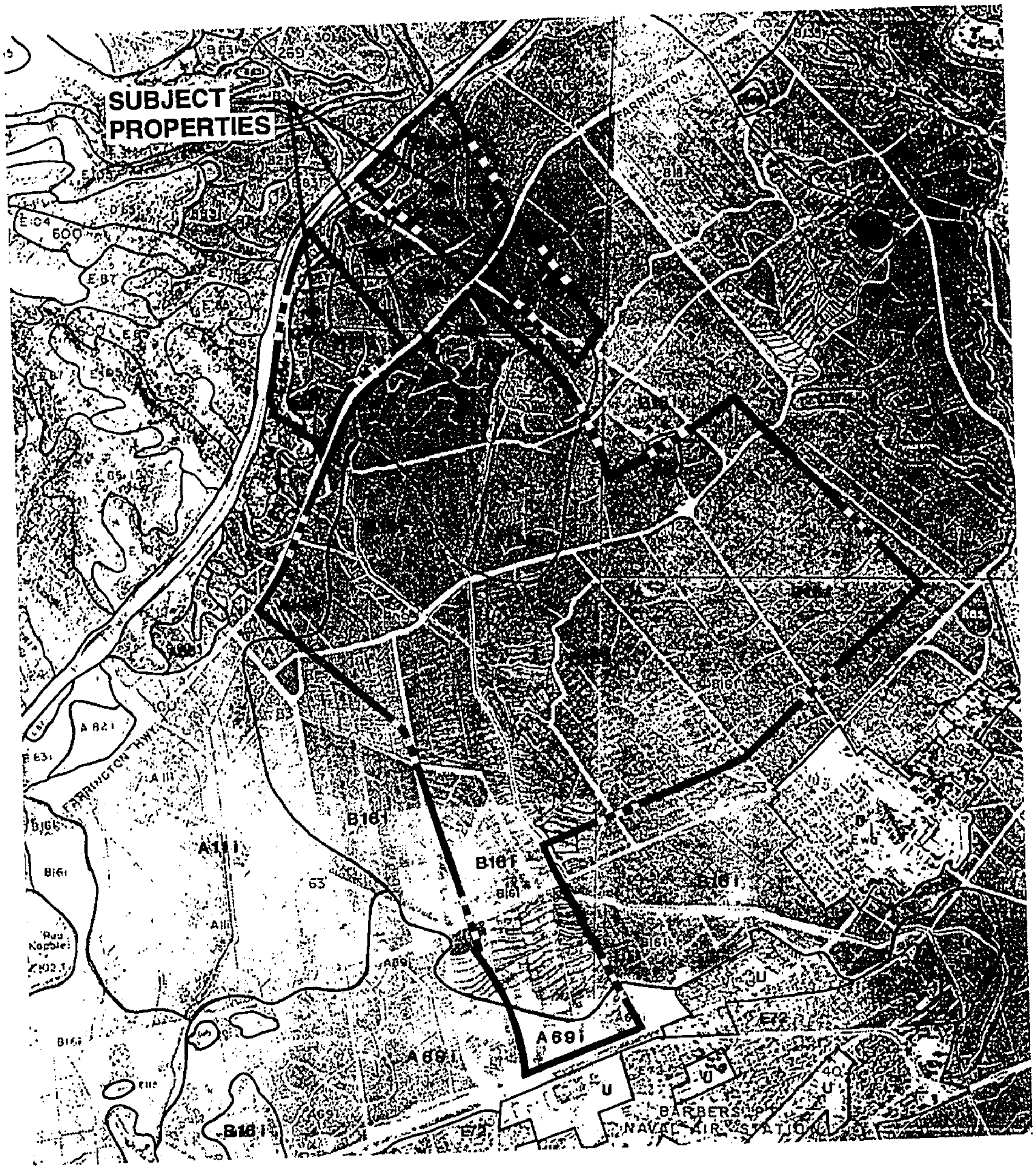


FIGURE 8
DETAILED LAND CLASSIFICATION

HCDCH EAST KAPOLEI

ISLAND OF OAHU

SOURCE: LAND STUDY BUREAU, UNIVERSITY OF HAWAII - STATE OF HAWAII, DECEMBER 1972

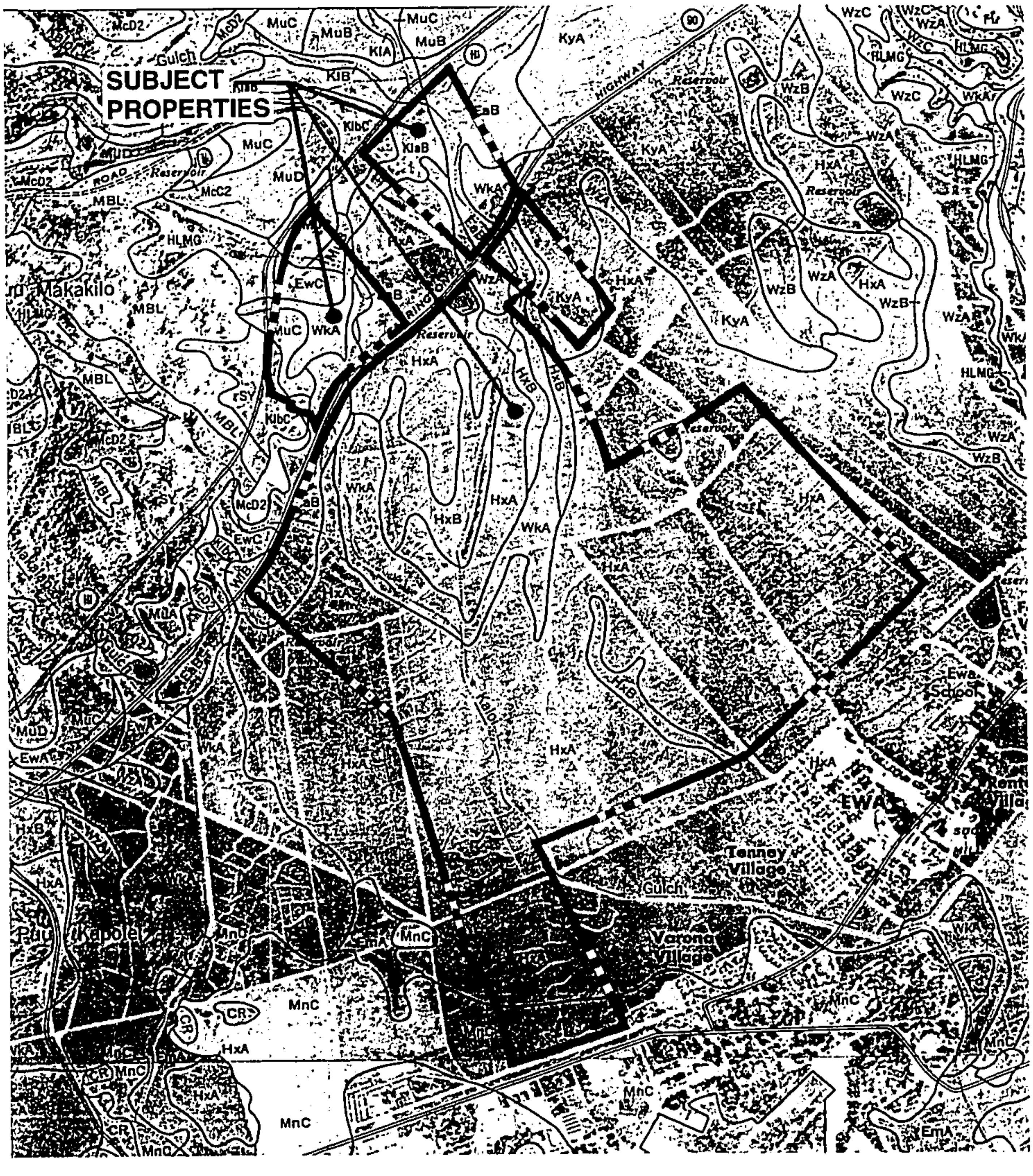


FIGURE 9
SCS SOIL SURVEY
HCDCH EAST KAPOLEI
ISLAND OF OAHU

NORTH

LINEAL SCALE (FEET) 500 0 500 1000 2000

PBR HAWAII

DATE 2/96

SOURCE: US DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE / THE UNIVERSITY OF HAWAII AGRICULTURAL EXPERIMENT STATION that reduce the choice of plants, require special conservation practices or both.

4.4.1.3 Agricultural lands of Importance to the State of Hawaii

The Agricultural Lands of Importance to the State of Hawaii ("ALISH") (1977) system was also prepared for the entire state. The ALISH system consists of the mapped identification of three broad classes of agricultural land based, in part, on the criteria established by the Soil Conservation Service **(Figure 10)**. "Prime Agricultural Land" is defined as "...land best suited for the production of food, feed, forage, and fiber crops. This class of land has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed (including water management) according to modern farming methods. Prime agricultural land gives the highest yields with the lowest inputs of energy or money and with the least damage to the environment." The two other classes of the ALISH are "Unique Agricultural Land" and "Other Important Agricultural Land". Both describe successively less productive soils.

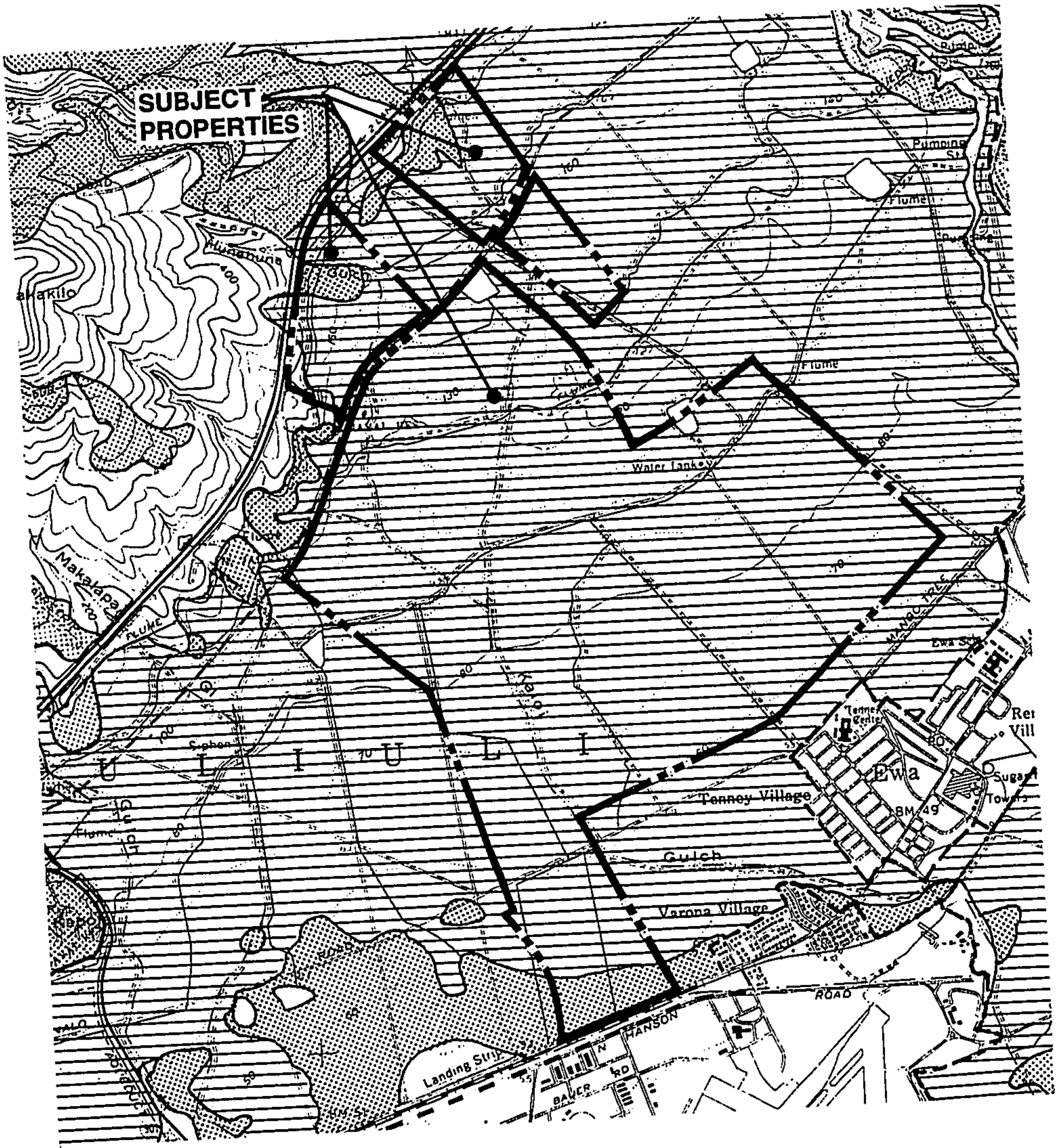
As shown on **Figure 10**, nearly all of the Subject property is located on lands designated as "Prime Agricultural Land" (a small portion along the OR&L boundary is classified "Other Important Agricultural Land"). The reservoir sites are unclassified.

Anticipated Impacts and Mitigative Measures

Once construction is complete, the soils on the property will be permanently lost for soil based agriculture. During the construction phases of the project, there is also a potential for soil loss through the generation of dust and water-borne soil erosion as areas are graded. However, since much of the site presently consists of exposed soil and scrub vegetation, overall soil loss will likely be reduced significantly after development compared to the historic agricultural use of the property. Landscaping, establishment of ground cover, and drainage improvements will also mitigate soil loss during construction and after build-out.

All grading operations will be conducted in full compliance with dust and erosion control and other requirements of the City and County of Honolulu Grading Ordinance and all applicable provisions of Chapter 11-60.1, Hawaii Administrative Rules, Section 11-60.1-33 regarding Fugitive Dust.

In addition, a National Pollutant Discharge Elimination System (NPDES) permit will also be required prior to construction to address non-point source discharges. Prior to issuance of a grading permit by the City Department of Public Works, an erosion control plan and best management practices required for the NPDES permit will be submitted describing the implementation of appropriate erosion control measures. These generally include use



LEGEND

- PRIME AGRICULTURAL LANDS
- OTHER IMPORTANT AGRICULTURAL LANDS
- URBAN
- EXISTING URBAN DEVELOPMENT
- U.S. GOVERNMENT

SOURCE: DEPARTMENT OF AGRICULTURE-STATE OF HAWAII, JANUARY 1977

FIGURE 10
AGRICULTURAL LANDS OF IMPORTANCE TO THE STATE OF HAWAII (ALISH)

HCDCH EAST KAPOLEI

ISLAND OF OAHU

NORTH

LINEAL SCALE (FEET) 500 0 500 1000 2000

PBR HAWAII

DATE: 2/98

of cut-off ditches, temporary ground cover, and use of detention areas.

A watering program will be implemented to minimize soil loss through fugitive dust emission during construction. Other control measures include cleaning of construction equipment on the job-site and establishment of ground cover as quickly as possible after grading.

Permanent landscaping will also be established to retain soil throughout the project area. This long-term landscape maintenance will significantly reduce erosion compared to the previous agricultural conditions.

In addition to landscaping and watering programs, other mitigation measures generally associated with best management practices include:

- early construction of drainage control features,
- construction of temporary sediment basins to trap silt,
- use of temporary berms and cut-off ditches where needed, and;
- use of temporary silt fences or straw bale barriers to trap silt.

4.5 Agricultural Impact

Existing Conditions

According to an "Impact on Agriculture" report prepared for the proposed project (Appendix C), the entire 1,300-acre project area was cultivated in sugarcane. Currently, about 1,100 acres are fallow and the remaining 200 acres are farmed by two operations which lease most of the farm lands on the Ewa Plain and in Kunia below the pineapple fields. Approximately 140 acres of cultivated lands between Farrington Highway and the H-1 Freeway are underlease to the year 2005. In total, 380 acres adjacent to and off-site from the property will also be taken out of production due to the potential nuisance problems associated with agricultural activity proximate to residential areas and the expense of rerouting existing water irrigation lines for lands under short-term lease.

Anticipated Impacts and Mitigative Measures

Therefore, the 380 off-site acres and the 200 on-site acres represent the total area of agricultural lands that will be withdrawn from agricultural production. This production represents approximately $5.8 million per year in gross revenues, 80 jobs, and $1.4 million in annual payroll. However, the Impact on Agriculture report concludes that this agricultural production is likely to be compensated for by the affected operations farming their remaining lands more intensively to replace the lost production and/or farmers elsewhere on Oahu increasing their production to meet demand. For example, 12,000 acres of Waialua Sugar Company land on the North Shore of Oahu was recently fallowed.

Consequently, the limiting factor to the growth of diversified agriculture will not be the land supply, but rather the size of the market for those crops than can be grown profitably in Hawaii. This finding is also supported by State Department of Agriculture projections in 1991, that Oahu will require only about 1,000 acres of additional land to accommodate the demand for diversified agricultural production.

Based on the ample supply of land suitable for diversified agriculture on Oahu and lack of market demand, no mitigation measures are proposed by the Impact on Agriculture Report to replace the lost agricultural production associated with the subject property.

4.6 Groundwater Resources/Hydrology

Existing Conditions

The Ewa region of Oahu, overlies the Southern Oahu Basal Aquifer (SOBA), a designated Sole Source Aquifer. The gently sloping topography of the Ewa Plain is comprised of terrestrial alluvium which is made up of clay and mud eroded from volcanic rock and is inter-layered with coral lime stone deposited during periods when the area was covered by the ocean. This geologic feature is commonly referred to as "caprock" which is *approximately 1,000 feet thick near the shoreline. Water in the caprock is too saline to be* potable. Relative to the East Kapolei Master Plan, the caprock extends approximately from the proposed East Kapolei Avenue makai toward the ocean (Yuen and Associates, 1989 and Mink and Lau, 1980).

The potential for surface contamination of water under the caprock is low due to artesian conditions and the relative impermeability of the caprock. Infiltration of surface water mauka of the caprock (north of the proposed East Kapolei Avenue), could cause contamination to the potable ground water resource since the caprock is no longer present to function as a barrier in this area. Hydrological modeling (Mink and Yuen, 1993) predicts that the salinity of the caprock aquifer will increase as fresh water recharge declines with the reduction in sugarcane irrigation.

The State Department of Health has established the UIC line at North Hanson Road to the south of the project. The primary purpose of the UIC line is to protect potential sources of drinking water by not allowing wastewater injection wells or cesspools mauka of the line. However, no injection wells or cesspools are proposed at the project and any runoff or wastewater disposal required for the project will be managed in full compliance with the UIC and other applicable regulations. Use of non-potable irrigation water on the Ewa Plain is encouraged to facilitate the recharge of caprock water and to reduce the demand for potable water from the BWS system.

If treated wastewater effluent is used for non-potable irrigation purposes in the immediate area of the Ewa caprock aquifer, the Department of Health (DOH) will grant Water Use Permits from this aquifer only if no other alternative source is available, and only until treated effluent is available to the property. Once the effluent is available, DOH has indicated that reasonable time to connect to the effluent water system will be provided and that the Water Use Permit should be withdrawn after treated effluent is available for project irrigation.

To further protect the groundwater resource, the Commission on Water Resource Management (CWRM) officially adopted the Ewa Caprock Aquifer (March, 1993), as a separate aquifer within the existing Pearl Harbor Ground Water Control Area. Since this designation, the Commission has awarded one-year interim permits for new users of the Ewa Caprock Aquifer. However, with the shutdown of Oahu Sugar Company's irrigation practices in 1994, a re-evaluation of the Ewa Caprock Aquifer sustainable yield was initiated. (See the Staff Submittal regarding the "Proposed Establishment of Aquifer Systems and Adoption of Sustainable Capacities by Well" provided as Appendix D.

Comments from Ewa water users regarding the sustainable yield for the caprock aquifer were received in late 1996 and early 1997. The Puuloa Caprock Users Group (PCUG) which includes ~~HFDC~~HCDCH and the City Department of Wastewater Management as members, responded with a preliminary plan to establish sustainable yields of the Ewa caprock aquifer. In May, 1997, the Commission on Water Resource Management staff recommended that the chloride level of water pumped by each well is the best available indicator of source sustainability and that 1,000 mg/l cap per well provided adequate protection of the aquifer for irrigation and other nonpotable uses.

Anticipated Impacts and Mitigative Measures

All storm water entering the subject property must ultimately flow through the property and evaporate, discharge into the ocean, or infiltrate into the ground. Consequently, all development downstream of the subject property must also accommodate existing Kaloi Gulch drainage.

To mitigate the increase in runoff and facilitate groundwater recharge, a drainage control system is planned within the 300-foot wide utility, drainage, and access corridor along the proposed North-South Road. This corridor includes a 96.5-foot wide corridor for a realigned and channelized Kaloi Gulch with appropriate detention basins. The future development of the subject property will need to include measures such as detention/retention basins in order to maintain off-site storm runoff at existing levels and to promote the recharge of groundwater. By promoting on-site infiltration of surface water with retention basins, the groundwater recharge lost when irrigation for sugar cane was terminated would be partially mitigated.

Irrigation for common areas will utilize brackish water from the Ewa caprock in accordance with sustainable capacity regulations adopted by the CWRM. In addition, treated effluent will be similarly utilized for irrigation in accordance with State Department of Health regulations when available from the City's wastewater treatment plant.

4.7 Natural Hazards

Existing Conditions

Natural hazards are events such as tsunami, earthquakes, floods, hurricanes, soil slippage, and volcanic hazards. The East Kapolei development may be subject to hurricanes and minor earthquakes in the future; however, the site is not unique to these potential hazards. Earthquakes in the Hawaiian islands are associated with volcanic eruption or tectonic movement. Volcanic hazards in the area are considered minimal due to the extinct status of former volcanoes.

The State of Hawaii has been affected twice since 1982 by devastating hurricanes, Iwa in 1982 and Iniki in 1992. While it is difficult to predict these natural occurrences it is reasonable to assume that events could be likely given the record of the past fourteen years. The project area, as the rest of the island, is no more or less vulnerable to the destructive winds and torrential rains associated with hurricanes and cyclones.

Flood hazards are primarily identified by the Flood Insurance Rate Map ("FIRM") prepared by the Federal Emergency Management Agency ("FEMA") **(Figure 11)**. However, with the development of the adjacent Kapolei Villages drainage improvements (i.e. golf course, lined drainage ditch, injection wells), the drainage conditions impacting the subject property have been significantly altered. According to the revised (1995) FIRM, a portion of the East Kapolei site is subject to inundation by the 500-year flood generally in the area makai of the proposed Kapolei Parkway classified as Flood Zone X.

Anticipated Impacts and Mitigative Measures

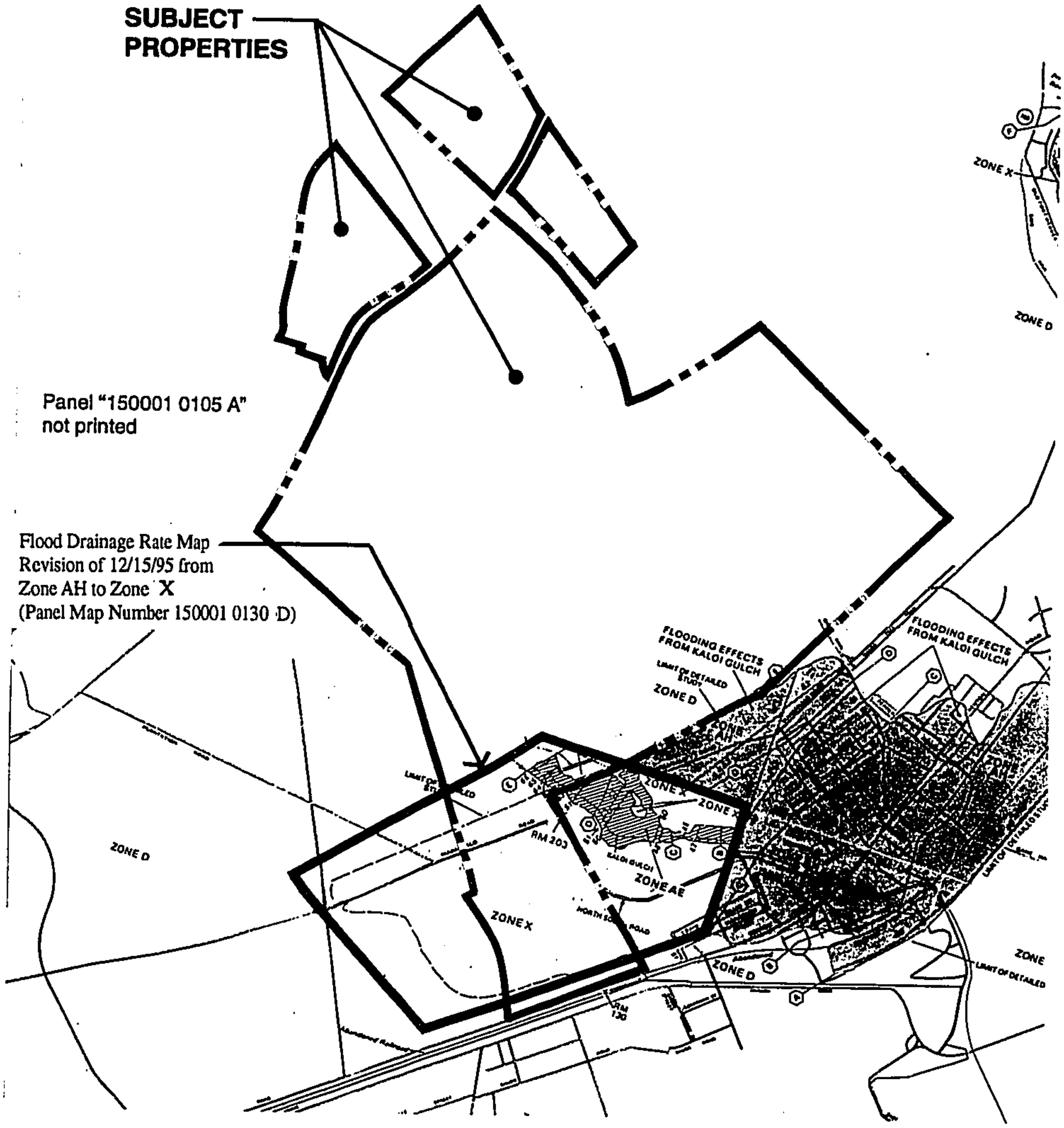
The anticipated impact and mitigative measures are primarily applicable to potential flooding and drainage conditions. The applicable mitigative measures for drainage improvements are described in Appendix K.

Impacts of hurricanes and earthquakes will be mitigated by compliance with the Uniform Building Code adopted by the City of Honolulu. All structures will be constructed for protection from earthquakes and tropical hurricanes in accordance with the requirements of the City.

4.8 Flora and Fauna

Existing Conditions

As indicated in the Impact on Agriculture Report (Appendix E) the subject property was previously utilized for agricultural cultivation for many years which significantly disrupted the original vegetation characteristic of the property. To ascertain whether there are any



LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

(blank box)	ZONE X	AREAS DETERMINED TO BE OUTSIDE 500-YEAR FLOOD PLAIN
(stippled box)	ZONE AH	FLOOD DEPTHS OF 1 TO 3 FEET (USUALLY AREAS OF PONDING); BASE FLOOD ELEVATIONS DETERMINED.

SOURCE: NATIONAL FLOOD INSURANCE PROGRAM, FEMA, SEPT. 1990

FIGURE 11
FLOOD INSURANCE RATE MAP
HCDCH EAST KAPOLEI
ISLAND OF OAHU

NORTH LINEAL SCALE (FEET) 500 0 500 1000 2000

PBR HAWAII

DATE: 2/98

endangered plants or animals currently associated with the subject property, a site survey of the property was undertaken in late 1996 to determine the whether endangered flora and fauna species are present on the project site.

According to the survey prepared by Nagata (Appendix E), the property was classified by Ripperton and Hosaka (1942) as one of lowland shrub with a coastal fringe of kiawe trees. Several recent surveys conducted on certain portions of the subject property and adjacent lands recognized sugar cane fields, Ruderal fields and Fallow Fields. These communities were characterized by actively cultivated sugar cane fields, abandoned cane fields, common "weedy" introduced plants and lowland wayside species including those mentioned by Ripperton and Hosaka.

According to the recent Nagata survey, the vegetation of these lands are entirely secondary and determined by the history of cultivation (or disturbance) on each individual parcel of land. Eight plant communities were recognized, each community existing as a continuum with one blending into another. Species composition and vegetational cover will differ somewhat during the rainy season.

Within the eight plant communities identified, 99 different plant species were recorded with two indigenous ('ilima and pa'uohi'iaka), two probably indigenous ("uhaloa and hoary abutilon) and one endemic (ko'oloa'ula, Abutilon menziesii). Except for ko'oloa'ula, all of the native species on the site are common lowland species in Hawaii. At least 38 individuals of the ko'oloa'ula were recorded and an additional 50 plants were identified by Char in January 1997. The ko'oloa'ula, is now a federally listed endangered species once endemic to Lanai, Maui, Oahu and Hawaii. It may now be extinct on Hawaii. According to Char, the largest population of approximately 600 plants currently exists on Lanai.

Historically, the ko'oloa'ula was once sold by several nurseries as "red 'ilima" prior to its listing as an endangered species due to its attractiveness and ease of cultivation. It is not known how many plants remain as urban landscape elements resulting from prior nursery sales. The ko'oloa'ula was formally listed under the provisions of the Endangered Species Act as an endangered species in 1986.

According to the Flora Report, the individuals were found within the central portion of the subject property roughly under the overhead electrical transmission lines. Apparently, unknown individual plants existed within uncultivated portions of the property during the many years of sugarcane cultivation. After the property became fallow, seeds from the remaining individuals were able to establish themselves within the previously cultivated area. Ko'oloa'ula was not found in any of the prior surveys in the immediate area (Funk 1990, 1994; Nagata 1994, 1996).

The only mammals known to inhabit the property are introduced species such as feral cats, dogs, rats, mice, and mongooses. No mammals were observed on the property during the field survey, although pig trails were observed in several plant communities.

Seventeen species of birds were observed on the property, of which 15 were introduced, one is a common migratory species (Pacific golden-plover) and one is indigenous (Black-crowned night heron).

Anticipated Impacts and Mitigative Measures

With development of the proposed master plan, those portions of the subject property containing the ko'oloa'ula will be extensively modified by grading and urban development. Therefore, in accordance with both State and Federal regulations, a Habitat Conservation Plan was prepared in consultation with the State Department of Land and Natural Resources (Appendix F) to protect the existing ko'oloa'ula and establish a methodology to ensure the future propagation of new plants.

~~After careful consideration of several alternative mitigative programs described in Appendix F, a combination of on-site cultivation of the ko'oloa'ula, distribution of plants for off-site propagation, and use of the plant in project landscaping was recommended by DLNR to mitigate the impact of the proposed project on the ko'oloa'ula. Funds to support the proposed mitigation program will be available from the HFDC revolving fund and future revenues generated from the sale of the large-lot development parcels.~~

~~Because the protection, propagation, and relocation of the ko'oloa'ula is a long term undertaking, the final implementation of the mitigation plan will extend well into the project's construction period. Once construction and build-out of the project master plan is complete, use of the ko'oloa'ula in project landscaping and continued use of the ko'oloa'ula nursery for propagation will ensure a much larger and vigorous population of the ko'oloa'ula than would have occurred without development of the proposed project.~~

In 1997, the Hawaii State Legislature enacted and passed House Bill 1292 to provide private landowners with incentives to promote the conservation and recovery of threatened and endangered species and their habitats. House Bill 1292 was signed into law by the Governor and now augments Chapter 195D, *Hawaii Revised Statutes.* The Act provides for the preparation and implementation of Habitat Conservation Plans and Safe Harbor Agreements under the federal Endangered Species Act and the State of Hawaii endangered species law, and for the State law to complement the federal law.

In addition, it provides new incentives for private landowners to recover and protect threatened and endangered species on their lands, while providing a dynamic and flexible framework to allow creative solutions, increase public appreciation and understanding of endangered species issues, and encourage partnerships to help Hawaii recover its unique natural heritage. This legislation makes Hawaii law generally consistent with the federal Endangered Species Act.

~~5.0 ASSESSMENT OF THE EXISTING HUMAN ENVIRONMENT, POTENTIAL IMPACTS AND MITIGATIVE MEASURES~~

~~This section presents summary background information applicable to the existing human environment.~~
After careful consideration of several alternative mitigative programs described in Appendix F, a combination of on-site cultivation of the ko'oloa'ula, distribution of plants for off-site propagation, and use of the plant in project landscaping was recommended by DLNR to mitigate the impact of the proposed project on the ko'oloa'ula. Funds to support the proposed mitigation program will be available from the HCDCH revolving fund and future revenues generated from the sale of the large-lot development parcels.

These mitigation measures have been finalized in the Habitat Conservation Plan (HCP) for *Abutilon menziesii* (Appendix F). Included in the HCP is the *North-South Road Mitigation Plan for Abutilon menziesii*, in its entirety. This plan relied on the expertise of the staff of both the U.S. fish and Wildlife Service and the staff of DLNR. Numerous meetings were held to present the HCP to affected agencies. Comments were received and incorporated into the final revised HCP as applicable.

The USFWS has also indicated that they will assist in identifying an appropriate area and developing a long term management plan for these plants. Therefore, ready-to-plant propagules from an onsite nursery facility will be provided to any agency interested in establishing off-site propagation areas.

Any impact to *Abutilon menziesii* will be incremental over a ten-year period. Therefore, portions of the plant clusters would remain *in situ* for varying periods of time. If an offsite preserve can be established, some of the plants would remain *in situ* for many years.

Because the protection, propagation, and relocation of the ko'oloa'ula is a long term undertaking, the final implementation of the mitigation plan will extend well into the project's construction period. Once construction and build-out of the project master plan is complete, use of the ko'oloa'ula in project landscaping and continued use of the ko'oloa'ula nursery for propagation will ensure a much larger and vigorous population of the ko'oloa'ula than would have occurred without development of the proposed project.

5.0 ASSESSMENT OF THE EXISTING HUMAN ENVIRONMENT, POTENTIAL IMAPACTS, AND MITIGATION MEASURES

5.0 ASSESSMENT OF THE EXISTING HUMAN ENVIRONMENT, POTENTIAL IMPACTS AND MITIGATIVE MEASURES

This section presents summary background information applicable to the existing human environment. Subject areas addressed include archaeology, traffic, air, noise, socio-economic, and visual conditions that may impact the property. Technical studies and analysis have been undertaken to address the potential impacts of the project and to identify appropriate mitigative measures to minimize the identified short and long term impacts.

5.1 Archaeological and Historic Resources

Existing Conditions

The presence of any significant archaeological sites on the surface or subsurface of the subject property is unlikely due to the disruption caused by continuous cane cultivation for nearly 70 years. This has been confirmed by a site survey and a review of existing literature concerning previous surveys of the subject property. The archival research included a review of relevant archaeological research previously conducted in the project area, historic records, and maps. The full report is attached as Appendix G.

The earliest detailed map of the area shows no habitation closer than the western edge of West Loch in the vicinity of Papapapuhi Point. The Monsarrat survey map of 1878 documents substantial settlement at the "Honolulu Taro Lands" in the Papapapuhi Point area which appears to have been the focus of the population of Honouliuli ahupua'a. The amenities of that area, such as fishponds, taro lo'i, shellfish collecting, and salt drying would have focused population there in prehistoric times, and the name of that place must have secondarily come to apply to the entire ahupuaa. The richness of the coastal Papapapuhi area is a contrast to the dry Ewa Plain environment of the subject project.

In brief, while very little is known about the prehistory of the immediate vicinity of the subject property, there is no indication of human occupation or any other utilization or that the remains of any prehistory activity remains.

Anticipated Impacts and Mitigative Measures

According to the archaeological survey, literature search, and assessment of potential significant sites by the State Historic Preservation Division (SHPD), there are no significant archaeological or cultural resources associated with the subject property. According to a letter received from SHPD (Appendix G) "it is unlikely that historic sites will be found and believe that this project will have 'no effect' on historic sites." However, should any unknown sites be uncovered during project construction, work in the area of the site will stop and the SHPD will be notified in accordance with applicable state regulations.

5.2 Roadways and Traffic

Existing Conditions

The primary roadways which presently provide access to the subject property are Farrington Highway and the proposed Kapolei Boulevard (construction will start in the summer of 1998). The mauka portion of the subject property is located adjacent to Farrington Highway, which begins at the west end of the H-1 Freeway at Palailai Interchange. Farrington Highway continues in service towards the east (Honolulu) from Palailai Interchange and becomes wider through Waipahu.

In addition, the proposed North-South Road and a new roadway (identified for planning purposes as the East-West Road) is planned as the two major internal roadways servicing the project area. The proposed North-South Road (presently being planned and designed by the SDOT) would be a major regional roadway traversing the length of the entire project ultimately connecting the Ewa Beach and Ewa Marina areas with the H-1 Freeway.

Transit "nodes" generally consisting of ~~new park-and-ride facilities adjacent to the sports complex and~~ future mass transit stations located along the North-South Road are also planned. These bus stops and future mass transit station locations (as envisioned by the City's *Ewa Development Plan*) would be located at the intersections of Farrington Highway and North-South Road, the intersection of the East-West Road and North-South Road, and Kapolei Boulevard and North-South Road.

Planned as a self supporting community, the Estate of James Campbell Ewa Regional Master Plan was designed so that residents will have the opportunity to live, work, shop, and attend school within the same area. Bus service within Kapolei will develop on routes which offer sufficient demand for this service. Jobs created at the future University of Hawaii West Oahu Campus and within the City of Kapolei will also employ people who live outside of Ewa in areas such as Aiea, Mililani or Honolulu. Therefore, the use of public transit by these residents will help balance bus service in the morning and evening, to and from the City of Kapolei. ~~The proposed park-and-ride adjacent to the sports complex will service state employees working at the new state office building in the City of Kapolei.~~

The Honolulu Public Transit Authority operates TheBus on a supply and demand basis, subject to the availability of resources. Existing public transit service to the vicinity is provided by Route 51 between Honolulu and Makaha passing on Farrington Highway in front of the subject property.

The makai portion of the subject property is bordered by Renton Road. Renton Road is a paved, two-lane road which connects to Fort Weaver Road. Along this segment of

Renton Road, the State of Hawaii maintains a 40-foot railroad right-of-way immediately makai (of Renton Road) which is adjacent to the makai property boundary of the subject property. The right-of-way is part of the former OR&L rail network.

The "Oahu Regional Transportation Plan" ("ORTP") prepared for the Oahu Metropolitan Planning Organization ("OMPO"), identifies roadway concepts for the Ewa Plain necessary to support the future development in the region. The major roadway improvements identified by the ORTP are completion of the Kapolei Parkway and the North-South Road. Plans are presently underway for construction of the "North-South Road" which will connect the areas between the Kapolei Parkway and Farrington Highway and the H-1 Freeway. Ultimately, this transportation corridor will connect to the new University of Hawaii West Oahu Campus.

Anticipated Impacts and Mitigative Measures

Development of the subject property will produce traffic impacts on local, collector and regional transportation systems as the residential population of the area increases in the future. To identify these impacts, existing and projected traffic flows and proposed transportation improvements have been provided in the East Kapolei Project Traffic Report (Appendix H).

According to the Traffic Report, project related traffic impacts will result primarily within internal roadways and intersections. Regional impacts of the project, including conditions at the proposed H-1 Interchange with the new North-South Road, were addressed as part of the North-South Road study. Compared to the projected volumes entering and leaving the project site, the findings of the North-South Road and East Kapolei traffic studies are not significantly different. Therefore, the North-South Road study off-site transportation improvement recommendations, have already incorporated anticipated impacts of the East Kapolei project in formulating recommendations for regional improvements.

To calculate project related traffic impacts, trip generation rates were applied to the low and high range of the land use projections. The distribution of the inbound or outbound traffic was adjusted so that the estimates of net traffic generated from the project site for the land use high range were approximately equal to those of the north-South Road study.

According to the East Kapolei Project Traffic Report, signalization would be required at seven intersections. At the intersection of the collector roadway serving Parcels "K" and "L" (See Appendix H) with Farrington Highway, peak hour volumes do not satisfy the peak hour warrant for signalization, however, traffic turning left out of the collector or proceeding across Farrington Highway would have very long delays, at unacceptable Levels of Service (LOS) E and F. This unacceptable LOS could be mitigated, however, by establishment of two access points into Parcel L and/or the future use of East Kapolei Avenue as an alternate access roadway for Parcel K. As stated in Appendix H, "if additional roadway connections are provided, conditions would be better than shown in the analysis."

Signalized intersections would all operate at an acceptable level of service during the AM and PM peak hours as shown in Table 6 of Appendix H. Any additional roadways providing access would lessen the traffic demand, decrease delays, and improve the level of service.

To mitigate traffic impacts that do occur, the East Kapolei Project Traffic Report makes specific recommendations for intersection approach laneage and signalization. Based on these recommendations, acceptable conditions are expected at all intersections except for the unsignalized intersection on Farrington Highway with Parcels L and K. The Traffic Report concludes that "alternative access patterns may be necessary to mitigate this unacceptable condition." Consequently, it is recommended that (1) an additional access location be established for Parcel L from Farrington Highway and (2) an additional access location into Parcel K be established from East Kapolei Avenue.

5.3 Noise

Existing Conditions

According to the Noise Assessment Study (Appendix I), the exiting acoustical environment at the subject property is exposed to daytime ambient noise levels of 41 to 46 dBA by noise generated from traffic, wind in foliage and occasional aircraft flybys or flyovers. Within existing residential areas (i.e. Villages of Kapolei and Ewa Villages), ambient noise levels range from 44 to 47 dBA.

When no aircraft activities occur, noise generated by traffic on H-1 Freeway and Farrington Highway is the dominant source from locations within the subject property nearest these highways. At locations away from these roadways, and when no aircraft activities occur, wind through vegetation and birds are often the dominant sound.

The day-night equivalent sound level at the subject property area due specifically to aircraft operations is less than 60 dBA and compatible with the State Department of Transportation residential guidelines for noise. According to the Noise Assessment Study, there are no direct flyovers associated with the Honolulu International Airport. Day-night equivalent sound levels due to air traffic will be less that 60 dBA, although some overflights will be audible. This is also true for the proposed reliever airport planned for 1,000 acres of the Barbers Point Naval Air Station after it is turned over in July 1999. According to a draft master plan prepared for the reliever airport, the project area will continue to have aircraft noise levels less than 60 dBA for all alternatives considered. In addition, the noise corridors previously associated with Barbers Point aircraft operations will no longer be applicable after the Barbers Point Naval Air Station closes.

Anticipated Impacts and Mitigative Measures

The Noise Assessment Study projects noise level increases in 2020 will be perceptible by most residents near Farrington Highway due a the combination of the East Kapolei Master Plan Development and other proposed projects in the area. However, the predicted increases due to the East Kapolei Project alone will be less than or equal to 2.2 dBA and should not be perceptible to the residents near the roadway. Specifically, noise in the morning at Farrington Highway would decrease approximately -0.4 dBA and increase 2.2 dBA in the evening as a result of project development. At the H-1 Freeway, project related traffic will increase approximately 0.6 dBA in the morning and only 0.4 in the afternoon as a result of project development. Noise level increases greater than 3 dBA are not generally perceptible by most residents.

In addition, residential development along the H-1 Freeway, Farrington Highway, North-South Road, East-West Road and Kapolei Parkway may be exposed to future traffic day-night equivalent should levels greater than the HUD recommended limit of 65 dBA if located close to the roadways. The generous setbacks and proposed landscape will buffer much of the traffic noise generated by the roadway. In the areas of the proposed ~~park-and-ride and~~ sports complex, residences nearest to these facilities could be impacted, however, no residential development is planned for parcels adjacent to these facilities.

During project construction, noise will be generated by construction and earthmoving equipment. However, this noise will be relatively short-term, occur only during daytime hours, and will comply with State Department of Health noise regulations. Only on those margins of the subject property that border sensitive land uses (such as residential subdivisions) will such noise actually cause impacts. If construction noise exceeds DOH's "maximum permissible" property line noise levels, a permit must be obtained from the DOH to allow the operation of vehicles, construction equipment, power tools, etc.

The ultimate land uses planned for the subject property, including residences, roadways, neighborhood commercial, and public services will also generate some degree of noise, but nothing greater than noise levels generally associated with land uses of this kind. Once again, the exiting acoustical environment at the subject property is exposed to daytime ambient noise levels of 41 to 46 dBA by noise generated from traffic, wind in foliage and occasional aircraft flybys or flyovers. Within existing residential areas (i.e. Villages of Kapolei and Ewa Villages), ambient noise levels range from 44 to 47 dBA. Therefore, an increase of 2.2 dBA due to the project is not considered as a significant noise increase.

Specific noise mitigation measures for those areas proximate to noise sources that could impact residential neighborhoods are as follows:

1. Areas exposed to Ldn levels between 65 and 75 near high traffic areas will require noise mitigation measures such as construction of a sound barrier at the property line, installation of padded carpeting, louvered closet doors, use of absorptive ceiling tiles in affected bedrooms, air conditioning, and use of standard windows.

2. Noise mitigation for aircraft noise (if required) could include air-conditioning and implementation of sound insulation construction in the design of impacted residences. However, mitigation from aircraft noise would likely not be required since the projected Ldn levels are less than 60 dBA for all alternatives considered.

3. Noise from quarrying operations at Makakilo Quarry could be mitigated by providing noise disclosures to buyers, construction of noise barrier walls, and use of air-conditioning for impacted residences.

4. Minimal noise exposure is anticipated from the proposed ~~park-and-ride~~parking area and other heavily traveled areas. However, noise disclosures could be provided to alert noise sensitive homeowners of potential noise.

5. Compliance with DOH requirements regarding the location and design of stationary noise such as air-conditioning and refrigeration units, and exhaust fans and pumps will be followed.

6. The proposed sports complex could impact residences if potential noise sources such as public address systems, mechanical equipment, etc. are not controlled. Noise barrier walls, acoustical enclosures and/or exhaust silencers for the mechanical equipment should be implemented, and any sound system loudspeakers should be oriented away from nearby homes. Hours of park use should avoid noise sensitive times.

5.4 Air Quality

Existing Conditions

According to the Air Quality Study prepared for the project (Appendix J), the present air quality of the project area is relatively good and has probably improved recently with the discontinuation of sugar cane growing in the Ewa Plain area. Air quality data from the nearest monitoring stations operated by the State Department of Health suggest that all national air quality standards are currently being met, although occasional exceedances of the more stringent state standards for ozone and for carbon monoxide may occur.

Air quality impacts that do occur are mostly associated with emissions from vehicular, industrial, natural and/or agricultural sources. Several industrial sources of air pollution are located a few miles to the southwest at Barbers Point, but the prevailing winds carry emissions away from the project site more than 80 percent of the time.

The Honouliuli Wastewater Treatment Plant is approximately 1.5 miles from the proposed Sports Complex location. Considering that the WWTP meets Department of Health Cover Source Permit limits, the distance to the Sports Complex, the relatively low level of odors, and the direction of prevailing winds (both Tradewinds and Kona winds), any ordors will be mitigated. According to the air quality consultant, Barry Neal and Associates, DOH standards permit 25 parts/billion of hydrogen sulfide at the boundary of Honouliuli WWTP, although some individuals can detect odors at 5 parts/billion. At the sports complex site, these levels should be reduced approximately 1,000 times due to wind dispersion. Consequently, odors from Honouliuli WWTP should not be detectable.

Recently, several industrial air pollution events have occurred at Campbell Industrial Park which is located at Barbers Point southwest of the subject property. In response, the State Department of Health has established an extensive monitoring program to ensure that applicable air quality standards are met in the future.

The following represents the best available data of existing air quality in the region:

- During 1991 to 1993, sulfur dioxide levels in the region were measured at Makaiwa Gulch which were consistently low and below the national and state 24-hour Ambient Air Quality Standards (AAQS).
- During the same period, particulate matter of less than 10 microns was measured in Kapolei where only one incidence of exceedance of the state and national AAQS was reported.
- Carbon monoxide measurements were made at West Beach most recently in 1993. One exceedance of the state standard was measured, but no exceedance of the national standards were identified.
- Between 1990 and 1993, two to seven exceedances per year of the state AAQS for ozone were registered.

Anticipated Impacts and Mitigative Measures

Future construction within the subject property may produce short- and long-term air quality impacts. Short-term impacts will include fugitive dust and exhaust emissions produced by construction equipment and vehicles. Long-term impacts will result from gradual urbanization of the area associated with future population growth. These impacts include increased vehicular exhaust, as well as indirect emissions resulting from increasing electrical power demand.

All future construction activity on the subject property will maintain strict compliance with State of Hawaii Air Pollution Control regulations. A combination of measures such as watering active work areas, installation of wind screens, minimizing the amount of disturbed area through use of mulch, and paving and landscaping of project areas early in the construction schedule. During construction, these measures can be adjusted to reflect current site conditions. Particular care in implementing dust control should be taken when construction activities take place near existing homes, businesses, or highways. An effective dust control plan for the project construction phase will be necessary.

Impacts from exhaust emissions of construction vehicles will usually be mitigated by the effect of the winds, especially as most construction will be removed from existing residential areas or other sensitive land uses.

After construction, long-term impacts on air quality could occur as a result of emissions emanating from vehicular traffic. Based on an air quality modeling study prepared for the project (Appendix J), future worst-case carbon monoxide concentrations in the project vicinity would likely exceed the relatively stringent state ambient air quality standards for carbon monoxide near several roadway intersections. Carbon monoxide is selected for modeling because it is both the most stable and the most abundant of the pollutants generated by motor vehicles. A background carbon monoxide concentration of 1 ppm was assumed for the future (2020) year studied.

The results of the model (Appendix J, Table 6) indicate that with the project in the year 2020, the highest estimated worst-case concentration was predicted to occur near the intersection of Kapolei Parkway and the North-South Road. The next highest level could occur near the intersection of Kapolei Parkway and the project access road to areas F and ~~G (See Figure 5)~~. Concentrations at other locations ranged from 1.8 mg/cubic meter at the intersection of Farrington Highway and the project access road to areas K and L; and to 5.4 mg/cubic meter at the intersection of East Kapolei Avenue and the North-South Road.

Comparing the predicted values to the AAQS, it appears that worst-case 8-hour concentrations could exceed the state AAQS at five of the nine intersections studied and that one location, the intersection of Kapolei Parkway and the North-South Road, could potentially exceed the national 8-hour AAQS.

These worst-case projections assume wind speeds of 1 meter/second. Wind speeds of 2 meters/second, however, would result in carbon monoxide concentrations with about half the values given. Similarly, the 8-hour estimates are also conservative in that it is unlikely that anyone would occupy the assumed receptor site (within 3 meters of the roadways) for a period of 8 hours.

Emissions from electrical demand and burning/disposal of solid waste, would indirectly result in an increase of about 1 percent or less of the current island-wide emissions on Oahu. Table 8 of the Air Quality Report gives emission estimates assuming all project solid waste is burned at the H-Power plant. According to Appendix J, "emission quantities from the burning of project solid waste would be relatively small amounting to much less than 1 percent of the current emission levels on Oahu."

Based on these anticipated impacts, recommended short-term and long-term mitigation measures include the following:

Short term:

1. Frequent watering during construction activities to maintain dust control in active work areas at least twice daily on days without rainfall.
2. Initiate a construction phasing plan which considers wind patterns and existing and future residential land uses to minimize downwind dust impacts within residential areas.
3. Grassing as soon as practicable once grading has been completed.
4. Wind screening as appropriate to limit fugitive dust.
5. Use mulch and soil stabilizers on graded areas.
6. Trucks should be covered when traveling on roadways and washed on-site to keep dirt from traveled roadways.
7. Monitoring of dust at the project boundary during the construction period.

Long term:

8. Consider reduction of traffic volumes by promoting bus service and car pooling.
9. Consider adjustment of local school and business hours to begin and end during off-peak times.
10. Where possible increase buffer zones between major roadways and pedestrian facilities.
11. Establish extensive landscaping to maintain long-term air quality and aesthetically

integrate the Master Plan into the surrounding neighborhood.

5.5 Visual Resources and Open Space

Existing Conditions

The subject property is relatively flat and has been cultivated for sugar cane production for several decades by the Oahu Sugar Company, Limited. The average slope throughout the subject property is approximately one percent (1%). The site abuts the Kapolei Golf Course to the west and lands previously in sugar cane production along its northern and eastern borders, and Ewa Villages to the south. All of these adjoining lands are similarly flat. The best views of the subject property are off-site at Makakilo and the proposed University of Hawaii West Oahu Campus site (See **Figures 12a, 12b, and 12c**).

Because of these conditions, there are no ocean views from within the subject property. However, distant views are available of Diamond Head and Pearl Harbor, and mauka views toward Makakilo and the Waianae Mountains. Some residential lots along the southwestern portion of the subject property have views of the Kapolei Golf Course.

To assess visual resources on Oahu, the City and County of Honolulu, has conducted a comprehensive view shed assessment documented in "Coastal View Study, City and County of Honolulu Department of Land Utilization, 1987". In this study, the existing visual resources of the entire Oahu coastline are inventoried, prioritized, and documented.

According to the City's Coastal View Study, the Ewa view shed consists of generally flat terrain and absence of predominant land features. Views are decentralized with no particular focus. To protect the views which do exist, mauka and makai views and views of central Honolulu shall be protected whenever possible. Views from public streets and thoroughfares to the mountains and sea shall be preserved and enhanced whenever possible.

The only significant roadway view identified in the study is makai from Farrington Highway and portions of the H-1 Freeway. Views from future internal roadways will be given consideration to the extent possible. However, because the site is relatively flat, views that do exist will be impacted primarily by the siting of future buildings and residences similar to other developments in the Ewa region.

Anticipated Impacts and Mitigative Measures

The visual appearance of the subject property will change from vacant scrub agricultural vegetation to an urban residential built environment, similar to other master planned communities which have occurred elsewhere in the Ewa region. The visual appearance of the proposed new development, can be controlled by design review that will occur during

Ⓐ View looking mauka toward the proposed University of Hawaii West Oahu Campus site. Note the old cane haul road and scrub vegetation characteristic of the entire subject property.

Ⓑ View looking west toward the proposed North/South Road corridor. Note the existing power lines which also illustrate the location of the corridor. This view also depicts the relatively flat topography and undefined drainageways that have caused flooding in the past.

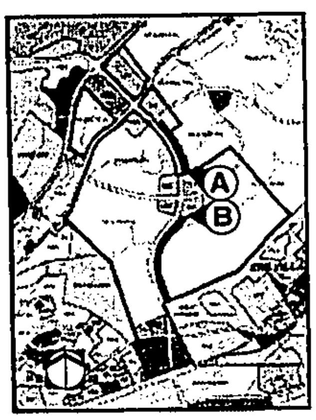


FIGURE 12 a
SITE PHOTO ANALYSIS
HCDCH EAST KAPOLEI
ISLAND OF OAHU

PBR HAWAII
DATE: 2/98

(C) Mauka edge of the subject property looking east along Farrington Highway. This portion of Farrington Highway will be widened and improved in 1998 and 1999.

(D) Existing blacktop roadway going mauka from Farrington Highway toward the H-1 Freeway and the proposed University of Hawaii Campus. Note the existing underpass currently providing access under the H-1 Freeway to the proposed campus.

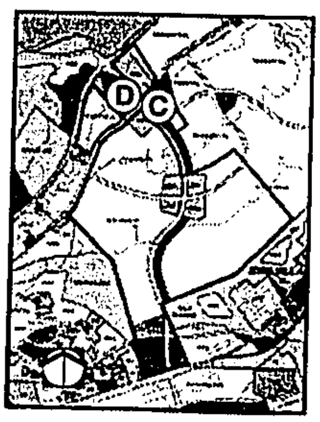
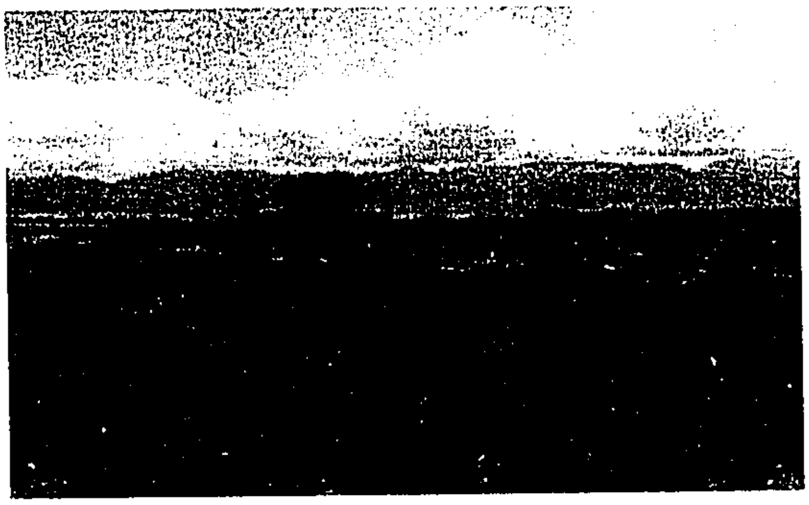
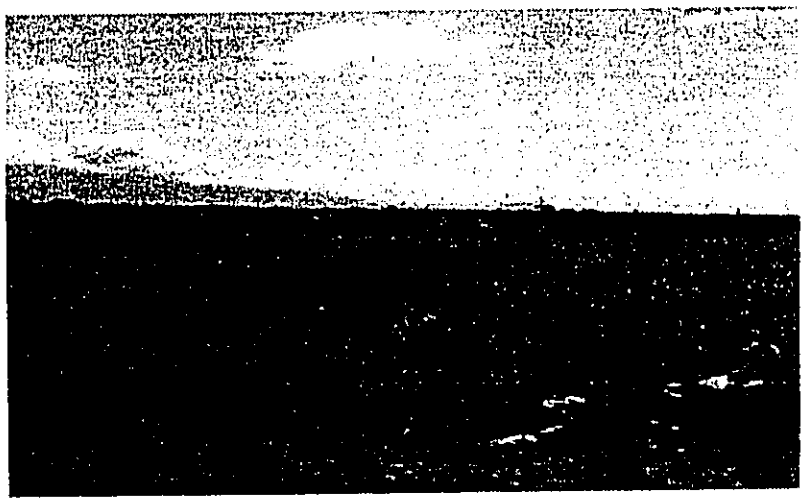


FIGURE 12 b
SITE PHOTO ANALYSIS
HCDCH EAST KAPOLEI
ISLAND OF OAHU

PBR
HAWAII
DATE: 2/98



Ⓔ View of Kaloi Stream and existing vegetation. Note current cultivation area abuts closely to stream edge.



Ⓕ View along Farrington Highway looking makai toward Diamond Head in the distance. Note relatively level topography.

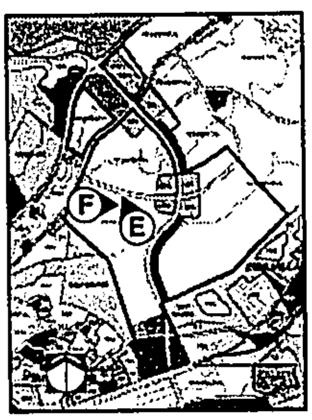


FIGURE 12 c
SITE PHOTO ANALYSIS
HCDCH EAST KAPOLEI
ISLAND OF OAHU

PBR HAWAII
DATE 2/98

the City zoning process.

Extensive landscaping, development of the open space drainage corridor, and provisions for parks will also add to the visual character of the future urban environment. For example, landscaped views toward the City of Kapolei from the edge of the proposed Intermediate School Site will consist of the proposed district park and the drainage/open space corridor along the North-South Road for a distance of approximately 2,000 feet. Considering the current views of vacant scrub vegetation compared to the proposed urban landscaping, significant portions of the proposed project will be dramatically improved from a visual perspective.

5.6 Social Characteristics

Existing Conditions

5.6.1 Population

According to the City and County of Honolulu Planning Department (Appendix K, p. 2-5), the 1990 population of the Ewa DP area is projected to increase 65.6 percent (81,844 persons) from a population of 42,931 in 1990 to 124,775 residents in 2020. In comparison, the City and County as a whole is expected to experience a population growth of 21.9 percent (234,995 persons) from 836,231 to 1,071,226 total residents during the same thirty year period. This trend clearly reflects Oahu's relatively high population growth that will be directed toward new developments in Ewa. This in-flow of new Oahu residents is also consistent with the City's General Plan policy to direct most new residential development into the Ewa Development Plan area. For example, the Socio-Economic Impact Assessment (Appendix K) indicates that in the 20-year period from 1990 to 2010, Ewa's housing stock is expected to increase by nearly 24,136 units, almost triple the 1990 stock.

Anticipated Impacts and Mitigative Measures

Because there are no residential land uses on the subject property, its development would support the State and City policy of directing population growth into the Ewa Development Plan area. Specifically, the following discussion reflects the adopted governmental policies applicable to the proposed project and its impact on population:

- The *General Plan* population distribution policy directs future population growth for each Development Plan area. The forecast of population, which is prepared by the Planning Department, is based on a set of simulation models referred to collectively as the Land Use Model. This model involves the detailed identification of projects that may result in additional visitor units, housing units or employment within the framework of the Development Plans, past performance, and extrapolation of probable trends.

- While the forecasts for most of Oahu's Development Plan areas fall within or close to the desired range for those areas, population growth in the Ewa Development Plan area is not expected to achieve the 2010 population guideline policy for Ewa. For example, the General Plan population distribution policy for Ewa is 119,000 - 132,900 in 2010 while the forecasted population for 2010 is only 93,112. Clearly, the *General Plan* population distribution policy for Ewa cannot be achieved unless a sufficient supply of land is designated on which to develop housing. Therefore, complementary policies to reclassify agricultural land for urban purposes is necessary if the population distribution policy for future new growth in Ewa is to be realized.

  As indicated, the *General Plan* population policy and Planning Department projections for the Ewa Development Plan Area indicate that there will be sufficient capacity to support additional population growth to achieve the *General Plan's* population growth policy for the Ewa Development Plan area.

- Even with a forecasted population that is lower than the *General Plan* distribution policy for the area, Ewa's population is expected to more than double by 2010. At buildout, the project could be home to some 20,950 to 27,050 persons in about 6,500 to 8,400 housing units for Oahu residents. Occupancy rates are estimated based on approximately 3.2 persons per unit.

5.6.2 Housing

Existing Conditions

Most of the island's new housing stock is planned for development in the Ewa and Central Oahu regions of the island. This trend is expected to continue over the next several decades to accommodate the anticipated population growth and housing demand projected for Oahu.

The Ewa region offers the island's major opportunity for fee-simple home ownership at relatively reasonable prices. This is due to a combination of circumstances. For example, both the City and ~~HFDC~~HCDCH, and some private developers, have undertaken large scale housing development projects to ensure that the houses to be built are affordable to households in the low- and moderate-income and "gap-group" ranges.

Lower interest rates in recent years, and pricing of Ewa area housing units, have expanded the opportunities for home-ownership to many more households. Consequently, the market seems to be directed more toward areas which provide moderately priced housing rather than the generally more expensive market priced housing which is available outside of the Ewa and Central Oahu region. Based on these trends, the Market Study (Appendix

A) has determined that the ~~HFDC~~HCDCH East Kapolei Master Plan Development will capture 18 percent of Oahu's single family market and 11 percent of Oahu's multi-family market.

Anticipated Impacts and Mitigative Measures

The proposed development will address much of the future demand for residential units in the Ewa and Central Oahu housing market that will occur with or without the project. Approximately 200 acres of the 1,300 total will be used for native Hawai'ian homes, responding to strong demand from a group that has a high incidence of over-crowding and other housing problems (Urban Institute, 1995). The total impact of the East Kapolei project on housing will be positive. When persons with permanent jobs due to the project start their own households, new household formation will result. According to the Socio-Economic Impact Report, p. 4-13, new household demand associated with the project comes to about 270 to 450 units, of which some 140 to 260 units might well be in Ewa.

To meet the existing and projected housing demand, reclassification of the subject vacant lands from the current State Land Use Commission Agriculture District to the Urban District will be required. The proposed reclassification, with the necessary zoning from the City and County of Honolulu, would then expand home ownership opportunities for existing and future residents of Oahu. The market study (Appendix A) provides additional information on the pricing of residential property and future projections of market demand.

5.6.3 Lifestyle/Character of the Community

Existing Conditions

Some of the components of a developing secondary urban center have begun to emerge in Kapolei. New commercial establishments and businesses are operating, a day care facility has opened, and new City and County district police station and civic center is planned. Ko Olina resort is comprised of a hotel, golf course and 280 unit residential development.

Many residents live and work in the area, but most still commute to work. However, as new employment centers are established, the Ewa region will evolve into a self-contained community with less dependence on Honolulu for essential services and employment opportunities.

Anticipated Impacts and Mitigative Measures

According to the Social-Economic Impact Study (Appendix K, Section 6.0), the major social impacts associated with the East Kapolei project are summarized as:

- Provision of needed housing for Oahu;
- Enhancement of Kapolei's customer base;
- Development of a new community focus at the Sports Complex;
- Increase in traffic and congestion;
- Possible impacts on social life due to construction noise or dust;
- Competition for community resources and facilities, namely parks and schools;
- Continued transformation of Ewa into a bedroom community; and
- Financing for development of the University of Hawaii West Oahu.

In addition, a community interview process was conducted to identify the concerns felt by Ewa residents. Most concerns were voiced in terms of potential cumulative impacts on the region especially regarding adequacy of infrastructure and public facilities. Other concerns centered generally around;

- Quality of life issues (primarily infrastructure),
- Community character (i.e. design, configuration, timing of development), and;
- Community involvement (coordination with developers and community representatives to seek pro-active steps to mitigate anticipated project impacts.

Regional identity will also change as the East Kapolei property is changed from vacant agricultural land to an urban residential community. However, as the Ewa Development Plan area achieves buildout, a sense of Ewa as a region, rather than as a jumble of separated communities, will evolve. Regional facilities such as transportation improvements, schools, and recreational facilities and their development must also be coordinated as the regional population increases in the future.

Regional impacts of the East Kapolei project would also result from development of the:

East Kapolei Sports Complex - Generally, the social impacts resulting from the sports complex will be positive provided that economic activity will be generated and residents will have opportunities for public use of the facility or other recreational facilities in the region supported by the sports complex.

University of Hawaii West Oahu Campus - The University of Hawaii West Oahu Campus was viewed favorably. New employment and educational facilities both contribute positively to the quality of life in the region. The university may also serve as a unifying force for the region, particularly if it includes a sports program.

DHHL Communities within the East Kapolei Project - The DHHL component of the East Kapolei Master Plan, will create more housing for Hawaiian families and will extend the Hawaiian presence in the Ewa urban area.

5.7 Economic Characteristics

5.7.1 Employment, Personal Income and Expenditures

Existing Conditions

Presently, the subject property produces relatively low levels of employment and income generated from short term agricultural operations that utilize only a small portion of the project area. As described in the Agricultural Impact Assessment Report (Appendix C), there are 380 off-site acres and 200 on-site acres that represent the total area of agricultural lands that will be withdrawn from agricultural production. This production represents approximately $5.8 million per year in gross revenues, 80 jobs, and $1.4 million in annual payroll.

Anticipated Impacts and Mitigative Measures

According to the Socio-Economic Impact Report (Appendix K), the East Kapolei project will generate direct, indirect, and induced jobs both within the subject property and on an island-wide basis. These jobs will occur both during construction and after construction as operational employment.

Direct construction employment is estimated as about 7,350 to 8,050 person-years of work over 25 years time for an average annual employment of about 290 to 320 construction workers over that time. Total direct, indirect and induced employment is projected as about 18,700 to 20,600 person-years of employment over the entire period.

Construction related income (Appendix K, Exhibit 4-D) from direct, indirect and induced jobs is as follows (shown in 1997 millions of dollars):

	1998-2002	2003-2007	2008-2012	2013-2017	2018-2022
Low Range	$115.2	$188.1	$202.8	$128.0	—
High Range	$117.3	$191.7	$224.0	$164.8	$100.9

Operational employment after buildout is achieved and construction is complete would also be significant. Total direct, indirect and induced jobs associated with the project's operations would be in the range of 2,350 to 2,625 jobs after buildout. Of those jobs, some 1,350 to 1,500 jobs would be located in the Ewa Development Plan Area. Operational incomes are projected to amount to some $55.3 million to $62.8 million annually at buildout.

Ground was recently broken for the construction of a new six-story office building which will accommodate approximately 1,000 state employees after the building completion in late 1998. In addition, a 36,600 square foot police station and first phase of the Kapolei Civic

Center with a city work force of 450 will also be nearing completion.

5.7.2 Economic Factors/Government Revenues

Residential Demand

The real estate market will apply to the proposed project in two respects. The first concerns the market demand for large lot parcels which will be sold by ~~HFDC~~HCDCH to individual developers. This demand for developable improved property will fluctuate as overall economic conditions influence consumer demand for housing in the future.

Secondly, market support for the large lot development parcels will be determined by the values created by the improvements made on the properties, level of development permitted by planning and zoning restrictions, and the overall market demand for the real estate products produced at the time of construction.

According to the Market Study prepared for the project (Appendix A), the Ewa Development Plan Area appears to have an adequate supply of residential product either planned or proposed to meet the demand for housing until approximately 2005. This level of absorption assumes a product mix of approximately 40 percent multi-family and 60 percent single family. First units for the East Kapolei Master Plan project have been assumed for delivery between 2001 and 2005.

Based on a review of past market trends and projected demand, the Market Study has determined that the East Kapolei Master Plan will produce an average annual absorption of approximately 225 single family homes or 18 percent of the Oahu single family new sale market. Similarly, the Market Study estimates multi-family product absorption at approximately 150 units per year or 12 percent of the Oahu multi-family new sale market.

The unit sales absorption can also be used to convert to acres of land necessary for development. For example, the above unit absorption translates into an average of approximately 37 acres of single family land and 15 acres of multi-family land developed each year (assuming 6 units/acre single family and 10 units/acre for multi-family). Therefore, availability of large lot parcels must be "packaged" at a size suitable for developers to produce and turnover the real estate product in a timely fashion without carrying large undeveloped tracts of land in their inventory.

Some developers will prefer to purchase large amounts of land at one time in order to provide themselves with the potential for several years of continued development. However, the Market Study indicates that these bulk land sales will need to have their price reduced to account for the extended period of carrying the property. According to ~~HFDC~~HCDCH, this discount could range from 5 percent to 15 percent depending on the amount of land to be "bulk-purchased".

Commercial Demand

According to the Market Study, approximately one acre of commercial land is required for every 230 residential dwelling units. Assuming development of 375 residential units per year, estimates of approximately 1.6 acres of commercial development will be required each year during the buildout period until the planned 18 acres of commercial area are developed.

5.7.2.1 State of Hawaii - Revenues and Expenditures

The State of Hawaii will incur major costs as developer, but also gain significant revenues from the project. Development costs are estimated as about $95 million for infrastructure and $27.5 million for the Sports Complex. (DHHL construction costs and interest are not included here.) Revenues include receipts from land sales, taxes on construction-related cash flows, operating revenues for the Sports Complex and new income associated with visitor spending due to the Sports Complex.

~~HFDC~~HCDCH will be able to cover its development costs and supply the University of Hawaii West Oahu with funds for infrastructure soon after major land sales occur. *Overall, the proposed development on the East Kapolei site will result in continuing* cash flows for the State over and beyond State costs. By 2022, the net balance of revenues to the State over costs of the project is estimated as $200 million to $213 million (1997 dollars).

5.7.2.2 City and County of Honolulu - Revenues and Expenditures

According to Appendix K, development of the East Kapolei project will provide the City and County of Honolulu with significant new tax revenues. If rates remained at current levels, the new taxes will grow to about $6.3 million to $7.5 million (1997 dollars) annually at buildout. Costs to the City and County will be very small in relation to this income.

Presently, no significant revenues to the City or State are generated from the subject property due to the undeveloped nature of the project area.

5.8 Infrastructure

On-site Improvements. Presently, there are no significant on-site infrastructure facilities located on the subject property. Farrington Highway is the major transportation access, however, plans are presently being prepared for improvement of Farrington Highway and future construction of the North-South Road.

Therefore, new on-site infrastructure will be required including facilities for water transmission and distribution, wastewater collection, traffic circulation, drainage, and electrical and communication systems.

Off-site Improvements. Off-site infrastructure consists of extensive improvements designed to accommodate Ewa and Kapolei as Oahu's second city. These include transportation systems, water and wastewater facilities, and electrical/communication systems. A brief description of existing and planned infrastructure is provided below:

5.8.1 Water Supply Facilities

Existing Conditions

Presently, there is no potable water system servicing the subject property. However, dual systems of potable and non-potable water currently serve or will be included in the infrastructure development of the Ko Olina Resort (West Beach Estates), Ewa by Gentry, Ewa Marina, City of Kapolei and Kapolei Business Park, and the subject ~~HFDC~~HCDCH East Kapolei Development.

The East Kapolei project spans two Board of Water Supply service pressure zones, 215-feet and 440-feet. The portion of the project below the planned East-West Road is primarily within the 215-foot service elevation zone. Most of the remaining portion is within the 440-foot service elevation zone.

Existing BWS infrastructure in the area includes a 30-inch and 36-inch water mains running along Farrington Highway that connect a series of 215-foot and 228-foot reservoirs. The 228-foot Honouliuli reservoir sustains pressure for much of Ewa Villages and provides water to the Barber's Point 215-foot reservoir as well as the Kapolei 215-foot tank via the Honouliuli Booster Pumps.

Anticipated Impacts and Mitigative Measures

Maximum daily demand generated by the East Kapolei is estimated at 6.8 mgd and 7.5 mgd which also includes water demand for the University of Hawaii West Oahu Campus. Average daily demand for the East Kapolei project will be approximately 4.5 mgd (Appendix B, Water Master Plan, Table 3-1). When East Kapolei is fully developed, the total storage requirement is also 6.8 mgd. Therefore, new 4.0 mg reservoir for the 215' system and 4.0 mg reservoir for the 440' system will be developed which will surpass the storage requirement for the proposed East Kapolei project. To provide water to the higher elevation system, a booster pump at the 215' elevation will pump water to the 440' reservoir. The system will be connected to the 36-inch water main along Farrington Highway. New distribution lines include 12-inch and 16-inch lines along the North-South Road and East-West Road and a 16-inch along Farrington Highway. A 12-inch line will also be located within Kapolei

Parkway.

Non-potable water will also be used to supplement the potable water system in meeting the total water demand for East Kapolei. This non-potable system will utilize brackish water and/or reclaimed water for irrigation purposes primarily within road right-of-ways, parks, sports complex, and the 15-acre district park. The average daily non-potable water demand for the East Kapolei development is 0.95 mgd. The East Kapolei potable and non-potable water systems will be completely separate and fully comply with all applicable State Department of Health regulations.

As with any newly-developed area, the rate of development cannot exceed the rate of expansion of the potable water source, storage and distribution system that will be necessary to support the master planned development. Presently, the Board of Water Supply is requesting a water reservation from the State Commission on Water Resource Management to convert agricultural water allocations from the Waiawa-Waipahu aquifer to urban use. This is needed to serve the needs of the projects (including the East Kapolei Project) envisioned by the Ewa Development Plan. There will be a re-allocation of water from agricultural uses by October 1998. When this occurs, the water source for projects included in the Ewa Development Plan can be identified.

5.8.2 Wastewater Facilities

Existing Conditions

East Kapolei is located within the City and County of Honolulu's Honouliuli Wastewater Treatment Plant ("WWTP") service area. The WWTP is located adjacent to Barbers Point Naval Air Station ("NASBP") approximately 4,000 feet makai of the subject property. The only major trunk sewer line dear the subject property is the 30-inch Makakilo Interceptor which runs from Makakilo, along Ft. Barrette Road and Renton Road (parallel to the OR&L Railroad right-of-way) to the Honouliuli WWTP.

The Honouliuli WWTP has a primary treatment capacity of 38 mgd and a deep ocean outfall with a design capacity of 112 mgd. This WWTP presently treats approximately 25 mgd to a primary level and has secondary treatment facilities which process 13 mgd. The planned ultimate capacity of the Honouliuli WWTP is 51 mgd, with a planned 13 mgd of tertiary treatment for re-use purposes. WWTP capacity is based on average daily flows.

Anticipated Impacts and Mitigative Measures

Maximum design flow generated by the East Kapolei project is projected at 14.6 mgd and 19.5 mgd if the University of Hawaii West Oahu Campus is included. However, the design average flow based on the sewage generated on-site is estimated at 3.338 mgd and design average flow including the UHWOC is 5.258 mgd. Because the East Kapolei project is estimated to achieve build out in approximately 20 years, the phased expansion of the Honouliuli WWTP will also be implemented concurrently with development of the East Kapolei Master Plan. Therefore, the East Kapolei Sewer Master Plan (Appendix B) has determined that the Honouliuli WWTP presently has a remaining capacity of 13 mgd available. Therefore, the Honouliuli WWTP will be able to accept projected flows from the proposed project at its current capacity.

The major streets and utilities required for the East Kapolei Master Plan will be provided by ~~HFDC~~HCDCH including the wastewater collection system. The East Kapolei "backbone" sewer system will be comprised of a major trunk line along the North-South Road with sizes varying from 18-inches to 36-inches, and 12-inch and 15-inch branch lines along connecting collector roads. All pipe sizes range from a minimum diameter of 12-inches to a maximum of 36-inches.

Off-site trunk sewers are planned to include the existing 30-inch Makakilo Interceptor and the proposed 54-inch Kapolei Interceptor Sewer along Renton Road. Presently, the Makakilo Interceptor is operating at approximately 65% of its 10.587 mgd capacity. Therefore, the East Kapolei project at buildout will potentially exceed the capacity of the Makakilo Interceptor.

To add the additional capacity for East Kapolei and other large scale development projects in the Ewa region, a 54-inch "Kapolei" Interceptor Sewer is proposed that would have a capacity of 42.0 mgd. This additional capacity would serve the Villages of Kapolei, the Kapolei Town Center, and Ko Olina. Construction of the proposed Kapolei Interceptor Sewer is dependent upon the time frame of future developments in the tributary area.

5.8.3 Drainage Facilities

Existing Conditions

According to the East Kapolei Drainage Master Plan (Appendix B), the primary drainage feature potentially impacting the subject property is the Kaloi Stream (Gulch). Although usually dry, Kaloi Stream can flood during intense storm events. Therefore, drainage improvements such as control structures, retention/detention basins, and grading will be required to control surface flows, thereby mitigating potential flood damage from the existing inadequate drainage system.

Kaloi Stream - The Kaloi Stream presently enters the northern portion of the site and continues down into the western corner of the Ewa Villages Golf Course. It is a small ditch with a full bank capacity of less than 1,000 cfs. Numerous road crossings further restrict flow to less than 500 cfs in some locations. Overflows are generally not able to return to the channel. Kaloi Stream was used by Oahu Sugar Company (OSCo) to carry irrigation water down to the lower fields and therefore has built-up banks which are higher than the adjacent ground. The peak discharge (Plate 6) is calculated to be 7,075 cfs.

Drainage subareas S3 through S17 (Appendix B) contribute to the runoff into central Ewa Villages and ultimately back to Kaloi Stream. Runoff enters the golf course through several small culvert crossings in the relocated Mango Tree Road, as well as overtopping the road. The calculated 100-year, 24-hour runoff volume is 374 acre-feet and the Plate 6 peak discharge is 1,100 cfs at the top of the golf course.

West Loch Watershed - The West Loch watershed consists of subareas S18 through S21 and subarea 27. Runoff enters the northeastern portion of Ewa Villages, above Fernandez Village, and continues to an existing detention basin southeast of the West Loch subdivision via the cane haul road underpass, two 54-inch RCP culverts at Fort Weaver Road and shallow box drains. The culverts have a capacity of approximately 500 cfs. Discharge from the basins sheet flow into Pearl Harbor. Existing runoff is calculated to be 690 acre-feet, with a Plate 6 peak discharge of 2,100 cfs at the top of the Ewa Villages Golf Course.

Anticipated Impacts and Mitigative Measures

Kaloi Channel Improvements - The Kaloi Channel is the main regional facility. The channel is planned to be constructed along the east side of the proposed North-South Road within portions of the right-of-way, from the upper boundary of the Ewa Villages Golf Course to the H-1 Freeway. The channel will be improved to convey the City & County's Plate 6 (estimated 100-year storm) flows and eliminate flooding in the area.

Improvements include a combination of grass and CRM-lined channels and detention basins to attenuate the peak flows and to store the increase in runoff due to the East Kapolei development. The detention basins will also serve as water features, with the adjacent property gradually sloping shoulders also serving as a linear parks (Appendix B).

The series of detention basins along the Kaloi channel adjacent to the North-South Road, are planned to store the increase in runoff volume due to the East Kapolei development. Excess runoff that is retained in the basins will be slowly discharged via small drainage piping after storms have subsided. Ewa Villages and Ewa by Gentry have constructed similar facilities. All future developments will be required by the City to do the same.

Proposed Bridge Structures and Culverts - The improved Kaloi channel is planned to terminate at the entrance to the Ewa Villages Golf Course. The existing 20' x 8' box culvert at the relocated Mango Tree Road and the Ewa Villages upper boundary line is proposed to be replaced by an 80-foot wide inlet structure leading into the golf course. Mango Tree Road is planned to be abandoned at the time the channel is completed. If it is later desired to construct a road crossing the channel at this location, it is estimated that six, 15' x 10' box culverts would be required to convey the Plate 6 flow into the golf course without affecting the upstream hydraulic grades.

A 70-foot wide bridge is proposed to be constructed at the master planned East-West Road to allow the Kaloi channel to cross the intersecting road. A 30-foot wide bridge is proposed to replace the existing Kaloi Stream structure on Farrington Highway. Two other existing bridges on Farrington Highway, for the Hunehune Stream crossings, are also planned to be replaced upon widening of the highway. These improvements will be done by various developers, the State or the City. Each of the proposed bridges will be designed to pass the City & County Plate 6 discharge.

The existing dual 12' x 12' box culverts crossing the H-1 Freeway at Kaloi Gulch was looked at to determine its adequacy to convey the City & County Plate 6 flow. It is determined that this culvert is not adequate in passing this flow and excess runoff is calculated to overtop the freeway. This culvert inadequacy should be studied further in order to determine the most feasible solution to convey the appropriate design flows, and improvements should be made during construction of the North-South Road interchange with the H-1 Freeway.

The area on the east side of the North-South Road alignment is master planned to continue to drain in the same patterns as existing. It has been proposed in the *Ewa Villages Drainage Master Plan* to allow the construction of a large box culvert at the low point of the relocated Mango Tree Road upon development of the mauka areas. In this location, the golf course is planned to be able to take the consolidated peak flows from the East Kapolei development (See Appendix B, Drainage Report, Figure 4-3). Storage will need to be provided in the backbone infrastructure for this area to ensure that drainage flows into the golf course do not increase above the conditions stated in this master plan.

Ewa Villages Golf Course Channel - According to the *Ewa Villages Drainage Master Plan*, the Ewa Villages Golf Course is designed to accept the Plate 6 flow of 7,075 cfs from Kaloi Stream at the upper boundary. Due to the increase in watershed area for Kaloi Gulch, by the North-South Road alignment, a larger Plate 6 flow of 7,400 cfs was studied entering the golf course. The study is based on both interim conditions, where the OR&L Railroad bridge is not constructed, and the ultimate conditions, where the bridge is in. It was determined that the golf course can accommodate the increase in flow for both conditions, with an increase in water surface elevation of approximately 0.45-feet.

Backbone Drainage System - The backbone system for the project areas west of the North-South Road consists of collector box drains on the planned East-West Road and East Kapolei Avenue, and an on-site drainage channel to re-direct the Hunehune Stream. The box drains are proposed to carry the re-routed Hunehune Stream flows as well as on-site runoff , generated west of North-South Road, to the Kaloi Channel. There are five backbone collector box drains proposed for the project.

The east and west branches of the Hunehune stream are proposed to follow existing drainage patterns from the H-1 Freeway down to Farrington Highway. The flow from the west Hunehune crossing at Farrington Highway is proposed to be carried by a 16' x 8' box drain along the East-West Road to the Kaloi drainage channel. A CRM-lined channel is proposed to carry the runoff from the east Hunehune crossing at Farrington Highway to the East Kapolei Avenue (Collector Road "A"). A 12' x 8' box drain in East Kapolei Avenue is planned to feed into the proposed box drain along the East-West Road.

A smaller 8' x 5' box drain along East Kapolei Avenue, at the North-South Road intersection, is planned to convey runoff from the area between Farrington Highway and East Kapolei Avenue. Six equally spaced 60" pipe culverts are proposed to carry runoff from the area just below East Kapolei Avenue across the North-South Road into the Kaloi channel. Three other box drains (10' x 6' and 2 ea. 6' x 4') are proposed to convey runoff from the portions of the site below the proposed East-West Road, between North-South Road and the Kapolei watershed.

The backbone drainage system is planned to accommodate the master planned on-site tributary areas. Hydraulic analyses of these box drains were conducted to determine the Plate 6 and 50-year storm hydraulic grades. On-site tributary areas are planned to be able to drain into the backbone system with adequate freeboard. See Appendices C and D of the Drainage Report (Appendix B) for the hydraulic grades along the proposed Kaloi channel and box drains.

The existing drainage structures on Farrington Highway are planned to remain until Farrington Highway is widened. These structures presently cannot accommodate the Plate 6 flows and are proposed to be upgraded in the future as development in these areas progresses.

5.8.4 Solid Waste Disposal Facilities

Existing Conditions

On Oahu, residential and commercial wastes are hauled to landfills, the incinerator, or transfer stations. A waste-to-energy combuster, H-POWER (Honolulu Program of Waste Energy Recovery) located at the Campbell Industrial Park, began full commercial operation May 21, 1990. The facility is designed to process about 2,000 tons per day, and its gross generating capacity is 57 megawatts of electricity (approximately 1 megawatt/35 tons). About 1,800 tons per day are incinerated, producing ash and non-processibles that are transported to Waimanalo Gulch Landfill and buried. The electricity generated is bought under a purchase power agreement with Hawaiian Electric. Currently, the H-POWER facility receives all the residential and commercial packer truck wastes on the island.

Waimanalo Gulch Landfill, which opened in 1989, is located on the western side of Oahu. The land is owned by the City operated by Waste Management, Inc. The site accepts residential, commercial, and nonhazardous industrial solid wastes, demolition debris, and ash and residue from the H-POWER waste-to-energy facility. Commercial haulers pay $60 per ton to dispose of solid waste at the facility. Wastewater treatment sludges, septic tank wastes, and cesspool pumpings are accepted, provided such disposal is in accordance with the landfill's operating guidelines. The site handles special wastes such as spent lime, contaminated foods, and asbestos, all of which require special handling.

The current 1997 annual fill rate was estimated at 118,000 tons of solid waste along with 151,000 tons of ash and residue. However, actual fill rates were closer to 288,000 tons with the ash from the H-Power facility accounting for 161,000 tons of the total.

Anticipated Impacts and Mitigative Measures

As the population of Oahu grows in the future, loading on the City and County of Honolulu's H-Power Facility and the Waimanalo Gulch Landfill site will also increase irrespective of where the new development occurs. Since these two sites accept all of the island-wide solid waste that is generated, the actual impacts on landfill capacity is dependent on island-wide population growth rather than where the population growth occurs.

It is clear that the City's General Plan island-wide population projection of 1,012,073 persons for the year 2010 (an increase of 175,842 persons from the 1990 population of 836,231) will necessitate expansion of the H-Power plant or increased recycling of solid waste at some point in the future.

In addition, the East Kapolei Master Plan project is designed to address existing housing demand on Oahu and will not stimulate in-migration into the state and its associated potential to generate increased levels of solid waste. Fees will be paid by future East Kapolei residents and business to fund solid waste collection, disposal, and possible expansion of the H-Power plant in the future as applicable and in accordance with the City's fee structure for solid waste collection services.

According to the Engineering Report (Appendix B), the proposed project will generate solid waste during the construction of the backbone infrastructure and as the project achieves build-out during the twenty year planning period. Once the project is built out, typical levels of solid waste from residential and commercial facilities will be generated. Therefore, the projected solid waste generated by the project is estimated to average approximately 735.7 tons/day after project build-out. Consequently, short-term impacts to the City's solid waste facilities will not be significant since the solid waste contribution will stretch over the twenty year construction period. Fluctuations in the quantity of solid waste will occur in response to population growth, market trends, and construction activity on the project site and throughout Oahu.

The future developers of the large lot development parcels must cooperate with the State Department of Health and the City and County of Honolulu Department of Public Works to ensure that their projects conform to the program goals and objectives of the Integrated Solid Waste Management Act, Chapter 342G, Hawaii Revised Statues, and the County's approved integrated solid waste management plans in accordance with a schedule and time frame satisfactory to the Department of Health.

5.8.5 Electrical Service

Existing Conditions

Electricity for the surrounding area is currently being provided by Hawaiian Electric Company (HECO). HECO's available generation capacity ~~is approximately 199 MW~~

(~~megawatts), with a present~~ peak demand) is 1119 ~~of 166.3 MW~~megawatts (MW).

Hawaiian Electric Company (HECO) owns and maintains a pole line along Farrington Highway that supports two 138 KV (kilo-volt) lines (with provisions for a 46 KV line in the future) and two 12.47 KV lines from their "Ewa Nui" Substation to the vicinity of the intersection with Palehua Road. One of the two HECO 12.47 KV lines ends just before the intersection, while the second line continues along Farrington Highway to Kapolei. Both 138 KV lines turn south at the intersection and follow the alignment of the future North-South Road to the OR&L right-of-way. Also, two 138 KV pole lines from the HECO Kahe Power Plant pass to the north of the project site mauka of the H-1 Freeway.

In addition, an existing 46 KV circuit that is supported on wood poles follows the "H-1" alignment. On the Honolulu-side of Pu'u Makakilo, a spur continues across the freeway to the "Pacific Concrete & Rock" substation, while the main branch of the pole line continues to parallel the "H-1" alignment, then turning and heading towards the freeway to the "Ewa Nui" Substation.

Anticipated Impacts and Mitigation

Hawaiian Electric Company anticipates requiring new substations to serve the future urban development in the region. Two of the existing 138 KV lines that pass adjacent to the project site will need to be extended to the proposed substation. According to the Engineering Report (Appendix B), the East Kapolei Master Plan will generate a peak electrical demand of ~~57.8~~57,808.992 kva. However, much of this demand will be offset by the 735.7 tons of solid waste that will be produced daily from residential and commercial areas. Therefore, at 1 megawatt/35 tons, the solid waste production from the East Kapolei Master Plan will generate approximately 21 megawatts at the City's H-POWER waste-to-energy facility. Presently, the H-Power facility is contracted by HECO to provide 46 MW. Therefore, the additional waste material will not add to the H-Power's capacity withou additional generation capacity being added.

5.8.6 Telephone/Communication

Existing Conditions

Hawaiian Telephone Company provides existing service to the Ewa area. GTE Hawaiian Tel (HTCO) owns and maintains a pole line along Farrington Highway. Oceanic Cable has an agreement with HTCO for use of those poles, and has attached cables to extend their facilities to Kapolei. Also, AT&T has a fiber cable that is buried within the southern shoulder of the existing Farrington Highway road right-of-way.

At the Palehua Road intersection, circuits from one of the aerial telephone cables along Farrington Highway are tapped and extends north under the freeway following Palehua Road. Except for the overhead telephone cable along Palehua Road, telephone and cable television facilities do not exist on the site and must be extended to the project from trunking facilities located along Farrington Highway.

Anticipated Impacts and Mitigative Measures

GTE Hawaiian Tel and Oceanic Cable anticipate having to relocate their lines to new poles along Farrington Highway since the existing pole line is substandard. In addition, both GTE Hawaiian Tel and Oceanic Cable will need to extend their trunking facilities from Farrington Highway to serve the future West Oahu Campus and the East Kapolei projects.

The proposed action should produce no significant impacts to telephone service which cannot be mitigated by expansion of existing service improvements.

5.9 Public Services

5.9.1 Schools

Existing

Public schools in the vicinity of the subject property and there respective 1997 enrollments are Ewa Beach Elementary (519 students), Ewa Elementary (612 students), Pohakea Elementary (552 students), Ilima Intermediate (1412 students) and Campbell High School (2210 students). Other schools in the Ewa District include Barbers Point (565 students), Mauka Lani Elementary (709 students), Makakilo (669 students), ~~and~~ Kapolei Elementary (937 students), and Holomua Elementary (674 students).

Based on already anticipated residential growth, one elementary school will be available at ~~Kapolei Village and one each at Ewa Gentry,~~ Ewa Marina~~,~~ and in the Laulani development. In addition, a middle school and high school are proposed for the Villages of Kapolei Village (Phases 7 and 8).

Anticipated Impacts and Mitigative Measures

Assuming that the absorption rates projected by the Market Study (Appendix A) and the population forecast provided in the Social-Economic Report (Appendix K) is achieved, sites for three elementary schools and an intermediate school are planned for the subject property. Based on information provided by the Department of Education, the first elementary school would likely be developed by 2005, the second in 2007, and the third in 2015. The intermediate school would likely be required by approximately 2005. This tentative schedule is subject to change since the actual development of new schools will depend on population growth in the region and availability of funding. The site of the first school will be determined by the development patterns established by the purchase and development of the large lots by private developers.

~~HFDC~~ HCDCH has been working closely with the State Department of Education to identify the appropriate sites for the proposed schools and phasing for their construction. In addition, future developers will also contribute impact fees on a per unit basis in accordance with DOE's official policy. The DOE has indicated that the dedication of the 56 acres for school sites pluse the balance of the fair-share requirement will satisfy the DOE's requirements in full. Presently, the impact fee for new development is $850 for each residential unit developed. Therefore, unless the number of units exceeds 8,400, the DOE will require no additional fees from future developers.

5.9.2 Police Protection

Existing Conditions

The subject property falls within the Police Department's District 8, which encompasses the leeward coast and the Ewa Plain. There are about 105 field officers assigned to the district. Response time for the entire district fluctuates between five and seven minutes.

In order to meet the growing needs of the Ewa Plain communities, the City has recently opened a storefront station in the Campbell Building at 1001 Kamokila Boulevard. The new Regional Kapolei Police Station is currently being designed and will be constructed across the street from the Campbell Building. Completion of the new police station is projected by the year 2000.

Potential Impacts and Mitigative Measures

The preliminary population projection for the East Kapolei Master Plan is estimated at 20,950 to 27,050 persons at project buildout. Using the Police Department's staffing guideline of two officers per 1,000 population, it is assumed that approximately 42 to 54 new officers and staff will ultimately be required.

As described in the Socio-Economic Impact Assessment (Appendix K), additional revenues will be generated from real property taxes which can fund expansion of City police facilities and services. To fund the necessary expansion of police facilities and additional officers, property values and associated property taxes collected for improved residential and commercial property will increase above the currently assessed agricultural land values. Therefore, as the project achieves buildout, increased real property taxes paid to the City will contribute new tax revenue needed to mitigate the costs associated with expansion of the police force in the project area.

5.9.3 Fire Protection

Existing Conditions

Presently, the vacant scrub vegetation and low rainfall characteristic of the region create a potential fire hazard. Fire services in the Ewa area are provided from the Ewa Beach Fire Station, and additional fire support is available from the Waipahu Fire Station and the Makakilo Fire Station. The Kapolei Fire Station (previously, Campbell Industrial Park Fire Station), a battalion headquarters, has been completed to serve the expanding development on the Ewa Plain.

Other new facilities recently completed or being planned for the Ewa area include (1) an engine company at Tenney Village; (2) A Kapolei engine-and-ladder company; (3) a Ko Olina engine-and-ladder company; and (4) the relocation of the existing Ewa Beach Fire Station into a new facility within the Ewa Marina Project.

Potential Impacts and Mitigative Measures

Once the proposed urban structure and landscaping are in place, the potential fire hazard from scrub vegetation will no longer exist, however, the potential for fires in residential structures will increase. Consequently, no significant major impact to Fire Department facilities or services are anticipated. Fire protection services provided from Kapolei and Makakilo engine companies with ladder service from Kapolei are adequate. To fund the necessary expansion of fire protection facilities, property taxes collected for improved residential and commercial property will increase above the currently assessed agricultural land values. Access for fire apparatus, water supply, and building construction shall be in conformance to existing codes and standards.

5.9.4 Health Care/Hospitals

St. Francis Medical Center - West is the nearest hospital facility to the subject property. Ambulance service is coordinated with the City and County, and the hospital has a helipad. The medical center offers general hospital services including emergency care, outpatient care, lab and imaging services, and medical offices.

The hospital has 79 licensed beds available. Bed capacity will soon be expanded to 84 beds. The hospital is operating at about 80% occupancy. (Space for a total of 136 beds is available in the hospital.)

Nearby emergency medical and surgical services can also be provided by Pali Momi Medical Center (116 beds) in Aiea and Wahiawa General Hospital (162 beds of which 93 are for long-term care). Non-emergency medical services are offered at Kaiser Permanente's Punawai Clinic in Waipahu. In addition, medical services can be obtained at major hospital facilities in urban Honolulu, about 20-minutes drive from the subject property.

In addition to the facilities described above, construction of a new medical complex, to be known as the Kapolei Medical Park at the corner of Farrington Highway and Fort Barrett Road, was recently announced by the developer. The proposed facility will have more than 50,000 square feet of rental space for tenants including Ambulatory Services Inc, Hawaii Medical Services Association, and Kaiser Permanente, and will employ approximately 250 persons.

5.9.5 Recreational Facilities

Existing Conditions

Recreational facilities in the Ewa area are designated as regional parks, community parks, neighborhood parks, and beach/shoreline parks. Regional parks are large recreational complexes. According to the City's Department of Parks and Recreation, Community parks serve an approximate population of 10,000 people and normally include play fields, courts, and a recreation building. Neighborhood parks serve an approximate population of 5,000 people and normally include play fields, courts, and a comfort station. Beach/shoreline parks are day use parks primarily for swimming, sunbathing, and picnicking.

~~**The existing parks in the Ewa area are shown in the following table:**~~

Existing Parks in the Ewa Area

Name	Type	Size (acres)
Barbers Point Beach Park	beach	11.73
Ewa Beach Community Park	community	13.25
Ewa Beach Park	beach	4.88
Ewa Mahiko Park	neighborhood	10.00
Kahe Point Beach Park	beach	4.47
Kamokila Park	community	5.88
Kapolei Park	regional	43.00

Makakilo Community Park	beach	18.26
Makakilo Park	neighborhood	4.01
Mauna Lani Neighborhood Park	neighborhood	4.01
Oneula Beach Park	beach	30.00
Puuloa Playground	neighborhood	4.34
West Beach Shoreline Park, north	beach	10.00
West Beach Shoreline Park, south	beach	18.26
Villages of Kapolei	community	18.00

Potential Impacts and Mitigative Measures

Population growth within the subject property will create new demands for additional recreation facilities. Based on the City standard of 2 acres of park land per 1000 persons, the proposed master plan will require approximately 42 - 54 acres of new park land in accordance with the City's Park Dedication requirements. This can be provided by dedication of land or by paying a pro-rata share of park facilities to ensure that the long-term recreational needs of the community are satisfied.

According to the East Kapolei Master Plan, the following recreational facilities will be provided to satisfy the recreational needs of the community.

- 6 neighborhood parks totaling 18 acres,
- one 15.4-acre district park,
- 118 acres of lineal park/open space associated with the Kaloi drainageway improvements,
- playgrounds associated with each elementary school site,
- private parks within the multi-family developments, and
- 64.3 acre sports complex with approximately 7 ballfields and sport/community center

Based on the inventory of park land and recreational facilities described above, the proposed recreation areas envisioned by the East Kapolei Master Plan total approximately 218.2 acres (not including school playgrounds or private parks). Clearly, this extensive system of recreation and open space resources exceeds the City park dedication requirement of 42 - 54 acres of new park land required for the proposed project.

5.9.6 Public Transportation

The Bus Route #50 currently provides service to the subject property. Significant new facilities will also be provided with the future construction of the proposed North-South Road. Transit nodes are provided to facilitate The Bus and any future mass transit system that may be planned in the future. The transit nodes are located near the intersection of Farrington Highway/North-South Road, East-West

Road/North-South Road, and Kapolei Parkway/North-South Road. A transit corridor running parallel to the North-South Road is also planned to ultimately provide a dedicated lane for future transit system requirements.

5.10 Summary of Potential Impacts

The overall goal of the East Kapolei project, is to provide increased opportunities for moderately priced housing located proximate to places of work, education, shopping, and recreation. With the proposed new housing and employment centers (private and public) planned for development in the region, the overall quality of life for residents will be enhanced, incomes should grow with new employment, and opportunities for recreation and education will be readily available.

As with all large scale development projects, potential environmental and socio-economic impacts may occur both during and after project construction. These potential impacts are described as follows:

Potential Environmental Impacts

Environmental impacts that may occur during project construction primarily include air, water, and noise quality impacts and temporary visual impacts. No impacts are anticipated on endangered fauna or archaeological resources. One endangered plant species will be impacted, but this will be mitigated by conformance with implementation of an approved mitigation plan (Appendix F).

As described in Appendix C, the limited agricultural production on the subject property will be permanently lost for agricultural use. However, any agricultural use of the property would require extensive improvements to provide irrigation, access, and mitigation measures to protect surrounding residential areas from agricultural impacts. Consequently, agricultural use of the entire 1,300 acre property is not economically feasible at the present time.

Air quality will likely be affected by potential fugitive dust emissions and vehicular emissions from construction equipment. Off-site air quality may also be impacted at batching plants and electrical generation facilities, however, the emissions from these types of pollution sources are already highly regulated by the State Department of Health and Federal Environmental Protection Agency. After construction is completed, the primary air quality impact (relative to the current condition) will result from increased vehicular emissions from private automobiles. The greatest increases will likely occur at intersections of major arterial roadways. After construction, fugitive dust emissions will be reduced compared to the present condition due to the establishment of urban landscaping, increased turf areas, and establishment of hard surfaces. Smoke from sugar cane harvesting activities is no longer an air quality concern.

Noise quality will also be impacted during the construction period by the operation of construction vehicles, other construction equipment, and localized noise such as hammering, people talking, etc. After construction, noise will be impacted by increased vehicular traffic, localized noise from air conditioners, and sounds typical of residential neighborhoods (i.e. dogs, people talking, music). Noise from aircraft is also a consideration, however, the project is located outside of aircraft noise contours.

Visual impacts will be of some concern from the perspective of those who value the current vacant open space condition of the subject property. The views of the property will change as the project achieves buildout and extensive design and landscaping controls are imposed by project developers to ensure a high quality urban living environment.

Potential Social Impacts

Social impacts will occur during and after construction in terms of shifting population patterns, increased availability of housing, and enhanced economic conditions generated by increased employment opportunities and personal income. Significant infrastructure improvements for water, wastewater, transportation, and electrical/communication lines will be required to service the new population that will be moving onto the project site. Each of these impacts, however, will be generally positive and no mitigation measures will be necessary. Funding for the infrastructure improvements will ultimately be made by those purchasing the proposed residential and commercial parcels.

5.11 Summary of Proposed Mitigation Measures

As indicated above, few potentially adverse environmental impacts to the area are expected to result from implementation of the proposed Master Plan.

Short-term impacts will result during the initial construction phase which will require on-site grading, trenching, and movement of construction vehicles within the project site which will generate localized noise and dust during construction periods. Mitigation measures to minimize adverse air quality would include frequent watering of unpaved roads and construction areas, dust screens, and mulching and planting of ground cover and other vegetation as soon as possible after earth movement activities are completed. Construction related mitigation measures would comply with all applicable regulations of the City and State Department of Health.

Long-term affects (i.e. traffic congestion, noise) from the development may produce minimal impacts to adjacent residential property owners from growth in the area's population. Traffic levels in the area will increase, new public facilities will be required, and Kaloi Gulch will be modified. One endangered plant species will be impacted, however, its preservation and propagation of new individuals will be assured through implementation of the approved Habitat Conservation Plan (Appendix F).

The proposed project is not expected to have any impact on the micro climate of the project area or region. Planned structures would not be tall enough to significantly effect existing wind patterns; and new structures will not significantly effect temperature since some localized cooling can be expected to result from the establishment of new urban landscaping. No specific or predominate natural feature is visually associated with the project site.

Based on these anticipated impact, recommended mitigation measures include the following:

Short term:

- Frequent watering during construction and demolition activities to maintain dust control.
- Initiate a construction phasing plan which considers wind patterns and existing and future residential land uses to minimize downwind dust impacts within residential areas.
- Grassing of swales and sodding as soon as practicable once grading has been completed.
- Wind screening as appropriate to limit fugitive dust.
- Restrict use of construction equipment to daylight hours.
- Establishment of on-site drainage retention basins during construction to mitigate soil erosion and off-site runoff.
- Reduce construction time in accordance with market conditions to limit the amount of noise and dust associated with project construction.

Long term:

- Implement the Habitat Conservation Plan for the endangered abutilon menziesii in accordance with the requirements of the Fish and Wildlife Service and State Department of Land and Natural Resources.
- Develop new backbone infrastructure in accordance with the requirements of the East Kapolei Master Plan and capacity of existing off-site infrastructure systems.
- Establish extensive landscaping to maintain long-term air quality and aesthetically integrate the Master Plan into the surrounding neighborhood.

- Where appropriate, create landscape buffers between areas of high and low intensity land uses to reduce noise and glare within residential areas.

- Use of appropriate engineering, design and construction measures to ensure adequate drainage and irrigation of the site.

- Construct transportation improvements to mitigate traffic generated by the Master Plan.

6.0 Irreversible And Irretrievable Commitments of Resources

6.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The implementation of the proposed East Kapolei Master Plan Development Project would result in the irreversible and irretrievable commitment of the land resource and require use of fiscal resources from the State of Hawaii and private sectors. Major resource commitments include the land on which the proposed project is located and the financial commitment for construction materials, manpower and energy required for the project's completion.

The primary resource of concern is the use of prime agricultural land for urban development. Although the property is suitable for diversified agriculture, its historical use has been for the cultivation of sugarcane. However, extensive use of water and considerable energy resources are required for the cultivation and processing of sugarcane within an area of low rainfall. Without this commitment of water and energy in support of agricultural production, the property's agronomic qualities are not uniquely suited for this purpose. Significant replacement lands, more appropriately suited for agricultural purposes, currently exist elsewhere on Oahu and throughout the State.

In addition to the on-site physical improvements to be provided by the State and private developers in the future, development of the subject property will result in the increased use of public infrastructure as the project achieves build out. This commitment to new infrastructure includes transportation improvements, solid waste facilities, water, and wastewater collection and treatment, and facilities for public services such as education, and police and fire protection. However, the financial resources required to support these public improvements will be funded by increased property tax revenues. Land sale revenues will also support development of the University of Hawaii West Oahu Campus.

In addition to the physical resources described, labor and materials which are mostly non-renewable and irretrievable will also be necessary during the construction phase. After project completion, occupancy of the residential dwellings and operation of the commercial parcels and recreational areas will require continued use of irrigation systems and petroleum-generated electricity which also represents irretrievable commitments of resources.

The impacts reflected by the commitment of these resources, should be weighed against the positive socio-economic benefits that could be derived from the project versus the consequences of either taking no action or pursuing another less beneficial use of the property. Consumption of these resources will be replaced by the creation of new employment, housing, recreation, educational facilities, and transportation infrastructure. As such, significant enhancement to existing and future life-styles will result from the project compared to limited benefits derived from a "no-build" alternative.

6.1 Probable Adverse Environmental Effects Which Cannot Be Avoided

As with any large scale development, there will likely be instances during the construction period where soil erosion from wind and rain will occur and visual impacts will be altered from the current vacant scrub vegetation. Noise levels will also increase above current conditions due to the added traffic levels on the property, human activity (i.e. children playing), and the addition of mechanical equipment such as air conditioners, trucks backing up, and vehicular noise. Solid waste, energy consumption, water use levels, and waste water will all increase above current levels associated with the vacant property.

Each of these impacts, typical of all urban environments, will result wherever new population growth is directed. By developing a master planned community where potential impacts can be mitigated through site design and development standards, potential adverse environmental effects which cannot be avoided can be mitigated.

7.0 Conformance To Federal, State And City Planning Policies

7.0 CONFORMANCE TO FEDERAL, STATE AND CITY PLANNING POLICIES

7.1 Federal

According to comments received during their review of the Environmental Impact Statement Notice of Preparation, the U.S. Army Corps of Engineers indicated that work in waters of the United States (i.e. Kaloi Gulch) will require a Department of Army Permit from the Corps of Engineers. Consequently, ~~HFDC~~HCDCH has met with the Corps on site to evaluate the limits of their jurisdiction and associated permitting requirements. All applicable Corps permits will be obtained by ~~HFDC~~HCDCH in accordance with pertinent regulations prior to any alteration to Kaloi Gulch.

Abutilon menziesii, or Koʻoloaʻula, was recently discovered on the East Kapolei Master Plan property (Appendix E and F). *Abutilon menziesii* has been federally listed as an endangered species since 1986 and is now protected under the provisions of the Federal Endangered Species Act of 1973, as amended. Over the long term, the operation and management of the East Kapolei Master Plan mitigation program (i.e., research, operations, maintenance), may qualify for Endangered Species Act, Section 6 funding for the implementation of a recovery plan. The Section 6 program provides federal funds to States on a year to year basis. Section 6 initiatives are State driven, thus, coordination between DLNR, ~~HFDC~~HCDCH, FWS, and a third party researcher would be necessary. As such, the mitigation program must be approved by the U.S. Fish and Wildlife Service to ensure compliance with the Endangered Species Act and provisions of Section 6.

The Americans with Disabilities Act (ADA) of 1990 sets guidelines for accessibility to buildings and facilities by individuals with disabilities. These guidelines will be applied during the design and construction of new facilities covered by the ADA to the extent required by regulations issued by federal agencies including the Department of Transportation.

Other than the National Pollution Discharge Elimination System Permit, which is administered by the State Department of Health, there are no other known federal plans or programs applicable to the project.

7.2 State of Hawaii - Hawaii State Plan

According to the Hawaii State Plan (Chapter 226, Hawaii Revised Statutes), the purpose of the Plan is to *serve as a guide for the future long-range development of the State; identify the goals, objectives; policies, and priorities for the State; provide a basis for determining priorities and allocating limited resources, such as public funds, services, human resources, land, energy, water, and other resources; improve coordination of federal, state, and county plans, policies, programs, projects, and regulatory activities; and to establish a system for plan formulation and program coordination to provide for an integration of all major state and county activities.*

The Plan is divided into three parts. Part I (Overall Theme, Goals, Objectives and Policies); Part II (Planning, Coordination and Implementation); and Part III (Priority Guidelines). Part II elements of the State Plan pertain primarily to the administrative structure and implementation process of the State Planning process. As such, project specific comments regarding the applicability of Part II (Section 226-52(a) and 226-52(b) - Statewide planning system) do not directly pertain to the proposed project.

The applicability of specific sections of the Hawaii State Plan relative to the development of the East Kapolei Master Plan is discussed below. The cumulative impact of the proposed project is also considered in terms of Hawaii State Plan implementation and the attainment of state-wide planning goals and aspirations.

Hawaii State Plan

Section 226-5 (b) (3) Promote increased opportunities for Hawaii's people to pursue their socio-economic aspirations throughout the islands.

Section 226-6 (a) (1) Increased and diversified employment opportunities to achieve full employment, increased income and jobs, and improved living standards for Hawaii's people.

Discussion: The proposed East Kapolei Master Plan, provides for a variety of land uses including residential (single-family and multi-family), commercial, public facility, and open space recreation. Development of these land uses will provide a diverse range of employment and economic opportunities for Hawaii's people both during and after project construction. The planned land uses have also been designed to provide convenience shopping facilities.

With greater economic opportunities and increased availability of new housing, the ability to afford housing will be improved for a greater number of Hawaii residents. Overall living standards and lifestyles will also be enhanced by living and working within the "second city" planned for the Ewa Plain. New recreational opportunities will be available to the community through development of an extensive system of neighborhood parks and a linear park planned in conjunction with project drainage improvements.

With implementation of the proposed master plan, the project development will offer short-term (construction-related) and long-term (commercial, public facilities) employment by contributing to the overall level of construction activity. Permanent operational employment will directly and indirectly increase employment throughout the region and state.

State and county tax revenues (property taxes, income taxes, etc.) and revenue derived from the sale of large lot development parcels, are anticipated to more than offset any costs associated with providing public services necessary to accommodate the projected growth. Revenues from the sale of improved development parcels will support the future development of the University of Hawaii West Oahu Campus.

Section 226-11 (a) (2) Effective protection of Hawaii's unique and fragile environmental resources.

Section 226-11 (b) (2) Ensure compatibility between land-based and water-based activities and natural resources and ecological systems.

Section 226-11 (b) (3) Take into account the physical attributes of areas when planning and designing activities and facilities.

Section 226-11 (b) (6) Encourage the protection of rare or endangered plant and animal species and habitats native to Hawaii.

Section 226-11 (b) (8) Pursue compatible relationships among activities, facilities, and natural resources.

Discussion: Physical, environmental, and cultural attributes of the property were surveyed prior to preparation of the proposed East Kapolei Master Plan. Site features such as slope, soil stability, drainage characteristics, presence of important archaeological sites, and provisions for the protection of important flora and fauna were incorporated into the design as applicable. Provisions for existing services and infrastructure are also considered by the project master plan to assure more efficient use of existing facilities. In addition, new opportunities for recreation will be created where none presently exist. Most natural features on the subject property have been modified in the past by previous agricultural activities.

Implementation of proposed mitigation measures for the project will ensure continued protection of the land through better control of runoff and erosion, and reduced water, pesticide, and fertilizer use than under past agricultural conditions. In accordance with both State and City policy, new development is being directed toward the Ewa Plain since its physical attributes are compatible urbanized land uses.

There are no known unique or fragile environmental resources associated with the subject property. Although there is one species of endangered plant located on the subject property, appropriate mitigation plans have been prepared to ensure a compatible relationship with the flora resources in the area. The implementation of the plan will expand the population and viability of the endangered *abutilon menziesii* compared to the "no-build" alternative.

Section 226-12 (a) Planning for the State's physical environment shall be directed towards achievement of the objective of enhancement of Hawaii's scenic assets, natural beauty, and multicultural/historic resources.

Section 226-12 (b)(1) Promote the preservation and restoration of significant natural and historic resources.

Section 226-12 (b)(3) Promote the preservation of views and vistas to enhance the visual and aesthetic enjoyment of mountains, ocean, scenic landscapes, and other natural features.

Section 226-12 (b)(4) Protect those special areas, structures, and elements that are an integral and functional part of Hawaii's ethnic and cultural heritage.

Section 226-12 (b)(5) Encourage the design of developments and activities that complement the natural beauty of the islands.

Discussion: The proposed project is generally consistent with the intent of the Estate of James Campbell Ewa Master Plan and the City's Development Plan for Ewa. The plan, then and now, envisioned a community that was fully integrated into its natural setting. All of the East Kapolei Master Plan proposed land uses were determined, based on available site attributes suitable for the uses proposed, the City's adopted Ewa Development Plan land use designations for the property, and opportunities for integration into surrounding urban development patterns. This planning concept was adopted to maintain and/or enhance the natural features of the subject property and region.

Although no archaeological sites have been identified, the protection or preservation of any sites uncovered during the construction period will be undertaken in accordance with recommendations from the project archaeologist and other affected groups as applicable. Should any subsurface archaeological features be identified during construction, the Historic Preservation Division of the Department of Land and Natural Resources will be notified in accordance with State requirements.

Section 226-13 (a) (1) Maintenance and pursuit of improved quality in Hawaii's land, air, and water resources.

Section 226-13 (b) (2) Promote the proper management of Hawaii's land and water resources.

Section 226-13 (b) (3) Promote effective measures to achieve desired quality in Hawaii's surface, ground, and coastal waters.

Section 226-13 (b) (5) Reduce the threat to life and property from erosion, flooding, tsunamis, hurricanes, earthquakes, volcanic eruptions, and other natural or man-induced hazards and disasters.

Section 226-13 (b) (6) Encourage design and construction practices that enhance the physical qualities of Hawaii's communities.

Discussion: The existing potential flood hazard will be mitigated by the development of an elaborate system of retention/detention facilities which comply with city drainage regulations and ensure that the quantity of off-site drainage does not increase. As available, irrigation water will be derived from non-potable sources such as treated sewage effluent and brackish groundwater to conserve potable water for human consumption.

Hazards from hurricanes, earthquakes, and volcanic eruptions may exist, but are no more likely to affect the subject property than at any other location in the Ewa Plain area.

In keeping with the existing character of the surrounding community, the proposed development has been designed to maintain a high quality urban setting. Appropriate land uses have been selected for the project area based on market demand and sound planning practices.

Section 226-13 (b) (7) Encourage urban developments in close proximity to existing services and facilities.

Discussion: All proposed infrastructure has been sized and engineered to accommodate the projected population of the proposed project and planned land uses on adjoining properties. Where new infrastructure is required, occupancy will not be permitted until adequate infrastructure capacity is in place. As described in Appendix B, all necessary infrastructure either exists or will be provided as the project is developed.

The subject development has been planned and designed in an environmentally compatible and beneficial manner that would foster the recognition, importance, and value of the area's land, air and water resources. Design and construction will take advantage of the existing aesthetic and environmental qualities of the area while enhancing the physical attributes of the region.

Section 226-15 (a) (1) Maintenance of basic public health and sanitation standards relating to treatment and disposal of solid and liquid wastes.

Discussion: Existing and planned wastewater treatment facilities are presently adequate to accommodate all projected flows associated with project development. Other improvements such as wastewater transmission lines and pump stations will be expanded and constructed prior to the planned growth of the area in accordance with project phasing requirements. Treated wastewater will be collected, treated, and disposed of in accordance with applicable State Department of Health and City regulations at City owned and operated facilities.

Solid wastes will be transferred to the City's designated solid waste disposal facilities and/or recycled into electricity at the City's co-generation facility at Campbell Industrial Park.

As described in Appendix D, no significant impacts on ground water resources or the quality of surface water are anticipated. Best management practices will be employed to control erosion in accordance with all applicable State Department of Health regulations.

Section 226-16 (a) Planning for the State's facility systems with regard to water shall be directed towards achievement of the objective of the provision of water to adequately accommodate domestic, agricultural, commercial, industrial, recreational, and other needs within resource capacities.

Section 226-16 (b) (1) Coordinate development of land use activities with existing and potential water supply.

Discussion: Potable water will be provided by the Board of Water Supply distribution system and water source development will be provided. In addition, recent policies adopted by the State Commission on Water Resource Management to promote the reuse of nonpotable water and permit withdrawal of brackish water with a chloride cap of 1,000 mg/l will be followed. All applicable governmental regulations will be observed to ensure the public's safety and health.

Section 226-18 (a) Planning for the State's facility systems with regard to energy/telecommunication shall be directed towards the achievement of the following objectives.

(a)(2) Increased energy self-sufficiency.

(c)(3) Promote prudent use of power and fuel supplies through conservation measures including education and energy-efficient practices and technologies.

Discussion: The proposed project will promote greater energy self-sufficiency through increased efficiency in transportation systems, and proximity of essential services and employment centers to residential areas. Pedestrian walkways, bikeways, and development of employment, education, and commercial centers within the project area and region will eventually reduce energy consumption required for transportation between these facilities and residential areas.

Other components of the plan that would promote energy efficiency, include use of water efficient landscaping and provisions for open space to naturally cool structures, encourage natural ventilation in future structures, and insulation of buildings to permit more efficient use of air conditioning. ~~HFDC~~HCDCH will encourage project developers to implement the State's Model Energy Code in all phases of project design as applicable.

Section 226-19 (a) (1) Greater opportunities for Hawaii's people to secure reasonably priced, safe, sanitary, livable homes located in suitable environments that satisfactorily accommodate the needs and desires of families and individuals.

Section 226-19 (a) (2) The orderly development of residential areas sensitive to community needs and other land uses.

(b) (1) Effectively accommodate the housing needs of Hawaii's people.

(b) (3) Increase home ownership and rental opportunities and choices in terms of quality, location, cost, densities, style, and size of housing.

(b) (5) Promote design and location of housing developments taking into account the physical setting, accessibility to public facilities and services, and other concerns of existing communities and surrounding areas.

(b) (7) Foster a variety of lifestyles traditional to Hawaii through the design and maintenance of neighborhoods that reflect the cultures and values of the community.

Discussion: The proposed project consists primarily of single family and multi-family residential development and small neighborhood commercial facilities. These components of the East Kapolei Master Plan will be developed by private developers in response to market indicators and as completion of required infrastructure warrants.

According to the Market Report (Appendix A), there will be sufficient demand for the proposed residential development parcels throughout the twenty year project period.

By providing a wide range of housing choices to all residents of Oahu, the housing needs for Hawaii's people will be expanded in terms of quality, location, cost, densities, style, and size of housing. All projects will be built in a manner compatible with the natural and man-made setting, and with accessibility to public facilities and services.

All residential components of the master plan have been designed to reflect the character of existing neighborhoods in the surrounding community. The relationship of existing and proposed land uses will foster a sense of community and cohesiveness. This concept reflects the values and lifestyle that establish an appreciation and respect for the beauty of the land and a caring for the community.

(226-52) Statewide planning system.

(a)(2) ***The priority guidelines established in this chapter shall provide guidelines for decision-making by the State and the counties for the immediate future and set priorities for the allocation of resources. The formulation and amendment of state functional plans shall be in conformance with the priority guidelines.***

(b)(2)(D) ***Land use decision-making processes of state agencies. Land use decisions made by state agencies shall be in conformance with the overall theme, goals, objectives and policies, and shall utilize as guidelines the priority guidelines contained within this chapter, and the state functional plans adopted pursuant to this chapter. The rules adopted by appropriate state agencies to govern land use decision-making shall be in conformance with the overall theme, goals, objectives, and policies contained within this chapter.***

Discussion: The proposed project complies with the guidelines established by the Hawaii State Plan and Functional Plans regarding the Statewide planning system and the land use decision-making process. Appropriate land use entitlement approvals from both the State Land Use Commission and City Council will be required to ensure the project's adherence to applicable land use policies and regulations.

(226-103) Economic priority guidelines.

(f)(1) ***Encourage the development, demonstration, and commercialization of renewable energy resources.***

(f)(2) ***Initiate, maintain, and improve energy conservation programs aimed at reducing energy waste and increasing public awareness of the need to conserve energy.***

Discussion: The primary renewable energy resource available to the project will be solar water heating and combustion of solid waste into electricity. ~~HFDC~~HCDCH will encourage all future developers to consider the use of solar water heating in their design of residential structures. Energy use will become more efficient as residents will be able to live and work within the same community without long commuting distances.

(226-104) ***Population growth and land resources***

(b)(1) ***Encourage urban growth primarily to existing urban areas where adequate public facilities are already available or can be provided with reasonable public expenditures and away from areas where other important benefits are present, such as protection of important agricultural land or preservation of lifestyles.***

(b) (6) ***Seek participation from the private sector for the cost of building infrastructure and utilities, and maintaining open spaces.***

Discussion: The development of the subject property will accommodate projected population growth, address the demand for new housing, and facilitate the expansion of employment opportunities in the Ewa region for Hawaii's citizens. This new development will occur within a master planned community where adequate public facilities are available or can be provided by project developers. Preservation of lifestyles will be reinforced through the addition of new neighborhood commercial facilities and park/recreation land as the population continues to grow in the future. On a island-wide basis, this population growth will occur with or without the proposed project.

(b) (10) ***Identify critical environmental areas in Hawaii to include but not be limited to the following: watershed and recharge areas; wildlife habitats (on land and in the ocean); areas with endangered species of plants and wildlife; natural streams and water bodies; scenic and recreational shoreline resources; open space and natural areas; historic and cultural sites; areas particularly sensitive to reduction in water and air quality; and scenic resources.***

Discussion: No significant potable groundwater resources or recharge areas are associated with the subject property. Consequently, the State Commission on Water Resource Management has developed water reuse policies for the region to facilitate the use of treated sewage effluent and non-potable water for irrigation purposes.

During the various construction phases, best management practices will be employed to mitigate potential erosion which could impact air and water quality. Long-term air quality associated with vehicular emissions will also be mitigated as described in Appendix J. The one endangered plant species identified on the property will be propagated in accordance with an mitigation program prepared and approved in accordance with applicable State and Federal standards regarding the treatment of endangered plant species.

Should any historic and cultural sites be found during the construction period, they will be preserved in accordance with accepted standards and regulations of the Department of Land and Natural Resources.

(b) (12) ***Utilize Hawaii's limited land resources wisely, providing adequate land to accommodate projected population and economic growth needs while ensuring the protection of the environment and the availability of the shoreline, conservation lands, and other limited resources for future generations.***

Discussion: Existing services and infrastructure have been incorporated into the design of the project to more efficiently utilize already existing infrastructure facilities. No development which could negatively impact the shoreline, conservation lands, or other limited resources is proposed.

The proposed project will be constructed according to a phased schedule in accordance with the Ewa Development Plan, as market demand warrants and infrastructure development progresses. All public facilities, infrastructure, and services that require improvement or expansion as a result of project implementation will be provided by ~~HFDC~~HCDCH and future developers of the large lot parcels.
Approval of the proposed project will provide new land necessary to accommodate projected population and economic growth needs while ensuring the protection of the environment.

(226-106) Housing priority guidelines

(1) ***Seek to use marginal or non-essential agricultural land and public land to meet housing needs of low and moderate-income and gap-group households.***

(2) ***Encourage the use of alternative construction and development methods as a means of reducing production costs.***

(4) ***Create incentives for development which would increase home ownership and rental opportunities for Hawaii's low and moderate-income households, gap-group households, and residents with special needs.***

(6) ***Encourage public and private sector cooperation in the development of rental housing alternatives.***

(7) ***Encourage improved coordination between various agencies and levels of government to deal with housing policies and regulations.***

Discussion: To meet the anticipated future demand for housing within the Ewa region, the future developers of the project will work with the public and private sectors as applicable to provide a wide range of economically feasible housing products. As previously described, the Ewa region already contains extensive commercial, office, and recreational urban land uses. Therefore, the residential uses proposed and the projected demand for new housing in Ewa achieves these housing policies of the Hawaii State Plan while supporting the other existing and planned land uses in the region.

In addition to the increased housing opportunities afforded by the project, the community would also receive the recreational and open space values associated with the neighborhood parks, district park, and central drainageway recreational corridor. These planned recreational areas are all adjacent to large residential neighborhoods and other recreational areas such as the drainageway corridor. As such, the proposed new housing and use of the drainageway for recreation and open space would establish an important amenity readily available to the future residential population.

7.3 Hawaii State Land Use Districts (Chapter 205)

Chapter 205 of the Hawaii Revised Statutes (HRS) establishes the State Land Use Commission (LUC) and creates four districts by which all lands in the state are classified. These districts are: Urban, Rural, Agricultural, and Conservation.

In accordance with the long-term land use plan envisioned for the Ewa Plain, the region is undergoing urbanization in conformance with official policies established by the Land Use Commission and City and County of Honolulu. A boundary interpretation utilizing a metes and bounds description has been be obtained from the State Land Use Commission to specifically identify the Urban District boundary (**Figure 64**). According to the boundary interpretation, the entire subject property is located within the State Agricultural District. Within the existing State Agricultural District, however, public, private, and quasi-public utility lines and roadways are classified as permissible uses. Consequently, the reclassification from Agriculture to Urban is not technically necessary for the construction of these facilities. Therefore, construction of Kapolei Parkway, widening of Farrington Highway, and the construction of the North-South Road are permitted uses within the existing Agriculture District.

Development of the proposed residential, commercial, and recreational uses (including the sports complex), however, will require reclassification of the subject property to the State Urban District in conformance with Chapter 205, HRS and the State of Hawaii Land Use Commission Rules (Hawaii Administrative Rules, Title 15, Subtitle 3, Chapter 15). As provided in the Land Use Commission Rules, Section 15-15-24, "Permissible uses within the "U" urban district, and all uses permitted by the counties, either by ordinances or rules shall be allowed within this district, subject to any conditions imposed by the commission pursuant to Section 205-4(g), HRS". Therefore, the land uses proposed by the master plan would not be in conformance with Chapter 205, unless there is a Land Use District Boundary Amendment reclassifying the property to the State Urban District for the proposed residential and commercial land uses.

7.4 Hawaii State Functional Plans

Implementation of the Hawaii State Plan is guided primarily by the State Functional Plans and implemented by the Department of Budget and Finance and the State Land Use Commission. Each Functional Plan is prepared by various state agencies focusing on a specific functional area and, with citizen input, prepared with specific recommendations for action. The functional areas addressed by the plans are: agriculture, conservation lands, education, employment, energy, health, higher education, historic preservation, housing, human services, recreation, tourism, and transportation.

The relationship between the proposed project and the applicable State Functional Plans are described as follows.

State Housing Functional Plan

The residential land use element of the East Kapolei Master Plan, represents a mix of single family and multi-family development with different densities likely at each of the various sites. Final determination of densities and product type will be ascertained by individual developers in response to market conditions. With the implementation of the proposed project, the Honolulu's housing stock will increase and the opportunities for persons to acquire affordable housing will also expand.

The Housing Functional Plan focuses on governmental incentives to develop and deliver a wide range of affordable and market priced dwelling units. The East Kapolei Master Plan supports the Housing Functional Plan policies as herein described.

STRATEGY: Expand the supply of affordably priced residential units through joint public/private sector efforts. Mobilize resources to better assist families seeking home ownership opportunities. Alternate or Innovative approaches to developing housing should also be pursued.

POLICY

A(1) Direct Federal, State and county resources and efforts toward the development of affordable for-sale housing units.

A(2) Encourage increased private sector participation in the development of affordable for-sale housing units.

A(3) Ensure that (1) housing projects and (2) projects which impact housing provide a fair share/adequate amount of affordable home ownership opportunities.

A(4) Assist first time home buyers in purchasing a home.

A(5) Use alternative approaches in providing affordable housing for sale.

Discussion: The proposed project will provide opportunities for a wide range of single-family and multi-family housing types with diversity of pricing. This broad mixture of expanded housing opportunities will directly and indirectly stimulate and promote increased housing choices for Hawaii's citizens. Increasing the housing inventory will indirectly help to stabilize the price, overall quality, location, style, and size of housing. Construction and operational employment will also contribute to the ability of persons to afford housing in the region and elsewhere on Oahu.

To meet the objectives of the Plan, the master plan has provided for a wide range of housing types either as "for-sale" or rental housing as applicable. Affordable housing will be provided by in accordance with applicable requirements set forth by the City and County of Honolulu.

STRATEGY: Acquire public and, where applicable, privately-owned lands for future residential development.

POLICY

E(1) *Promote design and location of housing developments taking into account the physical setting, accessibility to public facilities and services, employment and other concerns of existing communities and surrounding areas.*

E(3) *Where feasible, acquire privately owned lands that are suitable for housing development.*

Discussion: Although the project area was previously privately owned, it has been demonstrated by its physical setting, accessibility to existing and proposed public facilities, and services, and anticipated enhancement of employment opportunities for area residents, that the project area is suitable for the development of new housing. In addition, the Ewa Plain has long been planned as a second city by both the State and City governments. Consequently, the State has acquired the subject property for the land uses proposed.

Adequate police, fire, and recreational facilities are all accessible or can be mitigated with development of the proposed master plan.

State Agricultural Functional Plan

The objectives, policies, and implementation actions in the State Agricultural Functional Plan address the broad issues of agricultural research, marketing, development, regulations, and protection. These actions do not have direct application to the proposed project. Although the subject property is currently zoned for agriculture use and has a history of sugar cane cultivation, the lands are vacant and planned for urban development by the State and City.

Protection of diversified agriculture is also a component of the Agricultural Functional Plan and some diversified agricultural crops are being produced on the subject property. However, as described in Appendix C, the affected farmers are operating on short-term leases and should not be significantly impacted by the proposed project. Sufficient replacement lands exist on Oahu to accommodate the continued production of diversified agricultural crops sufficient to meet market demand.

Other concerns generally center on potential nuisance complaints arising from noise, dust, and use of agricultural chemicals which could potentially impact future residential areas. Therefore, these off-site agricultural activities could also be relocated onto available replacement lands previously used for sugarcane cultivation to lessen potential nuisance complaints.

State Employment Functional Plan

The policies and recommended actions in the State Employment Functional Plan center around the development and improvement of career/job training programs, expansion of the labor pool, and the improvement of quality of life for workers. As such, the construction of the proposed project will provide additional short and long term direct and indirect employment opportunities to Hawaii residents. According to the Socio-Economic Impact Assessment prepared for the project (Appendix K), approximately 1,250 to 1,375 permanent direct jobs and 1,100 to 1,250 indirect or induced jobs generated by project spending will be created by development of the proposed project.

State Energy Functional Plan

This functional plan outlines policies to promote energy efficiency, displace fossil fuel consumption, support public education and legislation on energy, and better develop and manage energy.

Because the residential development planned for the project is located near the governmental, commercial, and employment centers planned for the Ewa Development Plan area, this locational advantage will encourage the conservation of existing energy resources by reducing commuting time and distances for many residents. In addition, a transit corridor is provided adjacent to the North-South Road with transit stops or nodes located proximate to the planned higher density residential areas consistent the Ewa Development Plan.

Internally, pedestrian walkways and facilities for bicycles will encourage non-vehicular forms of transportation. By promoting the development of master planned communities such as the East Kapolei Master Plan, the efficient use of energy for transportation will be enhanced.

The cost and energy effectiveness of utilizing energy efficient appliances and equipment within the planned residences and commercial establishments will also be encouraged to determine the most economical and energy efficient methods of providing hot water heating and cooling, and lighting systems for the proposed facilities. The State's Model Energy Code will be considered during the detailed design phases of project development.

State Historic Preservation Functional Plan

According to the Historic Preservation Functional Plan, *"the preservation of historic properties involves three major areas of activity: the identification, protection, and management and treatment of historic properties. Each of these areas of activity has its own specific problems and needs"* as addressed by the Plan.

The policies in the State Historic Preservation Functional Plan are aimed primarily toward government action to provide mechanisms for improving the State's inventory, preservation systems, public access, and public awareness programs on archaeological matters.

Discussion: In accordance with the Functional Plan, an archaeological survey and records search for the subject property was completed to locate, describe and determine the significance of any historic sites and features within the project area. Based on the findings of this search, there were no sites or features which required protection or management (Appendix G).

Should any archaeological sites be uncovered during project development, the State Historic Preservation Division of the Department of Land and Natural Resources will be notified in accordance with State regulations.

State Recreation Functional Plan

The State Recreation Functional Plan addresses government action toward the acquisition of recreation areas and accesses, the establishment and development of areas and facilities, and the management of recreation resources and usage.

Discussion: Although the subject project is not specifically described in the State Recreation Functional Plan, the proposed drainage and open space improvements may be designated as a State Park to ensure its proper use and maintenance in the future. In addition, a major district park, a 64-acre sports complex, and six neighborhood parks have been included in the East Kapolei Master Plan.

As an important element in connecting the proposed University of Hawaii West Oahu Campus to the ocean, this open space corridor can potentially connect the Waianae Mountains to the sea. This open space corridor is envisioned to have pedestrian walkways, bike facilities, and other recreational amenities running the length of the North-South Road. If the corridor does not become a State Park, it may be dedicated to the City and County of Honolulu, or be individually utilized and maintained as private park by private developers on adjoining properties. This alternative, however, would still require a drainage management plan or joint development agreement to ensure proper maintenance of the facility indefinitely into the future.

State Tourism Functional Plan

Objective II.A. *Development and maintenance of well-designed visitor facilities and related developments which are sensitive to the environment, sensitive to neighboring communities and activities, and adequately serviced by infrastructure and support services.*

Discussion: Although the East Kapolei Master Plan is not designed to facilitate tourism growth, Ko Olina Resort is planned for significant resort development. By supporting population growth though the development of new housing and limited commercial facilities, a critical population mass will reside in the vicinity of Ko Olina Resort. Therefore, support of the Ko Olina resort area through development of the proposed project will indirectly implement the stated objective of the Tourism Functional Plan to support *"related developments which are sensitive to the environment, sensitive to neighboring communities and activities, and adequately serviced by infrastructure and support services."*

State Transportation Functional Plan

Implementing Action

POLICY

I.A.1 Increase transportation capacity and modernize transportation infrastructure in accordance with existing master plans and laws requiring accessibility for people with disabilities.

Discussion: ~~HFDC~~HCDCH will provide the major backbone transportation infrastructure required to support the proposed project and to connect regional transportation linkages.

In addition, a transit corridor has been established by the East Kapolei Master Plan with transit stops located at higher density population centers. Within the open space drainage corridor, bikeways and walking paths will also be provided to facilitate these alternative modes of transportation. Other transportation improvements such as internal collector streets will be provided by private developers.

The proposed "North-South Road" is also planned to traverse through the project area. However, this improvement is being developed separate from the proposed project by the City Department of Transportation Services and State Department of Transportation. Specific transportation improvements are described in Appendix H.

All standards relating to accessibility of transportation facilities for people with disabilities will be implemented in accordance with Federal Americans with Disabilities Act requirements.

I.A.2 Improve regional mobility in areas of the State experiencing rapid urban growth and road congestion.

I.B.1 Close the gap between where people live and work through decentralization, mixed zoning, and related initiatives.

Discussion: Since its inception, development of the second city in the Ewa region was planned and designed to provide enhance the opportunity for residents to live and work within the same geographic area. For example, the City of Kapolei and Campbell Industrial Park already function as major employment centers. The present combination of commercial, industrial, resort and residential developments throughout the Ewa Development Plan area is rapidly making the Ewa Development Plan area truly "self-contained."

I.C.3.a. Require park-and-ride facilities be constructed in new residential developments. Include parking stalls accessible for people with disabilities.

Discussion: The project is located proximate to existing residential and employment centers. ~~As such, major park~~To encourage use of mass transit systems and ~~ride facility is planned~~alternative modes of transportation, bus stops, bike facilities, and land area for ~~development~~transit stations in ~~conjunction with~~support of a future mass transit system have been incorporated into the ~~proposed sports complex makai of~~East Kapolei ~~Parkway~~Master Plan.

~~In addition, bus stops, bike facilities, and facilities for a future mass transit system have been incorporated into~~The sports complex parking area could also be expanded in the ~~East Kapolei Master Plan~~future with an elevated parking structure to establish a park 'n ride facility.

~~The location of the proposed park and ride facility will~~This facility would be located proximate to the makai commercial area ~~and~~ at the intersection of Kapolei Parkway and the North-South Road ~~to be~~which would enhance its accessibility to potential users. ~~With commercial and recreational development surrounding the park-and-ride facility, its future use should also increase as the planned residential population increases in the future.~~ It would likely be open to public use and employees at the Kapolei Civic Center. With commercial and recreational development surrounding the park 'n ride facility, its future use should also increase as the planned residential population increases in the future.

III.A.2 Pursue private sector participation in the financing of transportation systems, developments and projects.

Discussion: The proposed ~~HFDCH~~HCDCH East Kapolei Development Plan will be entirely funded by private sector participation once the large lot development parcels are sold to individual developers. Although the initial backbone infrastructure improvements will be financed with State funds to make the parcels suitable for development, these funds should be readily replenished through the sale of large lot development parcels.

7.5 Coastal Zone Management Program

The objectives of the Coastal Zone Management (CZM) Program, (Section 205A-2 Hawaii Revised Statutes), are to provide the public with recreational opportunities, protect historic and prehistoric resources, protect scenic and open space resources, protect coastal ecosystems, provide facilities for economic development, reduce hazards, and manage development.

A discussion of the CZM Program objectives applicable to the East Kapolei Master Plan is presented below.

1. RECREATIONAL RESOURCES

Objective:

Provide coastal recreational opportunities accessible to the public.

Policies:

1.b. Provide adequate, accessible and diverse recreational opportunities in the coastal zone management area by:

- I. Protecting coastal resources uniquely suited for recreation activities that cannot be provided in other areas;
- iii. Providing and managing adequate public access, consistent with conservation of natural resources, to and along shorelines with recreational value;
- iv. Providing an adequate supply of shoreline parks and other recreational facilities suitable for public recreation;
- vii. Developing new shoreline recreational opportunities, where appropriate, such as artificial lagoons, artificial beaches, artificial reefs for surfing and fishing;
- viii. Encouraging reasonable dedication of shoreline areas with recreational value for public use as part of discretionary approvals or permits by the land use

commission, board of land and natural resources, county planning commissions and crediting such dedication against the requirements of 46-6.

Discussion: Presently, the subject property may flood during intense storms. This is due primarily to the undefined banks of existing drainageways, steep slope in mauka areas, and shallow soils. Consequently, the existing condition can permit uncontrolled flooding and water quality impacts on coastal resources even without the proposed development.

Consequently, after development of the proposed drainage improvements, drainage from the project area that could potentially impact coastal resources will be better managed than under present conditions. Retention and detention basins will permit the collection of silt on-site before it is discharged off-site through various control structures. The quantity and quality of off-site drainage will comply with all applicable State and City rules and regulations.

Inasmuch as the subject property is located well inland from the coastline, access to coastal resources will not be impacted by the proposed project.

2. HISTORIC RESOURCES

Objective:

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

Policies:

2.a. Identify and analyze significant archaeological resources;

2.b. Maximize information retention through preservation of remains and artifacts or salvage operations; and

2.c. Support state goals for protection, restoration, interpretation and display of historic resources.

Discussion: An archaeological survey and literature search was conducted for the subject property. No sites were identified and the State Historic Preservation Office has also concluded that no significant sites are likely to exist (Appendix G). However, should any archaeologically significant artifacts, bones, or other indicators of previous on-site activity be uncovered during the construction phases of development, their treatment will be conducted in strict compliance with the requirements of the Department of Land and Natural Resources.

3. SCENIC AND OPEN SPACE RESOURCES

Objective:

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

Policies:

3.b. Insure that new developments are compatible with their visual environment by designing and locating such developments to minimize the alteration of natural landforms and existing public views to and along the shoreline.

3.c. Preserve, maintain, and where desirable, improve and restore shoreline open space and scenic resources.

Discussion: Coastal scenic resources will not be significantly affected since all of the project area is located outside of the Special Management Area approximately 3 - 4 miles mauka from coastal areas. Applicable zoning regulations will restrict heights and density of development which will mitigate some visual impacts. Generous provisions for open space have also been provided by the East Kapolei Master Plan. No significant natural landforms will be altered.

4. COASTAL ECOSYSTEMS

Objective:

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

Policies:

4.a. Improve the technical basis for natural resource management;

4.b. Preserve valuable coastal ecosystems of significant biological or economic importance.

Discussion: None of the subject property directly fronts a natural shoreline. However, the proposed development will incorporate measures necessary to mitigate any water quality impacts from surface run-off in accordance with applicable State Department of Health Regulations and City and County of Honolulu drainage regulations. With the relatively low rainfall in the area, the drainage improvements have been designed to control the quantity and quality of surface water by containing it on-site to facilitate groundwater recharge. This will mitigate potential impacts to coastal resources by improving water quality before runoff leaves the site and restricting the quantity of runoff to current levels. Similarly, construction related impacts will be mitigated by the implementation of best management practices to control erosion over the 20-year planning period.

5. ECONOMIC USES

Objective:

Provide public or private facilities and improvements important to the State's economy in suitable locations.

Policies:

5.b. Insure that coastal dependent development such as harbors and ports, visitor industry facilities and energy generating facilities are located, designed and constructed to minimize adverse social, visual and environmental impacts in the coastal zone management area.

5.c. Direct the location and expansion of coastal dependent developments to areas presently designated and used for such developments and permit reasonable long-term growth at such areas, and permit coastal dependent development outside presently designated areas when:

ii. Adverse environmental effects are minimized.

Discussion: No coastal dependent development is planned by the East Kapolei Master Plan. Consequently, the residential land uses planned by the project are located well in-land from coastal areas and is an appropriate for the property.

To mitigate potential visual impacts, the master plan has been integrated into the surrounding topography to the extent possible. Heights of structures will be controlled in accordance with the City's zoning ordinances.

Because the land use elements of the project will be developed as part of an overall master plan, the associated visual and environmental impacts within the coastal zone management area will be minimized. Because the master plan is not dependent on *coastal resources, existing coastal areas will be unaffected by the project. Significant* social benefits will result from the future development of residential housing which will result in stabilization of prices and expanded employment opportunities.

6. COASTAL HAZARDS

Objective:

Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion and subsidence.

Policies:

6.b Control development in areas subject to storm wave, tsunami, flood, erosion and subsidence.

6.c. Ensure that developments comply with the requirements of the Federal Flood Insurance Program.

Discussion: The established governmental agency and public review process, along with the various permits required for the proposed project, ensure that adequate governmental controls on the project are being applied. The proposed project will be designed and constructed in compliance with all applicable federal, state and county environmental protection, design and building standards and regulations, including the Federal Flood Insurance Program.

Any possible impact to near-shore ecosystems resulting from surface runoff, will be mitigated by implementation of best management practices during the construction phases of development. Although portions of the project may be subject to occasional flooding, proposed drainage improvements will mitigate the existing flood hazard potential identified by the Flood Insurance Rate Maps (FIRM) (**Figure 11**). Development of drainage systems will follow City of Honolulu design standards to ensure the safe conveyance and discharge of storm runoff.

In addition, none of the subject property is located within the City's Special Management Area (SMA). As such, all phases of development will comply with federal, state, and county requirements relating to natural hazards.

7. MANAGING DEVELOPMENT

Objective:

Improve the development review process, communication and public participation in the management of coastal resources and hazards.

Policies:

7.a. Effectively utilize and implement existing law to the maximum extent possible in managing present and future coastal zone development.

7.b. Facilitate timely processing of application for development permits and resolve overlapping or conflicting permit requirements.

7.c. Communicate the potential short- and long-term impacts of proposed significant coastal developments early in their life-cycle and in terms understandable to the general public to facilitate public participation in the planning and review process.

Discussion: The applications for required land use entitlements will be reviewed by both City and State land use planning agencies. Further, ~~HFDC~~HCDCH has been meeting with appropriate City agency personnel as well as individuals and community groups to communicate the proposed plan and to solicit their comments for incorporation into the planning process. As such, no coastal resources or hazards will be impacted by approval of the proposed project, and the community has been kept informed of the project's progress through the environmental and entitlement review process.

7.6 City and County of Honolulu General Plan

As required by the City Charter, the General Plan for the City and County of Honolulu serves two purposes. The first is a statement of the long-range social, economic, environmental and design objectives for the general welfare and prosperity of the people of Oahu. Second, the General Plan is a statement of broad policies which facilitate the attainment of the objectives of the plan.

The following General Plan Objectives and Policies are applicable to the proposed development.

of development. Although portions of the project may be subject to occasional flooding, proposed drainage improvements will mitigate the existing flood hazard potential identified by the Flood Insurance Rate Maps (FIRM). Development of drainage systems will follow City of Honolulu design standards to ensure the safe conveyance and discharge of storm runoff.

In addition, none of the subject property is located within the City's Special Management Area (SMA). As such, all phases of development will comply with federal, state, and county requirements relating to natural hazards.

7. MANAGING DEVELOPMENT

Objective:

Improve the development review process, communication and public participation in the management of coastal resources and hazards.

Policies:

7.a. Effectively utilize and implement existing law to the maximum extent possible in managing present and future coastal zone development.

7.b. Facilitate timely processing of application for development permits and resolve overlapping or conflicting permit requirements.

7.c. Communicate the potential short- and long-term impacts of proposed significant coastal developments early in their life-cycle and in terms understandable to the general public to facilitate public participation in the planning and review process.

Discussion: The applications for required land use entitlements will be reviewed by both City and State land use planning agencies. Further, ~~HFDC~~HCDCH has been meeting with appropriate City agency personnel as well as individuals and community groups to communicate the proposed plan and to solicit their comments for incorporation into the planning process. As such, no coastal resources or hazards will be impacted by approval of the proposed project, and the community has been kept informed of the project's progress through the environmental and entitlement review process.

7.6 City and County of Honolulu General Plan

As required by the City Charter, the General Plan for the City and County of Honolulu serves two purposes. The first is a statement of the long-range social, economic, environmental and design objectives for the general welfare and prosperity of the people of Oahu. Second, the General Plan is a statement of broad policies which facilitate the attainment of the objectives of the plan.

The following General Plan Objectives and Policies are applicable to the proposed development.

Natural Environment

Objective A, Policy 4: Require development projects to give due consideration to natural features such as slope, flood and erosion hazards, water-recharge areas, distinctive land forms, and existing vegetation.

Discussion: The Ewa Plain has long been planned for urban development in accordance with both the City and State planning policies. The proposed project is adjacent or proximate to existing residential areas and the golf course at the Villages of Kapolei. The eastern property boundary is adjacent to vacant agricultural land. As such, the existing land use patterns adjoining the subject property are compatible with the surrounding land use patterns.

The only potential hazards that may exist are associated with potential flooding during intense storms. However, the proposed project improvements will incorporate extensive drainage control measures to mitigate the potential flood hazard and control of off-site drainage flows. There are no slope hazards, distinctive land forms, or extensive vegetation characteristic to the property.

Objective C, Policy 1: Encourage residential developments that offer a variety of homes to people of different income levels and to families of various sizes.

Discussion: The housing options offered to prospective buyers will be determined by project developers. However, a wide-range of housing types prices at levels affordable to many income groups will be provided in response to market conditions and City affordable housing requirements. Final unit size and pricing will reflect the market at the time of sale and vary depending on location and amenities provided. The number of affordable units and the unit pricing, will also be determined by project developers in accordance with applicable City and County of Honolulu guidelines in effect at the time of construction.

Transportation and Utilities

Objective A, Policy 2: Provide transportation services to people living within the Ewa, Central Oahu, and Pearl City-Hawaii Kai corridors primarily through a mass transit system including exclusive right-of-way rapid transit and feeder-bus components as well as through the existing highway system with limited improvements as may be appropriate.

Discussion: Although a mass transit system is not currently planned by the City, the project does a ~~park-and-ride facility~~include transit nodes located along the proposed North-South Road's intersections with major roadways. ~~Transit nodes and an~~An easement for development of future transit facilities along the proposed North-South Road Corridor ~~have~~will also be provided~~ by the East Kapolei Master Plan~~. All transit facilities will be located proximate to commercial areas and higher density residential areas. This will enhance the convenience of ~~the park-and-ride~~any future park 'n ride facility and encourage its level of use.

~~The park and ride will also be dedicated for use by state employees working at the Civic Center complex in the City of Kapolei. Shuttle buses will then transport employees from~~

~~the park and ride to the Civic Center.~~

In addition to the transportation improvements described, the overall planning objective of the proposed project is to encourage new development proximate to employment and residential centers. By locating these essential services, jobs, and housing proximate to the City of Kapolei or within the East Kapolei Master Plan area, the need to commute into Honolulu will be reduced or eliminated for many residents.

Objective D, Policy 5: Require the installation of underground utility lines wherever feasible.

Discussion: With development of the proposed project, all new utility lines and necessary improvements servicing the individual development parcels will be placed underground where feasible. Existing overhead lines within the North-South roadway corridor will remain in place.

Physical Development and Urban Design

Objective A, Policy 4: Require new developments to provide or pay the cost of all essential community services, including roads, utilities, schools, parks, and emergency facilities that are intended to directly serve the development.

Objective A, Policy 5: Provide for more compact development and intensive use of urban lands where compatible with the physical and social character of existing communities.

Discussion: All of the necessary on-site infrastructure intended to directly serve the proposed large-lot development parcels will be funded by project landowners. Major backbone infrastructure will be provided by the ~~HFDC~~HCDCH as master developer, however, revenues from sales of the large lot parcels will fund these improvements. By creating new parcels for development adjacent to existing urban areas, the proposed residential (urban) use of currently vacant lands will be consistent with the existing and planned physical character of the community. In addition, development of the proposed project will more efficiently utilize existing infrastructure and create a new community compatible with the physical and social conditions of the region.

Objective A, Policy 7: Locate new industries and new commercial areas so that they will be well related to their markets and suppliers, and to residential areas and transportation facilities.

Discussion: The proposed neighborhood commercial sites are located adjacent to residential areas at the intersections of major roadways and proximate to proposed transit and bus facilities. This proximity to the transit stops ~~and the proposed park and ride~~ will foster increased convenience and use for transportation alternatives, and stimulate new commercial activity in the area. By locating these neighborhood commercial facilities, the community will be more "self-contained" and less reliant on distant shopping centers.

Objective C: Develop a secondary urban center in Ewa with its nucleus in the Kapolei area.

Discussion: The proposed project will encourage the development of a major residential, commercial, and employment center within the secondary urban center at Kapolei. Another important component of the East Kapolei Master Plan, is to provide revenues to support the development of the University of Hawaii West Oahu Campus mauka of the H-1 Freeway. This new campus will create an important regional employment center as well as a major university proximate to residents of Kapolei, and Leeward and Central Oahu. Therefore, the East Kapolei Master Plan will directly and indirectly supply residential, commercial, educational, and recreational land uses in support of the secondary urban center.

Objective D, Policy 1: Develop and maintain urban-fringe areas as predominantly residential areas characterized by generally low rise, low density development which may include significant levels of retail and service commercial uses as well as satellite institutional and public uses geared to serving the needs of households.

Discussion: Designated as an urban-fringe area by the General Plan, Objective D, Policy 1, development of the subject property is consistent with the urban growth policy long established for the Ewa Plain. Large-lot development parcels will be utilized for single-family and multi-family residential land uses, with smaller nodes of neighborhood commercial land uses proximate to major intersections and higher density residential areas. Employment centers are planned or currently exist at the City of Kapolei, Campbell Industrial Park, and the proposed University of Hawaii West Oahu Campus.

Objective E, Policy 3: Encourage distinctive community identities for both new and existing districts and neighborhoods.

Objective E, Policy 5: Require new developments in stable, established communities and rural areas to be compatible with the existing communities and areas.

Discussion: The City of Kapolei and the Ewa Plain is envisioned by the City, State, and Estate of James Campbell as a master planned urban community. Implementation of the master plan will establish Honolulu's second city with attractive residential, commercial, and recreational areas and facilities. The development of the East Kapolei Master Plan also conforms to the intent and vision established for the Ewa Development Plan area.

Public Safety

Objective B, Policy 2: Require all developments in areas subject to floods and tsunamis to be located and constructed in a manner that will not create any health or safety hazard.

Discussion: Although the subject property is not subject to tsunamis, portions are presently subject to flooding during intense storms. However, with development of the extensive drainage improvements planned for the project, storm water runoff from the project area will be managed to mitigate all potential health and/or safety hazards. Storm water flows will be controlled to limit off-site discharges and to permit on-site detention and recharge of storm water.

Culture and Recreation

Objective C, Policy 10: Encourage the private provision of recreation and leisure-time facilities and services.

Discussion: Recreation needs will be accommodated by a system of neighborhood parks, a major district park, a linear park along the North-South Road open space corridor, and a large sports complex makai of Kapolei Parkway. Private parks will also be provided by private developers of the single-family and multi-family residential projects in accordance with the City's park dedication ordinance.

7.7 City and County of Honolulu Ewa Development Plan

The Ewa Development Plan was recently updated and officially adopted by the City Council in August 1997. Specifically, the Plan presents a vision for Ewa's future development consisting of conceptual schemes that will service as a policy guide for more detailed zoning maps and regulations and public and private sector investment decisions.

The following analysis describes the applicable provisions of the Ewa Development Plan **(Figure 13)** as it applies to the East Kapolei Master Plan.

7.7.1 Vision Statement

The Vision for Ewa as expressed in the Ewa Development Plan embraces two horizons, the first from the present to the year 2020 and the second horizon extending beyond 2020 when Ewa would become fully developed.

The vision to 2020 projects tremendous population growth and will make significant progress in establishing Ewa as a Secondary urban Center for Oahu. Population will grow from 43,000 in 1990 to 125,000 in 2020. Nearly 28,000 new housing units will have been built in a series of master planned communities. Job growth will rise from 17,000 jobs to more than 64,000 positions.

Beyond 2020, implementation of the Ewa Development Plan will have established an Open Space Network within an "Urban Growth Boundary." Communities and access to the ocean would be linked by a series of open space corridors with landscaping along major roads such as the North-South Road.

The City of Kapolei will also evolve into the Secondary Urban Center for Oahu with an urban mix of commercial, office, and residential uses. According to the Ewa Development Plan, "By 2020, it is projected that the City of Kapolei will house more than 7,000 residents and provide 25,000 private sector jobs and 7,000 public sector jobs. In addition, the University of Hawaii West Oahu campus will support approximately 7,600 students and 800 staff and faculty by 2020. Ko Olina and Ewa Marina will also add over 3,700 visitor units by 2020 providing basic jobs which will support office and commercial jobs in the City of Kapolei.

Other master planned communities envisioned by the Plan are East Kapolei, Ewa by Gentry, Ewa Marina, Ewa villages, Ko Olina, Laulani, Makaiwa Hills, Makakilo, and the Villages of Kapolei. All of the master planned communities envisioned by the Plan must

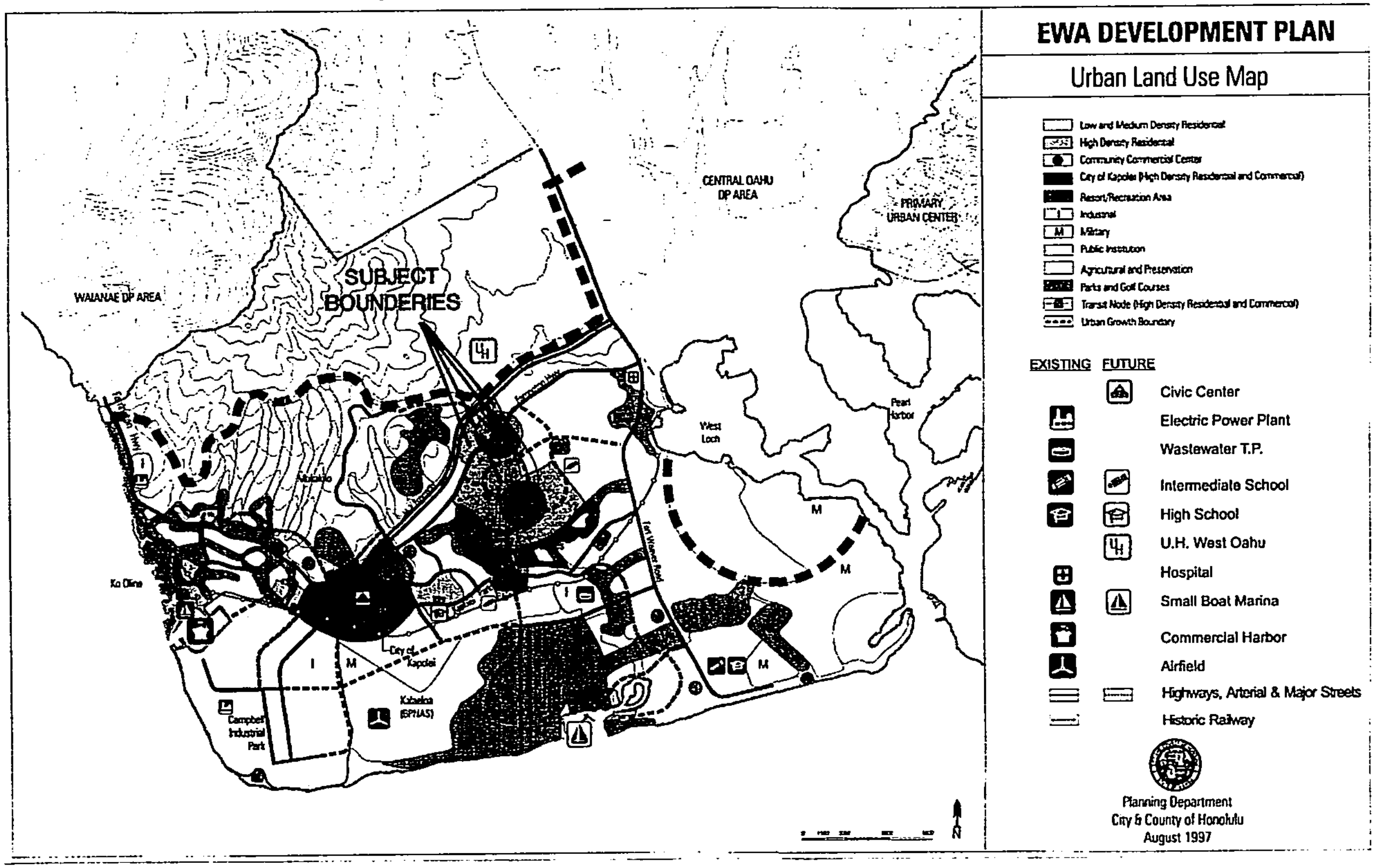


FIGURE 13
EWA DEVELOPMENT PLAN LAND USE MAP
HCDCH EAST KAPOLEI
ISLAND OF OAHU
NORTH
PBR HAWAII
DATE: 2/98

demonstrate how they would interact and support the vision for development of the entire Ewa region.

Discussion: The East Kapolei Master Plan represents one of the major master plan communities envisioned by the Ewa Development Plan. Located adjacent to the Villages of Kapolei and mauka of Barbers Point Naval Air Station, the East Kapolei Master Plan is a logical extension of needed residential, limited commercial, and recreational land uses within the Ewa Development Plan area.

The East Kapolei Master Plan calls for extensive recreational facilities including a District Park, and major international sports complex, neighborhood commercial areas, and an extensive system of open space "greenways' that will ultimately connect the future University of Hawaii West Oahu Campus with future development at Barbers Point. These connections will be provided by pedestrian walkways, bike paths, a transit corridor, and the proposed North-South Road. The residential component of the plan will provide housing in support of new employment opportunities created at the University of Hawaii West Oahu Campus, Campbell Industrial Park, and at the City of Kapolei.

Key Elements of the Vision

The Ewa Development Plan lists twelve "key plan elements" designed to advance a consistent implementation strategy to ensure that the vision for Ewa will be achieved. The following discussion describes those key elements that are applicable to the East Kapolei Master Plan.

Urban Growth Boundary

Discussion: The entire East Kapolei Master Plan Area is located within the Ewa Development Plan's Urban Growth Boundary. In addition, all proposed land uses are consistent with the Ewa Development Plan's Conceptual Maps which depict "Open Space," "Urban Land Use," "Public Facilities," and "Phasing" concepts to facilitate future implementation of the Plan. Although the subject property has been used in the past for plantation agriculture, the tremendous demand for irrigation water, lost profitability, and proximity of the site to future urban growth areas, directed that this area be located within the Urban Growth Boundary.

Network of Open Space and Greenways

Discussion: As shown on the East Kapolei ~~Master~~Conceptual Development Plan (**Figure 36**), a major open space and greenway system is planned adjacent to the proposed North-South Road. This greenway will serve a dual purpose as a drainage retention area during intense storms and as a passive park. Located adjacent to a major District Park and linking to the proposed Sports Complex, this facility will also serve as a buffer for land uses adjacent to the North-South Road. Other smaller pedestrian linkages and greenway areas are planned to connect neighborhoods with any of the three elementary school sites and neighborhood commercial facilities.

Major Regional Park and Recreation Complex at Kalaeloa

Discussion: During the 1997 Legislature, over $27.5 million dollars was allocated for the planning, design, and construction of a major sports complex on the East Kapolei property. The Plan envisions this facility to sustain and support a professional and semi-professional baseball team and baseball fields for use by the community.

After several sites were considered, the entire portion of the subject property makai of Kapolei Parkway (approximately ~~60~~64.3 acres) and adjacent to Kalaeloa was selected for numerous reasons. The most important is the compatibility of this use with surrounding land uses. To the north, Kapolei Parkway and the proposed North-South Road will provide major vehicular access to the facility. Mauka of Kapolei Parkway, commercial land uses will serve as a natural transition between multi-family land uses and the sports complex. Adjacent to the west side of the property, lies the Ewa Golf Course and Kalaeloa is located to the south. This site is depicted by the Ewa Development Plan Land Use Map as a Park and is described in the text as a possible replacement facility for the Aloha Stadium (p. 2-13).

As a facility designed for professional and semi-professional play, this facility would not compete with the community based facilities envisioned for Kalaeloa.

The Secondary Urban Center

Discussion: The Secondary Urban Center would function as the primary employment generator for the Ewa DP area by the year 2020. Major new employment is planned at the City of Kapolei, a Secondary Civic Center (now under construction), Ko Olina, the deep draft harbor, Campbell Industrial Park, civilian reuse of Barbers Point Naval Air Station, and future development of the University of Hawaii West Oahu campus.

As such, the major employment opportunities afforded by the East Kapolei Master Plan project will be during the construction period. After build-out, the residential units constructed by private developers would provide the much needed housing in support of the new employment opportunities previously described. This would also facilitate the larger goal of developing a "self-contained" second city whereby residents can live, work and shop within the same community without enduring long commute times.

Master Planned Residential Communities

Discussion: Approved master planned residential communities are intended to incorporate planing principles and guidelines to preserve historic and cultural values, establish open space and greenway networks, and create well-designed, livable communities. The East Kapolei project has been designed by the Ewa Development Plan as one of these master planned residential communities.

Communities Designed to Support Non-automotive Travel

Discussion: According to the Plan, master planned residential communities will be design to support pedestrian and bike uses, and transit use. In addition, *"A Rapid Transit Corridor will link the City of Kapolei, the Villages of Kapolei, the UH West Oahu campus, and Waipahu. High density residential development will be built along the corridor within walking distance of the major nodes and transit stops."* This transit corridor has been incorporated into the plan and is located within the North-South Road corridor. Transit stops along the North-South Road are planned near ~~the~~its intersection ~~of Farrington~~

~~Highway and North-South Road, the proposed East-West Road and North-South Road, and at the proposed Park-and-Ride which will be developed in conjunction~~with Farrington Highway, the proposed East-West Road, ~~the~~and at the proposed Sports Complex makai of Kapolei Parkway.

Higher density residential and neighborhood commercial development has been planned at each of the three transit node locations. Land area has been dedicated for mass transit bus service and right-of-way for a future separated at-grade rapid transit system.

Phased Development

Discussion: The Ewa Development Plan has set forth a phasing program for future development to more efficiently utilize existing and planned infrastructure. Major project are categorized by the time period or Phase in which they can apply for a zoning change. However, the Plan emphasized that these projects are not necessarily expected to be completed within the phase in which they are listed. Rather, housing development activities would continue for at least 10 years after the initial zoning approval and that over half of the projected housing supply would be provided after 2005.

For the East Kapolei Master Plan project, 4,000 housing units on 750 acres are envisioned for the period between 1997 - 2005, and 3,700 units on 300 acres for the period between 2006 to 2015.

7.7.2 Land Use Policies, Principles, And Guidelines

According to the Ewa Development Plan, the vision for development of Ewa will be implemented through application of land use general policies, principles, and guidelines. The following describes those provisions of the Plan applicable to the East Kapolei Master Plan.

Open Space Preservation and Development

The open space component of the East Kapolei Master Plan consists primarily of the open space drainage corridor along the North-South Road, a system of community parks, a large District Park, and open space pedestrian linkages connecting residential neighborhoods with schools, shopping areas, and transit nodes. No golf courses, agricultural open space areas, or shoreline areas are applicable to the project.

The use of drainage corridors is highly encouraged by the Plan. As stated by the Plan, the open space drainage corridor will maintain sufficient easement width to provide for major utility lines and to permit the growth of landscaping. Use of these easements for pedestrian and bicycle routes is planned consistent with all applicable operations, maintenance, and safety requirements. Suggest width for major arterials, is 120 feet wide and for major collectors is 100 feet wide. The North-South Road will have a right-of-way width of approximately 300'.

Regional Parks and Recreation Complexes

The proposed sports complex is planned for a ~~60-acre~~64.3-acre site located makai of Kapolei Parkway and mauka of the property boundary with Barbers Point. ~~A proposed~~

~~park and ride facility would be located adjacent to the facility and would be jointly used.~~

The proposed facility will be constructed and owned by the State of Hawaii and made available to American and foreign professional baseball teams during their spring training period. Japanese baseball teams have conducted some spring training in Hawaii, but have been restricted by the inadequate facilities available. Previously prepared surveys and marketing studies of baseball teams have indicated that at least one team would conduct spring training in an appropriately equipped Hawaii facility.

Benefits to the State of Hawaii would accrue from several sources, including the publicity and possible broadcasting the operations could generate, the attraction of tourists to the facility and to the State in general, and the expenditures in Hawaii associated with the professional teams, tourists, and media.

This concept is consistent with the intent of the Plan which states, "Regional sports and recreation complexes may be located on the Barbers Point Naval Air Station, on the fringes of the City of Kapolei, and in areas designated for commercial or park use..." The sports complex site is designated for Park use on the urban land use map.

Community-Based Parks

According to the Ewa Development Plan General Policies regarding Community-Based Parks, *"New residential development should strive to provide land for open space and recreation purposes at a minimum of two acres of park per 1,000 residents. Community-based parks (and associated service radius) include mini-parks (1/4 mile), neighborhood parks (½ mile), community parks (one mile), and district parks(two miles)."*

Based on this standard, and assuming three persons/unit, the recreation land area requirement for the East Kapolei Master Plan will range from approximately 45 to 50 acres. However, based on the 219.1 acres of active and passive park land planned for the project (i.e. neighborhood parks, district park, open space corridor, and sports complex), the proposed East Kapolei Master Plan will exceed the minimum by 170 acres. Even if the 119 acres of the open space drainage corridor are not included as a community based park, the recreation area requirement is still exceeded by 51 acres.

Historic and Cultural Resources

According to the Archaeological Survey Report prepared for the project and review by the State Office of Historic Preservation, there are no significant historic or cultural resources associated with the proposed project. Should any archaeologically significant artifacts, bones, or other indicators of previous on-site activity be uncovered during the construction phases of development, their treatment will be conducted in strict compliance with the requirements of the Department of Land and Natural Resources.

7.7.3 Residential Development

The Ewa Development Plan sets forth general policies, planning principles, and guidelines which are to be applied to existing and planned residential developments. These are specifically described for the Ewa Villages and Ewa Marina projects, and generally for other existing and planned residential communities. Policies, planning principles, and guidelines for new communities applicable to the East Kapolei Master Plan Project are as follows:

Existing and Planned Residential Communities

Density

General guidelines designed to achieve the desired compactness and character of development in planned residential communities is provided in Table 3.2 of the Ewa Development Plan. Generally, the aggregate area zoned for residential use should be in the range of 10 to 15 units per acre (including streets). Definitions of low, medium, and high density residential development are also provided as well as conceptual locations on the Urban Land Use Map.

Generally, the East Kapolei Master Plan calls for single family residential densities of approximately 6-8 units per acre and multi-family densities of 10 - 12 units per acre. The Ewa Development Plan defines low density at 5 - 12 units per acre. Therefore, both the single family and multi-family product envisioned for the project fall within the low density range. However, actual densities will be determined during the rezoning process and as market conditions in the future determine the type of product produced by individual developers.

As shown on the Master Plan, the boundaries of neighborhoods will be identified by street patterns, landscaping, and orientation of proposed land uses. The multi-family product is planned to be located at three nodes proximate to planned transit facilities to make it convenient to access as many households as possible. Pedestrian and bicycle travel will be encouraged through the development of related facilities to connect schools, parks, and convenience stores. All other single family and multi-family guidelines regarding building height, site design (i.e. varied setbacks, shared driveways) and building form (i.e. varied roof forms, orientation, and architectural details) will be followed.

Circulation

The Circulation Plan for the East Kapolei Master Plan presently consists of a major arterial road (North-South Road) and two minor arterials (East-West Road and Kapolei Parkway). Plans are also underway to improve and widen Farrington Highway. The first phase of North-South Road construction will be between Farrington Highway and Kapolei Parkway. A second phase will link the North-South Road to H-1 Freeway and the future University of Hawaii West Oahu Campus. Interior collector roads and cul-de-sacs will be designed by individual project developers. However, access to the North-South Road will be limited to intersections of Kapolei Parkway, the East-West Road, Farrington Highway, and the future H-1 Freeway interchange.

To further enhance a sense of place, a conceptual street tree plan is being prepared as well as landscape elements as major entries into the project. Canopy trees will be planted to shade the sidewalk/bike path area as applicable.

Relation to Zoning

In accordance with the zoning guidelines provided on Table 3.3 of the Ewa Development Plan, the preliminary zoning districts required to implement the project are R-5 Residential, A-1 Low Density Apartment, P-2 Preservation, and B-1 and B-2 Business to permit the Neighborhood Commercial Centers.

All non-residential development will adhere to the general policies, principles, and guidelines regarding lot size, mix of uses, siting, height and density, scale, architectural character, visual screening, signage, and accessibility.

7.7.4 Public Facilities and Infrastructure Policies and Principles

According to the Ewa Development Plan, the Public Facilities Map (**Figure 14**),and policies and principles are provided to guide planning and construction of proposed public and private public facility projects and infrastructure systems. Information on timing and phasing of both planned and proposed infrastructure and public facility projects is also provided. These guidelines have been incorporated into the East Kapolei Master Plan to define specific need, route alignment, site boundaries, capacity and other specifications for the project as follows:

~~Transportation Systems~~

~~Each of the major~~Public Facilities Map

The Ewa Development Plan Public Facilities Map, graphically depicts the planned ~~and proposed roadway~~public facilities and infrastructure development needed to implement the Vision of the ~~and other transportation system features identified in~~Ewa Development Plan and its major land use elements~~(applicable to the East Kapolei Master Plan) have been incorporated into the East Kapolei Master Plan~~ as presented on the Land Use Map. As shown on **Figures 6 and 14**, the East Kapolei Master Plan is consistent with all major planned improvements of the Ewa Development Plan Public Facilities Map. The major transportation related improvements include the North-South Road; three transit nodes at the intersections of the North-South Road with Farrington Highway, the East-West Road, and Kapolei Parkway, and the future park n' ride. Bike paths will also be located along the North-South Road corridor within the planned drainage/open space corridor. The proposed sports complex is depicted as a park, and symbols for both the Intermediate School and future High School are shown in the area (the respective locations of the Intermediate School and High School have been switched in accordance with DOE recommendations).

Transportation Systems

Each of the major planned and proposed roadway elements and other transportation system features identified in the Ewa Development Plan (applicable to the East Kapolei Master Plan) have been incorporated into the East Kapolei Master Plan. They include improvements to Farrington Highway and development of Kapolei Parkway. The North-South Road and interchange with the H-1 Freeway will also be developed by the State Department of Transportation as separate projects. Construction of Kapolei Parkway will begin in the summer of 1998 and the North-South Road in 2000 or 2001. However, much of the grading and infrastructure improvements required for development prior to the North-South Road construction will begin in 1998. Three transit nodes and rapid transit corridor are also planned along the North-South Road. The planned East-West Road will be constructed as warranted by future development.

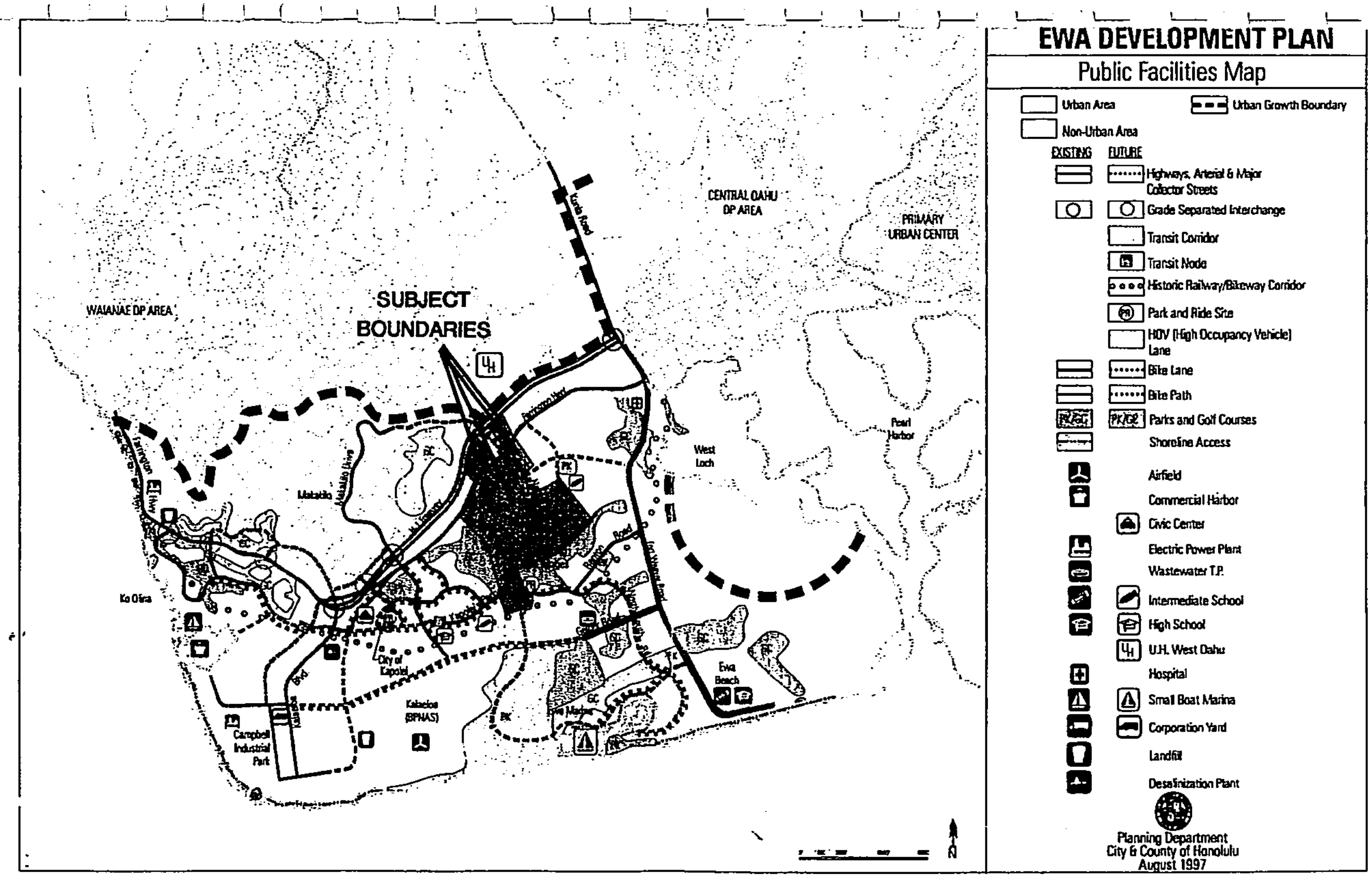


FIGURE 14
EWA DEVELOPMENT PLAN
PUBLIC FACILITIES MAP

HCDCH EAST KAPOLEI

ISLAND OF OAHU

NORTH

PBR
HAWAII

DATE: 8/98

The future interchange of the North-South road and the H-1 Freeway will eventually function as the primary gateway leading into the project area. As such, distinct landscaping along project entry common areas, will be established to reinforce project identity and aesthetic attributes, and reduce the dominance of paved surfaces.

Water Allocation and System Development

Presently, the subject property is serviced by two Board of Water Supply (BWS) service pressure zones, 215-feet and 440-feet. Maximum daily demand generated by the East Kapolei is estimated at 6.8 mgd and 7.5 mgd which also includes water demand for the University of Hawaii West Oahu Campus. When East Kapolei is fully developed, the total storage requirement is also 6.8 mgd. Therefore, new 4.0 mg reservoir for the 215' system and 4.0 mg reservoir for the 440' system will be developed which will surpass the storage requirement for the proposed East Kapolei project. To provide water to the higher elevation system, a booster pump at the 215' elevation will pump water to the 440' reservoir. The system will be connected to the 36" water main along Farrington Highway.

Wastewater Treatment

The Honouliuli WWTP has a primary treatment capacity of 38 mgd and a deep ocean outfall with a design capacity of 112 mgd. This WWTP presently treats approximately 25 mgd to a primary level and has secondary treatment facilities which process 13 mgd. The planned ultimate capacity of the Honouliuli WWTP is 51 mgd, with a planned 13 mgd of tertiary treatment for re-use purposes. WWTP capacity is based on average daily flows.

Maximum design flow generated by the East Kapolei project is 14.6 mgd and 19.5 mgd if the University of Hawaii West Oahu Campus is included. Because the East Kapolei project is estimated to achieve build out in approximately 20 years, the phased expansion of the Honouliuli WWTP will be implemented concurrently with development of the East Kapolei Master Plan.

Electrical Power Development

Electricity for the surrounding area is currently being provided by Hawaiian Electric Company (HECO). HECO's available generation capacity is approximately 199 MW (megawatts), with a present peak demand of 166.3 MW.

Hawaiian Electric Company (HECO) owns and maintains a pole line along Farrington Highway that supports two 138 KV (kilo-volt) lines and two 12.47 KV lines from their "Ewa Nui" Substation to the vicinity of the intersection with Palehua Road. One of the two HECO 12.47 KV lines ends just before the intersection, while the second line continues along Farrington Highway to Kapolei. Both 138 KV lines turn south at the intersection and follow the alignment of the future North-South Road to the OR&L right-of-way. Also, two 138 KV pole lines from the HECO Kahe Power Plant pass to the north of the project site mauka of the H-1 Freeway.

Hawaiian Electric Company anticipates requiring new substations to serve the future urban development in the region. Two of the existing 138 KV lines that pass adjacent to the project site will need to be extended to the proposed substation. According to the Engineering Report (Appendix B), the East Kapolei Master Plan will generate a peak electrical demand of 57.8 kva. However, much of this demand will be offset by the 735.7 tons of solid waste that will be produced daily from residential and commercial areas. Therefore, at 1 megawatt/35 tons, the solid waste production from the East Kapolei Master Plan will generate approximately 21 megawatts at the City's H-POWER waste-to-energy facility.

Solid Waste Handling and Disposal

According to the Engineering Report (Appendix B), the proposed project will generate solid waste during the construction of the backbone infrastructure and as the project achieves build-out during the twenty year planning period. Once the project is built out, typical levels of solid waste from residential and commercial facilities will be generated. Therefore, the projected solid waste generated by the project is estimated to average approximately 735.7 tons/day after project build-out. Consequently, short-term impacts to the City's solid waste facilities will not be significant since the solid waste contribution will stretch over the twenty year construction period. Fluctuations in the quantity of solid waste will occur in response to population growth, market trends, and construction activity on the project site and throughout Oahu.

Drainage Systems

The impact from developing the subject property will be an increase in storm runoff generated from the impermeable surfaces established on the site by roadways, parking areas, and buildings. The future development of the subject property will need to include measures such as detention/retention basins in order to maintain off-site storm runoff at existing levels. A complete engineering assessment of drainage system improvements necessary to accommodate the proposed project is provided in Appendix B.

All storm water entering the subject property must ultimately flow through the property and discharge into the ocean or infiltrate into the ground. Consequently, all development downstream of the subject property must also accommodate Kaloi Gulch drainage. Therefore, a drainage corridor is planned within the 300-foot wide utility, drainage and access corridor along the proposed North-South Road. This corridor provides for a realigned and channelized Kaloi Gulch with appropriate detention basins.

School Facilities

The East Kapolei Master Plan provides for three elementary school sites of twelve acres each and one intermediate school site of twenty acres. The high school located within the Villages of Kapolei will have sufficient capacity to accommodate the East Kapolei project until a new high school is built east of the subject property.

Public Safety Facilities

In order to meet the growing public safety needs of the Ewa Plain communities, the City has recently opened a storefront station in the Campbell Building at 1001 Kamokila Boulevard. The new Regional Kapolei Police Station is currently being designed and will be constructed across the street from the Campbell Building. Completion of the new police station is projected by the year 2000.

Fire services in the Ewa area are provided from the Ewa Beach Fire Station, and additional fire support is available from the Waipahu Fire Station and the Makakilo Fire Station. The Kapolei Fire Station (previously, Campbell Industrial Park Fire Station), a battalion headquarters, has been completed to serve the expanding development on the Ewa Plain.

Other new facilities recently completed or being planned for the Ewa area include (1) an engine company at Tenney Village; (2) A Kapolei engine-and-ladder company; (3) a Ko Olina engine-and-ladder company; and (4) the relocation of the existing Ewa Beach Fire Station into a new facility within the Ewa Marina Project.

7.8 City and County of Honolulu Zoning

Under the City's Land Use Ordinance (LUO), the subject property is currently zoned AG-1, Restricted Agriculture. Consequently, an appropriate zoning change will be necessary for all of the proposed land uses prior to development of the large lot parcels as set forth in the master plan.

Based on the ultimate type and density of land uses proposed by future developers, the appropriate zoning will be determined through consultation with the City's Department of Land Utilization later in the planning process. Tentative plans call for rezoning from the existing AG-1 Zoning District to R-5 Residential for the single family areas. The multi-family areas will be rezoned to ~~either R-5 Residential for development under the City's cluster provisions or to~~ A-1 Low Density Apartment. The neighborhood commercial parcels would be rezoned to B-1 Business (**Figure 15**).

Final zoning designation will be subject to City Council approval. During the rezoning process, the City's conditional approval regarding affordable housing will be implemented by project developers. Current affordable housing policy calls for 30 percent of the proposed units to be priced at affordable levels.

7.9 Special Management Areas

None of the subject property is located within the Special Management Area established by the City and County of Honolulu.

7.10 Conclusions

The location of the subject property within the Ewa Development Plan area establishes a logical expansion of urban land uses into an area long planned for urban development. Although existing infrastructure is not capable to support the proposed master plan, new infrastructure improvements will be provided in a manner reflecting existing and proposed land use patterns.

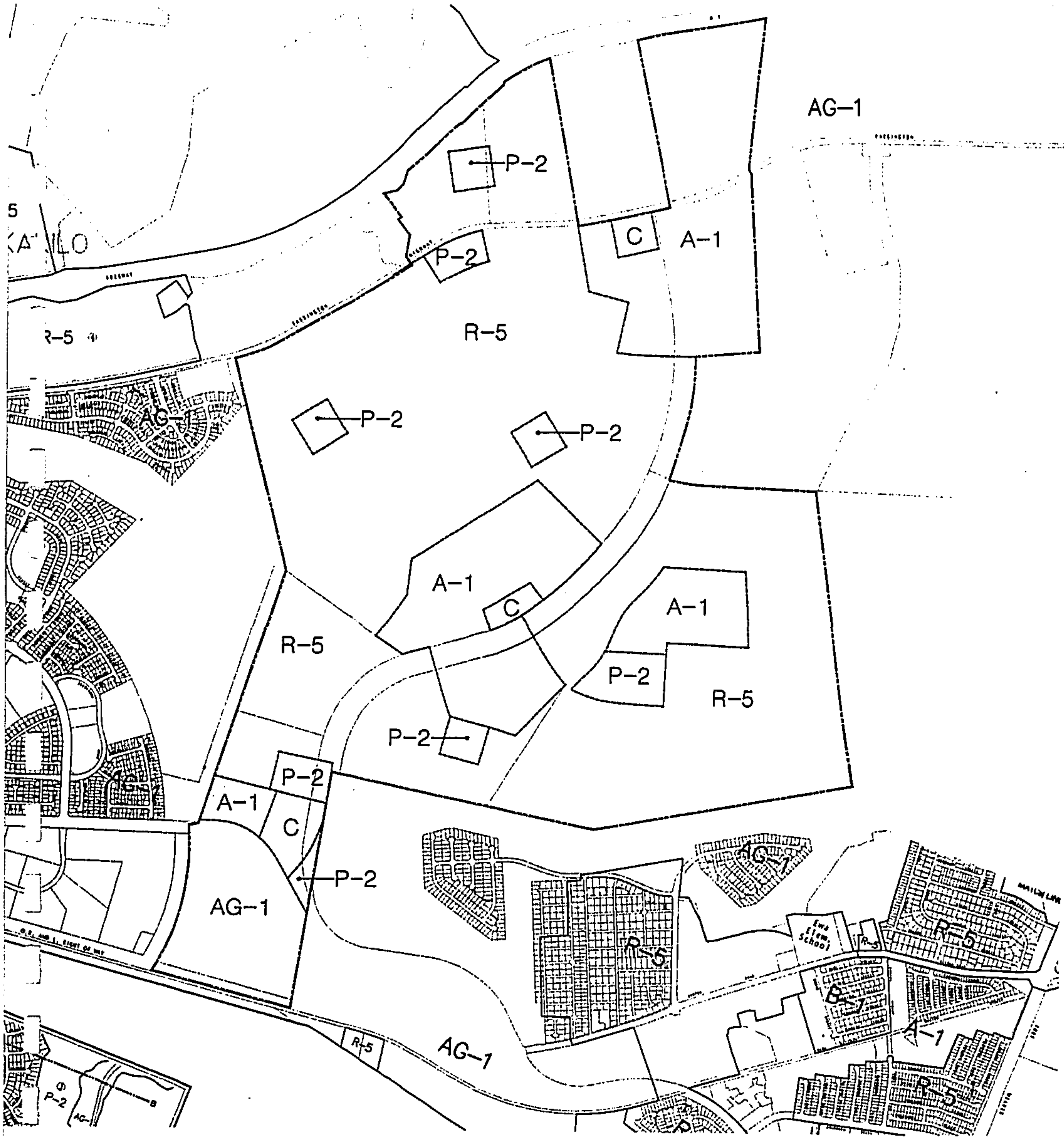


FIGURE 15
PROPOSED ZONING MAP
HCDCH EAST KAPOLEI
ISLAND OF OAHU

NORTH

LINEAL SCALE (FEET)
400 0 400 800 1600

PBR HAWAII
DATE: 7/98

8.0 Alternatives To The Proposed Action

8.0 ALTERNATIVES TO THE PROPOSED ACTION

8.1 Alternatives Considered

In compliance with the provisions of Title 11, Department of Health, Chapter 200, Environmental Impact Statement Rules, Section 11-200-17(b)(4) and (e)(f), the alternatives considered to the proposed Master Plan are limited to those that would allow the objectives of the Master Plan to be met, while minimizing potential adverse environmental impacts. The feasible alternatives must also realistically address the project's economic limitations while also responding to the surrounding residential land uses that will be impacted by the project. In conformance with applicable regulations, other possible alternatives to the proposed Master Plan have been investigated to identify the appropriate uses for the property and how they would best be accomplished.

The alternatives rejected do not meet the stated objectives of the State's plans as effectively as the proposed East Kapolei Master Plan. some of the alternatives considered various combination of single and multi-family units, a university campus for a portion of the project, and the alternative of "no-action".

8.2 Selected Alternative

Under the "Selected Alternative", the subject property would be developed for residential, commercial, recreation, and public facility purposes. As a result, the open space character of the vacant plantation agriculture would be lost. This alternative would respond to the population growth projected for the Ewa Development Plan Area, but also generate new demands on existing infrastructure, including increased use of potable water and generation of wastewater, and greater demand for public facilities and services. However, by developing a master planned community to comprehensively plan for the projected population growth that will occur, the environmental and social impacts of population growth will be mitigated as compared to scattered unplanned growth or over crowding that could be expected with the "no-action" alternative. Infrastructural impacts associated with the project will be minimized due to the efficient use of existing infrastructure and by providing necessary improvements to existing infrastructure, public services and facilities.

Although the final layout and configuration of the proposed project will be refined through the engineering design process, its development will ensure that the long range use of the property will be consistent with surrounding land uses and provide the necessary revenues required to fund other development in the region. This alternative has been judged best because the overall objective of providing new housing, economic development, and a new University of Hawaii campus can be achieved. As described in the Socio-economic Impact Assessment (Appendix K), revenues from the sale of large-lot development parcels will be sufficient in the future to help fund development of a new University of Hawaii West Oahu Campus mauka of the H-1 Freeway.

The selected alternative will provide new housing, public facilities and support of public services, new employment opportunities, commercial, and recreational land uses. Those environmental impacts that do occur can be mitigated by the installation of appropriate infrastructure improvements and implementation of best management practices during project construction. Because the project area lies adjacent to existing and planned urban areas, the relative impact to Oahu's agricultural industry will be minimized by "in-filling" land areas adjacent to existing urban development.

8.3 North-South Road Alternative

In each of the alternatives considered, it was assumed that the proposed "North-South Road" would be constructed as presently planned. However, if this major collector roadway is not developed as currently envisioned, the project could still proceed with access provided by the other major collectors existing or planned for the region such as Farrington Highway, Kapolei Parkway, and the future "East-West Road". Consequently, the ~~HFDC~~HCDCH East Kapolei Master Plan is not creating the need for the North-South Road construction, but is responding to the demand for additional residential development in the Ewa Development Plan area. This demand will occur with and without development of the North-South Road.

Without development of the North-South Road, mauka/makai traffic will be shifted onto Fort Barrette Road and Fort Weaver Road. This would also impact East-West traffic by limiting connections to the H-1 Freeway, thereby shifting traffic to the Fort Barrette Road and Fort Weaver Road interchanges. Regional traffic would also be likely to utilize the East Kapolei internal street system to connect from Kapolei Parkway to Farrington Highway.

8.4 "No-Action Alternative"

The "no-action" alternative would not be consistent with stated governmental policies of establishing new housing, employment opportunities, and revenues needed to fund further development in the region. This alternative would maintain the site as essentially vacant agricultural land. The site would remain under-utilized in terms of meeting the demand for additional housing, as an employment center, and would not support the State and City policy of directing future growth toward the Ewa Plain.

As under-utilized agricultural land, the property is not suited for intensive agricultural production due to its close proximity to existing urban residential areas. Environmental impacts to the area related to the application of agricultural pesticides, fertilizers, agricultural burning during harvest, and relatively higher soil erosion (compared to the preferred alternative) would continue when soils are exposed after harvest.

These impacts would occur adjacent to Oahu's second city and maintaining the property in an under-utilized condition in terms of addressing the future demand for new housing, economic development, and new public investment. Therefore, this alternative was rejected.

8.5 Low Density Alternative

The "Low Density" alternative was examined to assess the feasibility of a master plan with low densities and generous use of open space areas. Potential land uses considered were, park land, golf course, retirement community, single family residential development, and neighborhood commercial land uses oriented toward a pedestrian dominated internal circulation pattern.

Benefits of a golf/residential master plan include enhanced opportunities for: 1) on-site retention of surface runoff, 2) open space, 3) recreational opportunities, 4) less demand for infrastructure improvements including roadway and public services, and 5) disposal opportunities for treated wastewater. Golf course with residential development was rejected due to the current low market demand for golf and increased real estate values for lots with golf frontage, does not economically offset the corresponding loss of new housing units and increased employment opportunities afforded by the preferred alternative.

Since there are essentially little or no infrastructure facilities present on the subject property, new infrastructure must be sufficiently funded by revenues from the real estate product created. Therefore, costs associated with new infrastructure construction would likely force any development into higher density land uses to generate an adequate economic return. Therefore, the low density development alternative was rejected.

8.6 High Density Alternative

The "High Density" alternative was evaluated to reflect an intensity of uses and infrastructure improvements with facilities sufficient to generate revenues that could support the project development costs. Planned uses were primarily a mixture of recreational, commercial, industrial, and public facility development. Various concepts compatible with a high density development were considered including high density apartments, a medical/community facilities complex, university, and variations of each. These conceptual alternatives were rejected, however, due to their potential incompatibility with the surrounding land uses envisioned by the Ewa Master Plan and the City's Ewa Development Plan. Therefore, the high density alternative was rejected.

8.7 Alternatives Related to Different Designs or Details of the Proposed Actions Which Would Present Different Environmental Impacts

Because the subject property is entirely owned by the State of Hawaii and is located adjacent to an existing State sponsored master planned development (Villages of Kapolei), many potential land uses have been suggested by public and private sector entities for the subject property which appear to be potentially viable. The major land uses suggested have included the University of Hawaii West Oahu Campus, a sports complex, and theme park.

Each of these uses would present different environmental impacts relative to the proposed master plan, based on the development program selected, timing of the development, and more detailed information regarding design of proposed structures and facilities. Clearly, each of the major alternative land uses would generate wide fluctuations in usage in response to special events such as tournaments, concerts, and scheduled performances. Therefore, infrastructure improvements would necessarily be sized to accommodate periods of peak usage. Operations would also have to generate sufficient revenues to finance the infrastructure and site improvement costs necessary to accommodate the project requirements.

Development of the sports complex was included in the East Kapolei Master Plan in response to legislative initiative.

8.8 Actions of a Significantly Different Nature Which Would Provide Similar Benefits With Different Environmental Impacts

There are no known actions significantly different to those discussed which would provide the same levels of economic development while addressing the housing and educational needs of the community at the same time. Other land uses such as the proposed University of Hawaii West Oahu Campus have already been selected for a site mauka of the subject property.

Major medical facilities are already in place in the region and most of the major hospitals are looking to developer smaller satellite clinics within rapidly expanding growth areas. A prison or other major institutional public facility would likely be objectional to residents in the surrounding community.

8.9 The Alternative of Postponing Action Pending Further Study

Further study of proposed development on the property is not consistent with the City's Ewa Development Plan or the State's objective of providing new housing proximate to major employment centers or facilitate the future development of the University of Hawaii West Oahu Campus. Development of the subject property and the Ewa Plain as Oahu's "Second City" has been planned and studied for many years. Further analysis of the subject property for urban development would not achieve the overall objectives for the project.

8.10 Alternative Locations for the Proposed Project

The Ewa Plain has been designated by the State and City as the primary location for new residential, commercial, and public facility development on Oahu. After extensive planning, analysis, public input, and assessment of appropriateness based on environmental characteristics and availability of infrastructure, no alternative locations for a project of this scope presently exists on Oahu.

9.0 Relationship Between Local Short-Term Uses of Man's Environment And The Maintenance of Long-Term Productivity

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

As discussed in the previous sections of this ~~Draft~~Final EIS, the project area largely consists of vacant agricultural land. Long-term impacts from continuing the current use, such as visual impacts and the economic impact of inefficiently utilizing the property, have been identified. Clearly, these existing impacts are considered undesirable compared to the potential for long term productive use of the property. Retaining the property in its present use (the "No Action" alternative), would present a less than optimum use of the land especially considering the value of the property and its proximity to existing urban land uses, infrastructure, and community services. Without implementation of the proposed East Kapolei Master Plan, costs associated with under-utilization of the property could negatively impact the financial resources of the State of Hawaii.

Short term uses and long term productivity respectively consists of the project's construction phases and productivity of the project after it achieves buildout. Short-term construction related impacts can be mitigated while they occur. The proposed long-term land uses of the East Kapolei Master Plan would generate significant social and economic benefits to the community. These benefits consist of provisions for new public facilities, increased job opportunities, and increased tax revenues to the State and City government. Public revenues in the form of taxes paid by the project are expected to exceed and offset any expenses associated with the expansion of public services or public facilities needed to support both the project development and indirect population growth.

Long-term impacts to the environment will, on balance, be positive if the proposed mitigation measures are implemented. The physical attributes of the subject property are clearly appropriate for the land uses proposed. Existing transportation infrastructure is available, the East Kapolei Master Plan is appropriate to adjoining land uses, and improvements to existing infrastructure and drainage systems will benefit the entire community. Clearly, the proposed project is more compatible with surrounding land uses the present vacant condition.

Through careful site planning, the project area will be used in a manner that would complement the expanding urban character of the region. Increased recreational and economic opportunities for the community would also be provided, along with increased availability of community services and facilities.

10.0 Cumulative And Seconday Impacts

10.0 CUMULATIVE AND SECONDARY IMPACTS

10.1 Cumulative and Secondary Environmental Impacts

According to the Market Analysis (Appendix A), the East Kapolei Master Plan Development Project is projected to absorb approximately 12 percent of the future demand for residential space on Oahu and approximately 188 square feet of commercial land area/residential unit). This demand will occur from the growth of the existing population and in-migration over the 20-year planning period. Consequently, cumulative and secondary environmental impacts typical of these population trends, such as increased demand for public services and infrastructure, will result as the project is developed. However, if the project were not built, the future demand for residential and commercial land uses would still have to be satisfied by other new land development located elsewhere on Oahu.

Some of this demand would likely result in less efficient small scale developments scattered throughout the City. this type of "piecemeal" development would be costly for the City to provide infrastructure and public services to scattered small scale developments, and it is unlikely that all future development would occur as infill or in redevelopment projects.

Consequently, cumulative and secondary environmental impacts will continue to occur with or without the project on an island-wide basis. Only with the additional land use controls and infrastructure planning afforded by a master planned development can the potentially significant environmental impacts of scattered unplanned development be efficiently mitigated.

Therefore, the consideration of potential negative environmental and socio-economic effects of the unplanned or "no action" alternative should receive commensurate consideration during the planning and land use approval process compared to the proposed development.

10.2 Cumulative and Secondary Impacts on Public Services and Facilities

As the projected population of Honolulu grows in the future, cumulative and secondary impacts on public services and facilities will occur with or without development of the proposed project in response to the needs of the growing population. More solid waste will be created, there will be increased demand for electrical generation, traffic levels will increase, and facilities to provide additional public services will be necessary. However, these cumulative impacts will result from growth in the island-wide population, not from the approval and development of the East Kapolei project. Although other large scale projects on an island-wide basis have received some or all of the required land use approvals (or are presently under construction), there is no guarantee that any or all of these projects will be built as originally planned. Unforeseen events can occur that may alter market conditions or future population growth.

Consequently, cumulative and secondary impacts on public services and facilities are directly connected to the effect of population growth and fluctuations in the economy. Only site or regionally specific impacts to public services and facilities that will result from development of the project can be reasonably determined assuming project buildout will be achieved as presently envisioned.

The following is an analysis of potential cumulative impacts on public services and facilities that will result from the proposed project.

Land Use Character. As Honolulu's land use patterns change in the future in response to Oahu's growing population, major new development will take place in those areas planned for new growth. This type of pro-active planning will more efficiently utilize the public investment for new infrastructure and facilities that support the provision of public services. As this cumulative transition occurs, the demand for new development will be redirected into areas most suitable for urban development. On Oahu, major new development and investment in public infrastructure is planned by both the City and State for the Ewa plain. Therefore, the cumulative impact of the proposed project has been planned for many years and millions of dollars have been invested by the City and State to support new development in the region.

Traffic. Traffic levels throughout the Ewa Plain will continue to increase in the future as the region becomes settled and population shifts toward Ewa. Even without project development, traffic volumes are projected to increase as a result of cumulative population growth. To mitigate the impact of future traffic, new roadways are planned in concert with regional transportation plans prepared by the State and the City to address the projected increase in traffic levels. Traffic will be relieved by development of the East-West Road, widening of Farrington Highway, and construction of the North-South Road will be necessary to *mitigate* the projected cumulative increase of traffic levels from new developments on a regional scale.

Within the proposed East Kapolei project, the East Kapolei Project Traffic Report has projected that all major internal intersections will operate at acceptable LOS of C or above. Only one signalized intersection at Kapolei Parkway and the North-South Road would operate at LOS D which is still considered as acceptable.

Potable Water. Although the overall demand for potable water will increase with growth in the East Kapolei population, new demand for water will be addressed by installation of appropriate water source, storage, and distribution improvements by the Board of Water Supply to service the entire island. Improvements for water distribution to individual dwelling units and commercial parcels will be provided by each of the respective developer(s). Therefore, cumulative impacts should be evaluated relative to the capacity of the current water source, and not the facility improvements required for the future water distribution and storage system. These improvements will be made by ~~HFDC~~HCDCH and future developers as described in Appendix B.

The Board of Water Supply, which provides essentially all potable water for Honolulu, has developed water sources on a island-wide basis with a very high sustainable yield of millions of gallons per day. Development of the proposed East Kapolei Master Plan Development will require an average of approximately 4.54 mgd. According to the *Oahu Water Management Plan, Commission on Water Resource Management, DLNR,* March, 1990, sustainable yields for ground water sources on Oahu are estimated at 495 mgd. Consequently, the cumulative impacts of the East Kapolei project on the water resources of Oahu are estimated to require approximately 0.9 percent of the sustainable yield on Oahu.

Other Public Services and Facilities. The cumulative impact of the project and future population growth in Honolulu on other public services and facilities (i.e. fire, police protection, and health care), have been addressed in Section 5.0.

Economic Impact. According to Appendix A, the cumulative impact of construction during the first 5 years of development will total approximately 3,400 jobs. During years 6 to 10 an additional 5,550 jobs. Operational employment will consist of approximately 161 jobs in the first five years and 701 total jobs in years 6 to 10. By the year 2007, development and operation employment income will be approximately $340 million.

Fiscal Impact. According to Appendix K, p. 4-3, *"Project development will result in increased property taxes for the City and County of Honolulu. The **cumulative impact** amounts to some $84 to $86 million (1997 dollars) through the year 2022. At buildout, City and County property tax revenues would stabilize at about $6.3 million to $7.5 million annually from the project."*

11.0 Summary Of Unresolved Issues

11.0 SUMMARY OF UNRESOLVED ISSUES

According to the Department of Health Environmental Impact Statement Administrative Rules, a summary of "unresolved issues" must be provided in the Draft and Final EIS describing how such issues will be resolved and what overriding reasons there are for proceeding without resolving the issues. As herein described, the unresolved issues applicable to the East Kapolei Master Plan deal primarily with future actions and decisions of governmental bodies that cannot be determined at this time.

11.1 Overview

Many of the unresolved issues associated with the proposed project are characteristic of other similar development projects in Hawaii. Two finite resources, land and potable water will be utilized; visual alteration of the property will occur; noise and traffic impacts will result; and localized air pollution will increase compared to the current undeveloped condition. Indirect impacts will also occur that affect lifestyles and economic conditions for many residents. Issues that arise during the development process will be resolved through implementation of mitigative measures and coordination with the appropriate agencies.

The location of the subject property creates a logical opportunity for urban expansion into an area with high potential for viable urban development. These examples of integration into the surrounding neighborhood were reflected by comments received from presentations to the affected Neighborhood Boards and interviews from individual residents from the surrounding community.

Where appropriate, new land uses and infrastructure improvements will be provided in a manner reflecting existing land use patterns. However, the size, scale, and proximity of the project to existing residential land uses could significantly impact the surrounding community, so appropriate consideration to potential environmental impacts have been considered in the planning process.

All of the identified "Unresolved Issues" are considered as unresolved at the current time. However, each are in the process of being resolved by ~~HFDC~~HCDCH or other agencies with jurisdiction. None of the following Unresolved Issues, require acceptance of this Environmental Impact Statement prior to permit approval or construction. The identified "Unresolved Issues" are as follows:

Kaloi Gulch - U.S. Army Corps of Engineers permitting and approval to realign Kaloi Stream.

Discussion: According to their comments concerning the Environmental Impact Statement Notice of Preparation, the Corps of Engineers has determined that Kaloi gulch is a water of the United States and will, therefore, be subject to Section 404 of the Clean Water Act. An application for the alteration and realignment of Kaloi Gulch will be submitted to the Corps of Engineers and will be concurrently reviewed. In addition to the Corps of Engineers Application, State of Hawaii review, including a Section 401 Water Quality Certification and a Coastal Zone Management Federal Consistency Review, will be simultaneously processed. A Nationwide Permit is anticipated for the proposed alterations.

Abutilon Menziesii Habitat Conservation Plan - Approval and implementation.

Discussion: Coordination with the Department of Land and Natural Resources Division of Forestry and Wildlife, and the United States Fish and Wildlife Service has resulted in a Habitat Conservation Plan (HCP) for *Abutilon menziesii* (Red Ilima), an endangered plant which occurs on the property. The HCP requires the final approval of the BLNR. Once approved, implementation of the plan can proceed with final concurrence of the U.S. Fish and Wildlife Service. Implementation of the plan is subject to the use of ~~HFDCH~~HCDCH revolving funds and issuance of revenue bonds by ~~HFDCH~~HCDCH.

~~Hawaii~~Kapolei Sports Complex - Program development, site plan preparation, and facility operation.

Discussion: The State Department of Accounting and General Services (DAGS) has been designated as the lead agency in preparing the development program, site plan, and coordination of facilities operations for the ~~Hawaii~~Kapolei Sports Complex. For the preparation of this Environmental Impact Statement, general program assumptions were utilized to calculate impacts to transportation systems, infrastructure, and drainage. Final program development, facility design, and determination of operational management alternatives is underway and are presently unresolved. However, these issues should be resolved by the fall of 1998.

11.2 Conclusion

All of the unresolved issues described will ultimately depend on close cooperation between ~~HFDCH~~HCDCH, future developers, and various governmental bodies. Over the 20 year planning period, the East Kapolei Master Plan will evolve and change in accordance with the needs of the community and future population. The significant range of community and socio-economic benefits provided by the project warrants its immediate undertaking while simultaneously working with the affected agencies to determine solutions.

12.0 References And List of Preparers

12.0 REFERENCES AND LIST OF PREPARERS

12.1 References

Armstrong, R. W. ed. (1983). *Atlas of Hawaii.* 2nd edition. Honolulu: University of Hawaii Press.

Baker, H.L. et al. (1965). *Detailed Land Classification, Island of Hawaii.* L.S. Land Study Bureau, University of Hawaii.

U.S. Department of Agriculture Soil Conservation Service. (August, 1972). *Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii.*

Hawaii, State of. Office of State Planning. (1989). *The Hawaii State Plan.* Honolulu, Hawaii.

Hawaii, State of. Department of Agriculture. (1977). *Agricultural Lands of Importance to the State of Hawaii.* Honolulu, Hawaii.

Hawaii, State of. Department of Business and Economic Development and Tourism. (1991). *The Data Book.* Honolulu, Hawaii.

Hawaii, State of. Department of Business and Economic Development and Tourism. (1993). *Hawaii Model Energy Code.* Honolulu, Hawaii.

Hawaii, State of. Department of Transportation. (1991) *State Transportation Functional Plan.* Honolulu, Hawaii.

Mink, John F. and Stephen Lau, *Aquifer Identification and Classification for Oahu; Groundwater Protection Strategy for Hawaii,* Water Resources Research Center Technical Report No. 179, February, 1990.

Mink and Yuen, Inc., *Hydrogeological Impacts Proposed Expansion of the Barbers Point Harbor,* prepared for the Department of Transportation, July, 1993.

Yuen, George A. L. and Associates, Inc., *Groundwater Resources and Sustainable Yield Ewa Plain Caprock Aquifer,* Oahu, Hawaii, March, 1989.

U.S. Department of Agriculture Soil Conservation Service. (August, 1972). *Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii.*

12.2 Preparers of the Environmental Impact Statement

~~This~~The Draft and Final Environmental Impact Statement ~~has been~~was prepared by PBR Hawaii, Pacific Tower, Suite 650, 1001 Bishop Street, Honolulu, Hawaii 96813. The staff involved in the preparation of this document included:

W. Frank Brandt, FASLA	President
David S. Hulse, AICP	Senior Associate
Kenneth L. Jencks	Physical Planner
Yukie Y. Ohashi	Project Environmental Planner
Deena Turnbull	Graphic Artist/Designer
Nadine Matsunaga	Production

Several key technical consultants were employed to provide specific assessments of environmental factors for this project. These consultants, their company affiliation, and their specialty are listed below:

Jimmy Yamamoto, P.E.	R.M. Towill and Associates	Civil Engineering
Julian Ng	Julian Ng and Associates	Traffic
Winona P. Char	Char and Associates	Botanical Assessment
Kenneth Nagata		Biological Assessment
Robert Spear	Scientific Consulting Services	Archaeology
Mike Sklarz	*Prudential Locations Inc.*	Market Assessment
John Kirkpatrick, Ph.D.	SMS Research	Socio-Economic Assessment
Bruce Plash	Decision Analysts Hawaii, inc.	Impact on Agriculture
David Adams	Darby and Associates	Noise Assessment
Barry Neal	Barry Neal and Associates	Air Quality Impact Analysis

13.0 Consulted Parties And Participants In The EIS Process

13.0 CONSULTED PARTIES AND PARTICIPANTS IN THE EIS PROCESS

13.1 Government Agencies Consulted in the Preparation of the EIS

State

Department of Agriculture
Department of Accounting and General Services
Department of Budget and Finance - Housing ~~Finance~~ and Community Development Corporation of Hawaii
Department of Business, Economic Development and Tourism
State Energy Office
Department of Hawaiian Homelands
Department of Education
Department of Land and Natural Resources
Department of Health
Department of Transportation
State Planning Office
Department of Land and Natural Resources, Historic Preservation Division
Office of Environmental Quality Control
State Land Use Commission

City

Department of Land Utilization
Planning Department
Building Department
Department of Transportation Services
Department of Parks and Recreation
Department of Public Works
Board of Water Supply
Honolulu Public Transit Authority (HPTA)
Honolulu Fire Department
Honolulu Police Department

Federal

U.S. Department of the Interior, Fish and Wildlife Service
U.S. Department of the Interior - Geological Survey
Federal Aviation Administration
U.S. Geological Survey
U.S. Department of the Army, Pacific Ocean Division, Corps of Engineers
U.S. Department of Agriculture, Natural Resource Conservation Service
U.S. Department of Commerce

13.2 Individuals/Organizations Consulted During the EIS Preparation Process

Hawaiian Electric Company
Oahu Metropolitan Planning Organization (OMPO)
U.S. Congressmember Neil Abercrombie
State Representative Mark Moses
Councilmember Mufi Hannemann

13.3 Individuals/Organizations Contacted During the Master Plan Preparation Process

Upon completion and publication of the East Kapolei Notice of Preparation, HFDC and their consultants made numerous presentations to various community groups, boards, community associations, and government agencies as described below:

- Ewa Neighborhood Board #23 (2 presentations regarding the East Kapolei Master Plan and Sports Complex)
- Makakilo/Kapolei/Honokai Hale Neighborhood Board #34 (3 presentations)
- Ewa Community Association
- U.S. Army Corps of Engineers (field trip)
- U.S. Fish and Wildlife Service (1 presentation and 1 field trip)
- State Department of Land and Natural Resourses (Staff)
- Waipahu Neighborhood Board #22
- City Planning Department
- City Department of Land Utilization
- Councilmember Mufi Hannemann

Based on these response to these presentations and the comments received, the East Kapolei Master Plan was revised to reflect community concerns and to incorporate additional recreational facilities into the East Kapolei Master Plan. *Consequently, a new district park* was designed into the master plan in response to community comments. The proposed sports complex was also incorporated into the East Kapolei Master Plan in response to action by the Hawaii State Legislature.

14.0 COMMENTS AND RESPONSES TO THE DEIS

CORRECTION

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

14.0 Comments And Responses To The DEIS

14.0 COMMENTS AND RESPONSES TO THE ~~EISNOP~~DEIS

14.1 Agencies that Responded to the EISNOP and DEIS

COMMENT LETTER HISTORY REGARDING DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR
HCDCH EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT
Checklist of Responses Effective: July 8, 1998

	AGENCY	DEIS COMMENT DATE	RESPONSE DATE
	STATE		
1	Office of Environmental Quality Control	9/16/98	6/24/98
2	Dept. of Accounting and General Svcs.		
3	Dept. of Agriculture		
4	Dept. of Business, Econ. Dev. and Tourism	5/12/98	5/21/98
5	Dept. of Business, Econ. Dev. and Tourism Office of Planning	6/30/98	7/10/98
6	Dept. of Business, Econ. Dev. & Tourism (Energy)	5/21/98	6/1/98
7	Dept. of Defense		
8	Dept. of Education	5/19/98	6/1/98
9	Dept. of Hawaiian Home Lands	6/18/98	6/26/98
10	Dept. of Health	6/26/98	6/30/98
11	Dept. of Land & Natural Resources (Preservation)	5/18/98	5/21/98
12	Dept. of Land & Natural Resources	6/10/98	6/16/98
13	State Dept. of Public Works	6/24/98	6/30/98
14	Dept. of Transportation		
15	Office of Hawaiian Affairs		
16	University of Hawaii - Environmental Center	6/22/98	6/30/98
17	University of Hawaii - Water Resources		
18	State Land Use Commission		
19	UH Hamilton Library		
20	Legislative Reference Bureau		
21	State Main Library		
22	Waipahu Public Library		
23	DBEDT Library		
24	Housing Finance and Development Corporation (Applicant)		
	FEDERAL		
25	US Army Corps of Engineers		
26	Dept. of the Interior Fish and Wildlife	6/25/98	6/30/98
27	Federal Highways Administration		
28	Federal Aviation Administration		
	NON-GOVERNMENTAL AGENCIES/INDIVIDUALS		
29	American Lung Association		
30	Hawaiian Electric Company	6/22/98	6/26/98
31	Hawaiian Telephone Company	6/24/98	6/30/98
32	Office of Hawaiian Affairs		
34	Hawaii Audubon Society		
35	William Halliday		
36	Haseko (Ewa), Inc.	6/22/98	6/26/98
37	Outdoor Circle		
38	Oahu Metropolitan Planning Organization		
39	Estate of James Campbell		
40	Finance Realty Inc.		
41	Schuler Homes		
42	Gentry Companies		
43	John Desoto		
44	Mark Moses		
45	Brian Kanno		
46	Honolulu Advertiser		
47	Honolulu Star Bulletin		
	CITY AND COUNTY OF HONOLULU		
48	Board of Water Supply		
49	Dept. of Parks and Recreation	5/28/98	7/8/98
50	Dept. of Public Works	5/27/98	6/16/98
51	Building Dept.		
52	Dept. of Land Utilization	6/23/98	6/30/98
53	Dept. of Housing and Community Development	6/18/98	6/30/98
54	Dept. of Transportation Services		
55	Planning Dept.	6/22/98	6/30/98
56	Police Dept.	6/4/98	6/16/98
57	Fire Dept.	5/19/98	5/27/98
58	Dept. of Wastewater Management	6/16/98	6/22/98
59	Makakilo Neighborhood Board		
60	Honolulu Municipal Reference and Records Center		
61	Ewa Neighborhood Board		

14.2 ~~EISNOP~~DEIS Comment Letters and the Applicant's Responses

The following are the ~~EISNOP~~DEIS comment letters received and applicable responses.

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL

235 SOUTH BERETANIA STREET
SUITE 702
HONOLULU, HAWAII 96813
TELEPHONE (808) 586-4185
FACSIMILE (808) 586-4186

GARY GILL
DIRECTOR

PBR HAWAII
RECEIVED
JUN 22 1998
Project
Project No.

June 19, 1998

Mr. Roy S. Oshiro, Executive Director
Housing Finance and Development Corporation
677 Queen Street, Suite 300
Honolulu, Hawaii 96813

Dear Mr. Oshiro:

Subject: Draft EIS for East Kapolei Master Plan Development Project

Thank you for the opportunity to review the subject project. We have the following comments.

1. The Kaloi Channel improvements include a combination of grass and CRM-lined channels and detention basins to control storm water runoff. Please consider a completely grass-lined system to improve stormwater quality.

2. A 30-foot wide bridge is proposed to replace the existing Kaloi Stream crossing on Farrington Highway. A bridge that was built in 1920 is located next to the existing bridge. Please describe the historic significance of the bridge and disclose its future status. Also, consult with the State Historic Preservation Division regarding this issue and document the consultation in the Final EIS.

3. Two new reservoirs will be built to meet potable water storage requirement for the project. Please illustrate the visual impacts of the proposed structures from public places such as roads and lookouts. Photos of existing conditions taken from public view points are helpful in evaluating visual impacts. Renderings of future structures superimposed on photos of existing views should be provided. We recommend constructing and painting the reservoirs with materials and colors that blend with the surroundings. We also recommend landscaping with native Hawaiian plants to reduce the visual impacts.

4. The Draft EIS states that "the solid waste production from the East Kapolei Master Plan [735 tons/day] will generate

approximately 21 megawatts at the City's H-Power waste-to-energy facility." H-Power currently has 200 tons/day excess capacity and will not be able to accept all the solid waste generated from this project. Is H-Power going to be expanded to accept all the solid waste from this project? If not, please clarify the above statement.

5. Please describe whether any flying animal may be impacted by bright lights from the sports complex. If so, please consider designing the lighting using the Department of Land and natural Resources' guidelines entitled The Newell's Shearwater Light Attraction Problem, A Guide for Architects, Planners, and Resort Managers to reduce lighting impacts on flying animals.

6. Please describe whether any odors from the Honouliuli Wastewater Facility would impact future residents of the project. If so, please consider mitigation measures to reduce potential future odor related problems.

7. Two 138 kV powerlines follow the alignment of the future North-South Road. Please describe if there are any plans to place the powerlines underground in the future when the project is fully developed. We suggest designing the North-South Road to include an underground utility corridor that could accomodate the powerlines and other utilities.

8. Please describe the direct, indirect and cumulative impacts of the new sports complex. In particular, evaluate the impacts (noise, traffic, parking, crime, etc.) on existing and future residents of the neighborhood.

Should you have any questions, please call Jeyan Thirugnanam at 586-4185.

Sincerely,

Gary Gill
Director

c: PBR Hawaii

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587 0630

ROY S. OSHIRO
EXECUTIVE DIRECTOR

98:DEV/2296

June 24, 1998

TO: Gary Gill, Director
Office of Environmental Quality Control

FROM: Roy S. Oshiro, Executive Director

SUBJECT: **COMMENTS REGARDING EAST KAPOLEI MASTER PLAN (EKMP) DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)**

Thank you for your comments of June 19, 1998, regarding the EKMP Development Project - DEIS. We offer the following response to each of your comments:

1. You are correct that a portion of the proposed Kaloi Gulch channel improvements will include CRM-lined channels. This material was selected as an erosion control measure for portions of the channel that could potentially receive high velocity flows during intense storms. Without the CRM lining, the velocity of the water could potentially suspend a significant quantity of soil in the run-off flows and reduce the overall effectiveness of the retention/detention basins and damage other drainage channel improvements. We would prefer to use all grass lined channels for economic reasons; however, grass does not provide the desired level of erosion protection as does concrete in high velocity areas.

2. The bridge described in your comments appears to be the old Farrington Highway bridge built in 1920 and is located within the Farrington Highway right-of-way and is not located within the EKMP property. As you know, Farrington Highway is scheduled to be improved in this area by the City Department of Transportation Services (DTS) with Federal funding through the State Department of Transportation (DOT). As a City/State sponsored project utilizing Federal funds, Chapter 343 will automatically be triggered. That projects environmental assessment will include a site assessment that may have potential historical significance. The State Historic Preservation Division has previously

HFDC

stated that the EKMP project will have "no effect" on historic sites.

3. The proposed reservoirs will be located at elevations of 215' and 440' on future sites of the University of Hawaii West Oahu (UHWO) campus. Although the sites for the reservoirs are depicted in Figure 1-1 of the EKMP Water Master Plan Report, only their respective elevations have been determined at this time. From an engineering perspective, the actual sites for each reservoir can occur at any place along the elevation contours described.

   Inasmuch as these reservoirs will also service the UHWO campus, their specific locations and visual impacts will be determined during the site utilization process for the UHWO campus and as an element of the Chapter 343, HRS Environmental Impact Statement that is currently being prepared for the UHWO campus project.

4. As indicated in the DEIS, solid waste from the entire island is incinerated at the City's H-Power waste-to-energy facility. Consequently, the capacity of the plant and need for future expansion will be determined by the level of island wide population growth and not the development of any one specific project. It is clear that the City's General Plan island wide population projection of 1,012,073 persons for the year 2010 (an increase of 175,842 persons from the 1990 population of 836,231) will necessitate expansion of the H-Power plant or increased recycling of solid waste at some point in the future.

   In addition, the EKMP project is designed to address existing housing demand on Oahu and will not stimulate in-migration to the state and its associated potential to generate increased levels of solid waste. Fees will be paid by future EKMP residents and businesses to fund solid waste collection, disposal and possible expansion of the H-Power plant in the future as applicable and in accordance with the City's fee structure for solid waste collection services.

5. The island of Kauai is the only known habitat for the Newell Shearwater. According to the Department of Land and Natural Resources (DLNR) "The Newell's Shearwater Light Attraction Problem, A Guide for Architects, Planners and Resort Managers", the light attraction problem arises when young Shearwaters leave their nests for the first time and become disoriented from lights typical of urban areas. Usually, the Newell Shearwater flies in a makai direction down stream valleys to the ocean. Consequently, the greatest "fallout"

problem occurs near coastal towns on Kauai, particularly near river mouths. In addition, few coastal seabirds utilize habitat on the south shore of Oahu due to lack of suitable off shore nesting sites as was confirmed in our DEIS, Appendix E, Biological Survey. Therefore, no impact on the Newell Shearwater is anticipated to result from the lighting required for the Sports Complex.

To ensure that no other flying animals are attracted to the lights of the Sports complex, all high intensity lights, street lights, and parking lot lights will be shielded or directed downwards, and use of spotlights will be limited only to occasional special events.

6. As you know, the Honouliuli Wastewater Treatment Plant (HWTP) is approximately 1.5 miles from the proposed Sports Complex location. Considering that the HWTP meets Department of Health (DOH) Cover Source Permit limits, we feel that the distance to the Sports Complex, the relatively low levels of odors, and the direction of prevailing winds (both trades and Kona winds) will largely mitigate any potential air quality impacts from the HWTP on the EKMP project site. According to our air quality consultant, Barry Neal and Associates, DOH standards permit 25 parts/billion of hydrogen sulfide at the boundary of the HWTP, although some individuals can detect odors at 5 parts/billion. At the Sports complex site, these levels should be further reduced approximately 1000 times due to wind dispersion. Consequently, odors from HWTP should not be detectable.

7 The two existing 138KV power lines that follow the alignment of the proposed North/South Road are not planned to be placed underground. However, the North/South Road will include an underground utility corridor that will accommodate other power lines and utilities. Inasmuch as the power lines are existing above ground and only recently installed, the cost of replacement underground would be borne by the future purchasers of the residential units or tax payers of Hawaii, not Hawaiian Electric Company. If the lines were placed underground, the cost would be extremely high and di-electric coolant fluid would have to be pumped through the length of the underground line. Therefore, our plan is not to attempt relocation of the 138KV power lines underground.

8. The direct, indirect and cumulative impact of the new Sports Complex have been discussed in the DEIS in each of the applicable consultant studies (i.e., noise, air, traffic,

socio-economic, archaeology, civil engineering, agricultural impact and flora/fauna). Air and traffic reports have included projections for sports complex traffic. Noise impacts will be mitigated by redirecting the sports complex away from residential areas (the site plan in the DEIS will be revised), and each of the civil engineering reports have sized required infrastructure to accommodate sports complex requirements. In addition, a significant portion of Appendix K (Sections 3.0 and 6.5) specifically address the need for the sports complex, its economic impact, and regional social impact.

Security for the proposed sports complex will be administered by the Stadium Authority and any private sector operators that are contracted to manage the facility. We believe that provisions for additional security (i.e., private security and use of special duty officers) will likely be necessary during special events.

We hope our comments have addressed each of your concerns. Once again, thank you for participating in the environmental review process.

c: David Hulse, PBR Hawaii

BENJAMIN J. CAYETANO
GOVERNOR

ESTHER UEDA
EXECUTIVE OFFICER

STATE OF HAWAII
DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM
LAND USE COMMISSION
P.O. Box 2359
Honolulu, HI 96804-2359
Telephone: 808-587-3822
Fax: 808-587-3827

PBR HAWAII
RECEIVED
MAY 13 1998
Project

May 12, 1998

Mr. Steve Thomas
State Housing Finance and
Development Corporation
677 Queen Street, Suite 300
Honolulu, Hawaii 96813

Dear Mr. Thomas:

Subject: Draft Environmental Impact Statement (DEIS) for the East Kapolei Master Plan

We have reviewed the DEIS for the subject project and have the following comments:

1) We confirm that the project site, as represented in Figure 6 of the DEIS, is located within the State Land Use Agricultural District. We note that Figure 6 is a copy of Boundary Interpretation No. 97-35, dated November 25, 1997, which was prepared for the subject project and which confirms the State land use designation of the project site.

2) The project site includes or is located adjacent to lands which have been the subject of the following recent boundary amendment petitions before the Commission:

<u>LUC Docket No. A94-708/Office of State Planning</u> -
The project site includes a portion of the property that was the subject of this docket. The docket had proposed the reclassification of approximately 1,300 acres of land from the Agricultural District to the Urban District for land exchange, the University of Hawaii-West Oahu campus, housing, and public facility uses. By Order Granting Petitioner's Motion to Withdraw Petition Without Prejudice dated September 18, 1996, the petition was withdrawn.

<u>LUC Docket No. A96-718/Schuler Homes, Inc.</u> -
The project site is adjacent to the property that was the subject of this docket. The docket had proposed the reclassification of approximately 753.573 acres of land from the Agricultural District to the Urban District for residential, commercial, school, and park uses. By Order Granting Motion to Withdraw Petition for Land Use District Boundary Amendment dated September 18, 1996, the petition was withdrawn.

<u>LUC Docket No. A97-720/City and County of Honolulu, State of Hawaii, by its Director of the Department of Housing and Community Development</u> -
The project site abuts the property that was the subject of this docket. The docket had proposed the reclassification of approximately 100.281 acres of land from the Agricultural District to the Urban District for the Varona Village Phase II project. By letter dated May 15, 1997, Petitioner informed the Commission of its withdrawal of the boundary amendment petition in this docket.

3) Clarification should be provided as to who will be responsible for acquiring each of the required permits and approvals listed on page 30, section 3.4, of the DEIS.

4) Clarification should be provided as to the intended market for the proposed single-family and multi-family residential units. Are the units proposed for low and low-moderate income groups? First-time homebuyers? If so, what proportion of the total units planned will be targeted for these groups?

5) On page 88, section 7.3, third paragraph, line 8, of the DEIS, we note that the section within Chapter 205 referenced with respect to §15-15-24, Hawaii Administrative Rules (HAR), should be 205-4(g).

6) We note that a boundary amendment petition will be filed with our office in the near future to reclassify the project area from the Agricultural District into the Urban District. At such time, we will review the petition in the context of the petition content requirements as set forth in §15-15-50, HAR.

We have no further comments to offer at this time. We appreciate the opportunity to comment on the DEIS.

Should you have any questions, please feel free to call me or Bert Saruwatari of our office at 587-3822.

Sincerely,

ESTHER UEDA
Executive Officer

cc: OEQC
David Hulse, PBR Hawaii

BENJAMIN J. CAYETANO
GOVERNOR

ROY S. OSHIRO
EXECUTIVE DIRECTOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

98:DEV/1877

May 21, 1998

TO: Esther Ueda, Executive Officer
Land Use Commission

FROM: Roy S. Oshiro, Executive Director

SUBJECT: COMMENTS REGARDING EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)

Thank you for your comments of May 12, 1998 regarding the East Kapolei Master Plan Development Project - Draft Environmental Impact Statement (DEIS). We offer the following response to each of your comments:

1. We concur that the proposed project site is located entirely within the State Agricultural District and that reclassification of the property to the State Urban District is required.

2. We also concur that there are no outstanding boundary amendment petitions before the Commission that impact the property.

3. The Draft EIS table on page 30, Section 3.4 will be modified in the Final EIS to reflect the applicant responsible for acquiring the required permits and various agency approvals.

4. As indicated in the DEIS, the Housing Finance and Development Corporation (HFDC) will not be the developer for any new housing units. HFDC's role will be to provide the backbone infrastructure, land use entitlement, and subdivide the property into large lot development parcels to be sold to private sector developers. The ultimate product and market to be targeted will be determined by the individual developers in accordance with the City's affordable housing policy which will determine whether low, low-moderate, or first time buyers will receive preferences.

5. The reference to Section 15-15-24, Hawaii Administrative Rules will be revised in the final EIS as indicated in your comments.

6. We plan to submit the boundary amendment petition in late of May or early June 1998, and look forward to your comments and working with the Land Use Commission at that time.

Once again, thank you for your participation in the environmental review process.

HFDC

DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

ENERGY, RESOURCES, AND TECHNOLOGY DIVISION
235 South Beretania St., 5th Flr., Honolulu, Hawaii 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

BENJAMIN J. CAYETANO
GOVERNOR
SEIJI F. NAYA
DIRECTOR
BRADLEY J. MOSSMAN
DEPUTY DIRECTOR

Tel.: (808) 587-3807
Fax: (808) 586-2536

May 21, 1998

PBR HAWAII
RECEIVED
MAY 2 8 1998

Mr. Steve Thomas
State Housing, Finance,
and Development Corporation
677 Queen St., Suite 300
Honolulu, Hawaii 96813

Dear Mr. Thomas:

Subject: HFDC East Kapolei Master Plan Development Project

Thank you for the opportunity to comment on the East Kapolei Master Plan Development Project Draft Environment Impact Statement (DEIS). We refer to our comments of April 1, 1997, and urge that you include the energy efficient measures in your development guidelines.

Sincerely,

Maurice H. Kaya
Energy, Resources, and Technology
Program Administrator

C: OEQC
PBR

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

ROY S. OSHIRO
EXECUTIVE DIRECTOR

IN REPLY REFER TO

98:DEV/1954

June 1, 1998

TO: Maurice H. Kaya, Division Head
Energy, Resources, and Technology Division
Department of Business, Economic Development and Tourism

FROM: Roy S. Oshiro, Executive Director

SUBJECT: **COMMENTS REGARDING EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)**

Thank you for your comments of May 21, 1998 regarding the East Kapolei Master Plan Development Project - Draft Environmental Impact Statement (DEIS). We offer the following response to each of your comments:

1. We have included your comments of April 1, 1997 in the draft and final EIS and our response. The references made in your April 1, 1997 comments to the Hawaii State Plan have been addressed on pages 84 and 85 of the DEIS. In addition, implementation of the Model Energy Code and use of solar water heaters and heat pumps will be incorporated into the building design as applicable. However, all new residential and commercial structures will be constructed by private developers in the future.

Once again, thank you for your participation in the environmental review process.

c: David Hulse, PBR Hawaii

HFDC

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF EDUCATION
P.O. BOX 2360
HONOLULU, HAWAII 96804

HERMAN M. AIZAWA, Ph.D.
SUPERINTENDENT

OFFICE OF THE SUPERINTENDENT

RECEIVED
MAY 28 1998

May 19, 1998

MEMO TO: Mr. Steve Thomas, Housing Development Specialist
Housing Development Section, HFDC

F R O M: Herman M. Aizawa, Ph.D., Superintendent
Department of Education

SUBJECT: HFDC East Kapolei Draft EIS

The Department of Education (DOE) offers the following comments on the subject draft environmental impact statement:

1. Page 69. The report states that "Based on already anticipated residential growth, one elementary school will be available at Kapolei Village and one each at Ewa Gentry,..."

   As correctly noted in the report's previous paragraph, Kapolei Elementary is already open. The school in Ewa Gentry, Holomua Elementary, is also presently in operation and has a 1997 school year enrollment of 674 students.

2. Pages 22 and 70. The three 12-acre elementary schools and one 20-acre intermediate school to be provided in East Kapolei will satisfy a portion of the DOE's fair-share requirements. The DOE, HFDC, and the Office of Planning are in the process of determining how best to address the balance of approximately $1.53 million (based on a total of 8,400 units at $850 per unit).

The dedication of the 56 acres for school sites plus the balance of the fair-share requirement will satisfy the DOE's requirements in full. The report should be revised to indicate that unless the number of units exceeds 8,400, the DOE will require no additional fees from future developers.

Thank you for the opportunity to comment. If you have any questions, please call Mr. Sanford Beppu at 733-4862.

HMA:SB:hy

cc: A. Suga, OBS
Office of the Governor
D. Hulse, PBR HAWAII

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

ROY S. OSHIRO
EXECUTIVE DIRECTOR

IN REPLY REFER TO
98:DEV/1953

June 1, 1998

TO: Herman M. Aizawa, Ph.D., Superintendent
Department of Education

FROM: Roy S. Oshiro, Executive Director

SUBJECT: **COMMENTS REGARDING EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)**

Thank you for your comments of May 19, 1998 regarding the East Kapolei Master Plan Development Project - Draft Environmental Impact Statement (DEIS). We offer the following response to each of your comments:

1. The final EIS will be revised to more accurately reflect that Kapolei and Holomua Elementary Schools are already open and servicing educational needs of the community.

2. Your comments correctly state that the DOE, HFDC and the Office of State Planning are in the process of determining how best to address the yet-to-be-determined balance of funds, as impact fees requested by DOE, for the future high school site. Our current position is that the impact fees will be paid as the residential units are developed and sold in the future. We will continue to negotiate with the DOE to resolve this issue.

3. We also acknowledge that the dedication of the 56 acres of school sites plus the balance of the fair-share requirement will satisfy DOE requirements in full.

Once again, thank you for your participation in the environmental review process.

c: David Hulse, PBR Hawaii

HFDC

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF HEALTH
P O BOX 3378
HONOLULU, HAWAII 96801

LAWRENCE MIIKE
DIRECTOR OF HEALTH

In reply, please refer to:

June 26, 1998

97-064A/epo

PBR HAWAII
RECEIVED
JUN 29 1998
Project
Project No.

Mr. Steve Thomas
State Housing, Finance and
Development Corporation
677 Queen Street, Suite 300
Honolulu, Hawaii 96813

Dear Mr. Thomas:

Subject: Draft Environmental Assessment (DEA)
East Kapolei Master Plan Development Project
Kapolei, Oahu
TMK: 9-1-16: 8, 108, 109

Thank you for allowing us to review and comment on the subject document. We do not have any comments to offer at this time.

Sincerely,

BRUCE S. ANDERSON, Ph.D.
Deputy Director for
Environmental Health

c: OEQC
PBR Hawaii

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

ROY S. OSHIRO
EXECUTIVE DIRECTOR

IN REPLY REFER TO:

98:DEV/2372

June 30, 1998

Dr. Bruce Anderson, Ph.D.
Deputy Director for Environmental Health
State Department of Health
P. O. Box 3378
Honolulu, HI 96801

Dear Dr. Anderson:

SUBJECT: COMMENTS REGARDING HOUSING FINANCE AND DEVELOPMENT CORPORATION (HFDC) EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)

Thank you for your comments of June 24, 1998 regarding the East Kapolei Master Plan Development Project - Draft Environmental Impact Statement and for participating in the environmental review process.

Sincerely,

ROY S. OSHIRO
Executive Director

HFDC

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION
PO BOX 621
HONOLULU, HAWAII 96809

June 10, 1998

PBR ... RECEIVED
JUN 11 1998
Project
Project No.

LD-NAV
Ref.:EKDPLAN.RCM

Mr. David Hulse, Consultant
PBR HAWAII
Land Planning and Environmental Studies
1001 Bishop Street, Pacific Tower, Suite 702
Honolulu, Hawaii 96813

Dear Mr. Hulse:

SUBJECT: Review : Draft Environmental Impact Statement
Applicant : PBR Hawaii, on behalf of, Housing Finance and Development Corporation (HFDC)
Project : East Kapolei Master Plan, Oahu Hawaii
Tax Map Keys: 1st/ 9-1-16:, 17 and 18 (various parcels)

Thank you for the opportunity to review and comment on the subject Draft Environmental Impact Statement.

Attached herewith is our Oahu District Land Office and Commission on Water Resource Management's comments related to drainage facilities, toxic chemicals and water resources respectively.

The Department of Land and Natural Resources has no other comments to offer on the subject matter at this time.

Should you have any questions, please contact Nicholas Vaccaro of our Support Services Branch at 587-0438.

Very truly yours,

Dean Uchida

DEAN Y. UCHIDA
Administrator

c: Oahu District Land Office
Oahu Land Board Member

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
PO BOX 621
HONOLULU, HAWAII 96809

MEMORANDUM: MAY 20 1998

TO: Nick Vacarro
Central

FROM: Cecil Santos
Cecil Santos
Oahu District Land Agent

Subject: Drainage, Draft EIS, East Kapolei Master Plan Development

The section on Drainage Facilities (5.8.3) cites the possibility of the OR&L Bridge over the Kaloi Channel not being installed at the completion of this development. Currently the main Kaloi Drainage Channel stops abruptly at the OR&L tracks down at the far end of Renton Road. All the drainage generated by the sheet runoff in this development will eventually come to this point and currently it ends right there. The EIS relates to the drainage blocked at the OR&L tracks as being diverted to the Ewa Villages Golf Course. It is possible then that the drainage system developed for the East Kapolei Development will end in the Ewa Villages Golf Course rather than draining out into the ocean.

There should be more attention to the time frame of when the OR&L Bridge is going to be installed. Who is going to install it and what are the problems if any for its construction? There should be an accurate and realistic determination of the specifications of this structure and when it is going to take place. The completion of this bridge should be a condition for the final execution of the permits for the last phase of the East Kapolei Master Plan.

It doesn't appear to make practical sense to plan the entire development without no insurance that the OR&L bridge will be completed when the the East Kapolei Development is completed so that the drainage has an open passage to the ocean. This will insure that unpredicted extensive storms will have access to the ocean rather than the Ewa Villages Golf Course.

cc matsumoto

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

MEMORANDUM

JUN 10 1998

TO: Nick Vacarro
Central Office

Cecil Santos

FROM: Cecil Santos
Oahu District Land Agent

Subject: Amendment To May 20,1998 Memo, Drainage, Draft EIS, East Kapolei Master Plan Development

I am adding comments to the attached memo I sent you on the East Kapolei Master Plan. Please include in your report that there is a Herbacide Plant within this area consisting of 3,000 sq. ft. that is highly contaminated. The Land Division has received a letter from the State Department of Health which reports the concentration of high levels of toxins at this site. These toxins are the residue of chemicals that were stored in this plant during the sugar operation. These chemicals were used by the sugar cane plantation for destroying weeds.

Additional testing is needed on this site and a clean-up of this hazardous waste must be completed before the land on this site can be utilized.

cc matsumoto

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

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

MICHAEL D. WILSON
CHAIRPERSON

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

TIMOTHY E. JOHNS
DEPUTY DIRECTOR

May 29, 1998

JUN 2 4 06 PM '98

TO: Mr. Dean Uchida, Administrator
Land Division

FROM: Timothy E. Johns, Deputy Director
Commission on Water Resource Management (CWRM)

SUBJECT: Draft Environmental Impact Statement for East Kapolei Master Plan

FILE NO.: EKDPLAN.COM

Thank you for the opportunity to review the subject document. Our comments related to water resources are marked below.

In general, the CWRM strongly promotes the efficient use of our water resources through conservation measures and use of alternative non-potable water resources whenever available, feasible, and there are no harmful effects to the ecosystem. Also, the CWRM encourages the protection of water recharge areas which are important for the maintenance of streams and the replenishment of aquifers.

[ ] We recommend coordination with the county government to incorporate this project into the county's Water Use and Development Plan.

[X] We recommend coordination with the Land Division of the State Department of Land and Natural Resources to incorporate this project into the State Water Projects Plan.

[ ] We are concerned about the potential for ground or surface water degradation/contamination and recommend that approvals for this project be conditioned upon a review by the State Department of Health and the developer's acceptance of any resulting requirements related to water quality.

[X] A Well Construction Permit and/or a Pump Installation Permit from the Commission would be required before ground water is developed as a source of supply for the project.

[X] The proposed water supply source for the project is located in a designated water management area, and a Water Use Permit from the Commission would be required prior to use of this source.

[ ] Groundwater withdrawals from this project may affect streamflows which may require an instream flow standard amendment.

[ ] We recommend that no development take place affecting highly erodible slopes which drain into streams within or adjacent to the project.

[X] If the proposed project includes construction of a stream diversion, the project may require a stream diversion works permit and amend the instream flow standard for the affected stream(s).

[X] If the proposed project alters the bed and banks of a stream channel, the project may require a stream channel alteration permit.

Memo to Mr. Dean Uchida
Page 2
May 29, 1998

[X] OTHER:

Although the report indicates maximum daily potable demands are estimated at 6.8 mgd and 7.5 mgd for the 215- and 440-foot service elevation zones, the average daily potable demand for the project is not indicated. To meet the average daily potable demand, the report references the Honolulu Board of Water Supply reservation request to the Commission on Water Resource Management. This reservation request has been withdrawn for revision.

We strongly recommend that this project be incorporated into the State Water Projects Plan, which is currently being revised by the Department of Land and Natural Resources, Land Division, Engineering Branch. The State projects' demands will then be incorporated into the County Water Use and Development Plan through the integrated resource planning effort that is currently being funded by the Honolulu Board of Water Supply. Justification for water reservation requests should be based on a comprehensive long-term planning document like the Water Use and Development Plan.

With regard to the estimated 0.95 mgd nonpotable water demand, it is the policy of the Commission on Water Resource Management (Commission) to promote the viable and appropriate reuse of reclaimed water in so far as it does not compromise beneficial uses of existing water resources.

If there are any questions, please contact Lenore Nakama at 587-0218.

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

ROY S. OSHIRO
EXECUTIVE DIRECTOR

IN REPLY REFER TO:

98:DEV/2166

June 16, 1998

TO: Dean Y. Uchida, Land Administrator
Land Division
Department of Land and Natural Resources

FROM: Roy S. Oshiro, Executive Director

SUBJECT: **COMMENTS REGARDING EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)**

Thank you for your comments of June 10, 1998 regarding the East Kapolei Master Plan Development Project - Draft Environmental Impact Statement (DEIS). We offer the following response to each of your comments:

Oahu District Land Office

We concur that the off-site OR&L railroad bridge over the Kaloi Gulch is not sized sufficiently to accommodate existing flows from intense storms. You are also correct that the Ewa Villages Golf Course will receive runoff from the project which may be exacerbated by the Kaloi Gulch bridge problem. We concur that development of the proposed project will significantly increase the quantity of off-site drainage flows after development. However, we must emphasize that an extensive system of drainage improvements proposed for the East Kapolei Master Plan will retain most storm water on-site. Consequently, replacement of the Kaloi Gulch bridge will not be necessary due to development of the East Kapolei Master Plan project. The Kaloi Gulch bridge is also within the City's OR&L right-of-way and the City should be considered the responsible party for its replacement, improvement or maintenance. We do not presently have a time frame for its replacement. We do not agree that replacement of this bridge should be a condition for the final approval for the permits applicable for this project.

HFDC

Thank you for informing us that there may be chemical residue on approximately 3,000 square feet of the property resulting from herbicide spills which occurred during the time of sugar cane cultivation. We concur that additional testing is needed and a clean-up completed before the land can be utilized. As landowner of the property in question, we assume that the Department of Land and Natural Resources (DLNR) will undertake the clean-up measures prior to the transfer of the lands to the Housing and Community Development Corporation of Hawaii (HCDCH). In any event, the spill area is not scheduled for development in the near future. HFDC and its successor HCDCH is committed to ensuring that the site is clean before the spill site is developed.

Commission on Water Resource Management (CWRM)

We are also committed to promoting the efficient use of water resources through conservation measures and use of alternative nonpotable water resources whenever available. Extensive drainage improvements are planned to facilitate water recharge and replenishment of the underground aquifer.

We will continue to coordinate with the DLNR/CWRM to incorporate this project into the State Water Projects Plan.

We do not anticipate the need for additional water wells to accommodate this project. However, if additional development is required in the future, the appropriate well permits will be obtained from the CWRM.

STATE OF HAWAII
DEPARTMENT OF HAWAIIAN HOME LANDS
P O BOX 1879
HONOLULU, HAWAII 96805

PBR HAWAII RECEIVED JUN 2 3 1998

June 18, 1998

To: Mr. Roy S. Oshiro, Executive Director
Housing Finance and Development Corporation

From: Kali Watson, Chairman
Hawaiian Homes Commission

Subject: East Kapolei Master Plan - Draft Environmental Impact Statement (DEIS)

Thank you for allowing the Department of Hawaiian Home Lands (DHHL) the opportunity to comment on the DEIS. As background information, on October 28, 1994, the Board of Land and Natural Resources (BLNR) approved conveyance of 16,518 acres of State land to DHHL to settle land claims. In part, conveyance included 200 acres of the 1,300 acre East Kapolei development. Subsequent to BLNR's approval, the Housing Finance and Development Corporation (HFDC), as the State's lead agency for the East Kapolei development delayed conveyance pending legislative approvals for development of the University of Hawaii West Oahu Campus and completion of project planning by the Office of Planning and HFDC.

In review of the DEIS, we find that the HFDC has designated Parcels A, D, and I-2, consisting of 200 acres, for transfer to the DHHL. We also find these parcels to be representative of BLNR's previous approval, consistent with our preliminary discussions and therefore acceptable to DHHL.

With reference to Appendix K Socio-Economic Impact Assessment of the East Kapolei Project, we commend HFDC for pursuing an aggressive schedule to complete all land sales by year 2006. As indicated on page 1-3 land transfer to DHHL could occur by 1998. We agree and kindly request that these lands be expeditiously transferred to DHHL to facilitate house construction by year 2000.

In further reference to Appendix K, we note that Exhibits 4-Q & R: Balance of Revenues and Cost for the State of Hawaii: Low Range and High Range, imply that DHHL and Department of Accounting and General Services, State of Hawaii (DAGS) will repay HFDC for infrastructure cost at unspecified amounts and dates. Please note that the initial approval for transfer by BLNR placed no encumbrances on the 200 acre transfer. While it is reasonable to assume that the DHHL, DAGS, and/or others should pay it's fair share of improvement cost we must insure that all project charges are a result of benefits received, proper allocation of cost, or legally imposed, and that funds are available. It is suggested that your office begin detailing responses to these concerns early in your project schedules so that funding approvals and/or appropriations can be requested of the Hawaiian Homes Commission or Legislature.

Lastly, in prior response to the Environmental Impact Statement Notice of Preparation, DHHL requested discussion on the drainage systems development timetable, contributions to the cost of construction and the future maintenance of the system and related open space. In review, we are not able to find where these issues have been adequately addressed. As these items may significantly impact all landowners further discussion is requested.

Again, thank you for the opportunity to comment. If there are any questions or concerns, please call Mr. Cleighton Goo at 587-6452.

C: Office of Environmental Quality Control
Mr. David Hulse, PBR HAWAII

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

ROY S. OSHIRO
EXECUTIVE DIRECTOR

IN REPLY REFER TO:
98:DEV/2314

June 26, 1998

TO: The Honorable Kali Watson, Chairman
Hawaiian Homes Commission
Department of Hawaiian Home Lands

FROM: Roy S. Oshiro, Executive Director

SUBJECT: **COMMENTS REGARDING EAST KAPOLEI MASTER PLAN (EKMP) DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)**

Thank you for your comments of June 18, 1998, regarding the EKMP Development Project - DEIS. We offer the following response to each of your comments:

1. We concur that the Board of Land and Natural Resources (BLNR) authorized conveyance of 200 acres of land to the Department of Hawaiian Homelands (DHHL) within the 1300 project site. We are currently working with the DLNR to convey ownership of the 1300 acres to HFDC and subsequent transfer of 200 acres to DHHL. We are still working to achieve the late 1998 transfer; however, this date could potentially be delayed into 1999.

2. We concur that DHHL will own the 200 acre development site(s) and will not be sold by HFDC as stated in the Hawaiian Homes Commission Act. However, the improvement cost for the entire project must be borne by individual project developers in accordance with the project development parameters previously stated. Funds from the sale of improved development parcels will partially be used to fund development of the University of Hawaii West Oahu (UHWO) campus mauka of the H-1 Freeway. We believe this facility will also provide a tremendous new expansion of educational opportunities for the DHHL beneficiaries who will reside in the EKMP community.

3. As for the funding and schedule of construction of the planned drainage improvements, HFDC is presently processing

HFDC

the necessary U.S. Army Corps of Engineers and State Department of Health permit. Our preliminary estimate is that ground breaking on the drainage improvements will be in August of this year. The drainage improvements costs will be funded through the sale or transfer of the large lot development parcels as previously described. Responsibility for maintenance of the drainage system and related open space areas has not been determined at this time. However, it is likely that HFDC will provide this function until a permanent arrangement can be determined.

We hope our comments have addressed each of your concerns. Once again, thank you for participating in the environmental review process.

c: David Hulse, PBR Hawaii

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

PBR HAWAII
RECEIVED
MAY 19 1998

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

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

DEPUTIES
GILBERT COLOMA-AGARAN

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

May 18, 1998

Steve Thomas
State Housing Finance and Development Corporation
677 Queen Street, Suite 300
Honolulu, Hawaii 96813

LOG NO: 21478 ✓
DOC NO: 9805EJ09

Dear Mr. Thomas

SUBJECT: Chapter 6E-8 Historic Preservation Review -- Draft Environmental Impact Statement Notice of Preparation (DEIS) East Kapolei Master Plan Development Project
Honouliuli, 'Ewa, O'ahu
TMK: 9-1-16:8, 108 &109; 9-1-17: 71, 72, & por. 4; 9-1-18: por. 1

Thank you for the opportunity to review the draft EIS for this project. The DEIS has correctly incorporated our earlier comments that we believe that this project will have "no effect" on historic sites. The DEIS also includes the results of historical research of past land uses and field survey documenting existing conditions conducted by Scientific Consulting Services.

If you have any questions please call Elaine Jourdane at 587-0015.

Aloha,

Don Hibbard, Administrator
Historic Preservation Division

EJ:jk

c: OEQC, 235 S. Beretania Street, Room 702, Honolulu, HI 96813
✓Mr. David Hulse, PBR Hawaii, Pacific Tower, Suite 650 1001 Bishop Street, Honolulu, HI 96813

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

ROY S. OSHIRO
EXECUTIVE DIRECTOR

IN REPLY REFER TO:
98:DEV/1876

May 21, 1998

TO: Don Hibbard, Administrator
State Historic Preservation Division
Department of Land and Natural Resources

FROM: Roy S. Oshiro, Executive Director

SUBJECT: **COMMENTS REGARDING EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)**

Thank you for your comments of May 18, 1998 regarding the East Kapolei Master Plan Development Project - Draft Environmental Impact Statement. We offer the following response to each of your comments:

1. We concur that the proposed project will have no efect on historic sites and that we have included the result of historical research, past land uses, and field survey documenting existing conditions.

Once again, thank you for your participation in the environmental review process.

HFDC

MAY - 8 [illegible]

(P)1258.8

MAY 5 1998

TO: Mr. Roy Oshiro, Executive Director
Housing Finance and Development Corporation

SUBJECT East Kapolei Draft EIS

Please be advised that the Kapolei Sports Complex will not include a park 'n ride facility for Kapolei Civic Center State employees. This of course does not preclude the Stadium Authority in conjunction with the City and County of Honolulu or HFDC from charging parking fees for persons who would park at the sports complex and ride some form of rapid transit to and from downtown Honolulu. In view of the foregoing, you may wish to revise your draft EIS which, to the best of our knowledge, has yet to be issued.

Should you have any questions, please have your staff call Mr. Alan Sanborn of the Planning Branch at 586-0499.

Gordon Matsuoka
GORDON MATSUOKA
Public Works Administrator

AS:jk
c: Mr. Steven Thomas
Mr. David Hulse
Mr. John Kirkpatrick
Mr. Jerry Nishida
Mr. Steve Wong

PBR HAWAII RECEIVED
JUN 25 1998

(P)1380.8

JUN 24 1998

TO: Housing Finance and Development Corporation
Department of Budget and Finance

ATTENTION: Mr. Steve Thomas

SUBJECT: HFDC East Kapolei Master Plan Development Project
Draft Environmental Impact Statement (DEIS)

Thank you for the opportunity to review the subject DEIS which PBR Hawaii sent by their draft EIS cover letter and updated by PBR Hawaii's May 14, 1998 memorandum.

Please see Attachment A for our comments.

If there are any questions, please call Mr. Ronald Ching of the Planning Branch at 586-0490.

Gordon Matsuoka
GORDON MATSUOKA
Public Works Administrator

RC:jy
Attachment
c: OEQC w/attach.
Mr. David Hulse, PBR Hawaii w/attach.

A:\LTRS\1380HFDC.RC

Subject: DAGS, DPW comments on HFDC East Kapolei Master Plan Development Project's DEIS

Comments follow:

A. Pages 11 and 121. Where did the name "Hawaii Sports Complex" come from? The name should be the "Kapolei Sports Complex." Please revise accordingly.

B. Page 18 and 20. Shouldn't the acreage be 55 acres instead of 63 acres or 64.3 acres? Please revise accordingly.

C. Page 73. The 64.3 (55) acre sports complex should not be for community recreation. Please clarify accordingly.

D. Pages 6, 20, 21, 22, 29, 45, 93, 99, 100, 104 and 105. For consistency, use the name park 'n ride throughout the document instead of park-and-ride.

E. Figure 4, and pages 20, 21 and 22. There will not be a park 'n ride system for the State's civic center employees. Therefore, do not show the above park 'n ride system for state employees in Figure 4 and its existence throughout the document.

F. An elevated structure could be added over the parking lot for a public park 'n ride for a future transit system.

G. Include a statement-of-requirement for employee parking in the Kapolei Civic Center.

H. See the attached highlighted Future Traffic Conditions Tables 2, 3 and 4 and based on the comments above, revise appropriately.

Attachment A

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

ROY S. OSHIRO
EXECUTIVE DIRECTOR

IN REPLY REFER TO
98:DEV/2370

June 30, 1998

Mr. Gordon Matsuoka
Public Works Administrator
P.O. Box 119
Honolulu, Hawaii 96810

Dear Mr. Matsuoka:

SUBJECT: **COMMENTS REGARDING HOUSING FINANCE AND DEVELOPMENT CORPORATION (HFDC) EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)**

Thank you for your comments of June 24, 1998 regarding the East Kapolei Master Plan Development Project - Draft Environmental Impact Statement. We offer the following response to each of your comments.

A. The name of the sports complex will be revised in the final EIS to "Kapolei Sports Complex."

B. The acreage of the sports complex area has fluctuated as the Kapolei Parkway alignment has moved in a mauka/makai direction. For planning purposes in the EIS, we are using an estimated acreage of 64.3. This area will likely be revised again once the Kapolei Parkway design is complete.

C. We will revise the Final Environmental Impact Statement (FEIS) to indicate that the sports complex will not be used to satisfy the City's Park Dedication requirements.

D. We will use the name park 'n ride throughout the document instead of of park-and-ride.

E. We will revise the FEIS to reflect that the State's Civic Center employees will not have use of a park 'n ride facility at the sports complex in the near future. This area will be labeled as on the East Kapolei Master Plan as "parking".

F. We agree that an elevated parking structure could be added over the parking lot for a public park 'n ride for a future transit system. We will revise the FEIS to address this

HFDC

potential use.

G. According to the Department of Accounting and General Services, we understand that there will be adequate parking provided for public employees and others at the Kapolei Civic Center in accordance with City parking requirements.

H. According to our traffic consultant, the traffic estimates in the April 1998 traffic report, which included use of the Kapolei sports complex parking lot by employees located at the Kapolei Civic Center, would be the high estimate of traffic generated by Area H. If the parking lot is not used by off-site employees, the traffic generated by Area h would be less and impacts identified will also be less. The difference, however, would not be significant as traffic from Area H is only a small portion of the of the total peak hour traffic on the major roadways in the vicinity. Therefore, because the park 'n ride facility could be developed in the future on the site as originally planned, we prefer to keep the park n' ride facility factored into the projected traffic counts.

Thank you once again for participating in the environmental review process.

Sincerely,

ROY S. OSHIRO
Executive Director

DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

OFFICE OF PLANNING
235 South Beretania Street, 6th Flr., Honolulu, Hawaii 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

BENJAMIN J. CAYETANO
GOVERNOR
SEIJI F. NAYA
DIRECTOR
BRADLEY J. MOSSMAN
DEPUTY DIRECTOR
RICK EGGED
DIRECTOR, OFFICE OF PLANNING

Tel.: (808) 587-2846
Fax: (808) 587-2824

Ref. No. P-7535

June 30, 1998

MEMORANDUM

TO: Mr. Roy S. Oshiro, Executive Director
State Housing Finance and Development Corporation

FROM: Rick Egged
Director, Office of Planning

SUBJECT: Draft Environmental Impact Statement (DEIS) for
East Kapolei Master Plan
Prepared for: Housing Finance and Development Corporation (HFDC)

We have reviewed the subject HFDC East Kapolei Master Plan Development Project Draft Environmental Impact Statement (DEIS) for an approximately 1300-acre area in Kapolei, Ewa, Oahu. The master development plan consists of the following seven tax map key parcels: TMK(s) 9-1-16: 08, 108 and 109; 9-1-17: 04 and 71; and, 9-1-18:03 and 05. The purpose of the project is to provide the major infrastructure and support facilities necessary to facilitate development in the Ewa Development Plan area for residents of Hawaii. In addition, proceeds from the sale of developable land parcels (500 acres at the original university site) would be used to support initial construction of the University of Hawaii at West Oahu.

We note that a boundary amendment petition will be filed in the near future to reclassify the project area from the State Agricultural District into the State Urban District. At that time, OP will review and recommend conditions to be applied to the boundary amendment to mitigate anticipated impacts.

We submit the following comments for your consideration. Section 5.9.1 (p. 69-70), identifies the area's existing schools, enrollments and the anticipated impacts and mitigative measures committed to by HFDC. Previous discussions between HFDC, the Department of Education, Campbell Estate, and our office have focused on acreage obligations for school dedication to mitigate impacts. Those discussions indicated the need for approximately 78 acres for future schools. Based on the preliminary master plan, a minimum of three elementary school sites and one intermediate school site totalling 56 acres, and a balance of 22 acres towards a future high school site were identified. Section 2.9 (p. 22-23) references the elementary and intermediate school sites, but no mention is made of a high school site. The EIS should clarify and affirm HFDC's commitment to providing the necessary portion of land or in-lieu cash contribution for their portion of a new high school site. In addition, some discussion is appropriate regarding any constraints on a specific location for a needed high school site whether on HFDC land or adjacent privately-owned lands.

Section 2.11.3 pertaining to drainage facilities states that all storm water entering this subject property must ultimately flow through the property and discharge into the ocean or infiltrate into the ground. The existing Kaloi Gulch drainage system is inadequate and significant drainage impacts will be realized if appropriate mitigation measures are not implemented. Section 5.6 of Appendix B states that HFDC may need to negotiate a drainage plan with Campbell Estate and the City and County to attenuate the increased West Loch basin flows. It further states if Campbell Estate does not incorporate the West Loch basin portion of East Kapolei into their drainage plan, East Kapolei will need to provide for the storage onsite. The various options should be further discussed and schematically diagrammed in the Final EIS.

Appendix F: Habitat Conservation Plan (HCP), has been developed to address the existence of the endangered plant - *Abutilon menziesii* (Ko'oloa'ula or Red 'Ilima). A number of mitigative measures are proposed including staff required to implement the plan. Page 16 of the plan indicates that HFDC proposes to set up a "Trust Fund" that would generate sufficient revenues to fund the mitigation plan. The proposed funding source(s) for this "Trust Fund" should be identified. The EIS should discuss what assurances there are that this source(s) will be adequate to implement the actions identified in the HCP. As indicated on p. 6, the greatest impact to the *Abutilon* would be between 1998 and 2008. The EIS should discuss whether the funding source(s) will be available and adequate during this time period.

The Office of Planning is supportive of efforts to develop the Kapolei area as a means of fostering growth of Oahu's "Second City." Implementation of the proposed master plan further supports the economic vitality of the State. Thank you for the opportunity to review and comment. If you have any questions, please contact Scott Derrickson at (808) 587-2805.

cc: Seiji Naya, Director DBEDT
Esther Ueda, LUC
Earl Yamamoto, DOA

BENJAMIN J. CAYETANO
GOVERNOR

DONALD K.W. LAU
EXECUTIVE DIRECTOR

SHARYN L. MIYASHIRO
EXECUTIVE ASSISTANT

STATE OF HAWAII

DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM
HOUSING AND COMMUNITY DEVELOPMENT CORPORATION OF HAWAII

677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

98:DEV/61

July 10, 1998

TO: Rick Egged, Director
Office of Planning
Department of Business Economic Development & Tourism

From: Donald K. W. Lau, Executive Director

Subject: Comments Regarding Housing and Community Development Corporation of Hawaii (HCDCH) East Kapolei Master Plan Development Project - Draft Environmental Impact Statement (DEIS)

Thank you for your comments of June 30, 1998 regarding the East Kapolei Master Plan Development Project Draft Environmental Impact Statement. We offer the following response to each of your comments.

1. According to comments received from the Department of Education(DOE), three agencies (DOE, HCDCH, and the Office of Planning) are in the process of determining how best to address the balance of approximately $1.53 million due as impact fees requested by the DOE based on a total of 8,400 units at $850 per unit. Our current position is that the fees will be paid to DOE as the residential units are developed and sold in the future. We will continue to negotiate with the DOE to resolve this issue.

   Although a high school site is not planned within the HCDCH East Kapolei project area, an off-site high school site is indicated on the Master Plan located on adjoining Campbell Estate lands. The future transfer of the future high school site will be subject to negotiation between Campbell Estate and DOE. Because the East Kapolei Master Plan project will generate only a portion of the demand for a new high school, DOE has indicated to HCDCH that dedication of the 56 acres of school sites plus the payment of the balance of the fair share requirement to DOE will satisfy the DOE's requirements in full.

   We suggest that the specific wording to commit HCDCH to the DOE fair-share requirement can be determined during the Land Use Commission's review and conditional approval of the needed State Land Use District Boundary Amendment Petition.

2. As indicated in Appendix B, Drainage Master Plan, the East Kapolei project will provide improvements to a significant portion of the Estate of James Campbell's (EJC) Kaloi Gulch drainage basin runoff. Therefore, HCDCH feels that it is reasonable for EJC to also accept drainage runoff from the East Kapolei project area into the EJC's West Loch basin drainage system. Mitigation of flows to the West Loch basin from the East Kapolei project area is being negotiated with EJC to determine where future basins may be located. However, at this stage in the planning process, the EJC cannot prepare a feasible drainage study for their lands without having more specific details regarding future land use types, density, location of future roadways, and timing of future development on EJC lands.

3. The proposed Trust Fund proposed by HCDCH to mitigate the impact to Abutilon menziesii will be established by HCDCH through the use of their revolving fund in the short term, and then financed from project revenues in the long term. The specific details regarding establishment and management of the Trust Fund are being worked out by HCDCH in consultation with the Department of Land and Natural Resources and U.S. Fish and Wildlife.

Once again, thank you for participating in the environmental review process.

University of Hawai'i at Mānoa

Environmental Center
A Unit of Water Resources Research Center
Crawford 317 • 2550 Campus Road • Honolulu, Hawai'i 96822
Telephone: (808) 956-7361 • Facsimile: (808) 956-3980

June 22, 1998
RE:0690

David Hulse
PBR Hawaii
1001 Bishop Street, Pacific Tower 650
Honolulu, Hawaii 96813

Dear Mr. Hulse;

Draft Environmental Impact Statement
East Kapolei Master Plan
Ewa, Oahu

The State Legislature and the State Housing Finance and Development Corporation (HFDC) propose this development to create more housing, recreational and support facilities in the Ewa Development Plan area, while also generating income from State-owned land in support of a new University of Hawaii West Oahu Campus. The concept includes a mixture of single family and multi-family homes, commercial and public facilities, parks, open space, and recreational land uses, replacing existing fallow agricultural land.

Post HFDC infrastructure development, large-lot parcels will be sold to private developers. All residential and commercial lots will be developed by the private sector in accordance with the East Kapolei Master Plan and compliance with the City's zoning regulations and affordable housing policy.

The Environmental Center has reviewed the document with the assistance of Paul Ekern, Agronomy and Soil Science Emeritus; Frank Howarth, Graduate Affiliate Faculty in Entomology; and Victoria Cullins of the Environmental Center.

Loss of Agricultural Lands

Our reviewers agree that that the limiting factor to the growth of diversified agriculture will not be the land supply, but rather the size of the market for those crops that can be profitably grown in Hawaii. However, although considerable amounts of

agricultural land remain on Oahu and throughout the state, conversion of these lands to diverse use will raise land prices (both sale and rental) engendering far-reaching economic multipliers. The Final Environmental Impact Statement will need to address the impact of agricultural land use conversion in this context.

Drainage

The discussion of groundwater aquifers, should indicate the depth from the ground surface to the water table. Seepage and possible groundwater contamination should be discussed along with recharge potential. Sugar cane production has a high rate of aquifer recharge, while housing developments contribute very little. Grass berms should be used as much as possible in channeling the Kaloi Gulch or other drainage channels. Grass berms have potential for recharge while CRM berms do not.

Water Use

Our reviewers commend the objective of the plan to use reclaimed water as a non-potable water source. This plan is an excellent example of a development where a large volume of nonpotable water may effectively be utilized in an area where potable water is currently unavailable, and given future growth projections, will always be scarce. Reclaimed water should be the top priority for irrigation both makai and makau of the freeway boundary.

Landscaping of public areas and the sports complex should include the use of xeriscape vegetation to decrease the use of water resources. Recycling in these areas should also be encouraged and recycling facilities made readily available.

Sports Complex

Will noise from the Sports complex reach the residential areas? Will the area have lighting for evening activities and if so will this pose an impact to adjacent areas? These impacts should be discussed and mitigation methods described in the Final EIA.

Karstic Features

The Ewa plain is an emerged coral reef formed during the Pleistocene period when the ocean was at a higher level. Karstic features, such as dissolution caves (sinkholes) or anchialine pools in the sinkholes harboring rare or as yet undiscovered species, have been previously documented on the Ewa Plains. The *opae ula* (endemic Hawaiian red shrimp), is commonly found in these subterranean anchialine ponds. Dry sinkholes often contain fossils of prehistorically or historically extinct birds. These types of caves may also have been used for habitation by native Hawaiians.

David Hulse
June 22, 1998
Page 3

Due to past sea level changes and subsequent lava flows, most sinkholes are found at elevations of less than 50 feet. Most of the area contained within the East Kapolei plan is above the 50 foot elevation level. Sinkholes that were evident are probably now covered by previous agricultural activities.

Mitigation measures should be included in the Final EIS to assure protection of the scientific resources of the sinkholes during the construction of infrastructure, or further development of the project.

Our reviewers suggest that the potential for sinkholes to be present is significant whenever the area being developed is found to have limestone rather than lava substrate. Sinkholes can be recognized in limestone substrate as areas resembling man-made wells. Our reviewers suggest the following mitigation methods if a sinkhole should be found. They should be reported to the State Historic Preservation Division and excavated by a paleontologist or archaeologist. If excavation is not performed, the sinkholes should be preserved for later analysis by capping with concrete. Capping may also prevent further subsidence that could affect structures built on top of a sinkhole.

Conclusion

Thank you for the opportunity to review this Draft Environmental Impact Statement. The document is well formed overall. Our reviewers concur that addressing the concerns stated above in the Final EIS will further enhance the Master Plan.

Sincerely,
Jacquelin N. Miller
for John T. Harrison
Environmental Coordinator

c: OEQC
Roger Fujioka
Paul Ekern
Frank Howarth
Victoria Cullins

BENJAMIN J. CAYETANO
GOVERNOR

ROY S. OSHIRO
EXECUTIVE DIRECTOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

IN REPLY REFER TO:
98:DEV/2366

June 30, 1998

Mr. John T. Harrison
Environmental Coordinator
University of Hawaii - Manoa
Environmental Center
2550 Campus Road, Crawford 817
Honolulu, Hawaii 96822

Dear Mr. Harrison:

SUBJECT: **COMMENTS REGARDING HOUSING FINANCE AND DEVELOPMENT CORPORATION (HFDC) EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)**

Dear Mr. Harrison:

Thank you for your comments of June 22, 1998 regarding the East Kapolei Master Plan Development Project - Draft Environmental Impact Statement. We offer the following response to each of your comments.

Loss of Agricultural Lands

While the value of nearby agricultural lands may increase over time, it is not true that higher land values drive up agricultural land rents. In fact, it is common in Hawaii for land values to increase (reflecting the development potential many decades in the future), while agricultural land rents remain stable or even decline. Agricultural rents are determined by the underlying profitability of farming and market conditions (the demand for farm land versus the supply, competition among farmers and landowners, etc.).

Also, the City's property assessment for agricultural land that is farmed is based on the relatively low agricultural value of the land--not its much higher market value. Thus, increasing market values of land do not translate into higher property taxes on agricultural land that is farmed.

HFDC

Drainage

Regarding the discussion of groundwater aquifers, two staff reports from the Deputy Director of the Commission on Water Resource Management have been included as Appendix D of the DEIS. These are entitled "Proposed Establishment of Aquifer Systems and Adoption of Sustainable Capacities by Well, Ewa Caprock Ground Water Management Area, Oahu" and "Applications for Water Use Permits Applications for Well Construction/Pump Installation Permits and Allocation Plan for Water Use Permits".

The first report provides an analysis of issues that could potentially impact the Ewa Caprock Aquifer "in response to the large-scale modifications in land and water use as sugarcane is replaced by urban developments." Based on the findings of this analysis, a 1,000 mg/l chloride cap has been established by the Water Commission as the basis for providing "adequate protection of the aquifer for irrigation and other nonpotable uses." We wish to emphasize that sugarcane is no longer contributing to groundwater recharge anywhere on Oahu. Therefore, a comparison of sugarcane recharge with the recharge from urban developments is no longer applicable as described in the staff reports.

You are correct that a portion of the proposed Kaloi Channel improvements will include CRM-lined channels. This material was selected as an erosion control measure for portions of the channel that could receive high velocity flows during intense storms. Without the CRM-lined portions of the channel, the velocity of the water could potentially suspend a significant quantity of soil in the run-off flows. This could also reduce the effectiveness of the retention/settlement basins and damage other drainage channel improvements. We would prefer to use all grass drainageways for economic reasons, however, grass does not provide the level of erosion protection as concrete in high velocity areas.

At the appropriate time in the approval process, HFDC will apply to the Commission on Water Resource Management to obtain the necessary permits for the development of potable and non-potable water sources.

Water Use

According to the Department of Wastewater Management, reuse water from the Honouliuli Wastewater Treatment Plan (WWTP) may be available for irrigation use by June 30, 1999. A distribution system within the East Kapolei Master Plan area will be provided as applicable. A stub out point location will be determined in consultation with the Treatment and Disposal Division, Department

of Wastewater Management.

At the present time, landscaping of public areas and the sports complex will include the use of native plant materials and some xeriscape vegetation as important elements of the landscape design to decrease the use of water resources. Recycling will also be encouraged in accordance with the City's recycling program. Recycling is presently available at the City's H-Power waste-to-energy facility where solid waste is recycled into energy production.

Sports Complex

Noise impacts will be mitigated by redirecting the sports stadium away from residential areas (the site plan in the DEIS will be revised). To ensure that sports complex lighting does not impact residential areas, all high intensity lights, street lights, and parking lot lights will be shielded or directed downwards, and use of spot lights will be limited only to occasional special events.

Karstic Features

We concur that most sinkholes are found at elevation of less than 50 feet and most of the area contained within the East kapolei plan is above the 50 foot elevation. Sinkholes that may have been present would now be covered as a result of past agricultural activities. No sinkholes are evident on the surface.

As stated in the subject document, the proposed East Kapolei Master Plan was prepared in response to State policy to direct new development to the Ewa Plain. Along with this new development, appropriate geotechnical studies will be conducted by project developers to ensure that subsurface geology does not present safety hazards where heavy construction equipment will be required. However, at this stage in the planning process, known karstic features within the project area do not present a significant planning constraint. Please note that the Housing Finance and Development Corporation will not act as the project developer of individual dwelling units, but will only provide the major infrastructure for large lot development parcels.

Should any sinkholes be found during construction activities, the State Historic Preservation division will be notified to determine appropriate data collection measures.

We hope our comments have addressed each of your concerns. Once again, thank you for participating in the environmental review process.

Sincerely,

ROY S. OSHIRO
Executive Director

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Ecoregion
300 Ala Moana Boulevard, Room 3-122
Box 50088
Honolulu, Hawaii 96850

JUN 26 1998

In Reply Refer To: LTG

JUN 25 1998

Steve Thomas
State Housing Finance and Development Corporation
677 Queen Street, Suite 300
Honolulu, HI 96813

Re: Draft Environmental Impact Statement for the East Kapolei Master Plan Development Project, Ewa, Oahu, Hawaii

Dear Mr. Thomas:

The U.S. Fish and Wildlife Service (Service) has reviewed the Draft Environmental Impact Statement (DEIS) for the East Kapolei Master Plan Development Project (East Kapolei MPDP), Ewa, Oahu, Hawaii. The project sponsor is the State Housing Finance and Development Corporation. The proposed project occurs on 1,300 acres of land owned by the State of Hawaii Department of Land and Natural Resources and involves the construction of single and multi-family residential housing, commercial/retail facilities, a sports complex, schools, parks, and an open space corridor. The Service offers the following comments and recommendations for your consideration.

General Comments

Cumulative Impacts

The DEIS does not address cumulative impacts to the federally and State listed endangered plant, *Abutilon menziesii*. The Service recommends that the Final EIS (FEIS) address the impacts of the proposed project and the North South Road Project on this species. Incidental take of 86 plants is anticipated as a result of the implementation of both projects. These 86 plants represent the entire population of *Abutilon menziesii* on the island of Oahu and 17-20% of all known individuals of this plant.

Mitigation for *Abutilon menziesii*

The Habitat Conservation Plan (HCP) in appendix F of the DEIS provides a summary of the mitigation measures proposed for the incidental take of 86 plants of *Abutilon menziesii* as a result of the East Kapolei MPDP and the North-South Road Project, but, does not offer any alternatives that would avoid take of this species. The Service suggests that alternatives be proposed that would avoid some or all of the incidental take of *Abutilon menziesii*. For example, some of the proposed parks within the project could be designed around existing *Abutilon menziesii* plant clusters.

The current draft HCP proposes several measures to mitigate for impacts resulting from implementation of the East Kapolei MPDP, as well as a summary of the mitigation measure proposed for implementation of the North South Road Project. In summary, the HCP proposes that seeds, cuttings, and air layers taken from existing *Abutilon menziesii* plants, will be propagated at an on-site and two off-site nursery facilities, and the progeny will be transplanted into the open space corridor. The "mother plants" will be moved to the on-site nursery, transplanted into pots and eventually into the open space corridor within the project. The HCP proposes to propagate, transplant, and manage these plants for a time period of 10 years. According to HRS 195D, HCPs need to "...consider the full range of the species on the island so that cumulative impacts associated with the take can be adequately assessed... be consistent with an approved recovery plan for the endangered or threatened species...and result in an overall net gain in the recovery of Hawaii's threatened and endangered species." The Service views the mitigation measures proposed in the draft HCP as a good start but, does not believe these measures alone meet the above mentioned requirements.

The Service believes that the following actions, when implemented together, will minimize impacts to the species, offset the cumulative impacts of the proposed development plan, contribute to the recovery of the species, be environmentally beneficial, and permit the development plans to proceed:

1. Set aside and manage areas around existing plant clusters A, B, or portions of C, or a combination thereof, as *in situ* preserves for *Abutilon menziesii*. These preserves would be set aside and managed until a self-sustaining off-site population is established on Oahu.

2. Establish and preserve an off-site, self-sustaining, wild population of *Abutilon menziesii* on Oahu. The historic range of this species on Oahu is not well known, and identification of an appropriate site will require the assistance of botanical experts. Areas such as Barbers Point, Kaena Point, and Lualualei Naval Magazine may be appropriate for *Abutilon menziesii*. Our office will be happy to assist in identifying an appropriate area and developing a long term management plan for these plants.

3. Establish a propagation program that will assist in maintaining the genetic diversity and viability of *in situ* populations of *Abutilon menziesii* until a self-sustaining off-site population is securely established in a protected area on Oahu. These activities

should begin prior to the start of the development project to assure that there is no loss of individual plants. We emphasize that the cultivation of *Abutilon menziesii* is not a substitute for an *in situ* population, and is not adequate mitigation for the only known population of this species on Oahu.

Specific Comments

Pages 41-43. Flora and Fauna

Both this section of the DEIS and the HCP provides a description of the existing conditions, anticipated impacts, and mitigation measures regarding the federally and State endangered plant, *Abutilon menziesii*. The HCP, however, provides a more detailed description of the existing conditions (*e.g.* identifies that this population of *Abutilon menziesii* is the only known population on Oahu) and the anticipated impacts (*e.g.* the number of plants to be taken). The Service recommends that this section also include a more detailed description of existing conditions and anticipated impacts consistent with the HCP.

Appendix F. Habitat Conservation Plan

Page iii. Preface

According to the HCP, the plan will contribute to the recovery of *Abutilon menziesii*. However, it is unclear how this HCP contributes to the recovery of this species. The Service suggests that the HCP describe how it is promoting recovery of *Abutilon menziesii*.

Page 5. Impact to *Abutilon menziesii*

The HCP states that the period of impact for *Abutilon menziesii* is between 1998 - 2008. However, this refers only to the time frame during which "take" of the plants will occur. The impact, however, will be permanent. The HCP should be revised to reflect this. The Service also suggests that cumulative impacts be addressed in this section.

Page 6. Strategy 1 Determine Master Plan development schedule and mitigation phasing sequence

The HCP does not provide a map which indicates the location of populations C-1, C-2, and C-3. The Service recommends that the HCP include a map depicting the location of these three populations within the project area.

Page 9. 3.2 Manage current populations

This section identifies several measures that will be implemented to manage the current population prior to construction. The Service suggests that the Final HCP include details regarding each type of management technique (*e.g.* weed control, fire protection, predation and disease control) to be

implemented. Examples of the information to include would be identification of herbicides and the quantity that will be used, frequency of application, and monitoring methodology.

Pages 10 - 11. Strategy 5 Establish on-site nursery facility for propagation of *Abutilon menziesii*.

Brief descriptions are provided on the collection and propagation of *Abutilon menziesii*. The Final HCP or an appendix to the HCP should contain a detailed description of the propagation methods, and a description of cutting, air-layering, and seed collection techniques.

Page 12. Strategy 6 Transplant *Abutilon menziesii* to on-site drainage/open space corridor

The HCP states that *Abutilon menziesii* will be integrated with other native species, if appropriate, and if native plant materials are available at no cost. However, it is unclear why it might not be considered appropriate to plant other native species around clusters of *Abutilon menziesii* or why native plants wouldn't be used for landscaping unless the source materials are available at no cost. The Service suggests that the Final HCP state under which situations it would or wouldn't plant native species around *Abutilon menziesii* clusters and clarify why native plants won't be used in landscaping unless the source material is available at no cost.

Pages 12. Strategy 7 Long-term protection and management of permanent *Abutilon menziesii* population

This section implies that long-term management of *Abutilon menziesii* within the project area will only occur between 1998 to 2008, during the impact period. As previously stated, the impacts to this species are permanent, thus the mitigation should also be permanent. The HCP should ensure that mitigation includes protection and management of the species in perpetuity, and state who, will be responsible for the protection and management beyond the ten years that have been identified.

This section identifies several measures that will be implemented for the long-term protection and management of the cultivated population of *Abutilon menziesii*. The Service suggests that the Final HCP include details regarding each type of management technique (*e.g.* weed control, fire protection, predation and disease control) to be implemented. Examples of the information to include would be identification of herbicides and the quantity that will be used, frequency of application, and monitoring methodology.

Page 13. 7.4 Ensure availability of pollination vectors

The HCP states that it will ensure that pollen vectors remain available and that if they are missing, measures will be taken to compensate for the lack of them, but, it provides no details regarding such measures. The Final HCP should describe the measures to be taken to compensate for any loss of natural pollen vectors. The Service recommends that only native species be used or if not available, species that are already available on the island of Oahu so that new non-native species are not introduced or established.

Page 13, 7.5 Educational awareness through signage

It is unclear why there is a concern with hikers and their education regarding designated sensitive environmental areas and/or research areas. The Final HCP should clarify what is meant by a sensitive environmental area and why there is a concern with hikers since there are no proposed hiking trails within the project area.

Pages 14 - 15, Strategy 9 Conduct essential research

It is unclear how certain research topics identified in the HCP pertain to the cultivation of *Abutilon menziesii*. An example is the research topic involving mapping of alien vegetation. This topic does not seem appropriate since it is assumed that the majority of the vegetation surrounding cultivated *Abutilon menziesii* will be non-native species. The Service suggests that the HCP clarify proposed research topics so that there is no confusion regarding its pertinence to the cultivation of this species.

The Service encourages research that assists in the recovery of *Abutilon menziesii*. The Service recommends that any proposed research focus on establishing viable populations of *Abutilon menziesii* throughout its range (i.e. Lanai, Maui, Oahu, and the island of Hawaii) in the wild.

The Service offers these comments as technical assistance for your consideration in preparation of the Final EIS. We look forward to further coordination with you on this project as more specific information becomes available. If you have any questions concerning these comments, please contact Fish and Wildlife Biologist Leila Gibson at 808/541-3441.

Sincerely,

Brooks Harper
Field Supervisor
Ecological Services

cc: OEQC
PBR Hawaii
DOFAW, Hawaii

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION

98:DEV/2367

June 30, 1998

Mr. Brooks Harper, Field Supervisor
Ecological Services
U.S. Fish and Wildlife Service
300 Ala Moana Boulevard, Room 3-122
Box 50088
Honolulu, Hawaii 96850

Reference: LTG

Dear Mr. Harper:

SUBJECT: **COMMENTS REGARDING HOUSING FINANCE AND DEVELOPMENT CORPORATION (HFDC) EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)**

Thank you for your comments of June 25, 1998 regarding the East Kapolei Master Plan Development Project - Draft Environmental Impact Statement. As you know, the DEIS included a summary of the proposed *Abutilon menziesii* Habitat Conservation Plan ("HCP") prepared between December 1997 and April 1998. Since that time, HFDC and our consultants have met with your staff to prepare a HCP that addressed your concerns. Consequently, we have significantly revised the HCP based on the discussions and input received at several meetings. Therefore, the following response to each of your comments reflects our understanding of the appropriate course of action based on our discussions with your staff.

General Comments

Cumulative Impacts

We have finalized the Habitat Conservation Plan for *Abutilon menziesii* and will provide it in the East Kapolei - Final Environmental Impact Statement (FEIS). Included in the HCP is the *North-South Road Mitigation Plan for Abutilon menziesii*, in its entirety. The FEIS has been revised to address the cumulative impact of both the East Kapolei Master Plan and North-South Road projects on this species.

HFDC

Specific Comments

1. **(DEIS Text) Pages 41-43, Flora and Fauna**

   Section 4.8 of the EIS has been augmented and is now consistent with the Habitat Conservation Plan. The revised HCP has been finalized and incorporates your relevant recommendations and will be included in the FEIS as Appendix F.

2. **Appendix F. Habitat Conservation Plan**

   Page iii, Preface. The goal of this plan is to increase the number of *Abutilon menziesii* plants at the Kapolei population from the existing 86 plants onsite to double or more in number over a ten-year period. The Lanai Plant Cluster Recovery Plan indicates certain criteria to downlist and delist the taxa in the Lanai plan including the numbers of populations of the taxa on Lanai and elsewhere in the state. We anticipate that the proposed mitigation actions of the East Kapolei HCP will contribute towards the recovery of this species by cultivating a vigorous population with a minimum of at least a 100 plants. We anticipate that this population would then be considered as one of the required populations contributing to downlisting and eventual delisting.

   Page 5, Impact to Abutilon menziesii. As described in the revised HCP, the take on the existing plants will occur incrementally over ten years. The existing plants will be temporarily moved to the on-site nursery, thus, changing their location. With successful implementation of the HCP measures, plant progeny from the existing plants would continue the genetic diversity of the existing population, initially at the nursery facility and by establishment of new plant individuals to be relocated to the project drainage areas. Therefore, we believe that the impact is not a permanent impact.

   Page 6, Strategy 1: Determine Master Plan development schedule and mitigation phasing sequence. The revised HCP (Appendix F, FEIS) includes a map depicting the plant clusters as recommended.

   Page 9, Manage current populations. Additional detailed regarding the management of the plant population have been included in the revised HCP. This management program was prepared following the guidelines set forth in the Lanai

   Recovery Plan. The type and quantities of herbicides, if used at all, to manage weeds, predation, and disease will be determined through our research efforts and field observations once implementation of the revised HCP is underway.

   Page 10 -11, Strategy 5: Establish on-site nursery facility for propagation of Abutilon menziesii. The propagation methods, and a description of cutting, air-layering, and seed collection techniques have been described in the revised HCP attached to the FEIS for the East Kapolei project.

   Page 12, Strategy 6: Transplant Abutilon menziesii toon-site drainage/open space corridor. Other appropriate native plants will be used in the landscaping of the drainageway

   Pages 12, Strategy 7: Long-term protection and management of permanent Abutilon menziesii population. HFDC will establish a 20-year trust fund to ensure that revenues will be available to implement the HCP during the development period (approximately 10 years) and the long-term management period for *Abutilon menziesii*. *Abutilon* is considered to be a long-lived perennial by the Lanai Recovery Plan. Therefore, the long-term management plan as described in the revised HCP will be tied to the recovery goals as described in the Lanai Recovery Plan.

   Since field observations and research over an extended period have yet to be completed, the final details requested by your comments cannot be determined at this time. However, we are confident that the program we have proposed will provide the necessary background data required to ensure successful implementation and proper management of the HCP requirements.

   Page 13, 7.4 Ensure availability of pollination vectors. As described in the HCP, the project manager, who will be a botanist or horticulturist, will ensure that pollination will be adequate to ensure proper seed production. This will be accomplished by bees and other natives, or manually pollinated by the project manager.

   Page 13, 7.5 Educational awareness through signage. We wish to clarify that the proposed drainage areas will be designed with hiking and bike paths. Therefore, interpretive signage will be placed within these areas to public educational awareness of the *Abutilon* located in the area. Other signage will inform visitors to refrain from activities that could potentially be harmful to *Abutilon*.

Pages 14 -15, Strategy 9: Conduct essential research. The details regarding the research component are provided in the revised HCP, Appendix F FEIS.

We appreciate the Service's continuing assistance in providing technical support in preparation of the Final EIS. Once again, thank you for participating in the environmental review process.

Sincerely,

ROY S. OSHIRO
Executive Director

GTE Hawaiian Tel

Beyond the call

GTE Hawaiian Telephone Company Incorporated
P.O. Box 2200 • Honolulu, HI 96841 • 808 546-4511

June 24, 1998

Reply to
HIABY3

JUN 2 9 1998

Mr. David Hulse
PBR Hawaii
1001 Bishop Street, Pacific Tower #650
Honolulu, HI 96813

Dear Mr. Hulse:

Subject: **East Kapolei Master Plan Draft Environmental Impact Statement**

Thank you for the opportunity to review and comment on the your proposed environmental impact document for the East Kapolei Master Plan. We have no comments to add to your document at this time.

If you have any questions or require assistance in the future on the project, please call me at 840-1447.

Sincerely,

Paul K. Hanohano

Paul K. Hanohano
Designer - Access Design

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

ROY S. OSHIRO
EXECUTIVE DIRECTOR

IN REPLY REFER TO
98:DEV/2369

June 30, 1998

Mr. Paul K. Hanohano
Designer - Access Design
GTE Hawaiian Telephone
P.O. Box 2200
Honolulu, Hawaii 96841

Dear Mr. Hanohano:

SUBJECT: COMMENTS REGARDING HOUSING FINANCE AND DEVELOPMENT CORPORATION (HFDC) EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)

Thank you for your comments of June 24, 1998 regarding the East Kapolei Master Plan Development Project - Draft Environmental Impact Statement and for participating in the environmental review process.

Sincerely,

ROY S. OSHIRO
Executive Director

HFDC

Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840-0001

Scott W.H. Seu, P.E.
Manager
Environmental Department

PBR HAWAII
RECEIVED
JUN 24 1998

June 22, 1998

State Housing Finance and Development Corporation
677 Queen Street, Suite 300
Honolulu, HI 96813
Attention: Mr. Steve Thomas

Dear: Mr. Thomas

Subject: HFDC East Kapolei Master Plan Development Project

Thank you for the opportunity to comment on your April 1998 Draft EIS for the East Kapolei Master Plan Development, as proposed by the Housing Finance and Development Corporation. We have reviewed the subject document and have the following comments:

On Page 46: *"Development of the subject property will produce traffic impacts on local, collector and regional transportation systems as the residential population of the area increases in the future. To identify these impacts, existing and projected traffic flow and proposed transportation improvements have been provided in the East Kapolei Project Traffic Report (Appendix H)."* (The Project Traffic Report does not take into account the closure of the Barbars Point Naval Air Station and subsequent redevelopment of the areas not retained by the Navy. Traffic flow will increase and continuation of the North-South Road into this area should be considered.) Francis Hirakami

On Page 67: *"HECO's available generation capacity of 199 MW... present peak demand of 166.3 MW"* (HECO's current peak demand for 1998 is 1119 MW.) Matt Goo

On Page 68: *"Both 138 KV lines turn south at the intersection and follow the alignment of the future North-South Road to the OR&L right-of-way"* (The steel poles supporting both 138 KV lines are within easements granted by the DLNR and are generally parallel to the North-South Road alignment. HECO is in contact with the planners of the North-South Road to minimize any impacts that construction of the roadway will have on the steel poles. Engineers for the Kaloi Channel Improvements are to coordinate design and construction efforts with HECO to minimize any impact to the steel poles and foundations which support the two 138 KV lines.) Francis Hirakami

On Page 68: *"...the East Kapolei Master Plan will generate a peak electrical demand of 57.8 kva"* (In the Index of Electrical Demands and Refuse Calculations, it states a total demand of 57,808.992 kva.) Matt Goo

On Page 68: *"...the solid waste production from the East Kapolei Master Plan will generate approximately 21 megawatts at the City's H-Power waste-to-energy facility"* (H-Power is currently contracted by HECO to provide 46 MW. The additional waste material will not add to the H-Power's capacity without additional generation capacity being added.) Matt Goo/Bill Muench

Our points of contact for this project, and the originators of these comments, are Bill Muench (543-5657) Senior Customer Engineer, Francis Hirakami (543-7536) Principal Engineer and Matt Goo (543-7826) Lead Distribution Planning Engineer. I suggest your staff and consultants deal directly with these people to coordinate HECO's continuing input on this project.

Sincerely,

Scott W H Seu

cc: OEQC

Office of the Governor
c/o OEQC
235 S. Beretania St., Rm. 702
Honolulu, HI 96813

PBR Hawaii
1001 Bishop Street, Pacific Tower, #650
Honolulu, HI 96813
Atten: David Husle

B. Muench
F. Hirakami
M. Goo

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

ROY S. OSHIRO
EXECUTIVE DIRECTOR

IN REPLY REFER TO:
98:DEV/2315

June 26, 1998

Mr. Scott W. H. Seu, P.E.
Manager Environmental Department
Hawaiian Electric Company, Inc.
P. O. Box 2750
Honolulu, Hawaii 96840-0001

Dear Mr. Seu:

SUBJECT: **COMMENTS REGARDING HOUSING FINANCE AND DEVELOPMENT CORPORATION's (HFDC) EAST KAPOLEI MASTER PLAN (EKMP) DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)**

Thank you for your comments of June 22, 1998 regarding the EKMP Development project - DEIS. We offer the following response to each of your comments:

1. We agree that traffic flow in the region will be impacted by the future redevelopment of Barbers Point Naval Air Station (BPNAS). To assess these traffic impacts, we understand that a Draft Environmental Impact Statement is currently being prepared by the Navy and will be available for public review in mid-July. Based on the type of land uses proposed, it is not clear that the level of traffic will increase compared to the previous military use of the property. However, to accommodate a future connection to BPNAS from the North/South Road, should it be warranted in the future, sufficient land area will be retained as open space within the sports complex area to permit a future connection.

2. We will correct the statement on page 67 of the DEIS to reflect HECO's current peak demand for 1998 at 119MW.

3. Our civil engineer consultant, R. M. Towill Corporation, will continue to coordinate design and construction efforts with HECO to minimize any impact to the steel poles and foundations which support the two 138KV overhead power lines.

HFDC

4. We will also revise the Final EIS to correct the peak electrical demand statement to read 57,808.992kva rather than 57.8kva as presently stated.

5. We also concur that additional capacity at the H-power waste-to-energy facility may be required in the future to accommodate the solid waste generated by future island wide population growth.

Once again, we thank you for participating in the environmental review process.

Sincerely,

ROY S. OSHIRO
Executive Director

c: David Hulse, PBR Hawaii

HASEKO

HASEKO (Ewa), Inc.
820 Mililani Street, Suite 810 Honolulu, Hawaii 96813-2938
Phone (808) 599-1444 Fax (808) 545-5590

PBR HAWAII RECEIVED JUN 22 1998 Project Project No.

June 22, 1998

HAND-DELIVERED

Mr. Roy Oshiro, Executive Director
Housing Finance and Development Corporation
677 Queen Street, Suite 300
Honolulu, Hawaii 96813

Re: East Kapolei Master Plan Draft EIS

Dear Mr. Oshiro:

This letter is submitted in furtherance of our comments previously submitted during the EIS scoping period. As the developer of the Ocean Pointe project (formerly known as Ewa Marina), we are interested in plans for all projects mauka of our project, and in particular, in the potential drainage impacts of other projects within the Kaloi Gulch Watershed.

Regional drainage must be coordinated with all of the projects in the watershed. As you know, HFDC and HASEKO, together with all of the other developers in the watershed, are parties to the Technical Solution for the Kaloi Gulch Watershed, which details the drainage improvements for each project. We have therefore incorporated the Technical Solution into the drainage master plan for the Ocean Pointe project, which was approved by the City last year.

We recently started our first phase of the Ocean Pointe project and we look forward to working with HFDC and the other developers in the watershed in implementing the drainage improvements for the region.

Thank you for this opportunity to comment on your Draft EIS.

Sincerely,

Nelson W.G. Lee
Executive Vice President

cc: PBR Hawaii
Office of Environmental Quality Control

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

ROY S. OSHIRO
EXECUTIVE DIRECTOR

IN REPLY REFER TO:
98:DEV/2313

June 26, 1998

Mr. Nelson W. G. Lee
Executive Vice-President
Haseko (EWA), Inc.
820 Mililani Street, Suite 810
Honolulu, Hawaii 96813

Dear Mr. Lee:

SUBJECT: COMMENTS REGARDING EAST KAPOLEI MASTER PLAN (EKMP) DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)

Thank you for your comments of June 22, 1998 regarding the EKMP Development Project - DEIS. We offer the following response to each of your comments:

1. We concur that regional drainage improvements must be planned and coordinated with all projects in the watershed. We believe that the drainage improvements we have proposed for the EKMP project will contribute significantly toward meeting this common objective. HFDC and our Civil Engineer, R.M. Towill Corporation, will continue to work with the Department of Public Works and area landowners to ensure that all applicable regulations are implemented for the project and that the goals of the Technical Solution referenced in your comments can be achieved.

We look forward to working with landowners in implementing the necessary drainage improvements for the region. Once again, thank you for participating in the environmental review process.

Sincerely,

ROY S. OSHIRO
Executive Director

c: David Hulse, PBR Hawaii

HFDC

DEPARTMENT OF PUBLIC WORKS
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 11TH FLOOR • HONOLULU, HAWAII 96813
PHONE (808) 523-4341 • FAX (808) 527-5857

JEREMY HARRIS
MAYOR

JONATHAN K. SHIMADA, PhD
DIRECTOR AND CHIEF ENGINEER
ROLANDO D. LIBBY, JR.
DEPUTY DIRECTOR

ENV 98-120

May 27, 1998

MAY 29 1998

Mr. Roy Oshiro, Director
Housing Finance and Development
Corporation
State of Hawaii
677 Queen Street, Suite 300
Honolulu, Hawaii 96813

Attention: Steve Thomas

Dear Mr. Oshiro:

Subject: Draft Environmental Impact Statement (DEIS)
East Kapolei Master Plan
TMK: Various

We have reviewed the subject DEIS and have the following comment:

We understand that the Drainage Master Plan is currently being revised and has not yet been approved. However, we encourage the developer and your agency to sign the Kaloi Gulch Interim Drainage Plan, if not yet done.

Very truly yours,

JONATHAN K. SHIMADA, PhD
Director and Chief Engineer

cc: OEQC
PBR Hawaii (David Hulse)

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

ROY S. OSHIRO
EXECUTIVE DIRECTOR

IN REPLY REFER TO
98:DEV/2189

June 16, 1998

The Honorable Jonathan K. Shimada Ph.D., Director
Department of Public Works
City and County of Honolulu
650 South King Street, 11th Floor
Honolulu, Hawaii 96813

SUBJECT: **COMMENTS REGARDING EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)**

Thank you for your comments of May 27, 1998 regarding the East Kapolei Master Plan Development Project - Draft Environmental Impact Statement (DEIS). We offer the following response to each of your comments:

1. We concur that some revisions to the East Kapolei Drainage Master Plan may be necessary. The Housing Finance and Development Corporation (HFDC) and our civil engineer, R.M. Towill Corporation (RMTC), will continue to work with the Department of Public Works (DPW) during its review to ensure that all applicable regulations are implemented for the project.

2. We understand that the Kaloi Gulch Interim Drainage Plan has not been signed by any of the regional landowners and that the revisions to the Plan are forthcoming. Consequently, we will also work with your department and affected regional landowners to reach a consensus regarding regional drainage issues. We believe that the extensive drainage improvements proposed by the East Kapolei Master Plan will contribute significantly toward alleviating regional drainage problems.

Once again, thank you for participating in the environmental review process.

Sincerely,

ROY S. OSHIRO
Executive Director

HFDC

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

JEREMY HARRIS
MAYOR

JAN NAOE SULLIVAN
DIRECTOR

LORETTA K.C. CHEE
DEPUTY DIRECTOR

RECEIVED
JUN 25 1998

98-03331(DT)
'98 EA Comments Zone 9

June 23, 1998

Mr. Joseph K. Conant, Executive Director
Housing, Finance and Development Corporation
State of Hawaii
677 Queen Street, Suite 300
Honolulu, Hawaii 96813

Dear Mr. Conant:

Draft Environmental Impact Statement (EIS)
Housing Finance and Development Corporation (HFDC)
East Kapolei Master Plan Development Project
Tax Map Keys: 9-1-16: 8, 108, 109;
9-1-17: 4, 71; and 9-1-18: 3, 5

Thank you for the opportunity to review the Draft EIS. We offer the following comments:

1. The Final EIS should include a zone change map for all proposed uses in the project.

2. Parcels with less than 5,000 square feet are proposed in R-5 Residential zoning districts. This appears contrary to the department's policy for obtaining "greener" streets, as the application of zero lot line subdivisions will result in lot widths that are less than 50 feet. The State should encourage, if not require the applicant to seek the smaller lot sizes by requesting R-3.5 Residential District zoning for those areas where smaller lot sizes are beneficial to the project. These areas would be nearest the commercial, multi-family and school nodes.

3. Please clarify why schools are not adjacent to parks (Figure 4). Explain how the site plan contributes to neighborhoods that enhance pedestrian and other alternate forms of traffic. Figure 4 of the Draft EIS shows that some of the schools are not adjacent to a park. We recommend that all the schools be adjacent to a park in order for the school children to utilize the park area. We also suggest that the Department of Parks and Recreation be consulted.

4. There are two commercial areas proposed in the middle of the development as shown on Figure 4. What is the basis for the decision to have two, rather than one commercial center? If two commercial centers are still preferable, we suggest that one of the commercial centers be considered on the east side of the master plan in the vicinity of the intermediate school.

5. Sec. 3.2.2 of the Draft EIS (page 29) discusses the conformity to the Ewa Development Plan (DP) Public Facilities Map. This reference is to the map attached to the new Ewa DP under Ordinance No. 97-49 (effective August 22, 1997). There is also, however, a Public Infrastructure Map for Ewa adopted under City Council Resolution No. 97-325, CD-1 (effective date December 3, 1997). This map is required by Ordinance No. 97-49, but is not a formal part of the DP itself. Consistency with this document should also be referenced within the Final EIS document.

6. Sec. 3.2.3 of the Draft EIS (page 29), Land Use Ordinance Designation - Zoning: The EIS incorrectly suggests that future individual zone changes involving 25 acres or more are considered significant, and will therefore be required to submit an EA with the zone change application. Rather, the 25-acre milestone is relevant only to whether a project master plan will also be required as part of the EA/EIS. Pursuant to Sec. 24-3.1, ROH, (the new Ewa DP) a significant zone change, which must submit an EA/EIS as part of the zone change application, is determined based on the following criteria:

Zone Changes Involving the following type of Zoning District	Acreage Triggering Chapter 343, HRS Requirements
Preservation or Agricultural	Not applicable
Residential or Country	10 or more
Apartment, Resort, Commercial, Industrial, or Mixed Use	5 or more
Any combination (other than Preservation or Agricultural)	25 or more
Development having major impacts, or involving cumulative impacts	All, regardless of acreage

7. An EA/EIS may not be required for future zone changes within the East Kapolei Master Plan Development Project area provided the specific zone change involves development substantially the same as that covered by the subject Draft EIS. The Draft EIS should be corrected to acknowledge this possibility.

8. The Final EIS should identify all proposed park and open space parcels planned to be dedicated to the City.

9. Page 20 of the Draft EIS mentions that landscaped recreation land will be available to the community. What type of recreation is proposed?

10. A drainage master plan is included in the Draft EIS. The Final EIS should discuss how the Kaloi Gulch watershed will be able to accommodate the increased runoff from the proposed residential community.

Thank you for the opportunity to comment. Should you have any questions, please contact Dana Teramoto of our staff at 523-4648.

Very truly yours,

JAN NAOE SULLIVAN
Director of Land Utilization

JNS:am

cc: Office of Environmental Quality Control
√PBR Hawaii (David Hulse)

g:\pd\etapolei.djt

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

ROY S. OSHIRO
EXECUTIVE DIRECTOR

98:DEV/2368

June 30, 1998

The Honorable Jan Naoe Sullivan, Director
Department of Land Utilization
City and County of Honolulu
650 South King Street, 7th Floor
Honolulu, HI 96813

Dear Ms. Sullivan:

SUBJECT: COMMENTS REGARDING HOUSING FINANCE AND DEVELOPMENT CORPORATION (HFDC) EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)

Thank you for your comments of June 23, 1998, regarding the East Kapolei Master Plan Development Project - Draft Environmental Impact Statement. We offer the following response to each of your comments.

1. As you suggested in your comments, we will provide a preliminary proposed zoning map in the Final Environmental Impact Statement (FEIS). However, at this early stage of the entitlement review process, this exhibit will be subject to change. HFDC's tentative schedule is to submit a Change of Zone application for the entire project area soon after the State Land Use Commission acts to reclassify the property from the Agriculture to Urban District.

2. Our purpose in selecting the R-5 Residential zoning was two fold: 1) larger lots are more desirable to consumers from a marketing perspective, and 2) the 5,000 square feet minimum lot size gives the future developers more opportunities to create larger yards and open space areas. No zero lot line subdivisions are planned at this time, however, this decision will be made by the private developer of each large lot development parcel. We note that the minimum lot width and depth for the R-3.5 and R-5 Residential zoning districts are the same. Therefore, we see little advantage in requesting the R-3.5 Residential zoning at this time.

HFDC

describes how the project conforms to the vision for Ewa, and the relevant policies, principles, and guidelines for the site, the surrounding lands, and the region."

7. We agree that "An EA/EIS may not be required for future zone changes within the East Kapolei Master Plan Development Project area provided the specific zone change involves development substantially the same as that covered by the subject DEIS." The FEIS will be revised to acknowledge this interpretation of the Ewa Development Plan requirements.

8. At the present time, the only proposed neighborhood parks and district park would eventually be dedicated to the City in accordance with deed restrictions placed on the sale of the large lots to private developers. This will ensure that all applicable park dedication requirements are satisfied. Private parks and recreation centers will also be developed for the multi-family projects by the private developers.

9. Within the open space areas adjacent to the four major drainage basins, the "landscaped recreation land available to the City" will consist of: 1) walking paths and trails, 2) bike paths, 3) outdoor furniture, and 4) grassed and irrigated lawn areas, all within an extensively landscaped urban park setting.

10. Please review the Drainage Master Plan provided in Appendix B of the DEIS and page 65 which states, "According to the *Ewa Villages Drainage Master Plan*, the Ewa Villages Golf Course is designed to accept the Plate 6 flow of 7,075 cfs from Kaloi Stream at the upper boundary. Due to the increase in watershed area for Kaloi Gulch, by the North-South Road alignment, a larger Plate 6 flow of 7,400 cfs was studied entering the golf course. The study is based on both interim conditions, where the OR&L Railroad bridge is not constructed, and the ultimate conditions, where the bridge is in. It was determined that the golf course can accommodate the increase in flow for both conditions, with an increase in water surface elevation of approximately 0.45-feet."

    In addition, Tables 5-1 to 5-5 of the Drainage Report concludes that the amount of runoff volume for the developed condition will actually **decrease** 43 Ac-ft compared to the existing undeveloped condition of the property. Consequently, development of the East Kapolei project will decrease the amount of runoff leaving the property rather than increasing runoff as indicated in your comments.

DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 5TH FLOOR • HONOLULU, HAWAII 96813
PHONE (808) 523-4427 • FAX (808) 527-5498

JEREMY HARRIS
MAYOR

ROBERT AGRES, JR.
DIRECTOR

DARWIN J. HAMAMOTO
DEPUTY DIRECTOR

June 18, 1998

JUN 25 1998

Mr. Steve Thomas
Housing Finance and Development
Corporation
677 Queen Street, Suite 300
Honolulu, Hawaii 96813

Dear Mr. Thomas:

Subject: East Kapolei Master Plan Development Project

The Department of Housing and Community Development has reviewed the draft environmental assessment for the above subject project and has no objections at this time.

Sincerely,

ROBERT AGRES, JR.
Director

cc: OEQC
PBR Hawaii

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

ROY S. OSHIRO
EXECUTIVE DIRECTOR

IN REPLY REFER TO:

98:DEV/2371

June 30, 1998

The Honorable Robert Agres, Jr., Director
Department of Housing and Community Development
City and County of Honolulu
650 South King Street, 5th Floor
Honolulu, HI 96813

Dear Mr. Agres:

SUBJECT: COMMENTS REGARDING HOUSING FINANCE AND DEVELOPMENT CORPORATION (HFDC) EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)

Thank you for your comments of June 18, 1998 regarding the East Kapolei Master Plan Development Project - Draft Environmental Impact Statement and for participating in the environmental review process.

Sincerely,

ROY S. OSHIRO
Executive Director

HFDC

PLANNING DEPARTMENT
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 8TH FLOOR • HONOLULU, HAWAII 96813-3017
PHONE (808) 523-4533 • FAX (808) 523-4950

JEREMY HARRIS
MAYOR

PATRICK T. ONISHI
CHIEF PLANNING OFFICER

DONA L. HANAIKE
DEPUTY CHIEF PLANNING OFFICER

RNS 5/98-0965

June 22, 1998

JUN 24 1998

Mr. Roy Oshiro, Director
Housing Finance and Development Corporation
State of Hawaii
677 Queen Street, Suite 300
Honolulu, Hawaii 96813

Dear Mr. Oshiro:

Draft Environmental Impact Statement (DEIS)
for HFDC East Kapolei Master Plan Development Project
(TMK: 9-1-16:8, 108, & 109; 9-17:4 & 71, and 9-1-18:3 & 5)

In response to PBR Hawaii's May 7, 1998 letter, the Draft Environmental Impact Statement (DEIS) for the State Housing Finance and Development Corporation's East Kapolei Master Plan Development Project was reviewed and the following comments are provided:

1. The Ewa Development Plan (DP) indicates that "projects involving a significant zone change will be required to submit an Environmental Assessment ... to help the Department [of Land Utilization] determine whether the project involves a significant environmental effect and if the project is supportive of the vision for Ewa's development." (Sec. 5.4.1, p. 5-9)

   In addition, the DP requires that the Environmental Assessment (EA)/Environmental Impact Statement (EIS) for projects which are 25 acres or more include a Project Master Plan which shall help "the Planning Department to determine whether the project supports the vision, policies, principles, and guidelines of the Ewa Development Plan." (Section 5.4.2, p. 5-12)

   In some cases, projects which have already prepared an EA/EIS will not be required to prepare a new EA in support of their zone change application. (Section 5.4.1, p. 5-11)

   However, the DEIS for the HFDC East Kapolei Master Plan Development Project does not provide adequate information and analysis to permit the full determination of consistency with the vision and implementing land use and public facilities policies of the DP, and does not conform with the requirements for coverage, scope, and content for the Project Master Plan required under the DP.

   As a consequence, the City will reserve the right to require projects submitting zone change applications as part of the East Kapolei development to submit a Supplemental EA/EIS in order to provide the level of information required under the DP.

2. As noted in the DEIS, the proposed project is consistent with the General Plan's policies to direct residential and employment growth to Ewa. For completeness, the discussion in the final EIS of the project's relation to the General Plan should reference Population Objective C, Policy 2 and Economic Activity Objective G, Policies 1 and 2 which discuss growth within the secondary urban center and the Ewa urban fringe area.

3. As noted in the DEIS, the proposed project is consistent with the new Ewa DP's policies to provide for commercial and residential development in the Ewa DP area, is included in the list of master-planned residential communities expected to be developed in implementing the DP, and is in an area scheduled for urban development either during the 1997 - 2005 period or the 2006 - 2015 period as shown on the Phasing Map.

4. The final EIS should provide more information and discussion of how open space in the project will be used to implement the DP policies to protect scenic views and provide recreation, define the boundaries of communities, provide a fire safety buffer where developed areas border "wildlands," and create linkages between communities through a network of greenways.

5. The final EIS should provide more information and discussion of how the proposed sports complex will comply with the DP planning principles and guidelines for sports and recreation complexes, including those regarding appropriate scale and siting, environmental compatibility, community

integration, definition of use areas, transportation, views, landscape treatment, and natural environment.

6. The DP includes guidelines for Development of Community-based Parks which call for the co-location of parks with schools where "efficiencies in development and use ... can be achieved." (Section 3.3.2, p. 3-17). The final EIS should discuss why such co-location is not desirable for two of the elementary school sites shown.

7. The final EIS should include discussion of how the project will support the DP policy to "provide accessible pathways from surrounding streets to facilitate pedestrian and bicycle access to all features in parks." (Ewa DP, Section 3.3.2, p. 3-17)

8. The final EIS should indicate how the project will support the DP general historic and cultural resources policies to protect existing visual landmarks, to support creation of new culturally appropriate landmarks, and to retain significant vistas. In particular, the relationship and impact of the project on Ewa Villages, the OR&L Historic Railway, and the significant views and vistas listed in Table 3.1 of the DP should be discussed.

9. The information provided in the DEIS discussion of the project's conformance to the DP residential community development policies, principles, and guidelines is inadequate to determine if the DP vision and policies for master planned residential communities (Section 3.6.3) will be implemented by the project. As noted above, the City will reserve the right to require a supplemental EA/EIS when projects within the East Kapolei area apply for zone changes.

10. The DEIS shows four commercial areas within the project area, but includes no discussion of how the development of these commercial areas will conform with the DP vision and policies for commercial development. (Section 3.7.1)

11. The Ewa DP indicates that there should be an "extension from the North South Road south of Kapolei Parkway into the Kalaeloa Regional Park to provide a second access to the Park for residents of East Kapolei and staff and students from the UH-West Oahu campus." (Section 4.1.3, p. 4-6) The final EIS should discuss this DP policy and its relation to the proposed project.

12. The final EIS should provide a more adequate discussion of how the project will help implement the DP vision of transit nodes as the center of "high-density

and high-traffic land uses" in order to reduce automobile use. (Section 4.1.6, p. 4-14 and Section 4.1.7, p. 4.15)

13. The final EIS should provide a discussion of how the project will implement the DP transportation planning principles, including creating a comprehensive roadway network, transit-oriented community street systems, and community-level street standards. (Section 4.1.7)

14. The final EIS should discuss how the project will implement the DP policy regarding dual water lines to allow conservation of potable water and use of nonpotable water for irrigation and other appropriate uses. (Section 4.2.1)

15. The final EIS should discuss how the project implements the DP principles regarding impacts on the Ewa Village and other previously approved developments in the Kaloi Gulch basin. (Section 4.6.2, p. 4-29)

16. The DEIS indicates "a new high school" is to be built "east of the subject property." The final EIS should provide more specific details regarding the status of efforts to provide a site for the future East Kapolei high school in the area, and the acceptability of that site to the State Department of Education.

Should you have any questions, please contact Robert Stanfield of our staff at 527-6094.

Yours very truly,

PATRICK T. ONISHI
Chief Planning Officer

PTO:rns

cc: State Office of Environmental Quality Control
PBR Hawaii

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

ROY S. OSHIRO
EXECUTIVE DIRECTOR

IN REPLY REFER TO
98:DEV/2365

June 30, 1998

Mr. Patrick T. Onishi
Chief Planning Officer
Planning Department
City and County of Honolulu
650 South King Street, 8th Floor
Honolulu, HI 96813

Dear Mr. Onishi:

SUBJECT: **COMMENTS REGARDING HOUSING FINANCE AND DEVELOPMENT CORPORATION (HFDC) EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)**

Thank you for your comments of June 22, 1998 regarding the East Kapolei Master Plan Development Project - Draft Environmental Impact Statement. We offer the following response to each of your comments.

1. As indicated in the DEIS, HFDC is acting as the master developer only and will not be developer of any new residences or commercial projects. The East Kapolei Master Plan does establish a land use pattern consistent with the Ewa Development Plan Land Use Map. It is our understanding that the DP's are to provide a conceptual framework for future growth and not impose detailed design guidelines to be enforced by the Planning Department.

   In addition, we fail to see any benefit in requiring supplemental EA/EIS's from project developers when all applicable environmental information has already be provided during the HFDC EIS process. If the Planning Department is concerned about building architecture, site plan design, and circulation of internal roadways, and its conformance with the DP's requirements for coverage, scope, and content, we suggest that this information be provided to the Planning Department by individual developers as a project specific Master Plan in compliance with the DP. Submittal of a Project Master Plan could also be made a requirement of the unilateral zoning agreement when the East Kapolei Project

HFDC

goes through the rezoning review process. It is our position that a supplemental EA/EIS would be redundant.

2. We will revise the final EIS to include a discussion regarding the project's relation to the General Plan Population objective C, Policy 2 and Economic Activity objective G, Policies 1 and 2.

3. We agree that the East Kapolei project is consistent with the new Ewa DP's policies as stated in your comment No. 3.

4. We refer to the discussion on pages 103 and 105 of the DEIS regarding how open space will be used to implement DP policies. However, we will expand our discussion in the FEIS to include a discussion on fire safety buffers and more detail on the proposed linkages between communities through a network of greenways.

5. We will supplement section 7.7.2 of the FEIS to the extent possible at this level in the planning and design process. We wish to emphasize that the Sports Complex is presently being designed, so much of the details requested were not available when the DEIS was prepared. However, it is our understanding that the DP's were not intended to function as a design review document, but to establish a conceptual framework for future development. Nevertheless, the design of the sports complex will comply with Section 3.2.2 and Section 3.2.3.2 of the Ewa DP.

6. As you know, the East Kapolei Master Plan only conceptually identifies residential areas, schools, and parks. HFDC intends to impose deed restrictions requiring developers of the large-lot parcels to dedicate school and park sites in accordance with Department of Education requirements. Inasmuch as schools are permitted uses within all zoning districts, the exact location of schools can remain flexible until the optimum site is determined by DOE. During design of the East Kapolei Master Plan, HFDC was discouraged by DOE from establishing joint school and park uses due to potential security concerns.

7. HFDC is not developing residential subdivisions or the amenities typically provided by private developers. Review of pedestrian pathways and bicycle facilities within residential areas would be more appropriate during the review of the project subdivision or Project Master Plan.

8. According to the Historic Preservation Division, there are no archaeological or cultural sites of significance on the

subject property. Although the OR&L Railway runs adjacent to a small portion of the project's makai boundary, the project does not significantly impact the railway. A grassed retention area (which will also serve as a practice field) will provide a buffer between the sports complex structures and the OR&L Railway. Similarly, the sports complex site was selected because there are no residential land uses planned for adjoining properties and Varona Village could be developed in a manner which complements the sports complex.

The East Kapolei Master Plan will impact the "Significant Views and Vistas" from the Ewa Development Plan as follows:

- *Distant vistas of the shoreline from the H-1 Freeway above the Ewa Plain;*
  Discussion: The East Kapolei project is located at elevations below the H-1 Freeway and will not impact distant vistas of the shoreline.

- *Views of the ocean from Farrington Highway between Kahe Point and the boundary of the Waianae Development Plan Area;*
  Discussion: The East Kapolei project is not located in this area nor will it impact views from Kahe Point or the Waianae Development Plan Area.

- *Views of the Waianae Range from H-1 Freeway between Kunia Road and Kaloi Gulch and from Kunia Road;*
  Discussion: The East Kapolei project is located at elevations below the H-1 Freeway and will not impact distant views of the Waianae Range from the H-1 Freeway.

- *Views of na pu'u Kapolei, Palailai, and Makakilo;*
  Discussion: The East Kapolei project is located at elevations below the H-1 Freeway and will not impact distant views of na pu'u Kapolei, Palailai, and Makakilo;

- *Mauka and makai views; and*
  Discussion: None of the residential or commercial structures will exceed thirty feet. Therefore, Makai views from the H-1 Freeway will be altered from the vacant scrub vegetation to a suburban residential community. Mauka views will not be impacted.

- *Views of Central Honolulu and Diamond Head.*
  Discussion: Because there is no vantage point on the

property where these views are significant, views of Central Honolulu and Diamond Head will not be impacted.

9. Please refer to Section 7.7.3 of the DEIS regarding the residential community development policies, principles, and guidelines. We must also emphasize once again that HFDC is acting as the master developer only and will not be developer of any new residences or commercial projects. However, the East Kapolei Master Plan does establish a land use pattern consistent with the Ewa Development Plan Land Use Map. It is our understanding that the DP's are to provide a conceptual framework for future land use and not impose detailed design guidelines to be enforced by the Planning Department.

   In addition, we fail to see any benefit in requiring supplemental EA/EIS's from project developers when all applicable environmental information has already be provided during the HFDC EIS process. If the Planning Department is concerned about building architecture, site plan design, and circulation of internal roadways, and its conformance with the DP's requirements for coverage, scope, and content, we suggest that this information be provided to the Planning Department by individual developers as a project specific Master Plan in compliance with the DP. Submittal of a Project Master Plan could also be made a requirement of the unilaterial zoning agreement when the East Kapolei Project goes through the rezoning review process. It is our position that a supplemental EA/EIS would be redundant.

10. All of the proposed neighborhood commercial centers are planned to be 8 acres or less, located adjacent to residential areas, and capable of providing up to 100,000 square feet of floor area. Each commercial site has also been located in accordance with Ewa Development Plan Land Use Map. We must also emphasize once again that HFDC is acting as the master developer only and will not be developer of any commercial projects. Therefore, the detailed design issues raised by your comments would be more appropriately addressed during the Project Master Plan review when private developers would have site plans and renderings available for City review.

11. We agree that traffic flow in the region will be impacted by the future redevelopment of Barbers Point Naval Air Station. To assess these traffic impacts, we understand that a Draft Environmental Impact Statement currently being prepared by the Navy will be available for public review in mid-July. Based on the type of land uses proposed, it is not clear

that the level of traffic will increase compared to the previous military use of the property. However, to accommodate a future connection to Barbers Point Naval Air Station from the North-South Road, should it be warranted in the future, sufficient land area will be retained as open space within the sports complex area to permit a future connection.

12. As indicated in the DEIS, transit nodes will be located in accordance with the Ewa DP guidelines. These transit nodes will be located within the higher density residential and commercial areas near the intersections of 1) Farrington Highway/North-South Road, 2) East-West Road/North-South Road, and 3) Kapolei Parkway/North-South Road. A separated transit corridor is also being designed to run along the length of the North-South Road by the State Department of Transportation and City Department Transportation Services where you may be able to review the preliminary plans.

13. Please refer to Sections 7.7.3 and 7.7.4 of the DEIS. Because HFDC is acting as the Master Developer, the design of street standards and layout of the internal roadway network will be determined by individual developers during the design, review, and approval process of their individual Project Master Plans. It is our understanding that the Charter Amendments made to the Development Plans were to provide a conceptual planning framework and not establishment of a detailed design review process by the Planning Department during the EIS review process. We believe that the EIS should remain an environmental disclosure document and not become a mechanism for design review.

14. HFDC is working with the Department of Wastewater Management to design the dual water system to allow conservation of potable water and use of nonpotable water for irrigation and other appropriate uses. The Department of Wastewater Management has informed us that reuse water from the Honouliuli Wastewater Treatment Plan (WWTP) may be available for irrigation use by June 30, 1999. A distribution system within the East Kapolei Master Plan area will be provided as applicable. A stub out point location will be determined in consultation with the Department of Wastewater Management, Treatment and Disposal Division as you requested by the Department.

15. We note that Section 4.6.2 does not reference the East Kapolei project. However, please review the Drainage Master Plan provided in Appendix B of the DEIS and page 65 which

states, "According to the *Ewa Villages Drainage Master Plan*, the Ewa Villages Golf Course is designed to accept the Plate 6 flow of 7,075 cfs from Kaloi Stream at the upper boundary. Due to the increase in watershed area for Kaloi Gulch, by the North-South Road alignment, a larger Plate 6 flow of 7,400 cfs was studied entering the golf course. The study is based on both interim conditions, where the OR&L Railroad bridge is not constructed, and the ultimate conditions, where the bridge is in. It was determined that the golf course can accommodate the increase in flow for both conditions, with an increase in water surface elevation of approximately 0.45-feet."

16. HFDC has had extensive discussions with the Department of Education (DOE) regarding the future location of a high school in the area. DOE has agreed that a high school is not necessary for the East Kapolei project and that a site east of the subject property could be determined at a later date. At the present time, it appears that the site will be proximate to the Ewa side of the East Kapolei project and makai of Farrington Highway. Please contact the DOE if you have any questions.

Once again, thank you for participating in the environmental review process.

Sincerely,

ROY S. OSHIRO
Executive Director

POLICE DEPARTMENT

CITY AND COUNTY OF HONOLULU

801 SOUTH BERETANIA STREET
HONOLULU, HAWAII 96813 · AREA CODE (808) 529-3111

JEREMY HARRIS
MAYOR

LEE D. DONOHUE
CHIEF

WILLIAM B. CLARK
DEPUTY CHIEF

OUR REFERENCE CS-DL

June 4, 1998

Mr. Steve Thomas
State Housing Finance and Development
Corporation
677 Queen Street, Suite 300
Honolulu, Hawaii 96813

Dear Mr. Thomas:

Thank you for the opportunity to review and respond to the Draft EIS for the Kapolei Master Plan Development Project, TMKs: 9-1-16: 8, 108, and 109; 9-1-17: 4, 71; and 9-1-18: 3 and 5.

We concur with the statement in the document regarding the need to add 42 to 54 new officers and staff this proposed development. At this time, we would like to add the following comments:

- Principles of crime prevention through environmental design be used as a guide in designing the proposed area to assist in minimizing crimes and calls for police service.
- Special Duty officers be used during special events at the proposed sports arena in order that on-duty officers can be available to perform their regular patrol duties.

We have also noted that potential environmental and traffic impacts during the construction phase, which could have an effect on police services, have been addressed and that measures to mitigate these problems will be adopted. In addition, we have noted that there will be improvements to the transportation system to help alleviate traffic problems that the increase in population and general activity in this area and surrounding areas will have.

Should you have any questions, please call me at 529-3175 or Major Cary Tokunaga of District 8 at 674-8901.

Sincerely,

LEE D. DONOHUE
Chief of Police

By James Femia
JAMES FEMIA
Assistant Chief
Administrative Bureau

cc: Ofc. of Environmental Quality Control
✓Mr. David Hulse, PBR Hawaii
Major Cary Tokunaga, District 8

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

ROY S. OSHIRO
EXECUTIVE DIRECTOR

IN REPLY REFER TO
98:DEV/2167

June 16, 1998

The Honorable Lee D. Donohue
Chief of Police
Honolulu Police Department
City and County of Honolulu
801 South Beretania Street
Honolulu, Hawaii 96813

SUBJECT: **COMMENTS REGARDING EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)**

Thank you for your comments of June 4, 1998 regarding the East Kapolei Master Plan Development Project - Draft Environmental Impact Statement (DEIS). We offer the following response to each of your comments:

1. Principles of crime prevention through environmental design will be incorporated into all major phases of infrastructure and landscape design. In addition, future private developers will also be encouraged by the Housing Finance and Development Corporation (HFDC) to incorporate these design techniques into their projects.

2. Security for the proposed sports complex will be administered by the Stadium Authority and any private sector operator that may be contracted to manage the facility. We concur that provisions for additional security (i.e., private security and use of special duty officers) will likely be necessary during special events.

We also concur that the proposed internal and regional transportation improvements will facilitate police services by mitigating the existing high levels of traffic in the Ewa region.

Once again, thank you for participating in the environmental review process.

Sincerely,

ROY S. OSHIRO
Executive Director

HFDC

FIRE DEPARTMENT

CITY AND COUNTY OF HONOLULU

3375 KOAPAKA STREET SUITE H425
HONOLULU HAWAII 96819 1869

JEREMY HARRIS
MAYOR

ATTILIO K. LEONARDI
FIRE CHIEF

JOHN CLARK
DEPUTY FIRE CHIEF

PBR HAWAII
RECEIVED
MAY 22 1998

May 19, 1998

Mr. David Hulse
PBR Hawaii
1001 Bishop Street
Pacific Tower, Suite 650
Honolulu, Hawaii 96813

Dear Mr. Hulse:

Subject: Draft Environmental Impact Statement (DEIS)
HFDC East Kapolei Master Plan Development Project
HFD Internal No. OL 98-190

We have reviewed the DEIS for the subject project and have no objections with the East Kapolei Master Plan Development Project contingent upon the following conditions:

1. Fire apparatus accessibility roadways and water supply for fire protection is provided.

2. Building construction is in compliance with the current building and fire codes when construction plans are submitted.

If you need additional information, please contact Battalion Chief Charles Wassman of our Fire Prevention Bureau at 831-7778.

Sincerely,

Attilio K. Leonardi

ATTILIO K. LEONARDI
Fire Chief

AKL/CW:bh

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

ROY S. OSHIRO
EXECUTIVE DIRECTOR

IN REPLY REFER TO
98:DEV/1900

May 27, 1998

Mr. Attilio K. Leonardi, Fire Chief
Fire Department
City and County of Honolulu
3375 Kiapaka Street, Suite H425
Honolulu, Hawaii 96819-1869

Dear Mr. Leonardi:

Subject: COMMENTS REGARDING HOUSING FINANCE AND DEVELOPMENT CORPORATION (HFDC) EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT DRAFT - ENVIRONMENTAL IMPACT STATEMENT (D-EIS)

Thank you for your comments of May 19, 1998 regarding the above referenced project D-EIS. We offer the following response to each of your comments.

1. Fire apparatus accessibility roadways and water supply for fire protection will be provided by project developers in accordance with applicable fire code and fire insurance requirements.

2. All infrastructure and building construction will be implemented in compliance with the current building and fire codes when construction plans are submitted. As indicated in the D-EIS, HFDC will design and construct the major infrastructure and individual private developers will construct the residential and commercial structures.

Once again, thank you for participating in the environmental review process.

Sincerely,

ROY S. OSHIRO
Executive Director

c: PBR Hawaii

HFDC

DEPARTMENT OF WASTEWATER MANAGEMENT
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 3RD FLOOR • HONOLULU, HAWAII 96813
PHONE (808) 527-6683 • FAX (808) 527-6675

JEREMY HARRIS
MAYOR

KENNETH E. SPRAGUE, P.E., Ph.D.
DIRECTOR

CHERYL K. OKUMA-SEPE, ESQ.
DEPUTY DIRECTOR

In reply refer to:
WCC 98-112

June 16, 1998

PBR HAWAII
RECEIVED
JUN 17 1998
Project
Project No.

Mr. Steve Thomas
State Housing Finance and Development Corporation
677 Queen Street, Suite 300
Honolulu, Hawaii 96813

Dear Mr. Thomas:

Subject: HFDC East Kapolei Master Plan Development Project
Draft Environmental Impact Statement, Dated April 1998

We have reviewed the subject document and have the following comments:

1. Reuse water from the Honouliuli Wastewater Treatment Plant (WWTP) is tentatively scheduled to be available by June 30, 1999. A distribution system within the East Kapolei area may be required from a possible stub out point. Please contact Mr. Earl Ng or Mr. George Richardson of the Treatment and Disposal Division for information and coordination regarding the reuse program at 847-8300.

2. Odors from Honouliuli WWTP may be carried to Kapolei East especially during Kona winds. It is our experience that although we do meet Department of Health Cover Source Permit limits, some people cannot tolerate these low levels of odors from the WWTP. This information should be made known to potential residents and business owners by including this in the sale and resale disclosure statements. These odors may be difficult for patrons of the open air sports complex which is the closest to the WWTP. Please include a discussion of the anticipated impacts and mitigative measures.

3. Sewer capacity is allocated on a first come first serve basis.

   The Makakilo Interceptor is not adequate to accommodate all of the proposed developments in the Kapolei, Makakilo, Ko Olina areas. What coordination with Campbell has been made to schedule and insure that the projected wastewater flows from East Kapolei can be accommodated by the proposed Kapolei Interceptor Sewer? When is construction of this sewer line scheduled for completion?

   The Honouliuli WWTP is not adequate to accommodate all of the proposed developments in its service district. Although the capacity of the liquid stream at the WWTP is 38 million gallons per day, the solids handling facility is the limiting process and it is anticipated to reach capacity in five years. Construction of the Honouliuli WWTP 1A Solids Handling Facility project is tentatively scheduled for completion in 2003. This project will increase the solids handling facility's capacity to 51 million gallons per day.

   An increase of the liquid stream capacity at the WWTP is being studied under the West Mamala Bay Facility Plan Project. The facility plan is tentatively scheduled to be completed in October 1999.

4. We have been working with Mr. James Yamamoto regarding the completion of the Sewer Master Plan. We will continue to work with Mr. Yamamoto and have not included comments pertinent to the sewer master plan in EIS review process.

If you have any questions, please contact Ms. Tessa Ching of the Service Control Branch at 523-4956.

Sincerely,

CHERYL K. OKUMA-SEPE

for KENNETH E. SPRAGUE
Director

cc: Office of the Governor (c/o Office of Environmental Quality Control)
Mr. David Hulse (PBR HAWAII)

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

ROY S. OSHIRO
EXECUTIVE DIRECTOR

IN REPLY REFER TO

98:DEV/2258

June 22, 1998

The Honorable Kenneth E. Sprague, Director
Department of Wastewater Management
City and County of Honolulu
650 South King Street, 3rd Floor
Honolulu, Hawaii 96813

Dear Mr. Sprague:

SUBJECT: **COMMENTS REGARDING HOUSING FINANCE AND DEVELOPMENT CORPORATION's (HFDC) EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)**

Thank you for your comments of May 28, 1998 regarding the East Kapolei Master Plan Development project - DEIS. We offer the following response to each of your comments:

1. Thank you for informing us that reuse water from Honouliuli Wastewater Treatment Plant (HWTP) may be available for irrigation use by June 1999. A distribution system within the East Kapolei Master Plan area will be provided as applicable. A stub out point location will be determined in consultation with the Treatment and Disposal Division as you suggested.

2. As you know, the HWTP is approximately 1.5 miles from the proposed Sports Complex location. Considering the HWTP meets the Department of Health Cover Source Permit limits, we feel that the distance to the Sports complex, the relatively low levels of odors, and the direction of prevailing winds (both trades and Kona winds) will largely mitigate any potential air quality impacts from the HWTP on the East Kapolei Master Plan project site . According to the air quality consultant, Barry Neal and Associates, DOH standards permit 25 parts/billion of hydrogen sulfide at the boundary of HWTP, although some individuals can detect odors at 5 parts/billion. At the Sports Complex site, these levels should be reduced approximately 1000 times due to wind dispersion. Consequently, odors from HWTP should not

HFDC

be detectable and we have no plans at the present time to include potential odor impacts in a pre-sales disclosure statement.

3. As indicated in the Wastewater Master Plan, we acknowledge that the Makakilo interceptor is not adequate to accommodate all of the planned development in the Kapolei, Makakilo and Ko Olina areas, and that the capacity will be allocated on a first come first served basis. Given the relatively long build out period of approximately 20 years, we anticipate that it could be approximately 10 years before the proposed Kapolei Interceptor Sewer Line will be necessary. In addition, the first delivery of residential units in East Kapolei will likely occur in approximately in 2 - 4 years, or at about the same time the Honouliuli WWTP 1A Solids Handling Facility project is scheduled for completion. Therefore, we feel that sufficient capacity exists to accommodate the phased development of the East Kapolei Master Plan. Of course, this schedule will vary depending on the future level of development in the region and overall economic factors that typically impact residential construction.

4. Our civil Engineer, Mr. Jimmy Yamamoto at R.M. Towill, will continue to work with your department to resolve any other comments you may have regarding the East Kapolei Master Plan Sewer Master Plan.

Once again, thank you for participating in the environmental review process.

Sincerely,

ROY S. OSHIRO
Executive Director

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 10TH FLOOR • HONOLULU, HAWAII 96813
PHONE (808) 523-4182 • FAX (808) 523-4054

JEREMY HARRIS
MAYOR

WILLIAM D. BALFOUR, JR.
DIRECTOR

MICHAEL T. AMII
DEPUTY DIRECTOR

PBR HAWAII
JUN 3 1998

May 28, 1998

Mr. Steve Thomas
Housing Finance and
Development Corporation
Department of Budget and Finance
State of Hawaii
677 Queen Street, Suite 300
Honolulu, Hawaii 96813

Dear Mr. Thomas:

Subject: Draft Environmental Impact Statement (DEIS) for
East Kapolei Development Project, Ewa, Oahu, Hawaii
Tax Map Keys 9-1-016:008, 108 & 109
9-1-017:004 & 071
9-1-018:003 & 005

We have reviewed the DEIS for the above-described project and offer the following comments and recommendations:

1. A street tree master plan will need to be submitted to our Landscape Section for review and comment. Maintenance of street trees, except for the trimming located within the road right-of-way, will need to be done by the developer or the community association. You may contact Mr. David Kumasaka, Landscape Architect, at 523-4884 if you have any questions or need further information on this matter.

2. Section 2.6 of the DEIS states, "The project master plan envisions the establishment of a network of six neighborhood parks (each approximately 3 acres), a 15-acre district park, and an open space recreational/drainage corridor." Our park size standards are as follows:

<u>Neighborhood Parks</u> - approximately 6 acres in size and serving approximately 5,000 people.

<u>Community Parks</u> - approximately 10 acres in size and serving 10,000 people.

<u>District Parks</u> - approximately 20 acres in size and serving 25,000 people.

A copy of our park standards is enclosed for your use and information. In addition, the lineal park/open space associated with the Kaloi drainage way improvements will not meet the criteria of active park lands and should not be dedicated to the City.

Please contact Mr. Lester Lai, Planner in our Advance Planning Branch, at 523-4696 for assistance with your park plans and information on our requirements for park sites to be dedicated to the City and County of Honolulu.

Sincerely,

W. D. Balfour Jr.

WILLIAM D. BALFOUR, JR.
Director

WDB:ei

Enclosure

cc: Office of the Governor, Office of Environmental Quality Control
Mr. David Hulse, PBR Hawaii

PARKS AND SITES CLASSIFICATION SYSTEM: DEFINITIONS

COMMUNITY-BASED PARKS:

Parks that generally serve the appropriate recreational needs of the residential areas of the island. The City's park and recreational facilities' standard for community-based parks is two (2) acres of park space per every 1,000 persons[2]. However, this standard is more applicable to developing areas or where land shortages are not as acute as some older communities and should be considered flexible to meet the particular and reasonable needs of each community. Community-based parks are classified as follows:

District Parks	: Approximately 20 acres in size and serving approximately 25,000 people. Facilities may include playfields, playcourts, passive areas, a gymnasium/recreation complex, and swimming pool.
Community Parks	: Approximately 10 acres in size and serving approximately 10,000 people. Facilities may include playfields, playcourts, passive areas, and a recreation building.
Neighborhood Parks	: Approximately 6 acres in size and serving approximately 5,000 people. Facilities may include playfields, playcourts, passive areas, and a comfort station.
Mini Parks	: Small landscaped areas serving high density neighborhoods as well as high density business and industrial areas. Facilities may include benches, picnic tables, and a children's play area.
Urban Parks	: Passive landscaped areas including squares and triangles that are usually located in residential or business areas.

[2] ibid.

BENJAMIN J. CAYETANO
GOVERNOR

DEV
FILE COPY

DONALD K W LAU
EXECUTIVE DIRECTOR

SHARYN L. MIYASHIRO
EXECUTIVE ASSISTANT

STATE OF HAWAII
DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM
HOUSING AND COMMUNITY DEVELOPMENT CORPORATION OF HAWAII
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

98:DEV/59

July 8, 1998

The Honorable William D. Balfour, Jr., Director
Department of Parks and Recreation
City and County of Honolulu
650 South King Street, 10th Floor
Honolulu, HI 96813

Dear Mr. Balfour:

SUBJECT: COMMENTS REGARDING EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT

Thank you for your comments of May 28, 1998 regarding the East Kapolei Master Plan Development Project - Draft Environmental Impact Statement (DEIS). We offer the following response to each of your comments.

1. A street tree master plan is currently being prepared and will be submitted to your department at the appropriate time in the design and approval process. We concur that maintenance of street trees located outside of the road right-of-ways will be the responsibility of the developer or future community association.

2. Thank you for providing the current park size standards. The final design of the East Kapolei Master Plan will adhere to all applicable park standards based on the number of units ultimately developed. However, as master developer of the major backbone infrastructure, the Housing and Community Development Corporation of Hawaii (HCDCH), formerly Housing Finance and Development Corporation, will not be in a position to determine the actual number of dwelling units. The project design and number of dwelling units (which will determine the population to be served) will be determined by individual private developers.

   Please understand that the portion of the drainageway corridor planned for passive recreation will not be visually distinguishable from other park areas. As described in the DEIS Drainage Master Plan (Appendix B), Figure 4-2, the passive park areas will have slopes no greater than 5 percent (5%) and the width will range between 108 feet to 360 feet. These areas will provide a major recreation resource to the community. For example, the combined land area of the proposed district park and the adjoining passive park area is over 40 acres. Bikeways, jogging paths and extensive landscaping will all be provided to create an attractive open space recreation area. It is our position that some credit should be given by DPR for the development of these recreation areas.

The park area were sized in the DEIS for planning purposes only and can still be revised as appropriate to reflect city standards. The final size of the neighborhood parks will be determined during the rezoning process and through consultation with DPR.

We will continue to work with your department to determine the appropriate combination of parks and recreational facilities that are appropriate for the community.

Once again, thank you for participating in the environmental review process.

Sincerely,

Donald K. W. Lau

DONALD K. W. LAU
Executive Director

A. Market Assessment

EAST KAPOLEI

Market Study

March 14, 1997

PREPARED FOR

State of Hawaii

Housing Finance and Development Corporation

BY

The Prudential Locations
Real Estate Sales & Research

STUDY OUTLINE

I. EXECUTIVE SUMMARY

Property Overview - The development of East Kapolei is a logical continuation of residential development in the Ewa Development Plan Area (DPA). The subject property is expected to continue delivering the level of quality and sense of community seen at the Villages of Kapolei. The product types at the subject property are expected to provide housing for families in all income brackets and age ranges. The subject will have easy access from Farrington Highway and the to-be-constructed North South Road. The subject property should also be highly visibility from the H1 freeway. However, the current commute time from the subject property to Downtown Honolulu in peak traffic hours is approximately one hour. If nothing is done to reduce traffic (i.e., more local jobs, rail, greater highway capacity) an increased commute time should decrease demand for the subject property. If the commute time to Downtown Honolulu is reduced or remains the same, the combination of well designed homes in a well planned community at the middle to lower price ranges will be perceived as representing very good value to potential homebuyers. This will be crucial in the years ahead because, in an environment of low inflation, the investment/speculation aspect of a home purchase will likely be much less important.

Supply Analysis - The Central Oahu DPA appears to have adequate supply planned and proposed to meet demand until approximately 2016. These estimates assume Gentry Waiawa begins delivering units between 1997 and 2000, and Castle and Cooke is allowed to rezone additional land in the Central Oahu DPA. The Ewa DPA appears to have adequate supply planned and proposed to meet demand until approximately 2005. These estimates assume Ewa Marina begins delivering units between 1997 and 2000; Ewa Fairways, Kapolei Mauka, and Makaiwa Hills begin delivering units between 2001 and 2005; the City of Kapolei and Kapolei LDA begin delivering units between 2006 and 2010; and Kapolei North begins delivering units between 2011 and 2015. The project formerly known as "Schuler's East Kapolei" has been excluded. The overall makeup of housing inventory in the Ewa DPA is expected to be 60% single family and 40% multi-family and apartment. In conclusion, the West Oahu market currently has adequate housing planned and proposed to meet demand until approximately 2005. More developments could enter the market before 2005, however, they mite be met with increased competition and lower absorption rates.

Demand Analysis - Between 1997 and 2020, Oahu new sales are estimated to remain in the same sideways bracket of approximately 1,000 to 1,500 single family homes per year and approximately 1,000 to 1,500 multi-family units per year. These new sale levels have characterized the Oahu market for at least the past 15 years. However, market share by DPA will be better represented by new sale trends of the past 5 years. Because the subject property can be viewed as an extension or continuation of the Villages of Kapolei, we estimate that the subject property can continue to capture a similar market share. These market share estimations assume a similar competitive environment of two to three large competitive developments in the Ewa DPA and reduced or similar commute times to Downtown Honolulu.

Over the past 4 years, the Villages of Kapolei have averaged 230 new single family sales per year or approximately an 18% market share of Oahu's total new single family sales. We estimate that the subject property will continue to have a similar single family market share of approximately 18%. Over the past 3 years, the Villages of Kapolei has averaged 170 new multi-family sales per year or an 11% market share of Oahu's total new multi-family sales. We estimate that the subject property has the potential to capture approximately 12% of Oahu's new multi-family sales since increased multi-family development is expected around the second city of Kapolei as it grows. These estimated demand figures assume commute times from West Oahu to Downtown Honolulu will be either similar to or lower than current commute times, since greater commute time could reduce demand for housing in West Oahu.

Projected Unit Sales and Pricing - Using historical and projected economic and real estate data, our best estimate for the next 25 years is that Oahu new home sales will be of a similar order of magnitude as seen in the past 15 years (annual absorption of approximately 2,000 to 3,000 new for sale homes with approximately 50% being single family and 50% being multi-family units). However, market share by development plan area will be more reflective of the past 5 years. The subject property is estimated to have an average annual absorption of approximately 225 homes or 18% of the Oahu single family new sale market (2,500 new sales x 50% single family x 18% market share = 225 single family sales). The West Oahu multi-family market is expected to be more volatile than the single family market and the subject property is estimated to have an average annual absorption of approximately 150 units or 12% of the Oahu multi-family new sale market (2,500 new sales x 50% multi-family x 12% market share = 150 multi-family sales). Over the past four years, new sale prices at the Villages of Kapolei have been approximately $250,000 for a single family home and approximately $125,000 for a multi-family unit. Because the subject property can be seen as an extension of the Villages of Kapolei, it is concluded that an average price of $250,000 should be used for single family homes and $125,000 should be used for multi-family units in 1996 with an appreciation rate of 2% per year. Completed

construction of the North South Road between 2001 and 2005 and additional unit demand in West Oahu after 2005 suggests that completed units at East Kapolei can begin to be delivered between 2001 and 2005. The following table summarizes estimated unit mix, sales, and pricing.

Table I-1
East Kapolei Projected Unit Absorption and Pricing

Year	Units			Unit Price		Gross Revenue from Unit Sales		
	SF	MF	Total	SF	MF	SF	MF	Total
2001	133	88	221	$275,000	$138,000	$36,575,000	$12,144,000	$48,719,000
2002	225	150	375	$281,000	$141,000	$63,225,000	$21,150,000	$84,375,000
2003	225	150	375	$287,000	$144,000	$64,575,000	$21,600,000	$86,175,000
2004	225	150	375	$293,000	$147,000	$65,925,000	$22,050,000	$87,975,000
2005	225	150	375	$299,000	$150,000	$67,275,000	$22,500,000	$89,775,000
2006	225	150	375	$305,000	$153,000	$68,625,000	$22,950,000	$91,575,000
2007	225	150	375	$311,000	$156,000	$69,975,000	$23,400,000	$93,375,000
2008	225	150	375	$317,000	$159,000	$71,325,000	$23,850,000	$95,175,000
2009	225	150	375	$323,000	$162,000	$72,675,000	$24,300,000	$96,975,000
2010	225	150	375	$329,000	$165,000	$74,025,000	$24,750,000	$98,775,000
2011	225	150	375	$336,000	$168,000	$75,600,000	$25,200,000	$100,800,000
2012	225	150	375	$343,000	$171,000	$77,175,000	$25,650,000	$102,825,000
2013	225	150	375	$350,000	$174,000	$78,750,000	$26,100,000	$104,850,000
2014	225	150	375	$357,000	$177,000	$80,325,000	$26,550,000	$106,875,000
2015	225	150	375	$364,000	$181,000	$81,900,000	$27,150,000	$109,050,000
2016	225	112	337	$371,000	$185,000	$83,475,000	$20,720,000	$104,195,000
2017	225		225	$378,000	$189,000	$85,050,000		$85,050,000
2018	225		225	$386,000	$193,000	$86,850,000		$86,850,000
2019	225		225	$394,000	$197,000	$88,650,000		$88,650,000
Total	4,183	2,300	6,483					

Projected Developer Absorption and Pricing - Converting unit sales to acres estimates that an average of approximately 37 acres of single family land and 11 acres of multi-family land could be developed and absorbed each year. Land acquisitions by developers are estimated to occur between 1 and 2 years before homes are completed and sold. Therefore, the first developer sale is estimated to occur between 1999 and 2000. Since developers are willing to pay only a certain percentage of their gross revenue from unit sales for land acquisition, an analysis of developer land sales was performed. This analysis has shown that developers were willing to pay an average of approximately 20% of their gross revenue from unit sales for builder lots. The following analysis estimates that in 1999 developers should be willing to pay approximately $336,000 per acre for single family land and $387,000 per acre for multi-family land and by 2017 developers should be willing to pay approximately $481,000 per acre for single family land and $549,000 per acre for multi-family land.

Table I-2
East Kapolei Projected Developer Price per Acre

Year	Acres			Gross Rev. from Unit Sales		Land Acquisition		Developer Price per Acre		
	SF	MF	Total	SF	MF	SF	MF	SF	MF	Average
1999	21.80	6.28	28.08	$36,575,000	$12,144,000	$7,315,000	$2,428,800	$336,000	$387,000	$347,000
2000	36.89	10.71	47.60	$63,225,000	$21,150,000	$12,645,000	$4,230,000	$343,000	$395,000	$355,000
2001	36.89	10.71	47.60	$64,575,000	$21,600,000	$12,915,000	$4,320,000	$350,000	$403,000	$362,000
2002	36.89	10.71	47.60	$65,925,000	$22,050,000	$13,185,000	$4,410,000	$357,000	$412,000	$370,000
2003	36.89	10.71	47.60	$67,275,000	$22,500,000	$13,455,000	$4,500,000	$365,000	$420,000	$377,000
2004	36.89	10.71	47.60	$68,625,000	$22,950,000	$13,725,000	$4,590,000	$372,000	$429,000	$385,000
2005	36.89	10.71	47.60	$69,975,000	$23,400,000	$13,995,000	$4,680,000	$379,000	$437,000	$392,000
2006	36.89	10.71	47.60	$71,325,000	$23,850,000	$14,265,000	$4,770,000	$387,000	$445,000	$400,000
2007	36.89	10.71	47.60	$72,675,000	$24,300,000	$14,535,000	$4,860,000	$394,000	$454,000	$407,000
2008	36.89	10.71	47.60	$74,025,000	$24,750,000	$14,805,000	$4,950,000	$401,000	$462,000	$415,000
2009	36.89	10.71	47.60	$75,600,000	$25,200,000	$15,120,000	$5,040,000	$410,000	$471,000	$424,000
2010	36.89	10.71	47.60	$77,175,000	$25,650,000	$15,435,000	$5,130,000	$418,000	$479,000	$432,000
2011	36.89	10.71	47.60	$78,750,000	$26,100,000	$15,750,000	$5,220,000	$427,000	$487,000	$441,000
2012	36.89	10.71	47.60	$80,325,000	$26,550,000	$16,065,000	$5,310,000	$435,000	$496,000	$449,000
2013	36.89	10.71	47.60	$81,900,000	$27,150,000	$16,380,000	$5,430,000	$444,000	$507,000	$458,000
2014	36.89	8.00	44.89	$83,475,000	$20,720,000	$16,695,000	$4,144,000	$453,000	$518,000	$464,000
2015	36.89			$85,050,000		$17,010,000		$461,000	$528,000	
2016	36.89			$86,850,000		$17,370,000		$471,000	$539,000	
2017	36.89			$88,650,000		$17,730,000		$481,000	$550,000	

Some developers prefer to purchase large amounts of land at one time in order to provide themselves with the potential for several years of continued development. Clearly, such bulk land sales need to have their price reduced to account for the extended period of carrying the property. For East Kapolei, a bulk land sale was defined as any sale of over 90 acres. The Prudential Locations Research Department conducted a Present Value Analysis to determine a discount for bulk land sales at several discount rates. This analysis has shown that at a discount rate of 10%, an appropriate percentage of the current non-bulk land price should range from approximately 60% for 850 acres to approximately 95% for 180 acres.

The following table shows a likely scenario for residential land sales at East Kapolei. This scenario assumes there would be 13 transactions, two of which would be bulk land sales. Developer land sales are estimated to begin in 1999 with a bulk land sale of 400 acres and a second bulk land sale of 180 acres in 2007. The remaining 280 acres are estimated to be sold between 2012 and 2017 in approximately 37 acre single family lots and 11 acre multi-family lots. As shown in this scenario, the total revenue received by the State of Hawaii from residential land sales would be approximately $310,000,000.

Table I-3
East Kapolei Projected Residential Absorption and Pricing

Developer Sale Date	Acres	Type	Unit Sales Year	Developer Price per Acre	Developer Sale Prices	Discount for Bulk Sales	Discounted Sale Prices
1999	400	SF/MF	2001 - 2009	$347,000	$138,800,000	82%	$113,816,000
2007	180	SF/MF	2009 - 2013	$407,000	$73,260,000	95%	$69,597,000
2012	37	SF	2014	$435,000	$16,095,000	100%	$16,095,000
2012	11	MF	2014	$496,000	$5,456,000	100%	$5,456,000
2013	37	SF	2015	$444,000	$16,428,000	100%	$16,428,000
2013	11	MF	2015	$507,000	$5,577,000	100%	$5,577,000
2014	37	SF	2016	$453,000	$16,761,000	100%	$16,761,000
2014	11	MF	2016	$518,000	$5,698,000	100%	$5,698,000
2015	37	SF	2017	$461,000	$17,057,000	100%	$17,057,000
2015	11	MF	2017	$528,000	$5,808,000	100%	$5,808,000
2016	37	SF	2018	$471,000	$17,427,000	100%	$17,427,000
2016	11	MF	2018	$539,000	$5,929,000	100%	$5,929,000
2017	30	SF	2019	$481,000	$14,430,000	100%	$14,430,000
Total	850						$310,079,000

Real estate developments the size of the subject property always demand retail space to serve its residential components. It is estimated that one acre of commercial land area is demanded for every 230 new housing units built. Using an average residential absorption of 375 residential units per year, estimates that approximately 1.6 acres of commercial land will be demanded annually at East Kapolei. Currently, average market rents for retail space at subject property are estimated at $2.25 a sq. ft. per month of gross leasable area. For the purpose of a pricing analysis, it is estimated that developers would develop 40 percent of the land area as leasable space, the vacancy rate would be 10 percent, operating expenses would be approximately 25 percent of annual gross income, development costs are currently estimated at $110 per sq. ft. of gross leasable area, and the land value of the completed shopping center would be approximately 10 times the annual net income less construction costs. For projection purposes it is estimated that rents and construction costs will increase at an average annual rate of 2%. This analysis estimated that developers would be willing to pay approximately $1,400,000 per acre in 2001 and $2,000,000 per acre in 2020 for commercial land at East Kapolei.

The following table shows a likely scenario for commercial land sales at East Kapolei. This scenario assumes that there would be 4 transactions. Commercial land sales are estimated to begin with a sale of 2 acres in 2003 and a sale of 6 acres in 2008. The remaining 16 acres are estimated to be sold between 2014 and 2020 with two sales of 8 acres each. As shown in this scenario, the total revenue the State of Hawaii would receive from commercial land sales is estimated to be approximately $43,600,000.

Figure I-4
East Kapolei Projected Commercial Absorption and Pricing

Year	Acres	Sales Price
2003	2	$2,929,612
2008	6	$9,703,524
2014	8	$14,570,360
2020	8	$16,408,672
Total	24	$43,612,168

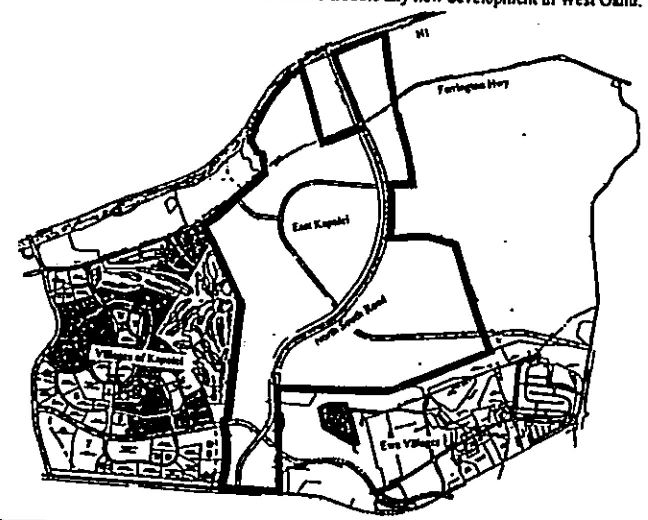
II. INTRODUCTION

The Prudential Locations Research Department was retained by PBR Hawaii to assess the market feasibility of a proposed HFDC development called East Kapolei. This report is the result of that market study. In no way has the fee for this study been contingent upon the recommendations of specified values or findings. Numerous data sources have been integrated into this study, including Multiple Listing Service (MLS) data, conveyance data, city and state reports, The Prudential Locations' own proprietary data banks, and survey data. While the information was obtained from sources deemed reliable, and every attempt has been made to ensure its accuracy, we are not responsible for inaccurate information provided by others.

III. PROPERTY DESCRIPTION

The subject property, East Kapolei, as evident in the name, is located to the east of the city of Kapolei and the Villages of Kapolei in the Ewa development plan area (DPA) (Maps 1 and 2). East Kapolei will contain approximately 850 acres of salable residential land and 24 acres of commercial land. All residential lands will be zoned R5, however, developers can rezone parcels to accommodate either cluster or multi-family development. The sale of this residential land to developers is currently estimated to begin in the year 1999.

The development of East Kapolei appears to be a logical continuation of residential development in the Ewa Development Plan Area (DPA). The subject property's location is approximately 16 miles to downtown Honolulu and approximately 3 miles from the second city of Kapolei. Access to the subject property will be from H-1, Farrington Highway, and the to be constructed North South Road. East Kapolei will be bisected by the planned North South Road which is currently estimated to be completed between 2001 and 2005. The completed construction of the North South Road is necessary to access some areas of the subject property. However, the first phases of development are planned to have access from Farrington Highway, therefore, land sales could occur before the completion of the North South Road. All developments at the subject property should be visible from H-1. Most new developments in the Ewa DPA will have a hotter climate and lower precipitation compared to most competitive developments in the Central Oahu DPA. Unfortunately, most buyers prefer the climate and precipitation levels of the Central Oahu DPA over the Ewa DPA. Some other drawbacks to the subject property could be red dirt, termites, commuter traffic, and the current lack of local white collar jobs. However, these drawbacks should also trouble any new development in West Oahu.



IV. ECONOMIC REVIEW

Overall Economy - Hawaii's economy appears to be making a gradual transition to a more service-oriented and moderately growing business environment. Once the recovery is complete, Hawaii's economy should be able to achieve a stabilized growth rate of 1.5% to 2% on a longer term basis. While this is approximately half the average growth rates achieved in the past 30 years, it will be in line with that of the overall U.S (Figures IV-1 and IV-2).

Visitor Industry - With the decline in agriculture and defense, the visitor industry is Hawaii's primary engine of economic growth. Tourists support the local economy directly via employment in visitor-related service industries and indirectly via construction and retail trade. Hawaii accommodates two distinctly different types of visitors - westbound visitors who come primarily from the West Coast of the U.S. Mainland, and eastbound visitors who come primarily from Japan. With regard to the westbound visitor, Hawaii has matured as a destination in that repeat visits outnumber first-time visits. In contrast to the westbound market, eastbound tourism continues to grow significantly with total visitors up 8.9% in 1996 to 1.9 million arrivals. In contrast to westbound visitors, eastbound visitors show a strong preference for Oahu in general and Waikiki in particular. Moreover, they spend much more money per day than Westbound visitors. The performance of the eastbound market has been particularly impressive in the past few years given the anemic growth of the Japanese economy. The potential for further growth in the eastbound market is obvious when one considers the rapid growth and rising living standards which are occurring in other Asian economies. All this suggests that Hawaii is at a relatively early phase as a tourist destination for the Asian (eastbound) visitor (Figures IV-3 to IV-5).

Employment Growth - The number of jobs in the local economy is, of course, closely tied to the performance of the overall economy. Thus, it should be expected that a moderation in future economic growth will lead to a moderation in job growth. In terms of numbers, the annual increase in jobs over the next 20 years is projected to be just over 1% per year (Figure IV-6). This is less than a third of the 2.9% rate of the 1980-90 period. Future job growth will be highest in those areas where population is expected to grow most rapidly. These include, of course, the Ewa DPA and Central DPA. Between 1990 and 2010, the Ewa DPA is projected to experience an increase of 19,749 new jobs (5.11% annually).

Many new jobs are planned near East Kapolei. Recently, both the City and County of Honolulu and the State of Hawaii began construction on office buildings at Kapolei which should bring over 1,000 government jobs to West Oahu. A medical facility is also expected to begin construction at Kapolei in the next few years. The State has also been moving forward with its plans to build the UH West campus located across H1 from the subject property. More retail, service, and construction jobs will also be created from the large amount of residential growth planned in the Ewa DPA.

Population Growth - Although Oahu's annual population growth rate is expected to moderate in future years to less than 1%, there will be significant differences among its development plan areas (Figures IV-7 and IV-8). The fastest growing region in recent years has been the Ewa DPA. Growth in this region averaged 1.87% per year in the 1980's and is expected to accelerate to 3.94% between 1990 and 2010; thereafter, annual population growth is expected to average 2.10% out to 2020. The second fastest growth region will be Central Oahu DPA which grew 2.54% per year in the 1980's and is projected to grow at 1.33% per year in the 1990-2010 period; thereafter, annual population growth is expected to average 0.88% out to 2020. These regional forecasts are based upon the City and County of Honolulu Planning Department's publication entitled "Forecast of Population, Housing and Employment on Oahu by Small Area 1990-2010"(Figures IV-9 and IV-10).

Household Growth - The mechanism to convert population growth into demand for housing units is the "household size" factor. Household size is defined as the ratio of the number of persons in households to the number of housing units. History has shown that Oahu's household size factors have steadily declined over time. For the island as a whole, the household size is projected to decline from 2.95 persons in 1990 to 2.80 in 2010, and 2.69 in 2020, according to the City and County of Honolulu Planning Department. The household size factors for individual areas on Oahu have also been projected in the Planning Department report. In the case of the Ewa DPA, the household size is projected to decline from 3.57 in 1990 to 3.34 in 2010. This decline assumes that future Ewa developments will be

similar to those of recent years. Not surprisingly, the lowest household size factor on Oahu will continue to be the Primary Urban Center (PUC) which had 2.69 persons per household in 1990 and is projected to have 2.52 persons in 2010. This is a reflection, of course, to the fact that there is more high-rise multi-family and rental apartment housing in the PUC than anywhere else on Oahu.

These factors can be coupled with projections of population growth to estimate the demand for new housing units on Oahu. In particular, the combination of the Oahu population growing by approximately 231,000 and the average household size declining to 2.69 results in the demand for approximately 2,900 new units per year between 1990 and 2020. In addition, we assume that there is further pent-up demand in the marketplace for up to 1,000 units annually of which we estimate half, or 500, could be met each year. The sum of the two results in a demand for approximately 3,400 new housing units per year.

In addition to our simple approach, the Planning Department of the City and County of Honolulu has also made estimates of future new housing units out to the year 2020. These estimates were based upon an econometric model which incorporated variables such as population, employment, and interest rates, to name a few. This model projected that the total number of housing units on Oahu would grow by approximately 97,000 units between 1996 and 2020, or an average of approximately 3,900 per year.

In conclusion, the combination of an increasing population (albeit at a lower growth rate), decreasing household size, and continued release of pent-up demand will give rise to a similar number of future housing units needed annually as seen in the past. In terms of numbers, there should be demand for between 3,400 and 3,900 new housing units per year on average out to the year 2020. This includes both units for sales as well as rentals.

Income Growth - In a housing market such as we have on Oahu, the primary driving force behind the purchase decision is affordability. In this regard, our research has found an interesting correlation between the actual median Oahu single family and multi-family composite sales price and the so-called "affordable price". As one might expect, the actual and affordable price series have criss-crossed one another over the years with the actual price shooting far above the affordable price during "boom" market conditions. Each time this overshoot has occurred, the market has slowed dramatically because of the affordability shortfall. This led to an extended period of subdued sales activity and flat prices which served to allow incomes and the associated purchasing power of consumers to catch up with prices again. Even when the economy recovers, both actual and affordable prices are expected to increase at more moderate rates in the foreseeable future. This suggests that the strongest sector of the Oahu real estate market in the years ahead should be in mid to lower priced housing, as is being planned for East Kapolei (Figures IV-11 and IV-12).

Residential Construction - The cyclical character of Oahu's real estate market is apparent in trends of new home construction. While overall Oahu new construction has been on a declining trend for nearly the past 20 years, the Ewa DPA has been one of the few areas on Oahu which has experienced an increasing annual performance in recent years. This trend should continue into the foreseeable future due to the limited availability of developable land on the rest of Oahu (Figures IV-13 and IV-14).

Oahu's New and Existing Home Market - Real estate markets are generally highly cyclical in nature and Oahu is no exception. Oahu's cycles, as seen in sales activity, have averaged approximately 7 to 10 years from peak to peak, with Oahu median home prices having approximately doubled each decade (Figure IV-15). The Oahu real estate market in the first half of the 1990's has been characterized by subdued sales activity and flat to declining prices depending upon the neighborhood. The recovery in the overall economy should lead to higher sales activity levels in the next few years. However, the upswing in sales will likely be gradual and with prices rising more in line with the overall inflation rate rather than the double-digit increases seen in the late 1970's and 1980's (Figure IV-16).

Demand for homes in the Ewa DPA should continue to be good for the foreseeable future. The combination of well designed homes in well planned communities at mid to lower price range will be perceived as representing very good value to potential homebuyers. This will be crucial in the years ahead because, in an environment of low inflation, the investment/speculation aspect of home purchase will likely be much less important.

Conclusions - After five years of little growth, the Hawaii economy finally is showing signs of a recovery. This is being led by a resurgence in tourism which has become Hawaii's primary engine of economic growth. Furthermore, within the visitor industry, the dynamics have changed since the early 1980's. The eastbound (Asian) market will be the fastest growing while the westbound market has become mature. This suggests that future economic growth for the state as a whole will be more moderate than the experience of the 1970's and 1980's.

Along with more moderate economic growth, we project more moderate growth in population. However, a declining household size will result in future new housing needs being similar in magnitude to those of the past ten years. The challenge for homebuyers will continue to be affordability. In this regard, a majority of new development on Oahu will be in the Ewa and Central Oahu DPAs. These will be the most rapidly growing regions on Oahu for the foreseeable future. This is because they both offer meaningful amounts of developable land at prices which make the total house and lot purchase attainable to the typical household.

V. RESIDENTIAL MARKET OVERVIEW

The analyses within this section focus on historical and projected Ewa DPA population, household formation, housing unit growth, and real estate sales trends. These variables give us the necessary tools to make projections of future supply and demand which form our conclusions. For the purposes of this section, we will use the term 'West Oahu' to refer specifically to the combination of the Ewa and Central Oahu DPAs.

Real estate markets are generally highly cyclical in nature and Oahu is no exception. Oahu's cycles, as seen in sales activity, have averaged approximately 7 to 10 years from peak to peak, with Oahu average home prices having approximately doubled each decade. The Oahu real estate market in the first half of the 1990's has been characterized by subdued sales activity and flat to declining prices, depending upon the area.

Since 1992, West Oahu has been absorbing approximately 600 to 1,500 new single family homes and 600 to 1,500 new multi-family units annually (Figure V-1 and V-2). New single family sales in 1996 compared to 1995 were down 24% to approximately 900 homes in West Oahu. By area, new single family home sales in 1996 compared to 1995 were down 36% to approximately 510 homes in the Ewa DPA and flat in the Central Oahu DPA at approximately 390 homes. New multi-family sales in 1996 compared to 1995 were down 45% to approximately 525 units in West Oahu. By area, new multi-family unit sales in 1996 compared to 1995 were down 38% to approximately 200 units in the Ewa DPA and down 49% to approximately 320 units in the Central Oahu DPA.

West Oahu new single family prices stabilized after large increases between the years 1988 and 1991. New single family median prices in 1996 compared to 1995 were down 14.1% to $317,000 in the Central Oahu DPA and down 15.8% to $230,000 in the Ewa DPA (Figure V-3). Visibly, prices have remained relatively stable for new single family homes in West Oahu since 1991. West Oahu new multi-family prices also stabilized after large increases between the years 1988 and 1991. New multi-family median prices in 1996 compared to 1995 were up 5.9% to $198,000 in the Central Oahu DPA and up 5.1% to $168,000 in the Ewa DPA (Figure V-4). Visibly, new multi-family prices have also remained relatively stable in West Oahu since 1991. However, these prices do not reflect the increased number of buyer incentives that developers are resorting to in order to bolster lagging sales rates. If these resulting effective prices were factored in, the evident trend would be that prices have dropped slightly but steadily since 1993.

Generally, developers in West Oahu have had to lower their prices in one way or another, either by means of incentives or outright price decreases, in order to sell the product they have already developed or are committed to develop. This only makes it more difficult for new projects, as they will enter an environment where competition is fiercer and buyers are shopping more carefully for the best deal or incentive package they can find. Most marketing and development professionals are unhappy about the slowdown in the new sales market. There is difference in opinion, however, as to whether this market change is due to a lack of overall demand, or a greater gap in affordability for those families who are currently in the market for new homes. In other words, there could be many potential buyers who simply can't meet the requirements in terms of down payment and income or potential buyers may be unwilling to invest in an uncertain market and are simply waiting for definite signs of improvement.

The recovery in the overall economy should lead to higher sales activity levels in the next few years. However, the upswing in sales will likely be gradual, and rising prices will be more in line with the overall inflation rate rather than the double-digit increases seen in the late 1970's and 1980's. Over the next few years, the West Oahu market will most likely face more competition from increased development elsewhere on the island, even in price ranges that have been somewhat exclusive to West Oahu for several years. For example, most affordable multi-family projects in Honolulu have been quickly absorbed, and there are several affordable to mid-market multi-family projects in various planning stages. Urban Honolulu may see anywhere from 200 to 1,000 new units per year constructed from 1997 to 2000. This will mean increased competition for the West Oahu multi-family market.

In conclusion, long term demand for single family homes and multi-family units in the Ewa DPA should continue to be good for the foreseeable future. The combination of well designed homes in well planned communities at mid to lower price ranges will be perceived as representing very good value to potential homebuyers. This will be crucial in the years ahead, because in an environment of low inflation the investment/speculation aspect of a home purchase will likely be much less important.

VI. DEMAND ANALYSIS

Economic Demand

Oahu year-to-year total new and resale activity levels have historically been highly correlated to the annual percent change in job growth (Figure VI-1). This helps explain why local real estate activity has been so slow in recent years, despite such favorable mortgage rates. We expect the Hawaii economy to gradually improve over the next several years, although the projected growth rates will be relatively mild by historical standards. This should keep overall new home sales in the range of 2,000 to 3,000 units per year, a rate which has been characteristic of the Oahu market for at least the past 15 years (Figure VI-2).

Despite a more moderately growing overall economy, the combination of an increasing population (albeit at a lower growth rate), decreasing household size, and ongoing release of pent-up demand will give rise to a similar number of future housing units needed annually as seen in the past. In terms of numbers, this translates to an average of approximately 3,700 housing units per year between 1997 and 2020. This estimated housing unit demand includes both for-sale units and for-rent apartment buildings. However, it does not include resort-oriented housing units.

Historical New Sale Market

Over the past 10 years, the Oahu real estate market has absorbed between approximately 2,000 and 3,000 new (for sale) housing units annually with approximately 50% being single family homes and 50% being multi-family units (Figure VI-3). Over the past 5 years, West Oahu has averaged 2,120 new sales or a 72% market share of Oahu's total new sales with a Central Oahu DPA market share of 37% and an Ewa DPA market share of 35% (Figures VI-4). Over the past 4 years, the Villages of Kapolei have averaged approximately 360 new sales per year or a 12% market share of Oahu's total new sales (Figure V-5).

Over the past 5 years, West Oahu has averaged approximately 1,050 new single family sales per year or a 81% single family market share of Oahu's total new single family sales with a Central Oahu DPA market share of 33% and an Ewa DPA market share of 48% (Figures VI-6 and VI-7). Over the past 4 years, the Villages of Kapolei averaged 230 new single family sales per year or a 18% market share of Oahu's total new single family sales (Figure VI-8).

Over the past 5 years, West Oahu has averaged approximately 1,070 new multi-family sales per year or a 66% multi-family market share of Oahu's total new multi-family sales with a Central Oahu DPA market share of 41% and an Ewa DPA market share of 25% (Figures VI-9 to VI-10). Over the past 4 years, the Villages of Kapolei have averaged 170 new multi-family sales per year or an 11% market share of Oahu's total new multi-family sales (Figure VI-11). The following table summarizes average market share for the past 5 years by area and product type.

Table VI-1
Historical Market Share by Area and Product Type (1992 - 1996)

Area	Single Family	Multi-family	Total
Oahu	100%	100%	100%
West Oahu	81%	66%	72%
Central Oahu DPA	33%	41%	37%
Ewa DPA	48%	25%	35%
Villages of Kapolei (1993 - 1996)	18%	11%	12%

Projected New Sale Market

The Prudential Locations Inc. Research and Consulting Department estimates that West Oahu's single family market share will continue to fluctuate between 70% and 90% over the next 25 years, since few large single family zoned parcels will exist elsewhere on Oahu. Over the past few years, the Ewa DPA has captured a higher percentage of Oahu's single family market than the Central Oahu DPA. Since 1992, the Central Oahu DPA has captured

approximately 33% of the single family market and the Ewa DPA has averaged approximately 48%. We estimate that the Ewa DPA should continue to capture approximately 45% of Oahu's single family market over the next 20 to 25 years. The Prudential Locations Research Department estimates the East Kapolei should have the ability to capture a similar market share as the Villages of Kapolei, since East Kapolei can be viewed as an extension or continuation of the Villages of Kapolei. Thus, for projection purposes, we estimate approximately 18% of Oahu's new single family sales can occur at the subject property between 2001 and 2020. This projection assumes a similar competitive environment (i.e., two or three major competitors in the Ewa DPA).

The West Oahu multi-family market share should continue to be volatile since multi-family zoned parcels exist in several areas outside of West Oahu. The West Oahu multi-family market share increased from approximately 15% in 1988 to just over 80% in 1993. This was the result of increasing land prices in the Primary Urban Center which reached levels where moderately priced developments were not financially feasible. This forced new affordable multi-family development into West Oahu where land prices were more reasonable. Since 1993, the West Oahu multi-family market share has decreased steadily to approximately 37% in 1996. This trend has been caused by several factors including decreasing land values in urban Honolulu and a reduced number of buyers willing to purchase multi-family products in West Oahu. The Prudential Locations Research Department estimates that the West Oahu multi-family market share should average between 50% and 70% over the next 25 years. In recent years, the Central Oahu DPA has captured a higher percentage of Oahu's new multi-family market than the Ewa DPA. In the near future, the Central Oahu DPA is anticipated to continue capturing a greater percentage of the Oahu multi-family market because of its superior location and climate. However, as the second city of Kapolei grows, the Ewa DPA is anticipated to capture an increasing percentage of Oahu's multi-family market. For projection purposes between 2001 and 2020, we estimate 32% of Oahu's new multi-family sales can occur in the Ewa DPA and 12% are estimated to occur at the subject property. This projection assumes a similar competitive environment of two or three major competitors in the Ewa DPA. Additionally, it assumes that commute times from West Oahu to Downtown Honolulu will be either similar to or lower than current commute times, since greater commute time will reduce demand for housing in West Oahu. The following table summarizes estimated average market share between 2001 and 2020 by area and product type.

Table VI-2
Estimated Market Share by Area and Product Type (2001 - 2020)

Area	Single Family	Multi-family	Total
Oahu	100%	100%	100%
West Oahu	80%	60%	70%
Central Oahu DPA	35%	28%	31.5%
Ewa DPA	45%	32%	38.5%
East Kapolei	18%	12%	15%

VII. SUPPLY ANALYSIS

Existing Housing Inventory

West Oahu, comprised of the Central Oahu and Ewa DPAs, contains the great majority of Oahu's developable land. Most of Oahu's new housing development over the past ten years has occurred there, and it is estimated that at least 80 percent of Oahu's new housing unit demand over the next 20 years will be satisfied by development in the West Oahu area. As shown in Table VII-1 below, West Oahu has seen almost as much housing construction in the past 5 years than in the entire construction-boom decade of the 1970's. The largest increase in construction occurred in the Ewa DPA, where approximately 45 percent of all housing was constructed within the past 5 years.

Table VII-1
Existing Housing Inventory by Product Type and Year Built

Area	Type	before 1960	1960-1969	1970-1979	1980-1989	1990-1995	Totals
Central Oahu DPA	Single Family	3,577	3,961	6,247	6,394	2,375	22,554
	Multi-family	62	927	3,038	2,147	3,172	9,346
	Apartment	481	1,353	926	333	712	3,805
	Total	4,120	6,241	10,211	8,874	6,259	35,705
Ewa DPA	Single Family	1,053	1,881	1,915	1,485	3,452	9,786
	Multi-family			1,109	731	3,010	4,863
	Apartment	61	47	30		349	487
	Total	1,114	1,928	3,054	2,216	6,811	15,123
West Oahu	Single Family	4,630	5,842	8,162	7,879	5,827	32,340
	Multi-family	62	927	4,147	2,878	6,624	14,209
	Apartment	542	1,400	956	333	1,061	4,292
	Total	5,234	8,169	13265	11,090	13,070	50,828

The current makeup of the West Oahu housing inventory is approximately 65 percent single family, and 35 percent multi-family and apartment. As land continues to be developed within the Central Oahu and Ewa DPAs, the logical progression has been to develop more units on less land, for economy from the developer's perspective as well as the buyer's perspective. This leads to smaller lots, cluster developments, and ultimately to a lower ratio of single family homes built to multi-family units. Recent construction shows this trend. The ratio of West Oahu's construction over the past 5 years has been closer to 45 percent single family. While the next two to three years may still see a high ratio of multi-family units built, our projection for the Ewa DPA between 2001 and 2020 is that the ratio of construction of single family homes to total housing units will be approximately 65 percent. This is because multi-family development in the primary urban center and elsewhere on Oahu is expected to increase, and will absorb a greater portion of Oahu's overall multi-family unit demand.

Table VII-2
Kapolei Housing by Type and Year Built

Year Built	Single Family	Multi-family
1990	298	
1991	225	
1992	73	
1993	103	88
1994	440	279
1995	303	128
1996	165	46
Total	1,607	541

Projected Housing Inventory

East Kapolei will likely contain varied product types from affordable multi-family to market single family. These product types will compete with developments in both the Central Oahu DPA and Ewa DPA. Therefore, all known potential developments in West Oahu were analyzed. Unfortunately for analysis purposes, developers continually modify their development plans to conform to changing market conditions. Therefore, the information on projected developments is only accurate for the next few years. Thus, rather than present information developers and city planners

have projected, The Prudential Locations Research Department has made an estimate of projected absorption between 2001 and 2020 from potential capacity derived from long term economic/demographic forecasts and historical and projected new sale demand. Absorption estimates between 1997 and 2000 were derived from current and projected new sale demand which should reflect adjustments for current market conditions. The following table summarizes our estimated absorption schedule for West Oahu between 1997 and 2020.

Table VII-2
West Oahu Estimated Absorption Schedule (1997 - 2020)

2001-2020 Model Assumptions

Development Plan Area	Percent of Total Units	Annual Unit Demand	5 Year Unit Demand
Central Oahu	30%	1,100	5,500
Ewa	40%	1,500	7,500
Central Oahu & Ewa	70%	2,600	13,000
All Others	30%	1,100	5,500
Oahu Total	100%	3,700	18,500

Ewa Development Plan Area

Development	Map Ref.	1997-2000	2001-2005	2006-2010	2011-2015	2016-2020	Total
Villages of Kapolei	A	1,600	1,250	0	0	0	2,850
Kapolei Knolls	B	300	100	0	0	0	400
Ewa Villages	C	600	675	0	0	0	1,275
Ewa by Gentry	D	1,400	1,600	800	0	0	4,000
Ewa Fairways	E	0	500	900	0	0	1,400
Ewa Marina	F	250	1,000	1,250	1,250	1,000	4,750
Laulani	G	0	0	250	500	500	1,250
Makakilo	H	300	400	0	0	0	700
Makaiwa Hills	I	0	500	500	1,000	1,100	3,100
Kapolei Mauka	J	0	250	500	0	0	750
Makakilo Extension	K	0	200	0	0	0	200
Kapolei North	L	0	0	0	250	500	750
City of Kapolei	M	0	250	750	1,000	1,000	3,000
Kapolei LDA	N	0	0	250	500	500	1,250
Ko Olina	O	250	250	250	500	750	2,000
Ewa DPA Totals		4,700	7,175	5,450	5,000	5,350	27,675
5 Year Unit Demand		4,700	7,500	7,500	7,500	7,500	34,700
Supply Surplus/(Shortfall)		0	(325)	(2,050)	(2,500)	(2,150)	(7,025)

Central Oahu Development Plan Area

Development	Map Ref.	1997-2000	2001-2005	2006-2010	2011-2015	2016-2020	Total
Launani Valley	A	300	375	0	0	0	675
Wakele	B	500	0	0	0	0	500
Royal Kunia	C	1,000	1,250	900	0	0	3,150
Mililani Mauka	D	1,700	1,825	0	0	0	3,525
Koa Ridge Mauka	E	0	0	1,700	1,000	0	2,700
Castle and Cooke Waiawa	F	0	650	1,150	0	0	1,800
Koa Ridge Makai	G	0	0	0	2,750	700	3,450
Kipapa Ridge	H	0	0	0	0	350	350
Gentry Waiawa	I	250	1,400	1,750	1,750	1,850	7,000
Central Oahu DPA Totals		3,750	5,500	5,500	5,500	2,900	23,150
5 Year Unit Demand		3,750	5,500	5,500	5,500	5,500	26,100
Supply Surplus/(Shortfall)		0	0	0	0	(2,600)	(2,600)

Central Oahu & Ewa Development Plan Areas

Development	1997-2000	2001-2005	2006-2010	2011-2015	2016-2020	Total
Central & Ewa DPA Totals	8,450	12,675	10,950	10,500	8,250	50,825
5 Year Unit Demand	8,450	13,000	13,000	13,000	13,000	61,450
Supply Surplus/(Shortfall)	0	(325)	(2,050)	(2,500)	(4,750)	(8,625)

The Central DPA appears to have adequate supply planned and proposed to meet demand until approximately 2016. These estimates assume Gentry Waiawa begins delivering units between 1997 and 2000, and Castle and Cooke is allowed to rezone additional land in the Central Oahu DPA. The Ewa DPA appears to have adequate supply until approximately 2005. These estimates assume Ewa Marina begins delivering units between 1997 and 2000; Ewa Fairways, Kapolei Mauka, and Makaiwa Hills begin delivering units between 2001 and 2005; The City of Kapolei and Kapolei LDA begin delivering units between 2006 and 2010; and Kapolei North begin delivering units between 2011 and 2015. The project formerly known as "Schuler's East Kapolei" has been excluded.

In conclusion, the West Oahu market currently has adequate housing planned and proposed to meet demand until approximately 2005. More developments could enter the market before 2005, however, it could be met with increased competition and lower absorption rates. There appears to be sufficient demand to allow for another major development after 2005.

VIII. ESTIMATED UNIT MIX, ABSORPTION, AND PRICING

Estimated Unit Mix

An analysis of historical and projected unit demand by DPA and product type indicates that in the Ewa DPA, approximately 65% of the unit demand will be for single family homes and approximately 35% will be for multi-family units. A ratio of 6 units per acre was used for single family and a ratio of 14 units per acre was used for multi-family. On a per acre basis the ratio is 4.9 single family homes to 2.7 multi-family units with a unit mix of 65% single family and 35% multi-family. The following table estimates acres and units by product type.

Table VIII-1
East Kapolei Estimated Unit Mix

Type	Acres	Units	Percent
SF	686	4,183	65%
MF	164	2,300	35%
Total	850	6,483	100%

Estimated Unit Absorption

Using historical and projected economic and real estate data, our best estimate for the next 25 years is that Oahu new home sales will be of a similar order of magnitude as seen in the past 15 years (annual absorption of approximately 2,000 to 3,000 new for sale homes with approximately 50% being single family and 50% being multi-family units). However, market share by development plan area will be more reflective of the past 5 years.

The subject property is estimated to have an average annual absorption of approximately 225 single family homes or 18% of the Oahu single family new sale market (2,500 new sales * 50% single family * 18% market share = 225 single family sales). The West Oahu multi-family market is expected to be more volatile than the single family market and the subject property is estimated to have an average annual absorption of approximately 150 multi-family units or 12% of the Oahu multi-family new sale market (2,500 new sales * 50% multi- family * 12% market share = 150 multi-family sales).

Table VIII-2
Estimated East Kapolei Absorption

Year	Units			Acres		
	SF	MF	Total	SF	MF	Total
1999				21.80	6.28	28.08
2000				36.89	10.71	47.60
2001	133	88	221	36.89	10.71	47.60
2002	225	150	375	36.89	10.71	47.60
2003	225	150	375	36.89	10.71	47.60
2004	225	150	375	36.89	10.71	47.60
2005	225	150	375	36.89	10.71	47.60
2006	225	150	375	36.89	10.71	47.60
2007	225	150	375	36.89	10.71	47.60
2008	225	150	375	36.89	10.71	47.60
2009	225	150	375	36.89	10.71	47.60
2010	225	150	375	36.89	10.71	47.60
2011	225	150	375	36.89	10.71	47.60
2012	225	150	375	36.89	10.71	47.60
2013	225	150	375	36.89	10.71	47.60
2014	225	150	375	36.89	8.00	44.89
2015	225	150	375	36.89		36.89
2016	225	112	337	36.89		36.89
2017	225		225	36.89		36.89
2018	225		225			
2019	225		225			
Total	4,183	2,300	6,483	686	164	850

It is estimated that the first developer land sale at East Kapolei will occur in 1999. Land acquisitions by developers in projects similar to the subject property generally occur between 1 and 2 years before units are completed and sold. Therefore, the first unit sales are estimated to occur around 2001. Converting unit sales to acres estimates that approximately 37 acres of single family land and 11 acres of multi-family land could be absorbed each year between 2001 and 2017.

Estimated Unit Pricing and Price per Acre

To estimate the sale price per acre for East Kapolei, a simple model was created. This analysis assumes developers are willing to pay only a certain percentage of their gross revenue from unit sales for land acquisition. In order to conduct this analysis two variables were estimated: gross revenue per acre and the percentage of gross revenue developers are willing to pay to acquire land. An analysis of the Waikele development was constructed to estimate the percentage of gross revenue developers are willing to pay to acquire land. This analysis can be seen in the following table.

Table VIII-3
Analysis of Waikele Estimated Gross Revenue and Developer Land Cost per Acre

Project	Land Area (Acres)	Sale Date	Land Price	Price per Acre	Units	Units per Acre	Type	Estimated Gross Revenue	Land Price/ Gross Revenue
Highland View, Highlands	16.4	1/11/94	$7,000,000	$426,517	150	9	SF, MF	$38,850,000	18.02%
Mahi Ko	11.6	11/5/92	$5,900,000	$508,621	230	20	MF	$32,430,000	18.19%
Hookumu, Parkview	12.0	12/23/91	$6,000,000	$500,000	216	18	MF	$31,752,000	18.90%
Hoomaka	11.0	4/23/90	$6,050,000	$550,000	242	22	MF	$31,944,000	18.94%
Park Glen	17.7	12/1/92	$9,563,000	$540,282	204	12	MF	$44,064,000	21.70%
Sunset Pointe	35.0	1/16/91	$15,300,000	$437,143	250	7	SF	$70,000,000	21.86%
Hoomalu	5.0	6/4/90	$2,000,000	$400,000	54	11	MF	$8,910,000	22.45%
Fairway Village, Greens	23.9	12/23/91	$13,600,000	$568,491	240	10	MF	$60,000,000	22.67%
Golf Club Estates	12.5	2/4/92	$8,900,000	$712,000	85	7	SF	$38,760,000	22.96%
Champions	17.5	8/24/92	$10,500,000	$600,000	118	7	SF	$44,250,000	23.73%
Royal Pines, Signatures	26.4	12/1/92	$18,000,000	$681,818	200	8	SF	$75,000,000	24.00%
Classics, Vlg on the Green	55.9	1/11/94	$30,000,000	$537,067	n/a		SF, MF		
Other	23.3	4/20/93	$12,250,000	$525,751	n/a		MF		
Tropics, Other	22.8	4/20/93	$11,700,000	$513,158	n/a		MF		
									21.22%

As shown in this analysis, developers were willing to pay between approximately 18% and 24% of their gross revenue to acquire land. However, most land sales were between 18% and 22% of gross revenue. A midpoint of 20% will be used for analysis purposes in this report. Developer lots at Waikele ranged from 5 acres to 56 acres with an average of approximately 20 acres. Single family lots ranged between 15 and 40 acres and multi-family lots were between 10 and 20 acres. Also the unit density per acre is 7.25 units per acre for single family lots and 15.5 units per acre for multi-family lots.

To estimate gross revenue per acre at East Kapolei, sales prices were estimated for both single family and multi-family products. In recent years, new single family projects in the Ewa DPA have averaged approximately $260,000 while multi-family projects averaged approximately $150,000 (Figures VIII-1 to VIII-4). Over the past four years, new sale prices at the Villages of Kapolei have been approximately $250,000 for a single family home and approximately $125,000 for a multi-family unit (Figures VIII-5 and VIII-6). Historical resale pricing and sales trends for Villages of Kapolei, Central Oahu DPA, and Ewa DPA have been included to informational purposes (Figures VIII-7 through VIII-15). Obviously it is difficult to project what sales prices will be in the distant future. However, for the purpose of this analysis, it is reasonable to assume that prices will increase by 1% to 3% per year between 1997 and 2020. Therefore, this model uses a starting average price of $250,000 for single family homes and $125,000 for multi-family units with an appreciation rate of 2% per year between 1997 and 2020. The following model estimates future price per acre for developer lots located at the subject property.

Table VIII-4
Projected Developer Price per Acre

Year	Units		Unit Price		Revenue from Unit Sales		Acres		Land Acquisition		Developer Price per Acre		
	SF	MF	SF	MF	SF	MF	SF	MF	SF	MF	SF	MF	Average
1999							21.80	6.28	$7,315,000	$2,428,800	$336,000	$387,000	$347,000
2001							36.89	10.71	$12,645,000	$4,230,000	$343,000	$395,000	$355,000
2001	133	88	$275,000	$138,000	$36,575,000	$12,144,000	36.89	10.71	$12,915,000	$4,320,000	$350,000	$403,000	$362,000
2002	225	150	$281,000	$141,000	$63,225,000	$21,150,000	36.89	10.71	$13,185,000	$4,410,000	$357,000	$412,000	$370,000
2003	225	150	$287,000	$144,000	$64,575,000	$21,600,000	36.89	10.71	$13,455,000	$4,500,000	$365,000	$420,000	$377,000
2004	225	150	$293,000	$147,000	$65,925,000	$22,050,000	36.89	10.71	$13,725,000	$4,590,000	$372,000	$429,000	$385,000
2005	225	150	$299,000	$150,000	$67,275,000	$22,500,000	36.89	10.71	$13,995,000	$4,680,000	$379,000	$437,000	$392,000
2006	225	150	$305,000	$153,000	$68,625,000	$22,950,000	36.89	10.71	$14,265,000	$4,770,000	$387,000	$445,000	$400,000
2007	225	150	$311,000	$156,000	$69,975,000	$23,400,000	36.89	10.71	$14,535,000	$4,860,000	$394,000	$454,000	$407,000
2008	225	150	$317,000	$159,000	$71,325,000	$23,850,000	36.89	10.71	$14,805,000	$4,950,000	$401,000	$462,000	$415,000
2009	225	150	$323,000	$162,000	$72,675,000	$24,300,000	36.89	10.71	$15,120,000	$5,040,000	$410,000	$471,000	$424,000
2010	225	150	$329,000	$165,000	$74,025,000	$24,750,000	36.89	10.71	$15,435,000	$5,130,000	$418,000	$479,000	$432,000
2011	225	150	$336,000	$168,000	$75,600,000	$25,200,000	36.89	10.71	$15,750,000	$5,220,000	$427,000	$487,000	$441,000
2012	225	150	$343,000	$171,000	$77,175,000	$25,650,000	36.89	10.71	$16,065,000	$5,310,000	$435,000	$496,000	$449,000
2013	225	150	$350,000	$174,000	$78,750,000	$26,100,000	36.89	10.71	$16,380,000	$5,430,000	$444,000	$507,000	$458,000
2014	225	150	$357,000	$177,000	$80,325,000	$26,550,000	36.89	8.00	$16,695,000	$4,144,000	$453,000	$517,000	$464,000
2015	225	150	$364,000	$181,000	$81,900,000	$27,150,000	36.89		$17,010,000		$461,000	$527,000	
2016	225	112	$371,000	$185,000	$83,475,000	$20,720,000	36.89		$17,370,000		$471,000	$538,000	
2017	225		$378,000	$189,000	$85,050,000		36.89		$17,730,000		$481,000	$549,000	
2018	225		$386,000	$193,000	$86,850,000								
2019	225		$394,000	$197,000	$88,650,000								

The previous analysis assumes developers purchase land as needed, however, some developers prefer to purchase large amounts of land at one time in order to provide themselves with the potential for several years of continued development. Clearly, such bulk land sales need to have their prices reduced to account for the extended period of carrying the property. For East Kapolei, a bulk land parcel was defined as any parcel over 90 acres since approximately 45 acres can be absorbed annually. The Prudential Locations Research Department conducted a Present Value Analysis to determine a discount for bulk land sales at several discount rates (Figures VIII-16). As shown on the following table, this analysis has shown that at a discount rate of 10%, an appropriate percentage of the current non-bulk land price should range from approximately 98% for a bulk sale of 135 acres to approximately 60% for a bulk sale of 855 acres.

Table VIII-5
Estimated 1999 Bulk Sale Prices

Acres	Current Price per Acre	Percent of Current Price	Bulk Sale Price per Acre	Bulk Sale Price
1	$347,000	100%	$347,000	$347,000
45	$347,000	100%	$347,000	$15,615,000
90	$347,000	100%	$347,000	$31,230,000
135	$347,000	98%	$340,060	$45,908,100
180	$347,000	95%	$329,650	$59,337,000
225	$347,000	93%	$322,710	$72,609,750
270	$347,000	90%	$312,300	$84,321,000
315	$347,000	87%	$301,890	$95,095,350
360	$347,000	84%	$291,480	$104,932,800
405	$347,000	82%	$284,540	$115,238,700
450	$347,000	79%	$274,130	$123,358,500
495	$347,000	76%	$263,720	$130,541,400
540	$347,000	74%	$256,780	$138,661,200
585	$347,000	72%	$249,840	$146,156,400
630	$347,000	70%	$242,900	$153,027,000
675	$347,000	68%	$235,960	$159,273,000
720	$347,000	66%	$229,020	$164,894,400
765	$347,000	64%	$222,080	$169,891,200
810	$347,000	62%	$215,140	$174,263,400
855	$347,000	60%	$208,200	$178,011,000

IX. COMMERCIAL ANALYSIS

The analyses within this section focus on projected commercial demand and pricing for the subject property. The development of East Kapolei has been defined as the trade area for the subject property's commercial component. The commercial properties located at the subject property will range from gas stations to small neighborhood centers. The total amount of land estimated for commercial use at East Kapolei is 24.3 acres. This commercial development will be supported by the projected residential development within East Kapolei. Therefore, the demand analyses will focus on population growth and household formation in East Kapolei since these will be driving factors behind commercial demand within the trade area. This commercial development is planned to occur between 1999 and 2020.

Demand Analysis

Real estate developments the size of the subject property always demand retail space to serve its residential components. Therefore, the analysis focuses purely on the need for additional retail space which is created by new housing. Previous analysis has shown that approximately 75 sq. ft. of gross leasable area is demanded to support each new housing unit. At a land area to gross leasable area ratio of 40%, this translates to approximately 188 sq. ft. of commercial land area per new housing unit. Using the average annual residential absorption projections from the residential section of this report, this analysis estimates that approximately 1.6 acres of commercial land can be absorbed between 2001 and 2016 at East Kapolei.

Figure IX-1
Estimated Residential Development And Commercial Absorption

Year	Residential Units	Land Area (Acres)
2001	221	1.0
2002	375	1.6
2003	375	1.6
2004	375	1.6
2005	375	1.6
2006	375	1.6
2007	375	1.6
2008	375	1.6
2009	375	1.6
2010	375	1.6
2011	375	1.6
2012	375	1.6
2013	375	1.6
2014	375	1.6
2015	375	1.6
2016	337	0.8
Total		24.3

Pricing Analysis

It is estimated that market rents for retail space at East Kapolei would currently average $2.25 a sq. ft. per month of gross leasable area. The amount of leasable area on each parcel is dependent on the type of buyer purchasing the parcel. For the purpose of this analysis we estimated the typical buyer would develop 40 percent of the land area as leasable space, the vacancy rate is estimated at 10 percent, operating expenses are estimated at 25 percent of annual gross income, development costs are currently estimated at $110 per sq. ft. of gross leasable area, and the land value of the completed shopping center would be between 10 times the annual net income less construction costs. It is estimated, that rents and construction costs will increase at an average annual rate of 2%. The analysis which estimates sales price per acre is shown in the following table.

Figure IX-2
Estimated Sales Price Per Acre

Year	Annual Net Income per Acre	Sales Price per Acre
2001	$352,404	$1,407,859
2002	$359,460	$1,438,096
2003	$366,648	$1,464,806
2004	$373,980	$1,494,092
2005	$381,458	$1,523,938
2006	$389,088	$1,554,446
2007	$396,876	$1,585,597
2008	$404,808	$1,617,254
2009	$412,908	$1,649,637
2010	$421,164	$1,682,608
2011	$429,588	$1,716,268
2012	$438,180	$1,750,595
2013	$446,940	$1,785,571
2014	$455,880	$1,821,295
2015	$465,000	$1,857,745
2016	$474,300	$1,894,899
2017	$483,792	$1,932,857
2018	$493,464	$1,971,476
2019	$503,328	$2,010,853
2020	$513,396	$2,051,064

The following table shows a likely scenario for commercial land sales at East Kapolei. This scenario assumes that there would be 4 transactions. Commercial land sales are estimated to begin with a sale of 2 acres in 2003 and a sale of 6 acres in 2008. The remaining 16 acres are estimated to be sold between 2014 and 2020 with two sales of 8 acres each. As shown in this scenario, the total revenue the State of Hawaii would receive from commercial land sales is estimated to be approximately $43,600,000.

Figure IX-3
East Kapolei Projected Commercial Absorption and Pricing

Year	Acres	Sales Price
2003	2	$2,929,612
2008	6	$9,703,524
2014	8	$14,570,360
2020	8	$16,408,672
Total	24	$43,612,168

X. CONCLUSIONS

The subject property is estimated to have an average annual absorption of approximately 225 single family homes and approximately 150 condominium units. This translates to a unit mix of 65% single family homes and 35% multi-family units. Converting unit sales to acres estimates that approximately 37 acres of single family land and 11 acres of multi-family land could be absorbed each year.

The West Oahu market currently has sufficient housing planned and proposed to meet demand until approximately 2005. More developments could enter the market before 2005, however, they could be met with increased competition. There appears to be sufficient demand to allow for another major development after 2005. Land acquisitions by developers in projects similar to the subject property generally occur between 1 and 2 years before units are completed and sold. Completed construction of the North South Road between 2001 and 2005 and additional unit demand in West Oahu after 2005, suggest completed units at East Kapolei can begin to be delivered between 2001 and 2005. Therefore, it is estimated that the first developer land sale at East Kapolei may occur around 1999.

Over the past four years, new sale prices at the Villages of Kapolei have been approximately $250,000 for a single family home and $125,000 for a multi-family unit. Since the subject property can be seen as an extension of the Villages of Kapolei, it is estimated that an average price of $250,000 should be used for single family homes and $125,000 should be used for multi-family units in 1996 with an appreciation rate of 2% per year between 1997 and 2020. Since developers are willing to pay only a certain percentage of their gross revenue for acquisition of land, an analysis of developer land sales was performed. This analysis has shown that developers were willing to pay on average approximately 20% of their gross revenue from unit sales for builder lots. This analysis estimates that in 1999 developers should be willing to pay approximately $336,000 per acre for single family land and $387,000 per acre for multi-family land and by 2017 developers should be willing to pay approximately $481,000 per acre for single family land and $549,000 per acre for multi-family land.

Clearly bulk land sales need to have their prices reduced to account for the extended period of carrying the property. For East Kapolei, a bulk land parcel was defined as any parcel over 90 acres. The Prudential Locations Research Department conducted a Present Value Analysis to determine a discount for bulk land sales at several discount rates. This analysis has shown that at a discount rate of 10%, an appropriate percentage of the current non-bulk land price should range from approximately 98% for a bulk sale of 135 acres to approximately 60% for a bulk sale of 855 acres.

The following table shows a likely scenario for residential land sales at East Kapolei. This scenario assumes there would be 13 transactions, two of which would be bulk land sales. Developer land sales are estimated to begin in 1999 with a bulk land sale of 400 acres and a second bulk land sale of 180 acres in 2007. The remaining 280 acres are estimated to be sold between 2012 and 2017 in approximately 37 acre single family lots and 11 acre multi-family lots. As shown in this scenario, the total revenue received by the State of Hawaii from residential land sales would be approximately $310,000,000.

Table X-1
East Kapolei Projected Developer Absorption and Pricing

Developer Sale Date	Acres	Type	Unit Sales Year	Developer Price per Acre	Developer Sale Prices	Discount for Bulk Sales	Discounted Sale Prices
1999	400	SF/MF	2001 - 2009	$347,000	$138,800,000	82%	$113,816,000
2007	180	SF/MF	2009 - 2013	$407,000	$73,260,000	95%	$69,597,000
2012	37	SF	2014	$435,000	$16,095,000	100%	$16,095,000
2012	11	MF	2014	$496,000	$5,456,000	100%	$5,456,000
2013	37	SF	2015	$444,000	$16,428,000	100%	$16,428,000
2013	11	MF	2015	$507,000	$5,577,000	100%	$5,577,000
2014	37	SF	2016	$453,000	$16,761,000	100%	$16,761,000
2014	11	MF	2016	$518,000	$5,698,000	100%	$5,698,000
2015	37	SF	2017	$461,000	$17,057,000	100%	$17,057,000
2015	11	MF	2017	$528,000	$5,808,000	100%	$5,808,000
2016	37	SF	2018	$471,000	$17,427,000	100%	$17,427,000
2016	11	MF	2018	$539,000	$5,929,000	100%	$5,929,000
2017	30	SF	2019	$481,000	$14,430,000	100%	$14,430,000
Total	850						$310,079,000

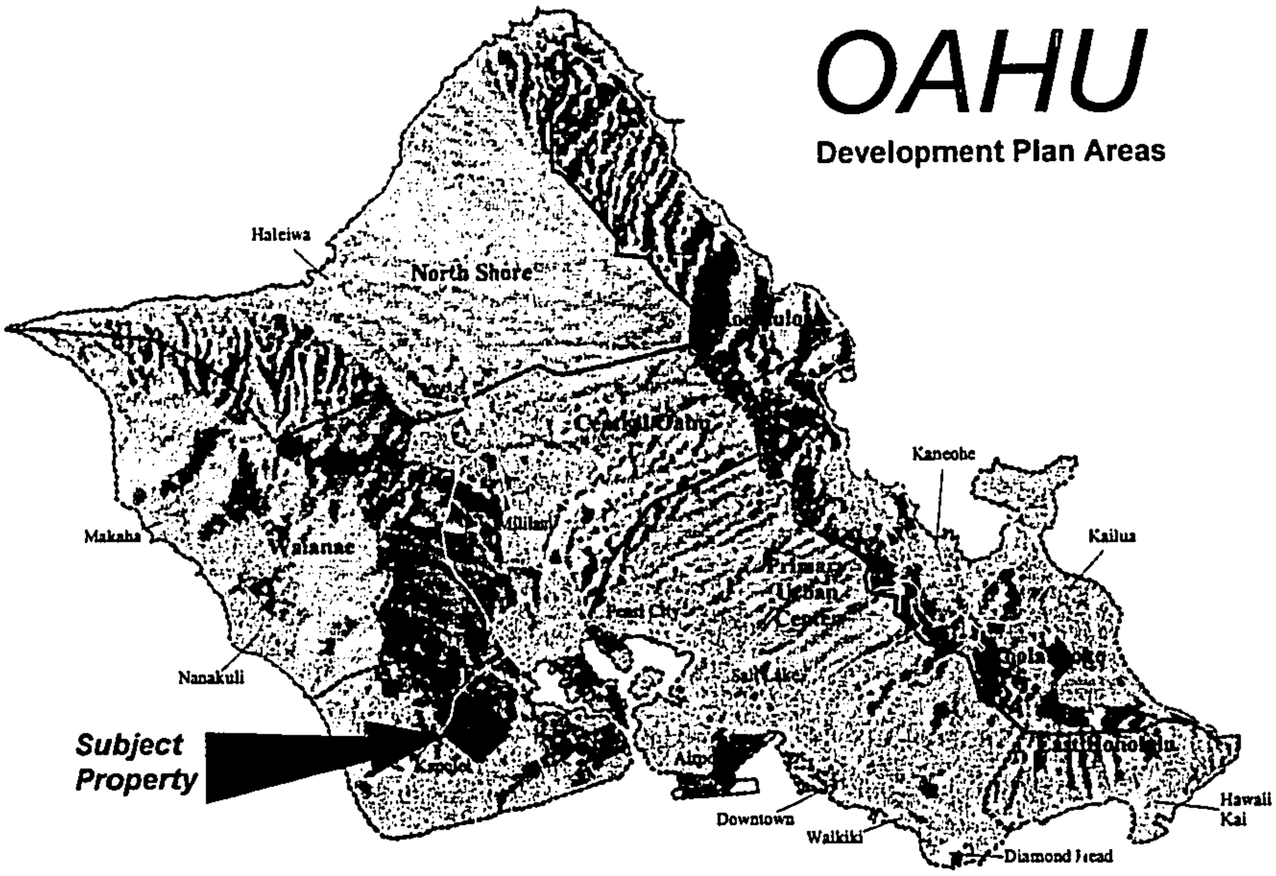
Real estate developments the size of the subject property always demand retail space to serve its residential components. It is estimated that one acre of commercial land area is demanded for every 230 new housing units built. Using an average residential absorption of 375 residential units per year, estimates that approximately 1.6 acres of commercial land can be absorbed annually at East Kapolei.

Currently, average market rents for retail space at subject property are estimated at $2.25 a sq. ft. per month of gross leasable area. For the purpose of a pricing analysis, it is estimated the typical buyer would develop 40 percent of the land area as leasable space, the vacancy rate would be approximately 10 percent, operating expenses would be approximately 25 percent of annual gross income, development costs are currently estimated at $110 per sq. ft. of gross leasable area, and the land value of the completed shopping center would be between 10 times the annual net income less construction costs. This analysis estimates rents and construction costs will increase at an average annual rate of 2%. The analysis estimates that developers would be willing to pay approximately $1,400,000 per acre in 2001 and $2,000,000 per acre in 2020 for commercial land at East Kapolei.

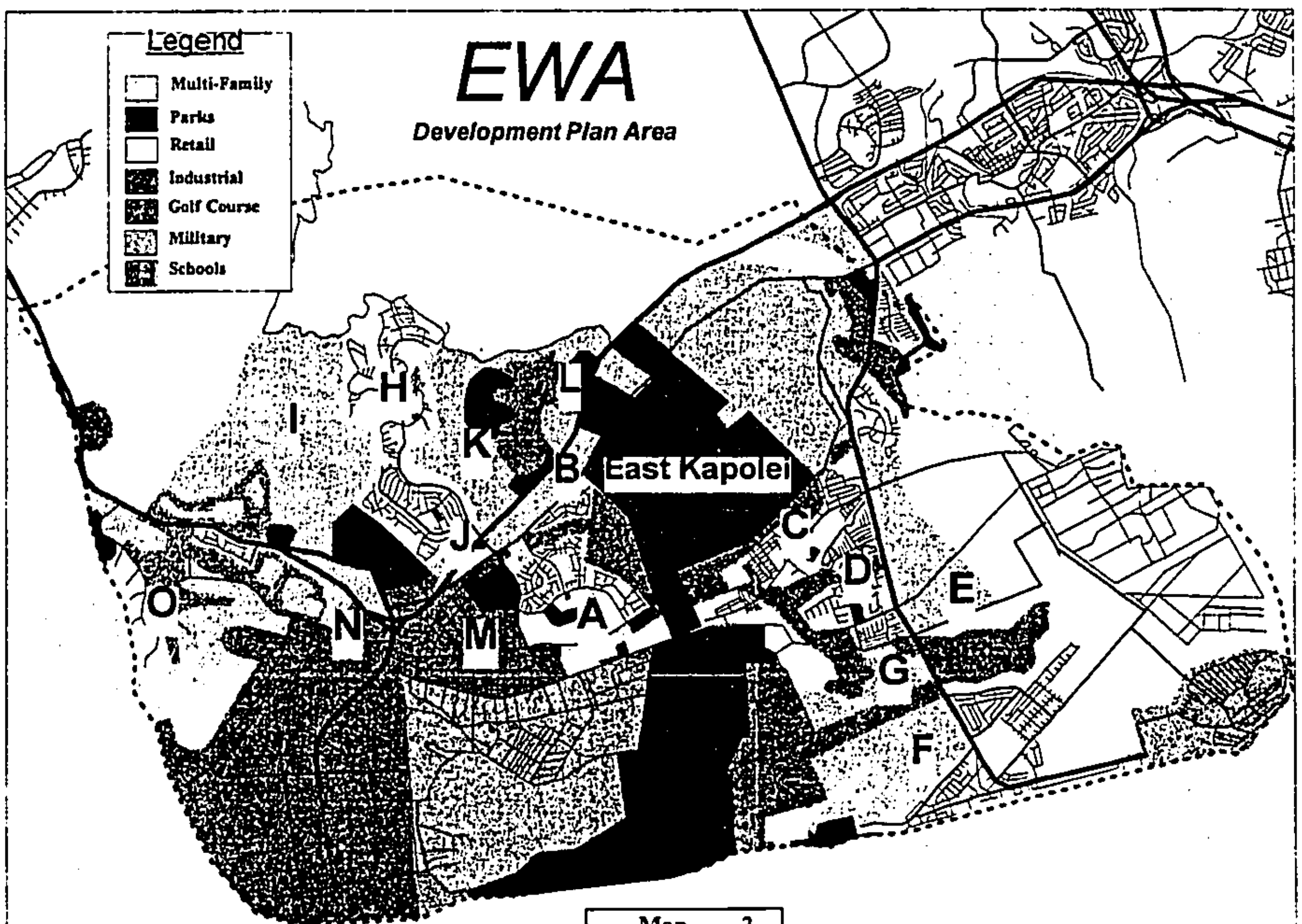
The following table shows a likely scenario for commercial land sales at East Kapolei. This scenario assumes that there would be 4 transactions. Commercial land sales are estimated to begin with a sale of 2 acres in 2003 and a sale of 6 acres in 2008. The remaining 16 acres are estimated to be sold between 2014 and 2020 with two sales of 8 acres each. As shown in this scenario, the total revenue the State of Hawaii would receive from commercial land sales is estimated to be approximately $43,600,000.

Figure X-2
East Kapolei Projected Commercial Absorption and Pricing

Year	Acres	Sales Price
2003	2	$2,929,612
2008	6	$9,703,524
2014	8	$14,570,360
2020	8	$16,408,672
Total	24	$43,612,168

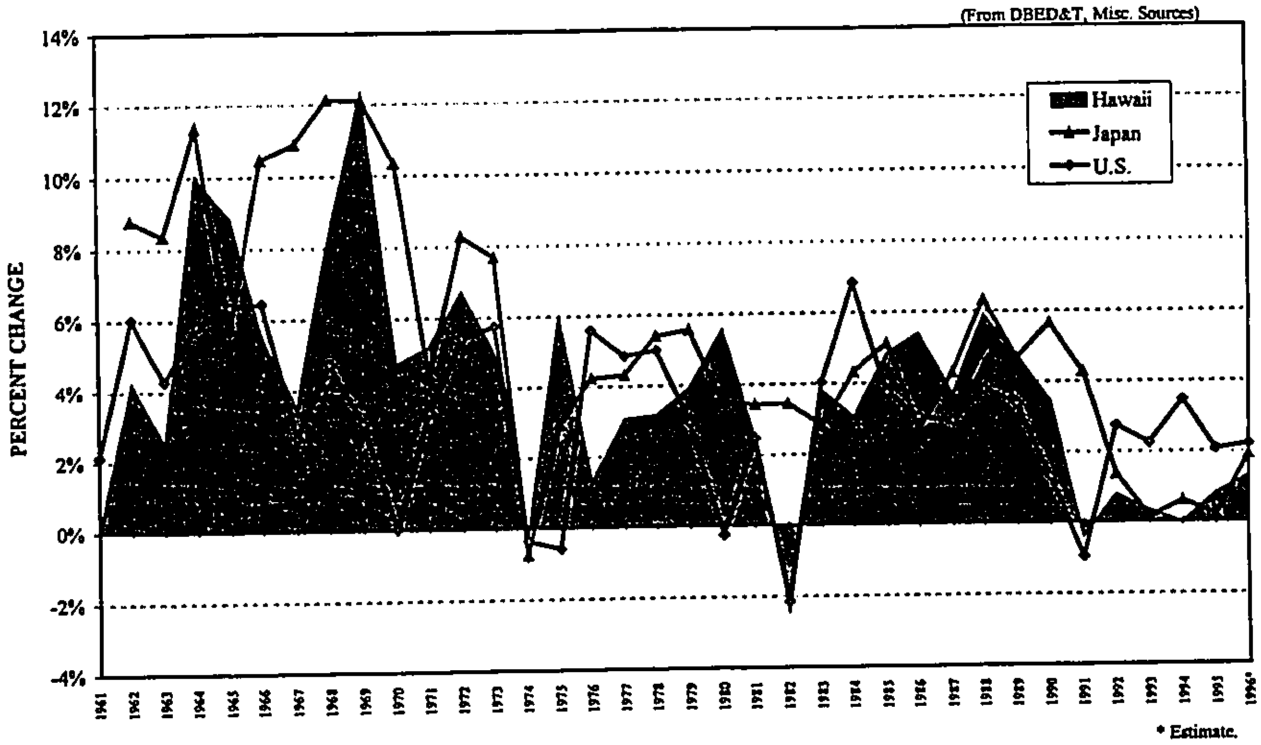

OAHU
Development Plan Areas
Haleiwa
North Shore
Makaha
Waianae
Nanakuli
Subject Property
Kaneohe
Kailua
Downtown
Waikiki
Diamond Head
Hawaii Kai

Map 1


Legend
Multi-Family
Parks
Retail
Industrial
Golf Course
Military
Schools
EWA
Development Plan Area
East Kapolei
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O

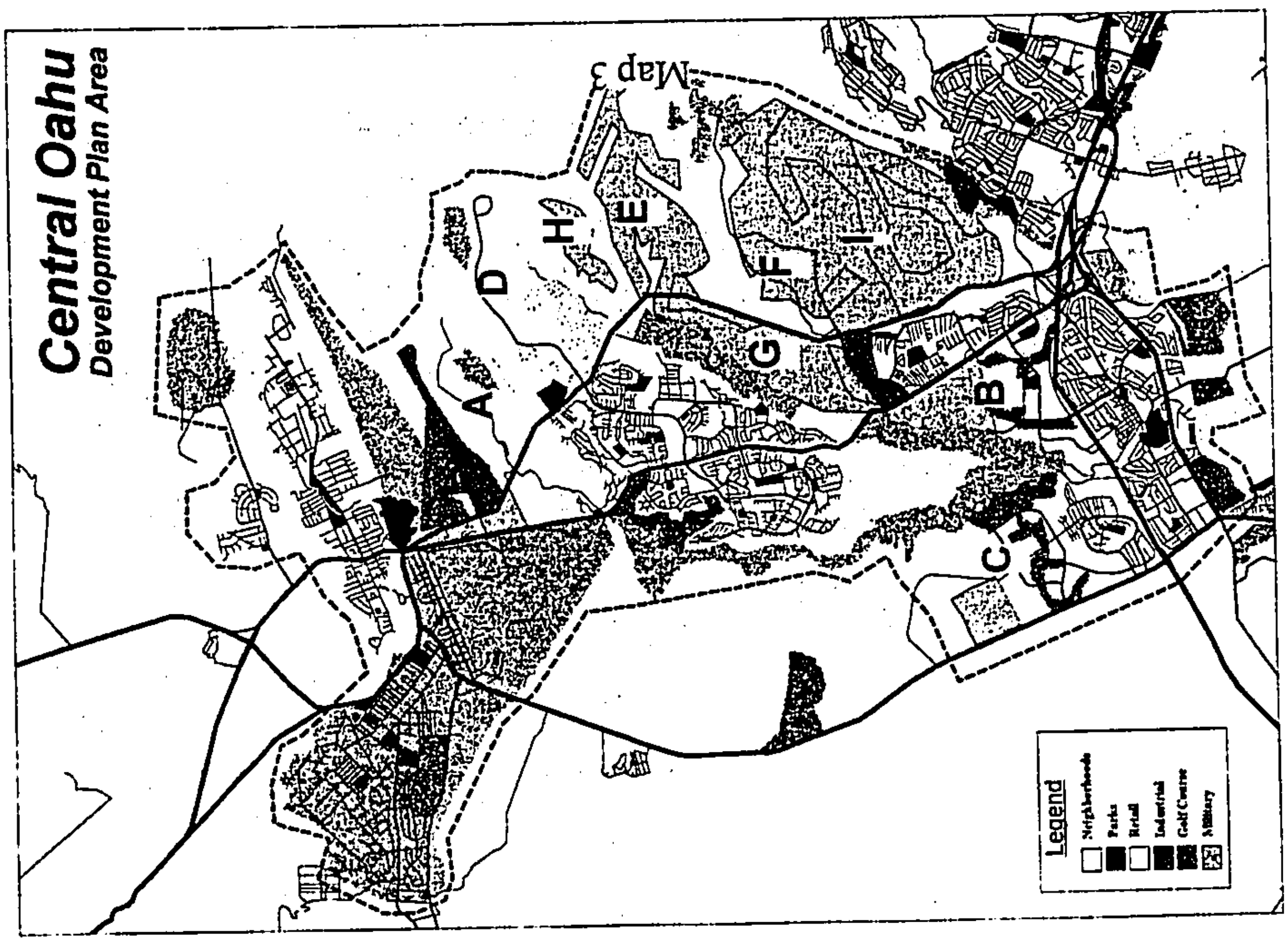
Map 2

ANNUAL CHANGE IN GROWTH OF THE ECONOMY
(Hawaii, Japan, U.S.)

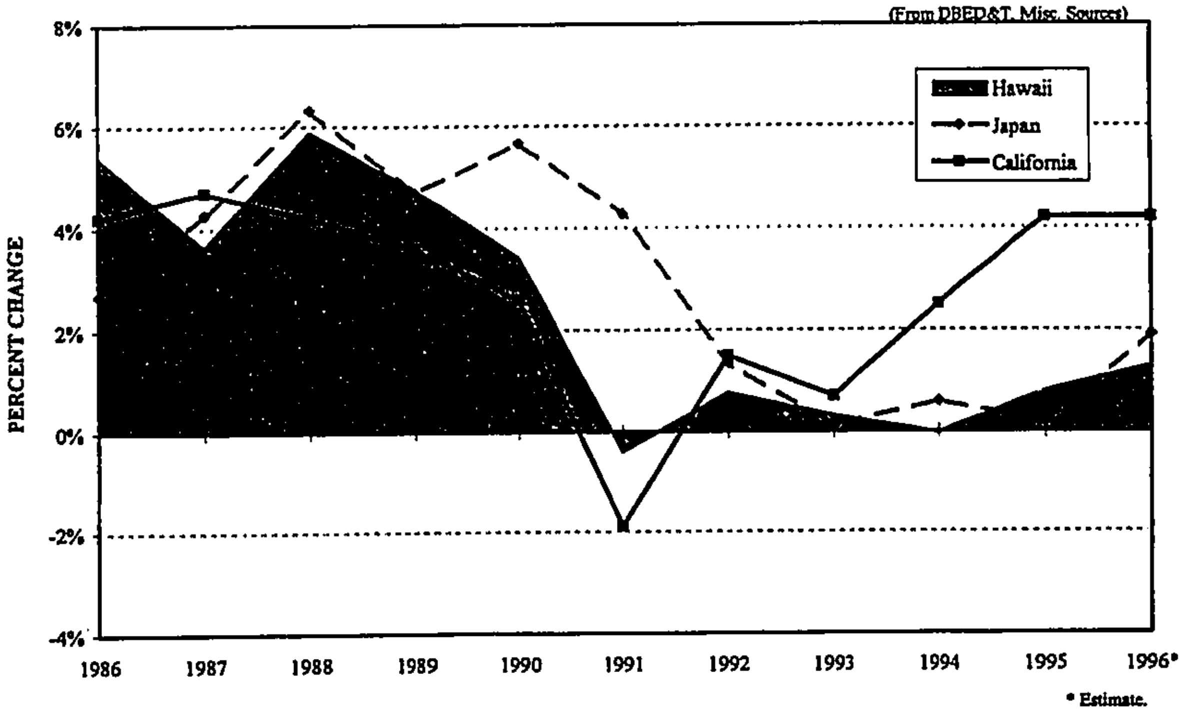


THE PRUDENTIAL *LOCATIONS INC RESEARCH & CONSULTING*

Figure IV - 1



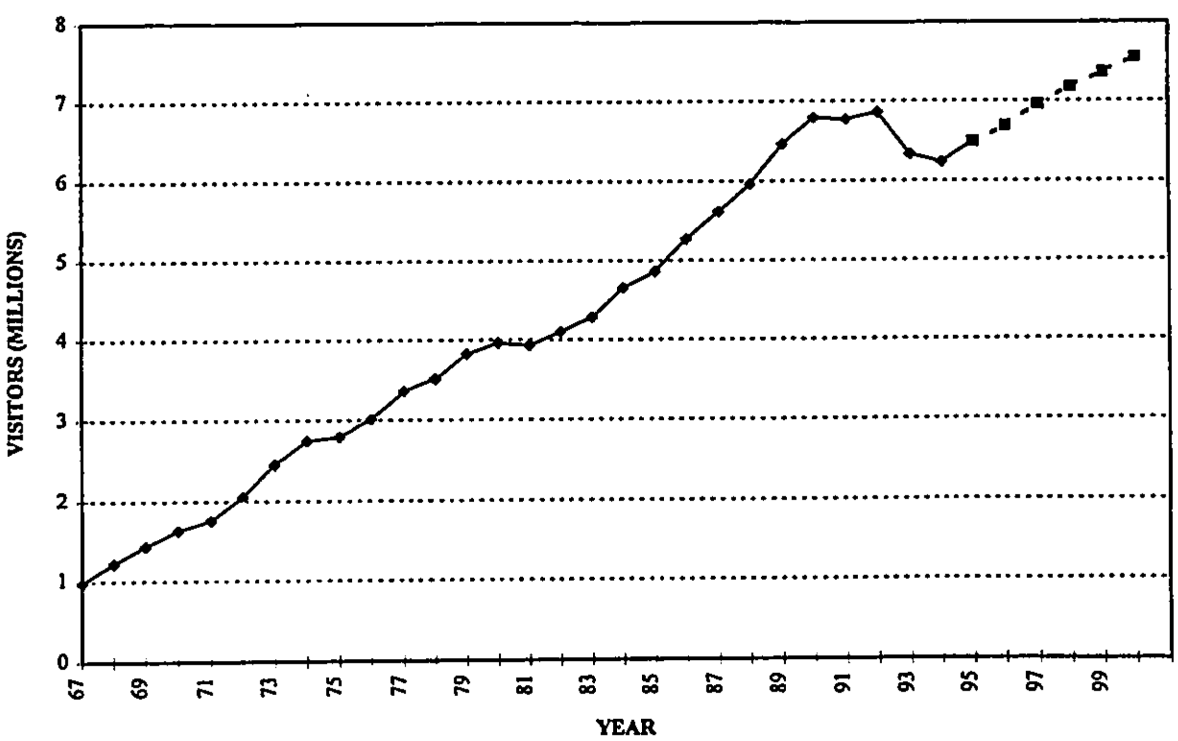
ANNUAL CHANGE IN GROWTH OF THE ECONOMY
(Hawaii, Japan, California)



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure IV - 2

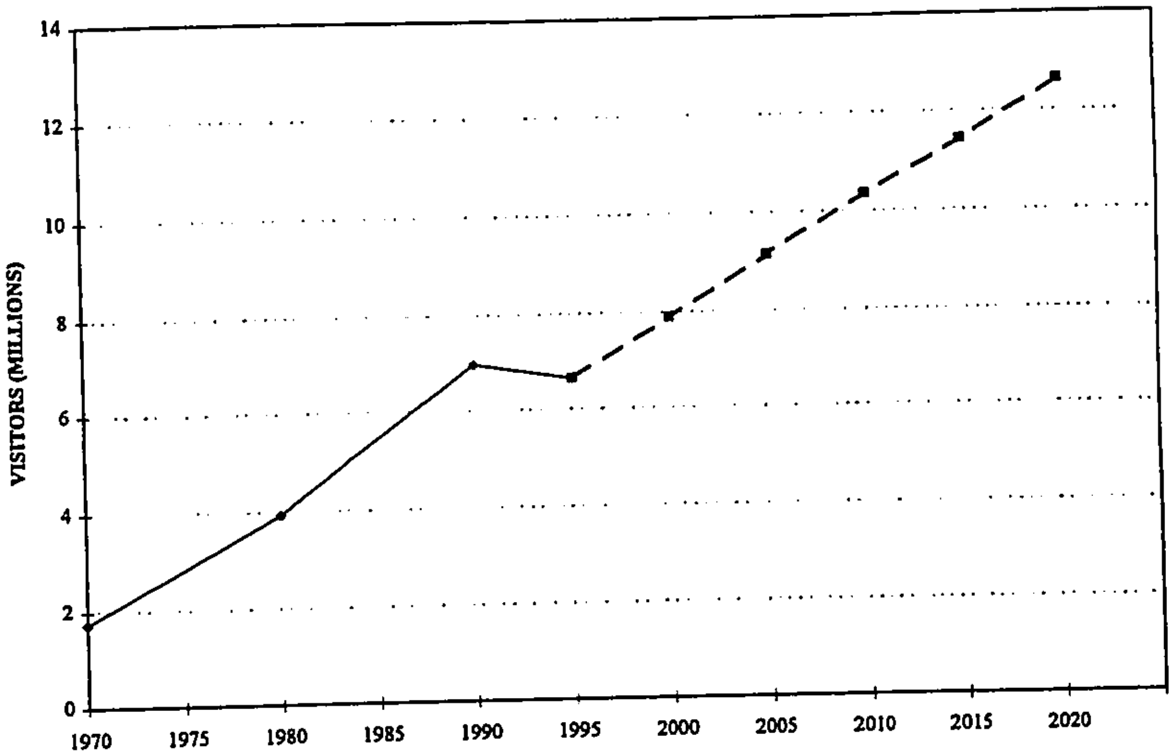
HAWAII VISITOR ARRIVALS AND FORECAST



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure IV - 3

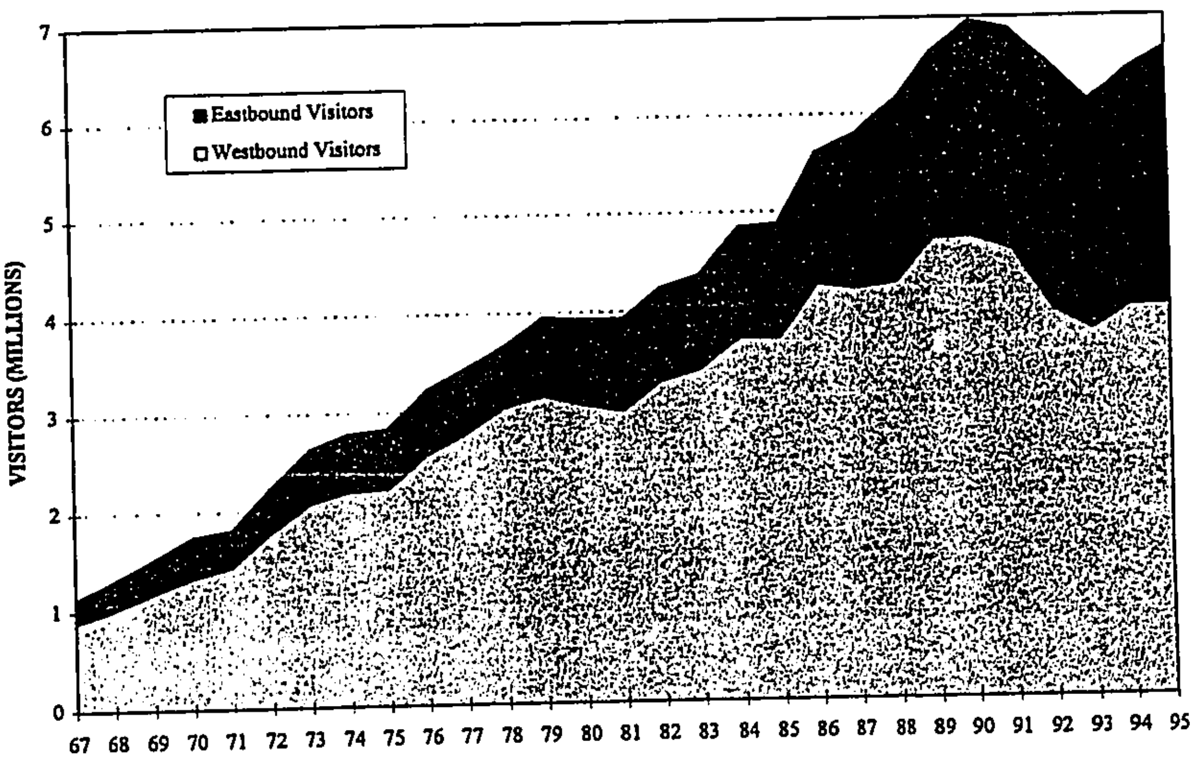
HAWAII ANNUAL VISITOR ARRIVALS AND FORECAST



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure IV - 4

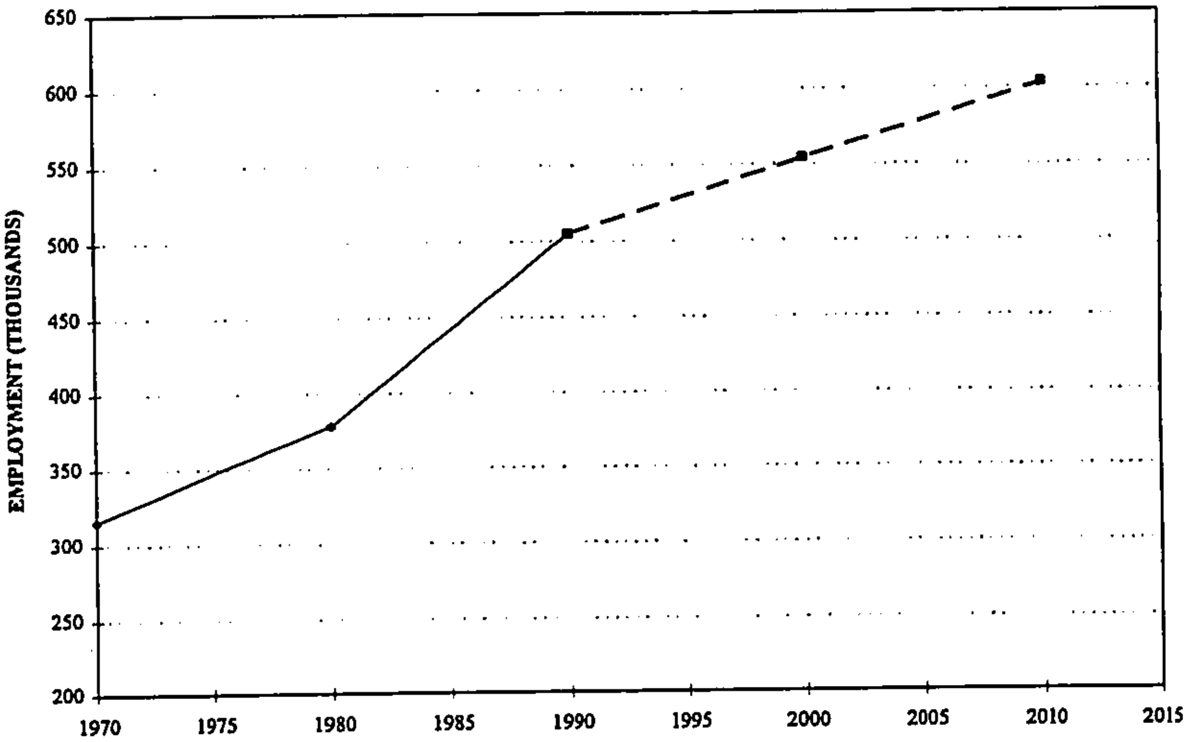
HAWAII ANNUAL VISITOR ARRIVALS



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure IV - 5

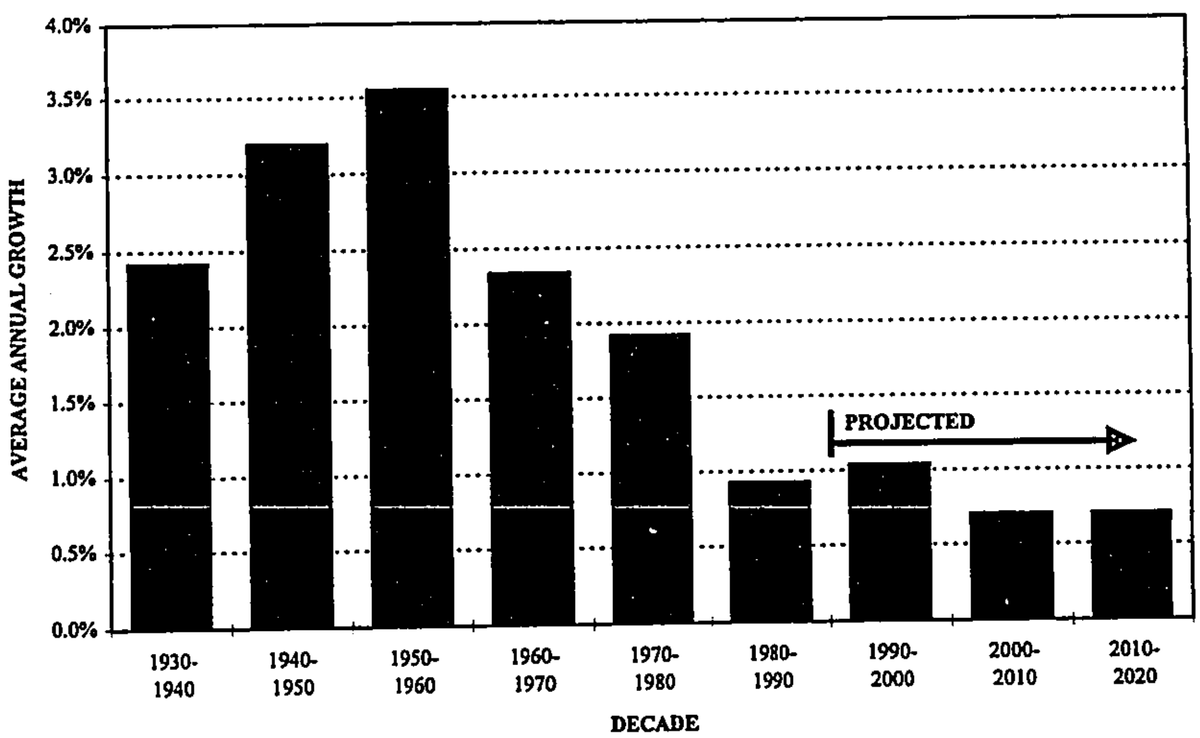
OAHU TOTAL EMPLOYMENT AND FORECAST



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure IV - 6

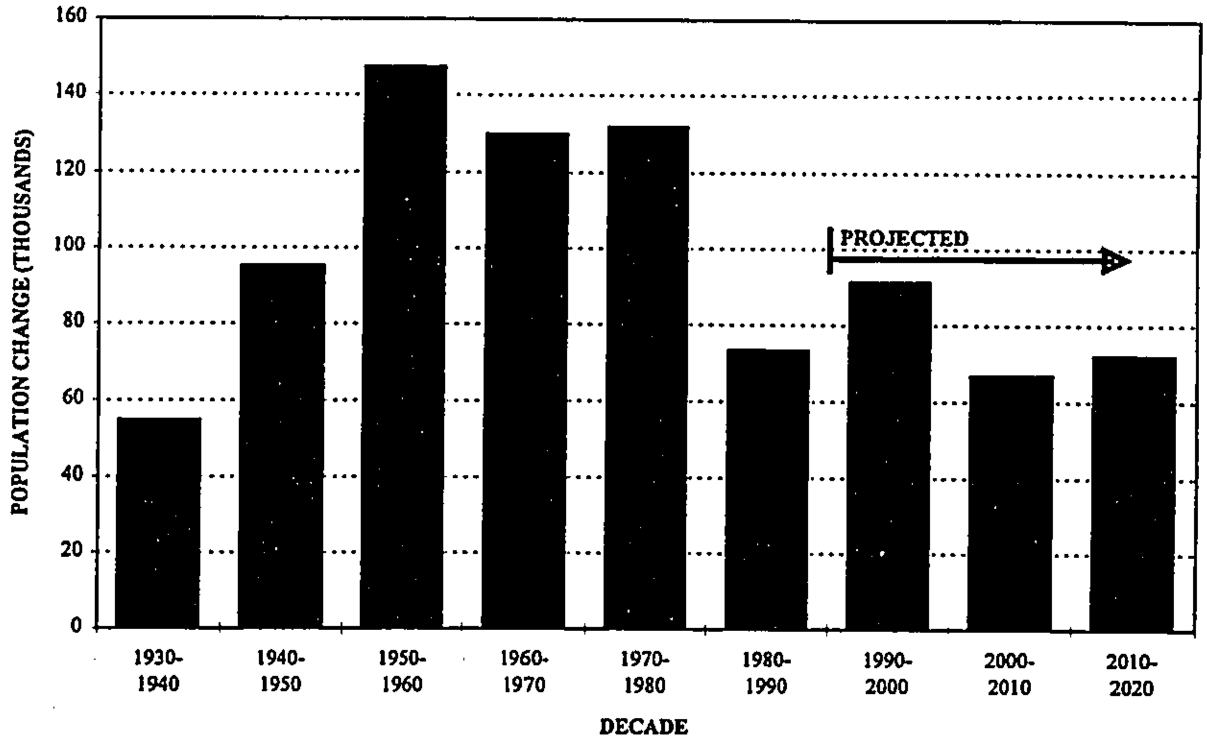
OAHU AVERAGE ANNUAL POPULATION GROWTH



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure IV - 7

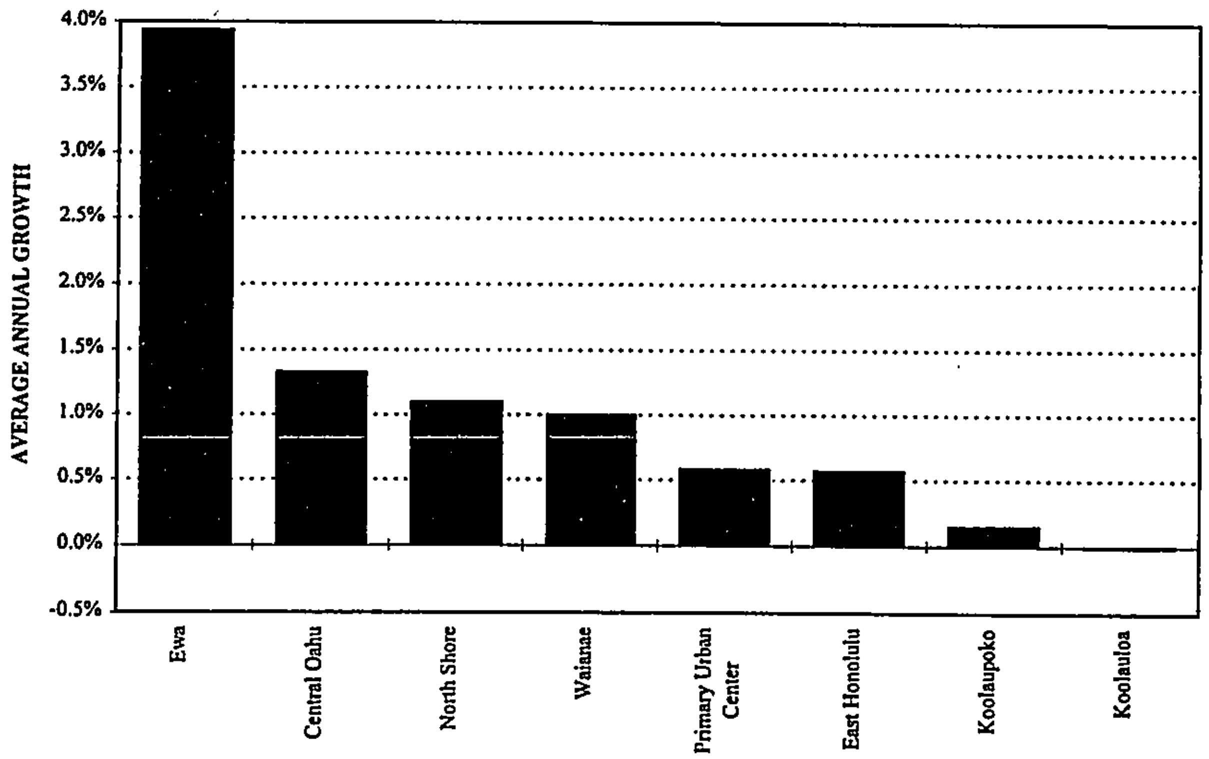
OAHU POPULATION CHANGE BY DECADE



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure IV - 8

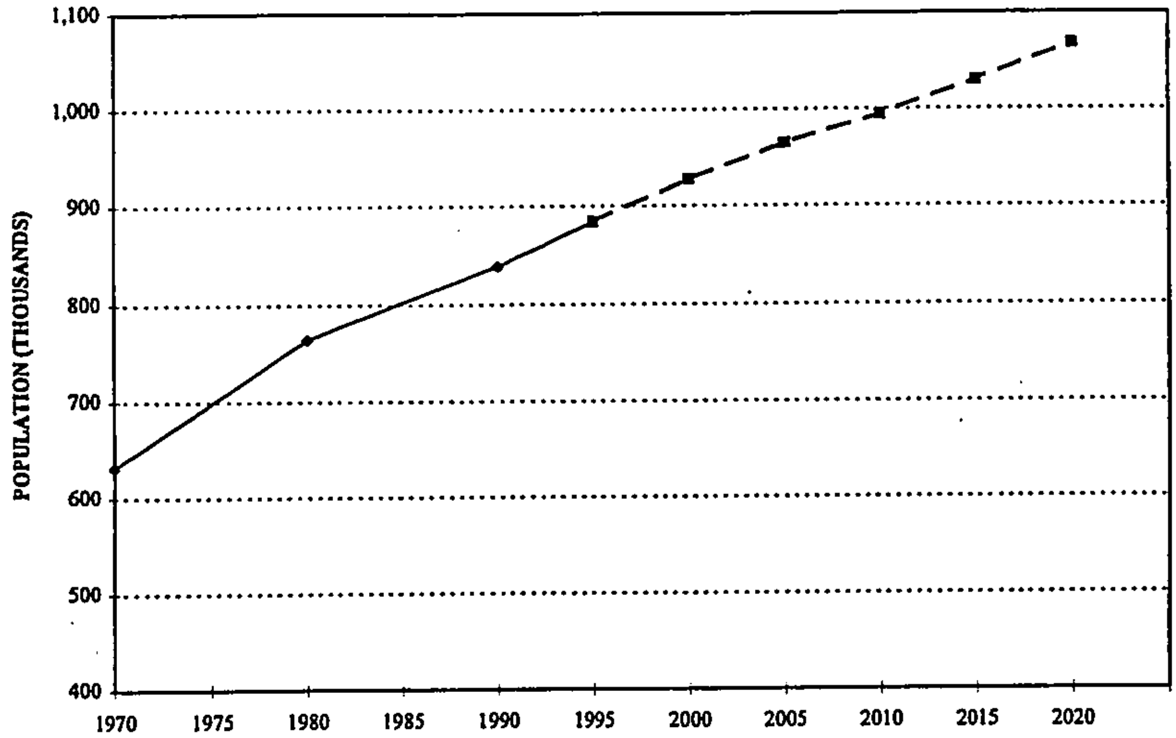
OAHU 1990-2010 PROJECTED AVERAGE ANNUAL POPULATION GROWTH BY DPA



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure IV - 9

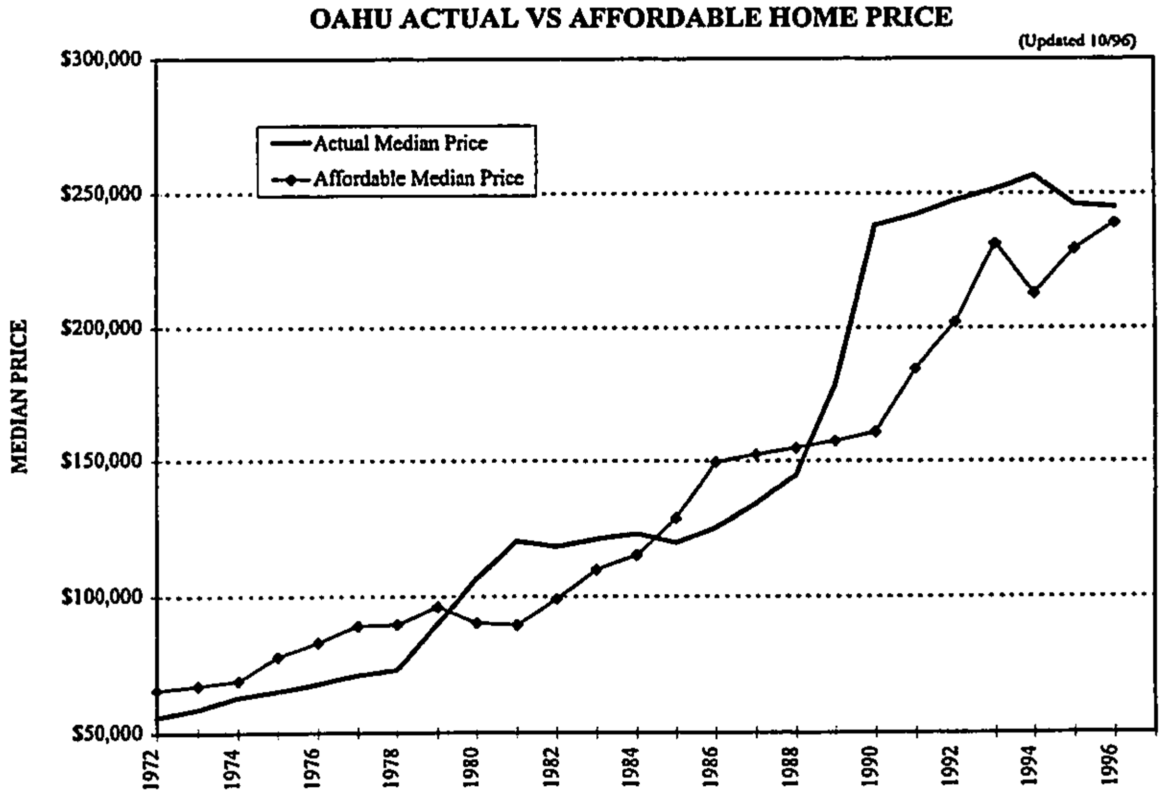
OAHU RESIDENT POPULATION AND FORECAST



THE PRUDENTIAL *LOCATIONS RESEARCH & CONSULTING*

Figure IV - 10

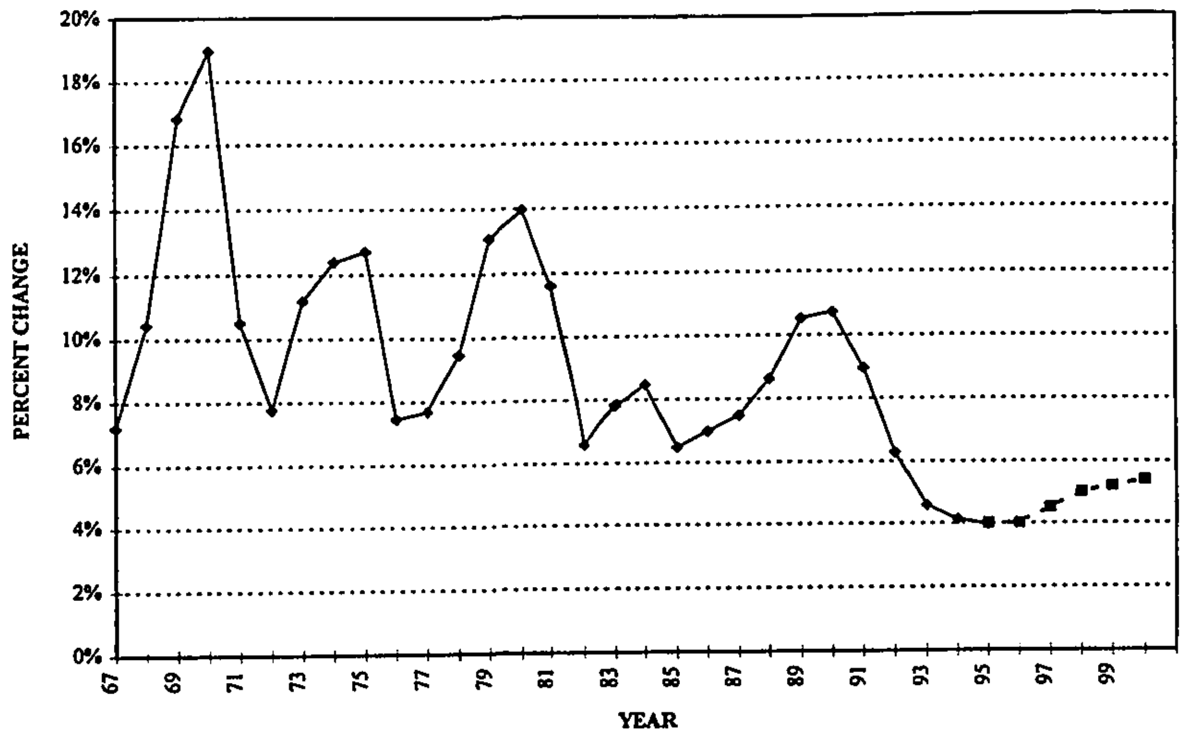
OAHU ACTUAL VS AFFORDABLE HOME PRICE



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure IV - 11

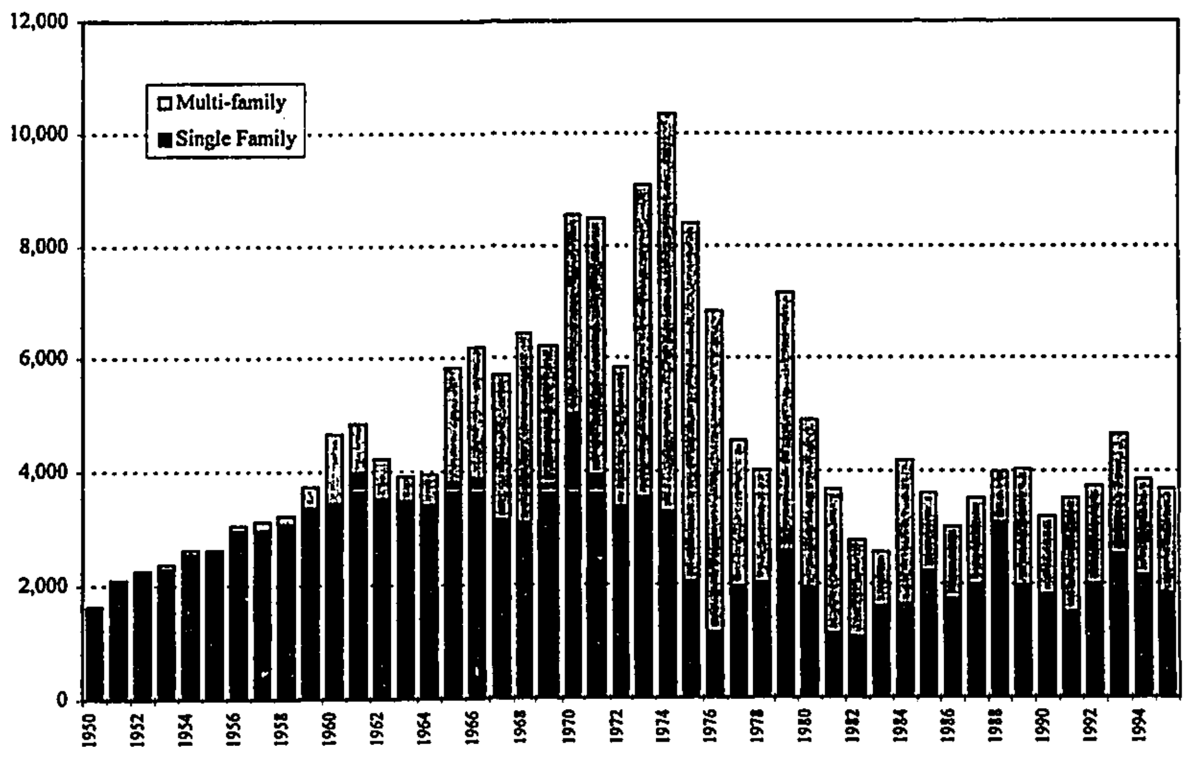
HAWAII TOTAL PERSONAL INCOME PERCENT CHANGE AND FORECAST



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure IV - 12

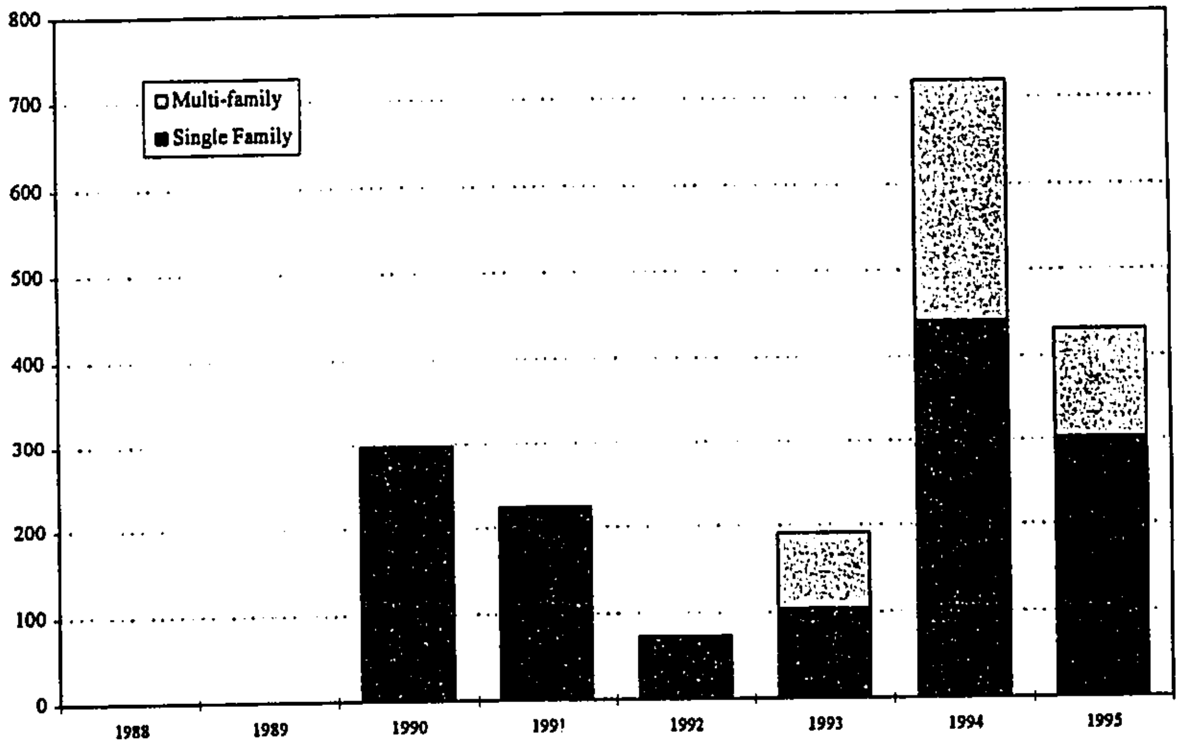
OAHU ANNUAL HOUSING CONSTRUCTION



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure IV - 13

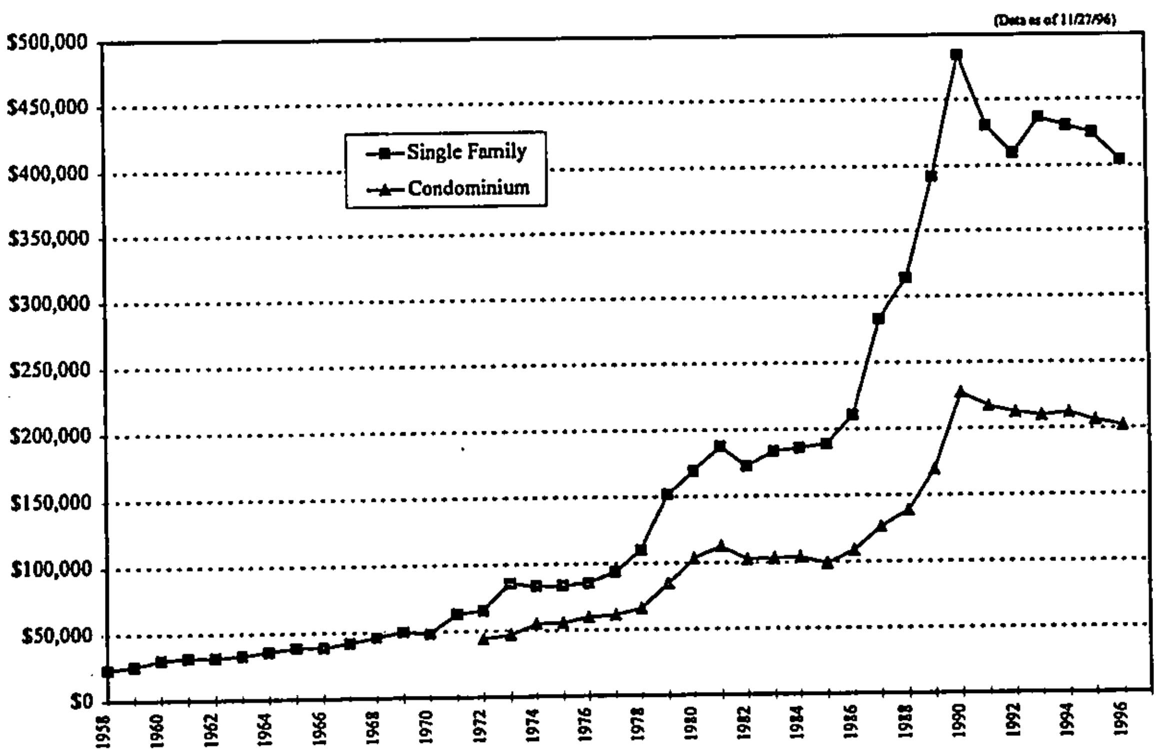
KAPOLEI ANNUAL HOUSING CONSTRUCTION



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure IV - 14

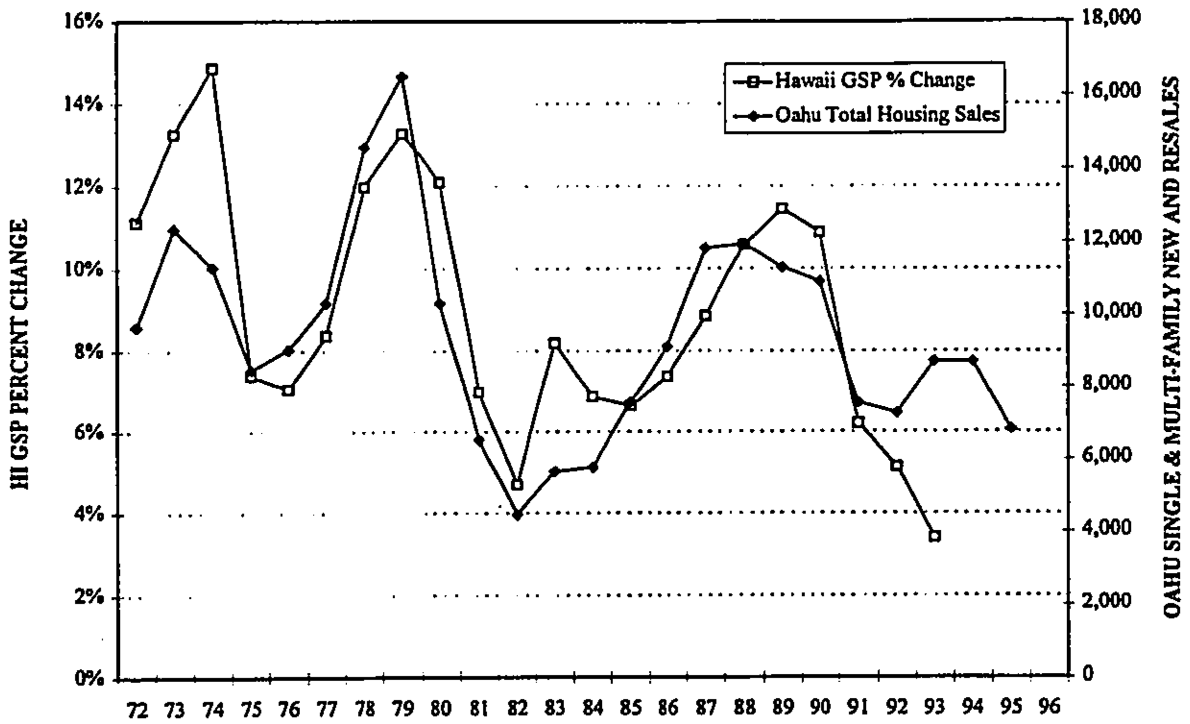
OAHU SINGLE FAMILY & CONDOMINIUM AVERAGE RESALE PRICES



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure IV - 15

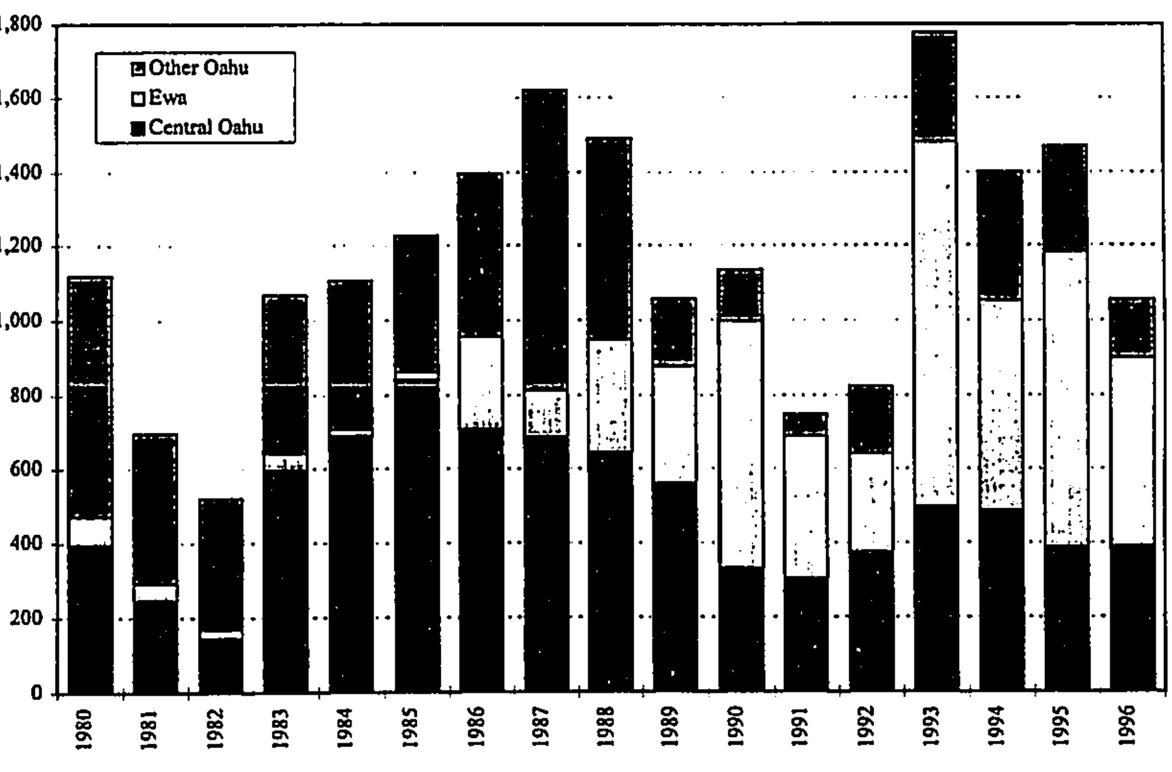
HAWAII GSP PERCENT CHANGE VS. OAHU TOTAL HOUSING SALES



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure IV - 16

OAHU NEW SINGLE FAMILY SALES BY DPA



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure V - 1

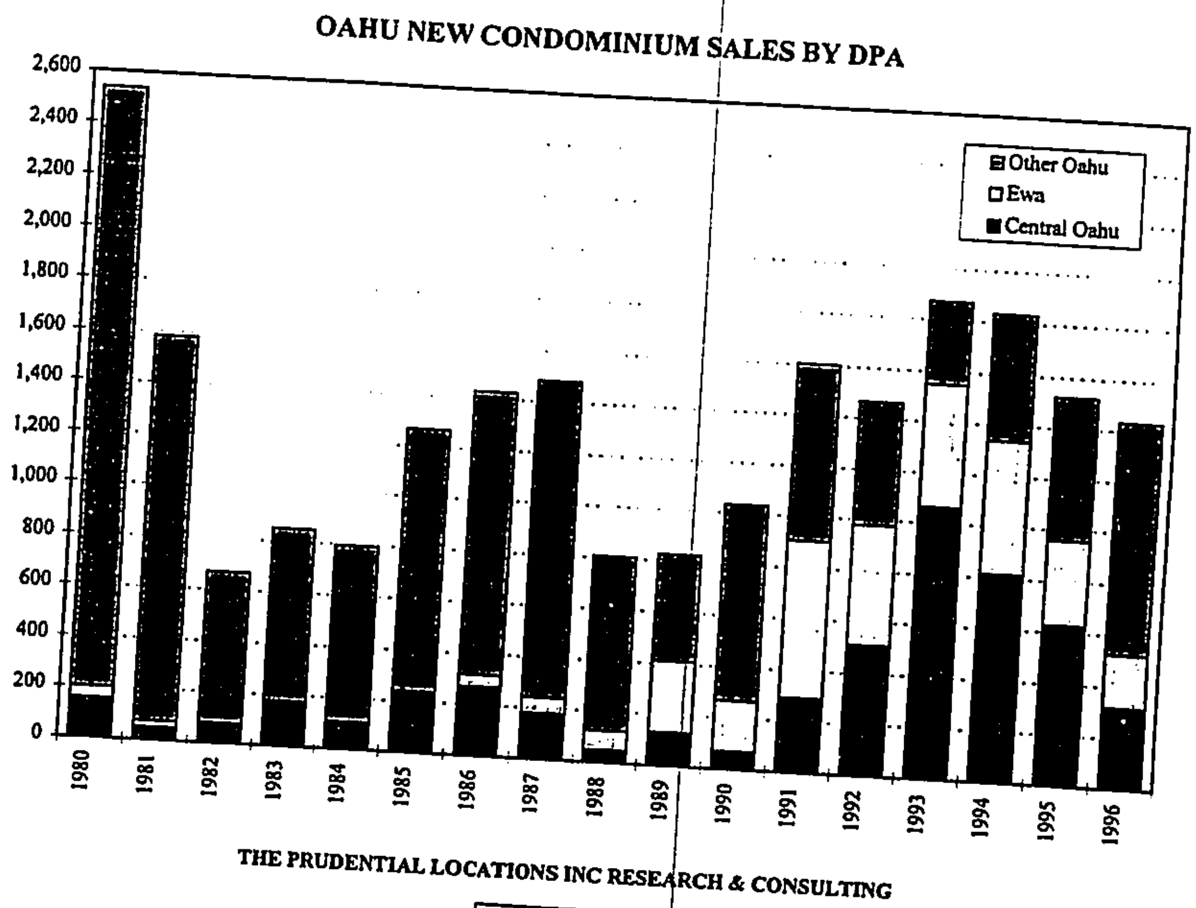


Figure V - 2

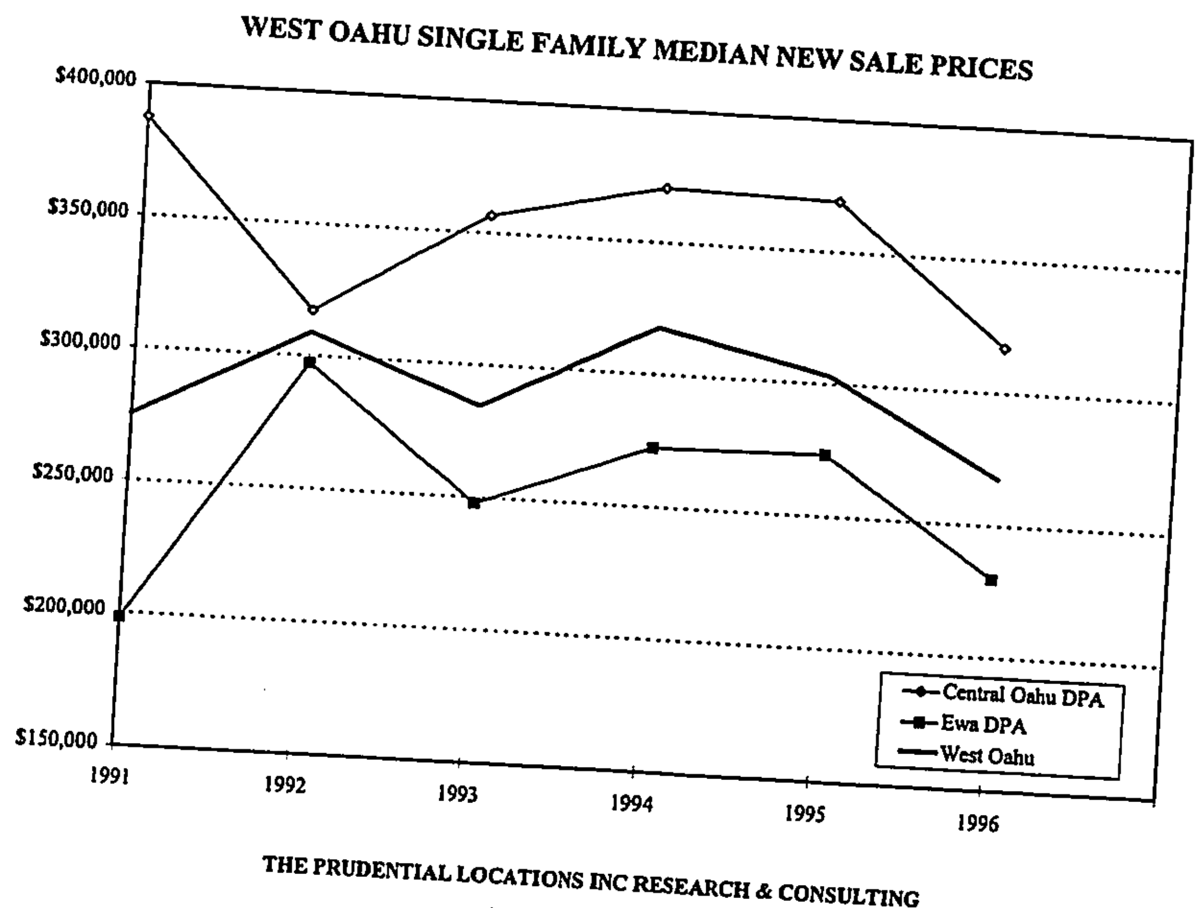
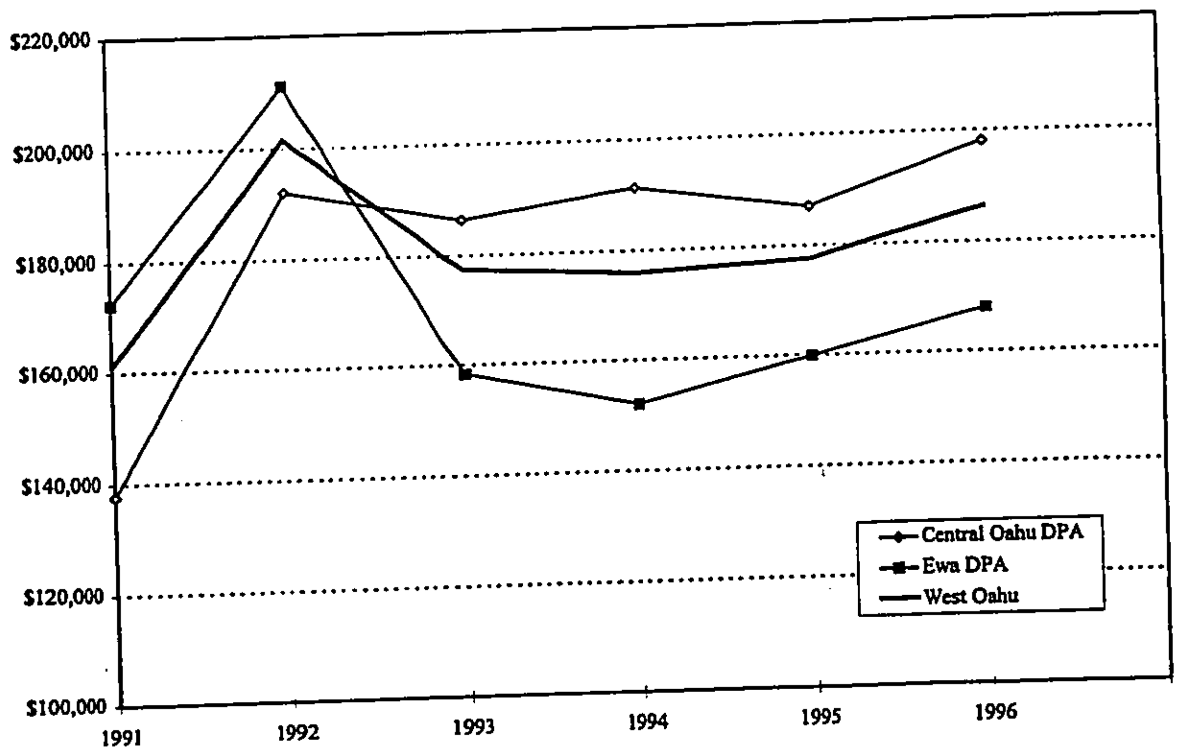


Figure V - 3

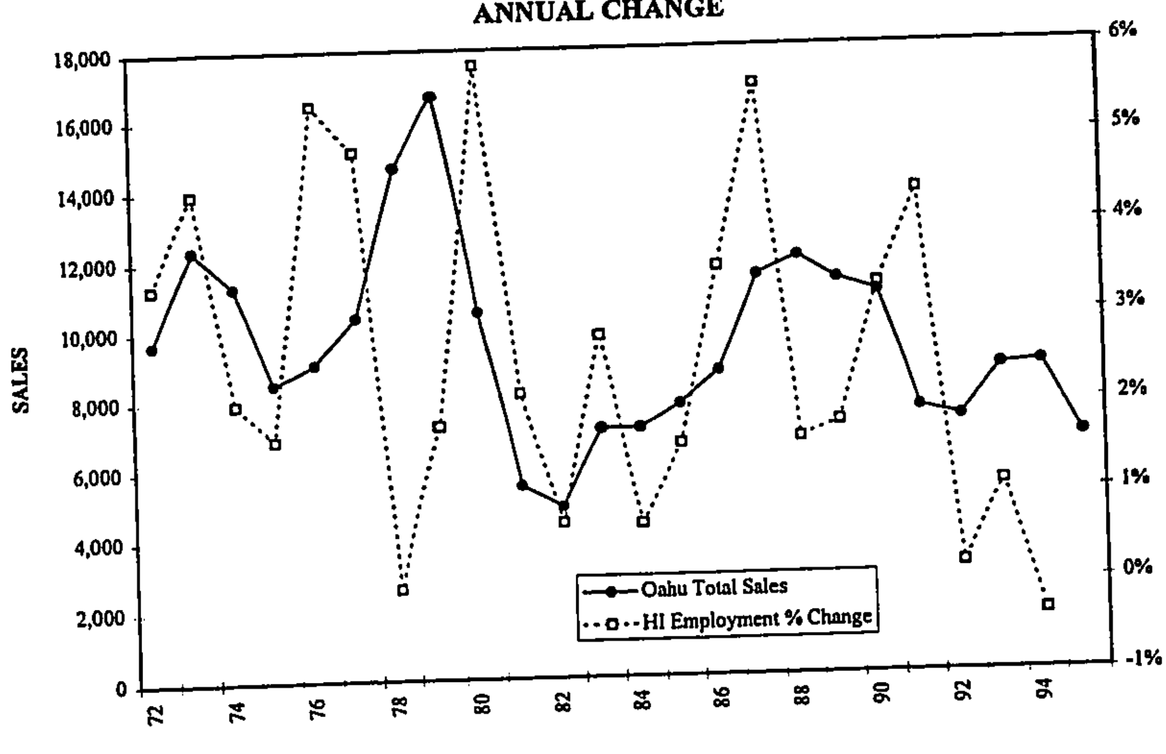
WEST OAHU MULTI-FAMILY MEDIAN NEW SALE PRICES



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

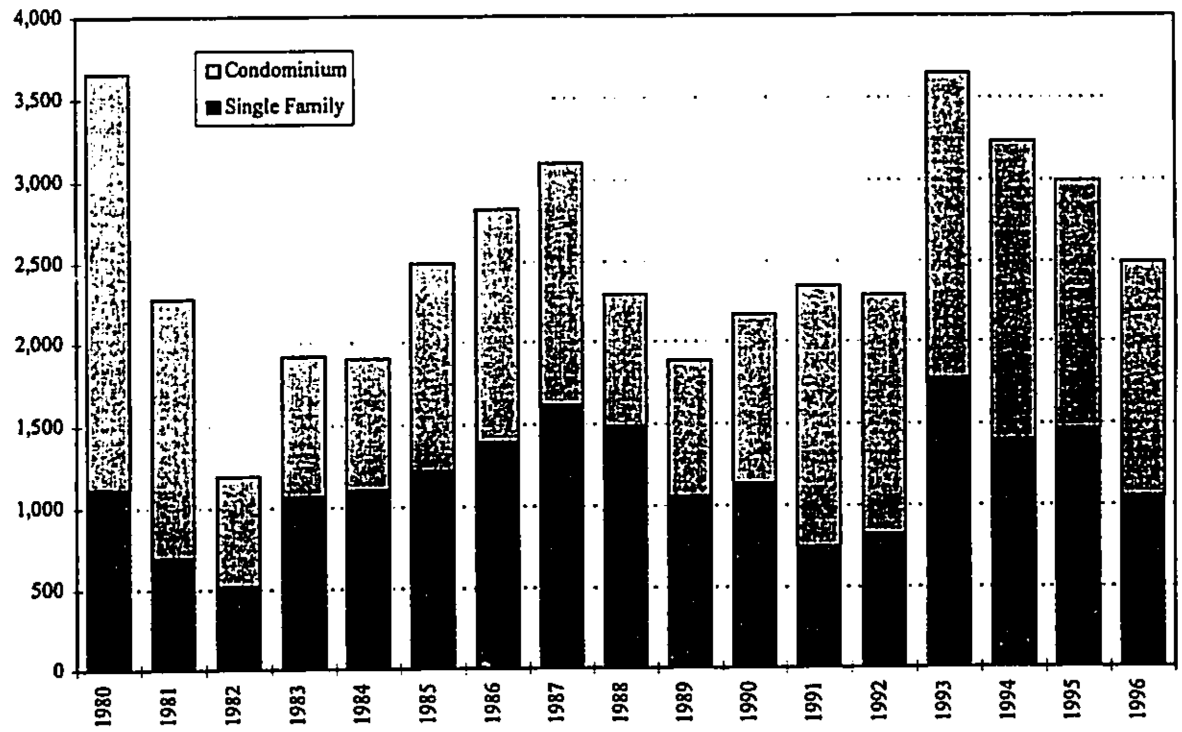
Figure V - 4

OAHU TOTAL REAL ESTATE SALES AND HAWAII EMPLOYMENT ANNUAL CHANGE



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

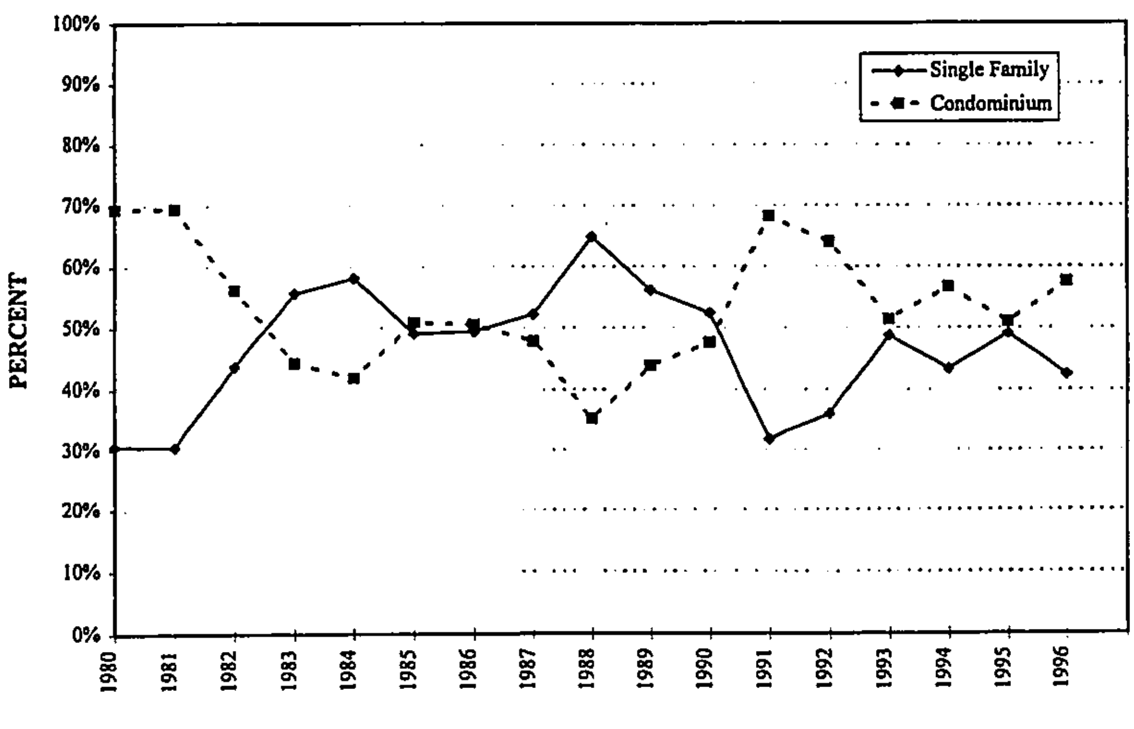
OAHU SINGLE FAMILY AND CONDOMINIUM NEW SALES



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure VI - 2

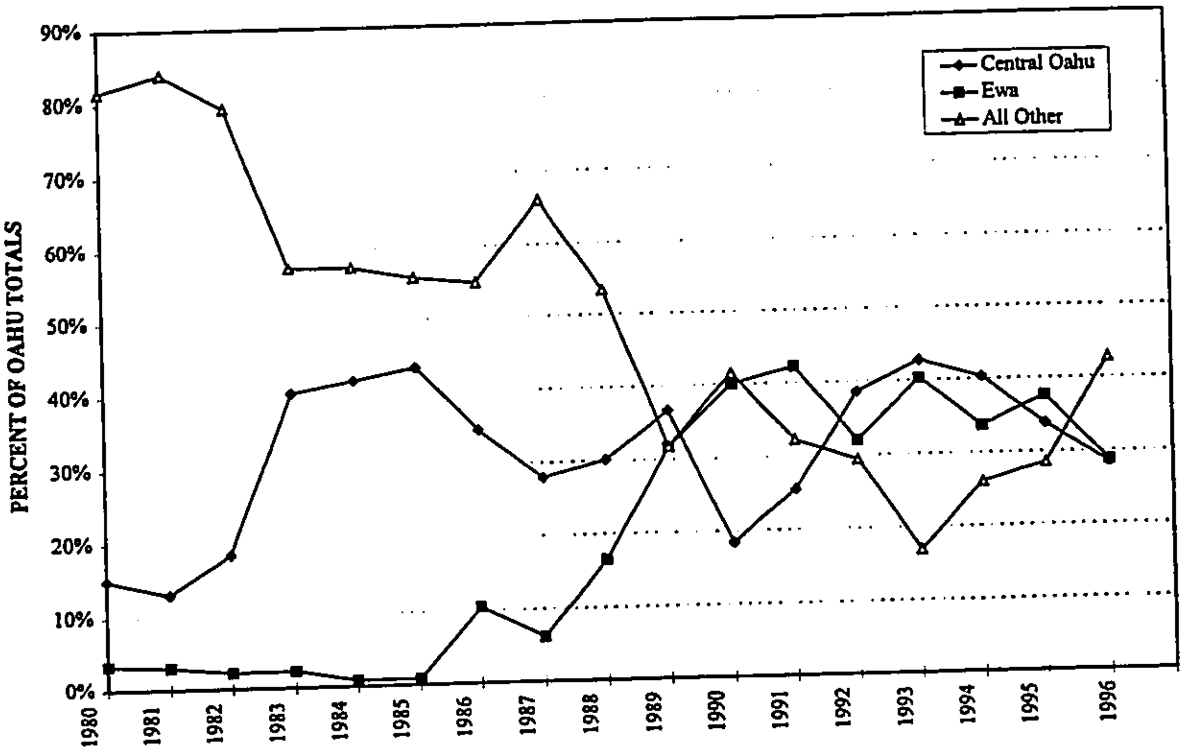
OAHU NEW SALES BY TYPE



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure VI - 3

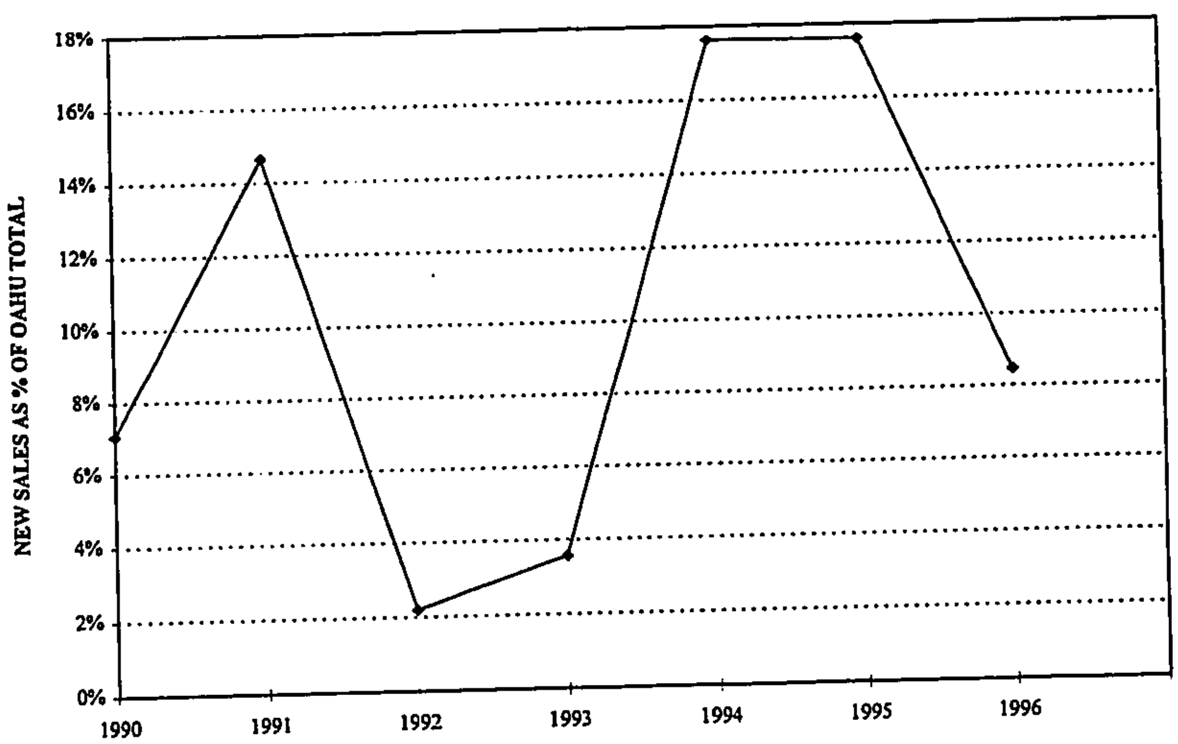
NEW SALES AS % OF OAHU TOTAL BY DPA



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure VI - 4

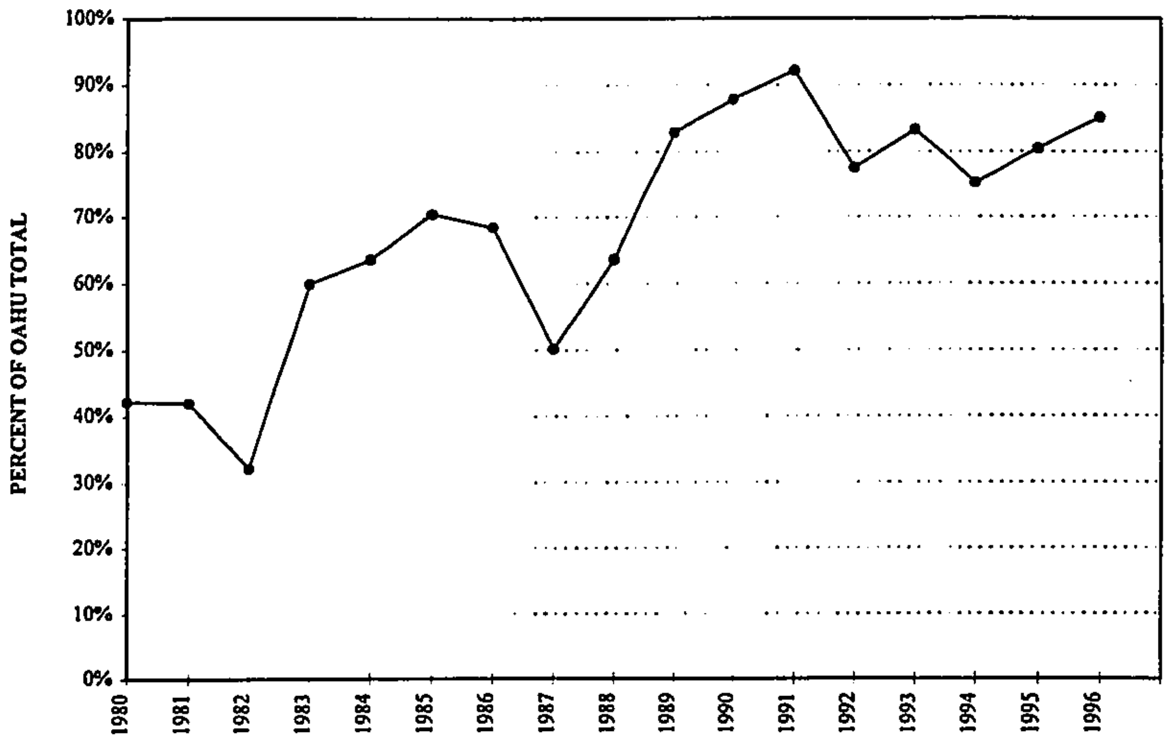
KAPOLEI TOTAL NEW SALES AS % OF OAHU TOTAL



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure VI - 5

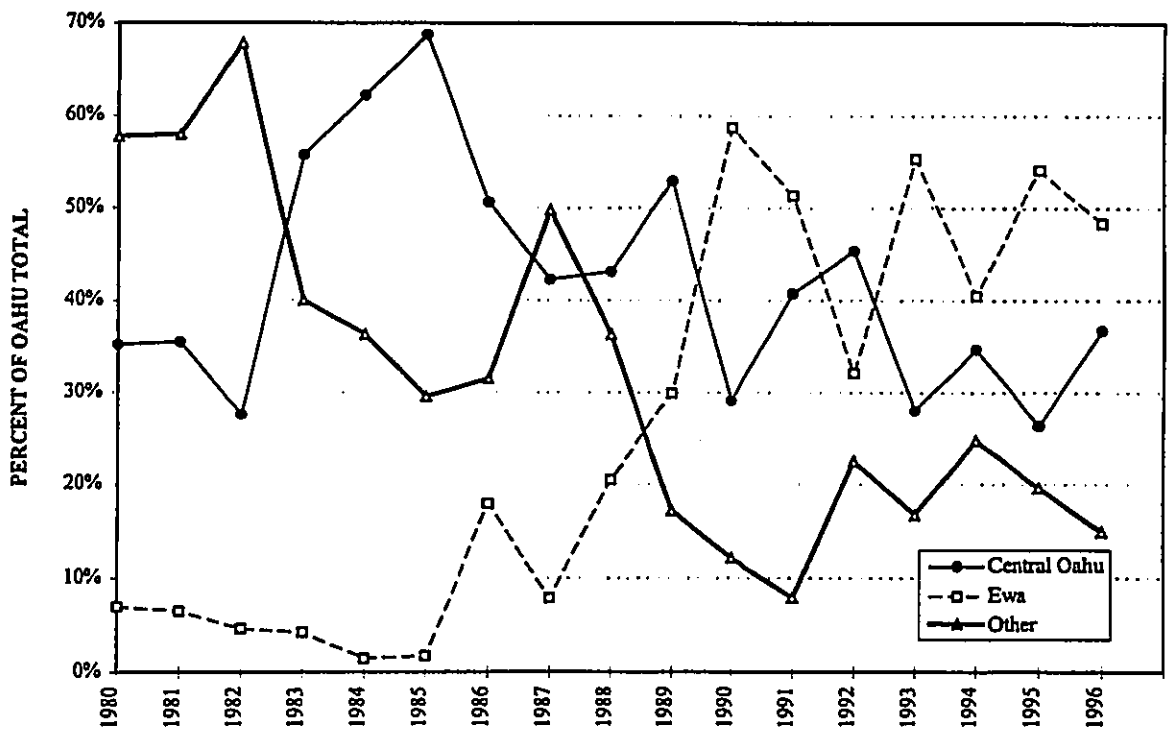
WEST OAHU NEW SINGLE FAMILY SALES AS % OF OAHU TOTAL



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure VI - 6

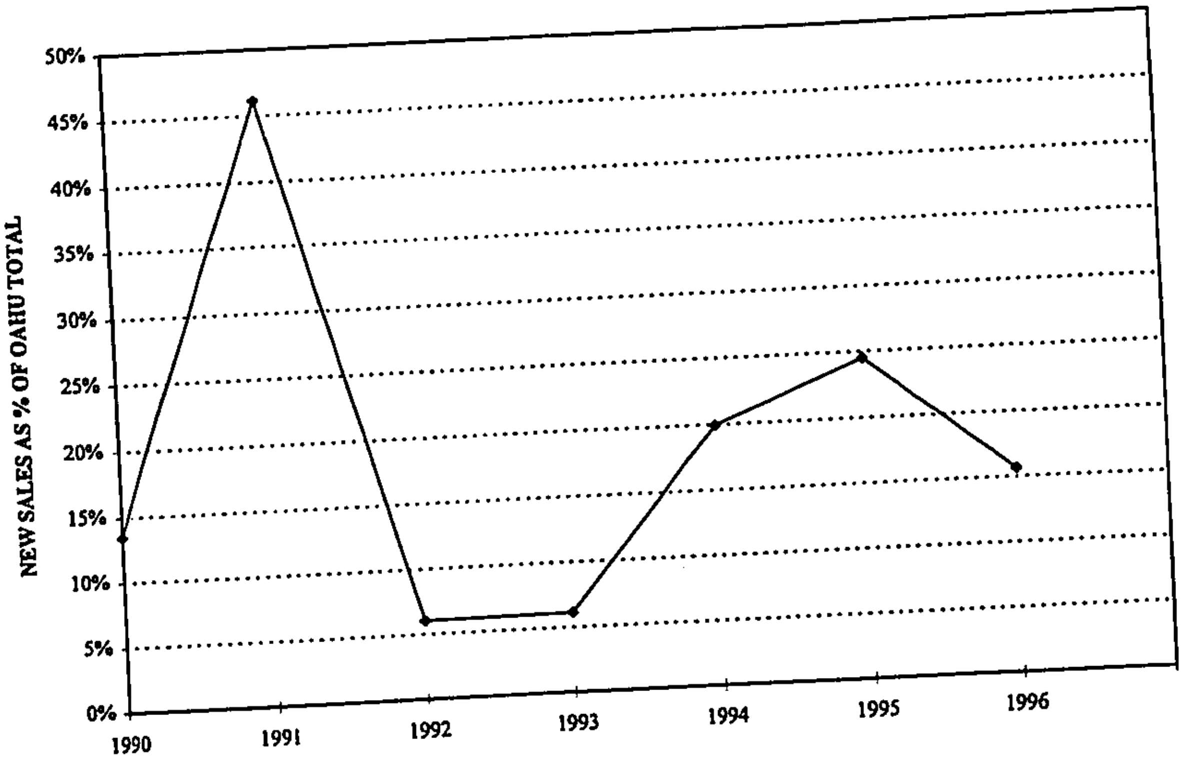
OAHU NEW SINGLE FAMILY SALES AS % BY DPA



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure VI - 7

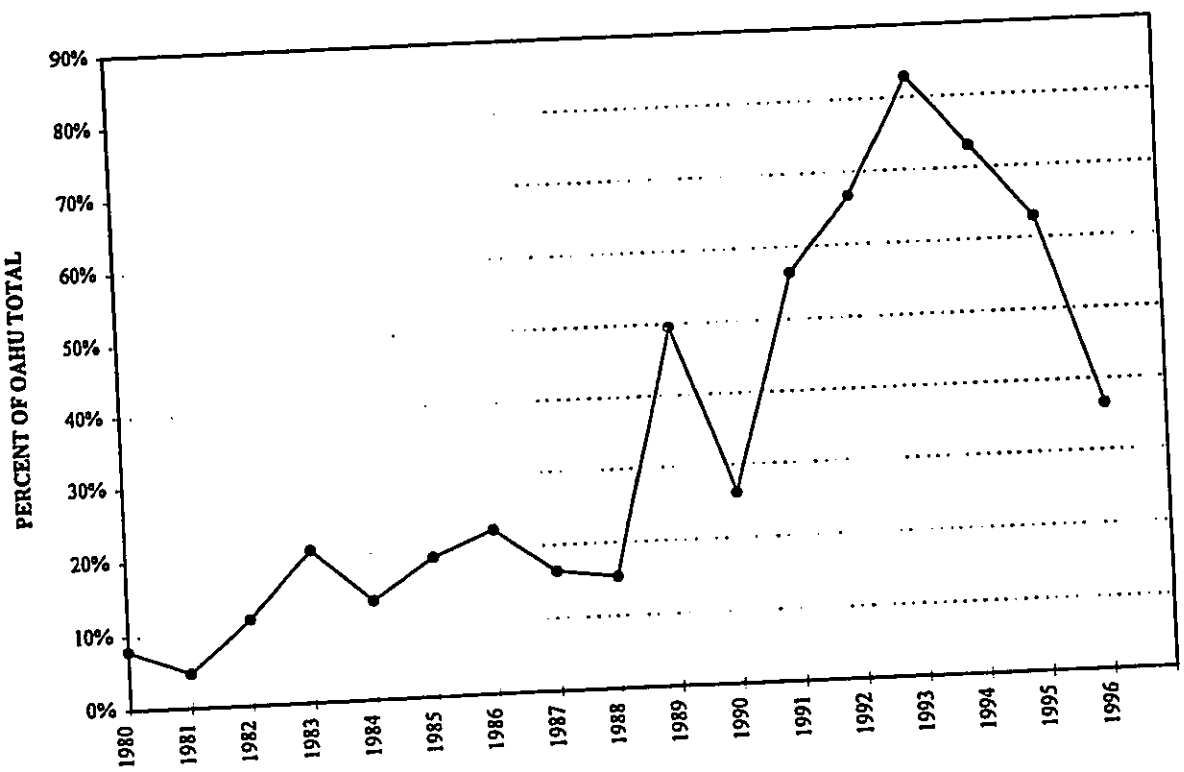
KAPOLEI SINGLE FAMILY NEW SALES AS % OF OAHU TOTAL



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure VI - 8

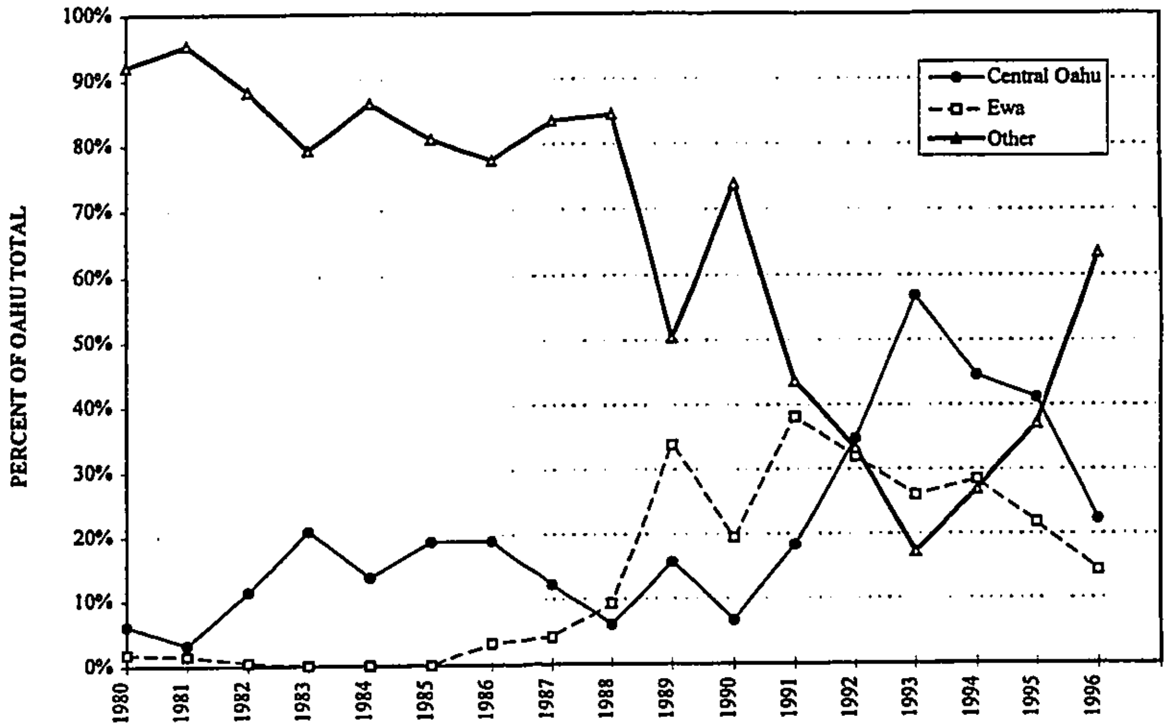
WEST OAHU NEW CONDOMINIUM SALES AS % OF OAHU TOTAL



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure VI - 9

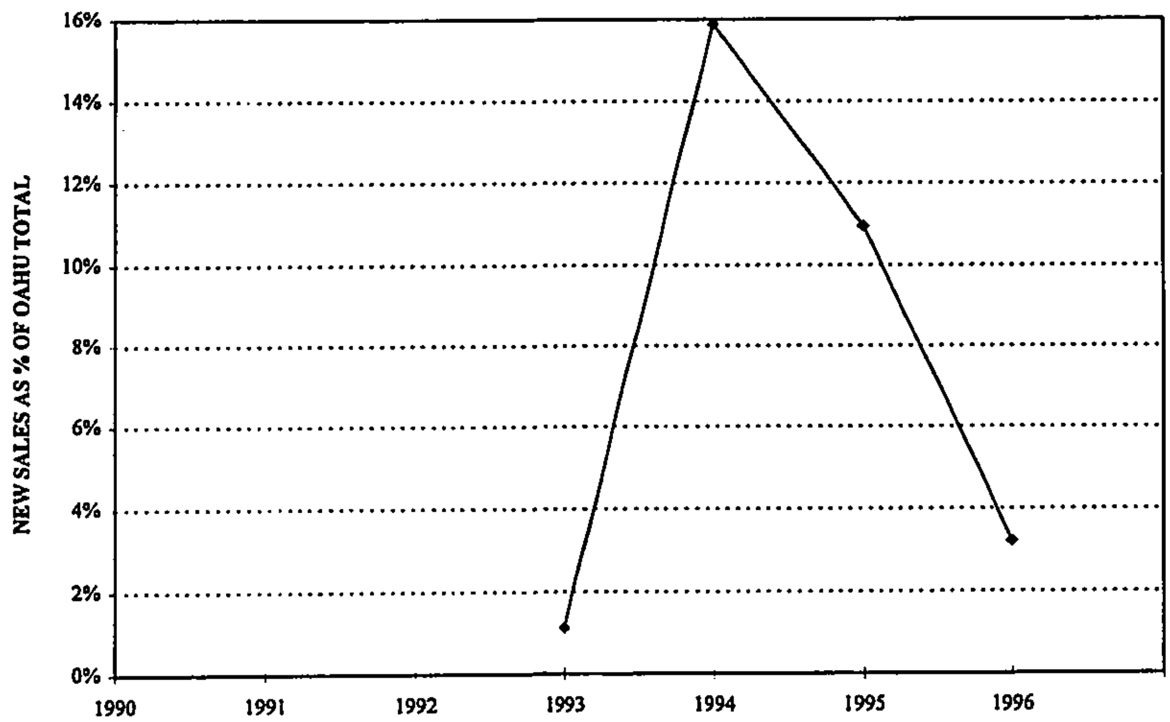
OAHU NEW CONDOMINIUM SALES AS % BY DPA



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure VI - 10

KAPOLEI MULTI-FAMILY NEW SALES AS % OF OAHU TOTAL



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure VI - 11

OAHU 1996 NEW SALES BY PROJECT BY MONTH BY PRICE RANGE

type	Single Family

prcrng	Aeloa	Champions	Country Cottages/Lanes	Country Gardens	Court Yard	Ewa Villages	Fiesta	Hawaii Loa Ridge	Highland View Estates	Island Bungalows	Islander	Iwalani	Kulalei	Lofts By Gentry	Maili Kai	Misc
<$100				1												
$100-$125						1										
$125-$150						13										2
$150-$175						29						2		1		1
$175-$200	7		6			66								10	5	2
$200-$225	18		7	1		7	38					21		5	27	6
$225-$250	8		46	2		2	79					10	13		18	5
$250-$275			15				3					8	18		3	4
$275-$300	7		17		1		3			9		11	5			3
$300-$325	6	1	1		4					5	4	18				5
$325-$350	12		11		4				1		15	6				5
$350-$375	5	1	5		3						14					4
$375-$400	6								4		1					5
$400-$425	6	1						1	4							7
$425-$450																1
$450-$475																1
$475-$500	3															3
>$500	1							8								11
Grand Total	79	3	108	4	12	118	123	9	9	14	34	76	36	16	53	65

prcrng	Na Kuki	Na Pali Haweo	Pacific Heritage	Pacific Islander	Pacific Traditions	Royal Kunia	Royal Pines	Royal Ridge	Sea Breeze	Signatures	Soda Creek	Summer Hill	The Bluffs	The Palms at Kekuilani	Tropics At Waikele	Village at Pokai Bay	West Hills	West Park	Woodcrest	Grand Total
<$100																				1
$100-$125																				1
$125-$150																				15
$150-$175																5				38
$175-$200											1					10				107
$200-$225											5					5				140
$225-$250									2		1	1		2		2				191
$250-$275	3								2		1	7		6	7					77
$275-$300	13	1				1		2				12			15					100
$300-$325	26					6		1						2	25		1	1		106
$325-$350	29	1		6		1	4	4		3					3		5	1		111
$350-$375	5		10	7	1	2	1	3		1							2			64
$375-$400			4	1	4	1	2	1		6			2							37
$400-$425			2		6	1	1						1							30
$425-$450			2		1								1							5
$450-$475					1															2
$475-$500	1		1																1	9
>$500		2																	1	23
Grand Total	77	4	19	14	13	12	8	11	4	10	8	20	4	10	50	22	8	2	2	1,057

COMPILED BY: THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure VIII - 1

OAHU 1996 NEW SALES BY PROJECT BY MONTH

type	Single Family

Month	Aeloa	Champions	Country Cottages/Lanes	Country Gardens	Court Yard	Ewa Villages	Fiesta	Hawaii Loa Ridge	Highland View Estates	Island Bungalows	Islander	Iwalani	Kulalei	Lofts By Gentry	Maili Kai	Misc
Jan	2		15				14				1	4			5	8
Feb	8		2			1	9				5	1			5	6
Mar	8		16		3	3	6		1		13				3	4
Apr	10	3	19		3	2	12	2	1		12	9			8	4
May	15		9			14	13				2	4			5	8
Jun	6		8			40	21	2	1			5			6	8
Jul	3		4			20	15	2	1			6	2		6	9
Aug	6		5		1	3	14	2	1			14	4		3	9
Sep	1		6		1	15	3	1		3		20	10		5	7
Oct	3		2		1	7	5			1		8	7	3	1	1
Nov	4		6	1	1	6	9		3	1		1	4	5	3	
Dec	13		16	3	2	7	3		1	9	1	4	9	8	3	1
Grand Total	79	3	108	4	12	118	123	9	9	14	34	76	36	16	53	65

Month	Na Kuki	Na Pali Haweo	Pacific Heritage	Pacific Islander	Pacific Traditions	Royal Kunia	Royal Pines	Royal Ridge	Sea Breeze	Signatures	Soda Creek	Summer Hill	The Bluffs	The Palms at Kekuilani	Tropics At Waikele	Village at Pokai Bay	West Hills	West Park	Woodcrest	Grand Total
Jan		1			2	2	1					3		1		1				60
Feb					1					1		3		1		5		1	1	50
Mar	11	1			1	2	2			2		2		2		2	3	1		85
Apr	23				8	3	4	1		3		1		4	2	2	1			137
May	5	1						3			1	1		1	5	3	2			92
Jun	3				1						6	1			6	3	1			118
Jul	1					1		2				3			4	1				80
Aug	8					1		1				2			6	3				83
Sep	4	1				3				1	1	1		1	6	2	1			93
Oct	7							2		3			3		4					58
Nov	5		3				1	2	2			2			9				1	69
Dec	10		16	14					2			1	1		8					132
Grand Total	77	4	19	14	13	12	8	11	4	10	8	20	4	10	50	22	8	2	2	1,057

COMPILED BY: THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure VIII - 2

OAHU 1996 NEW SALES BY PROJECT BY MONTH BY PRICE RANGE

type	Multifamily

Project

prcrng	1133 Waimanu	Aalea Terrace	Alewa Townhomes	Coronado	Country Club Village	Courtyards At Punahou	Crescent Lane	Crowne at Wailuna	Executive Center	Gardens at Launani Valley	Hale Makalei	Hale Makani Kai	Harbor Court	Hillsdale	Honuakaha	Imperial Plaza	Ka Momi Nani Heights	Kalele Kai	Kapalama Gardens	Kauluokahaloa III	Kekuilani Villas	Ko Olina Fairways	Kulalani Village	Kulana Knolls	Kulanui Hale	Kuulako	Laiea At Hawaii Kai	Lukepane Gardens	Mililani Pinnacle	Nauru Tower	Northpointe	Nuuanu Parkside	Olaloa	Pae Ko Gardens	Parkglen at Waikele	Parkside	Pearl Horizons	Queen Victoria Residences	Royal Garden-Makiki	Royal Towers	Seaside Suites	Spencer Terrace	Streamside At Launani Valley	Sunset Shores	Terraces At Launani Valley	Village on the Green at Waikele	Waikiki Landmark	Westview At Makakilo Hts	Woodlands	Grand Total
<$100				2					2										3						1																									8
$100-$125		1		12						14									1				1		7						6			3						2										47
$125-$150	11	1		20					5	3									4					5	7						5		1	5						14				1						82
$150-$175	102	33		5			4		6	7	7			1	19						1			16	25						45		4			2				5	3			16			4	12		317
$175-$200	106								3	2	3				9						1	8		7	3	40	3				13		1				3				3	1	9	3	7	13	4	18		260
$200-$225	60				21																	10			7	27	6						8		1						7	2			6	42	13			210
$225-$250					53																	27				12	15		1				1								2				14	6	9			140
$250-$275					10																	9					5		1																	5	3			33
$275-$300					22																	2					17					2							1							11	4			59
$300-$325					10			2										5				6					17					2							2							8	1			53
$325-$350								22							1			25		1							1	6				5														2				63
$350-$375			1					15				1					1	12		3							2					7															4			46
$375-$400								4				1						6														9															10			30
$400-$425								1				1																				1															10		3	16
$425-$450													1			1		3														2															5			12
$450-$475																														1																	2			3
$475-$500																		13												1																				14
>$500						13												12												7		2						5									2			41
Grand Total	279	35	1	39	118	13	4	44	16	26	10	3	1	1	29	1	1	76	8	4	2	62	1	28	50	79	66	6	2	9	69	30	15	8	1	2	3	5	3	21	15	3	9	20	27	87	71	30	3	1,434

COMPILED BY: THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure VIII - 3

OAHU 1996 NEW SALES BY PROJECT BY MONTH

type	Multifamily

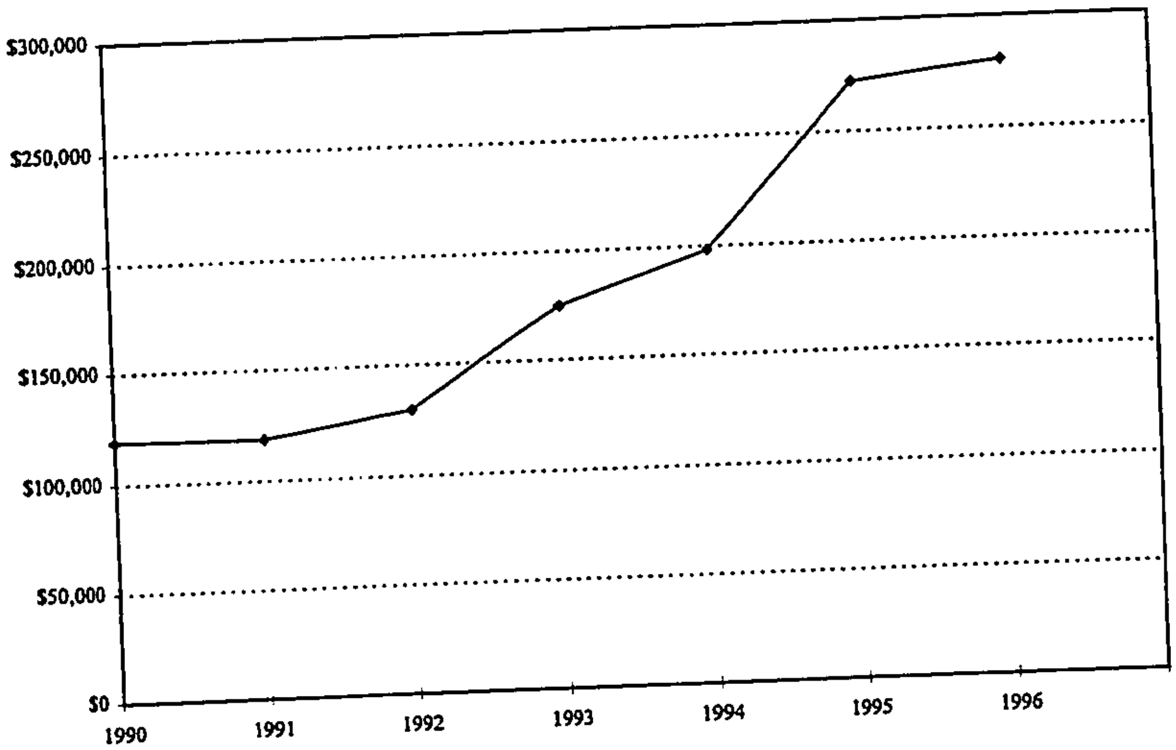
Project

Month	1133 Waimanu	Aalea Terrace	Alewa Townhomes	Coronado	Country Club Village	Courtyards At Punahou	Crescent Lane	Crowne at Wailuna	Executive Center	Gardens at Launani Valley	Hale Makalei	Hale Makani Kai	Harbor Court	Hillsdale	Honuakaha	Imperial Plaza	Ka Momi Nani Heights	Kalele Kai	Kapalama Gardens	Kauluokahaloa III	Kekuilani Villas	Ko Olina Fairways	Kulalani Village	Kulana Knolls	Kulanui Hale	Kuulako	Laiea At Hawaii Kai	Lukepane Gardens	Mililani Pinnacle	Nauru Tower	Northpointe	Nuuanu Parkside	Olaloa	Pae Ko Gardens	Parkglen at Waikele	Parkside	Pearl Horizons	Queen Victoria Residences	Royal Garden-Makiki	Royal Towers	Seaside Suites	Spencer Terrace	Streamside At Launani Valley	Sunset Shores	Terraces At Launani Valley	Village on the Green at Waikele	Waikiki Landmark	Westview At Makakilo Hts	Woodlands	Grand Total
Jan				1	6		2	2	1	2				1	8			8	1		1	6		2		7		3			6	2	1	3				1		3		1				2		1	1	71
Feb				1	5	1		3	1	2		2	1		5	1		2	1			11	1	3		1			1		4	2	1	3		2				2				18	6	1		1		82
Mar				2	17	1		6	4	2					4			1	1			7		1	22	3		1		2	6	6	1	1	1		1			2	1				1	10		2		106
Apr				1	20	4	1	14		1		1			2			13				6		2	6	7		2			13	4						1		1	4	1		1	3	13		2		123
May			1		12	2		7			1				3			24			1	7		2	3	11					5	3	1							1	3	1		1	1	8		5		103
Jun	143			1	9	2		3	2						1			6				11		1	1	12				1	1	5	1				2		1		1		2		2	13		5	2	228
Jul	132				5	1		1	3	2	5				1			8				3		1		12					6	1	1	1					2	2	2		3		1	9		4		206
Aug	4				10			7	1	1								3		2		4		4	1	5				3	4	4	1					1		3	1		1		3	10	30	1		104
Sep		7			13			1		9							1	2		1				2		5	21				10		3							5	3				1	8	24	1		117
Oct		8		11	7		1		2	6	1							1	1	1				1	8	1	20		1	1	3	2	3							1			2		5	6	10	1		104
Nov		8		11	7				2	1	1				3									2	4	3	4			2	3	1	1					2					1		4		4	2		66
Dec		12		11	6	2					2				2			8	4			7		7	6	12	21				7		1							1						7	3	5		122
Grand Total	279	35	1	39	118	13	4	44	16	26	10	3	1	1	29	1	1	76	8	4	2	62	1	28	50	79	66	6	2	9	69	30	15	8	1	2	3	5	3	21	15	3	9	20	27	87	71	30	3	1,434

COMPILED BY: THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure VIII - 4

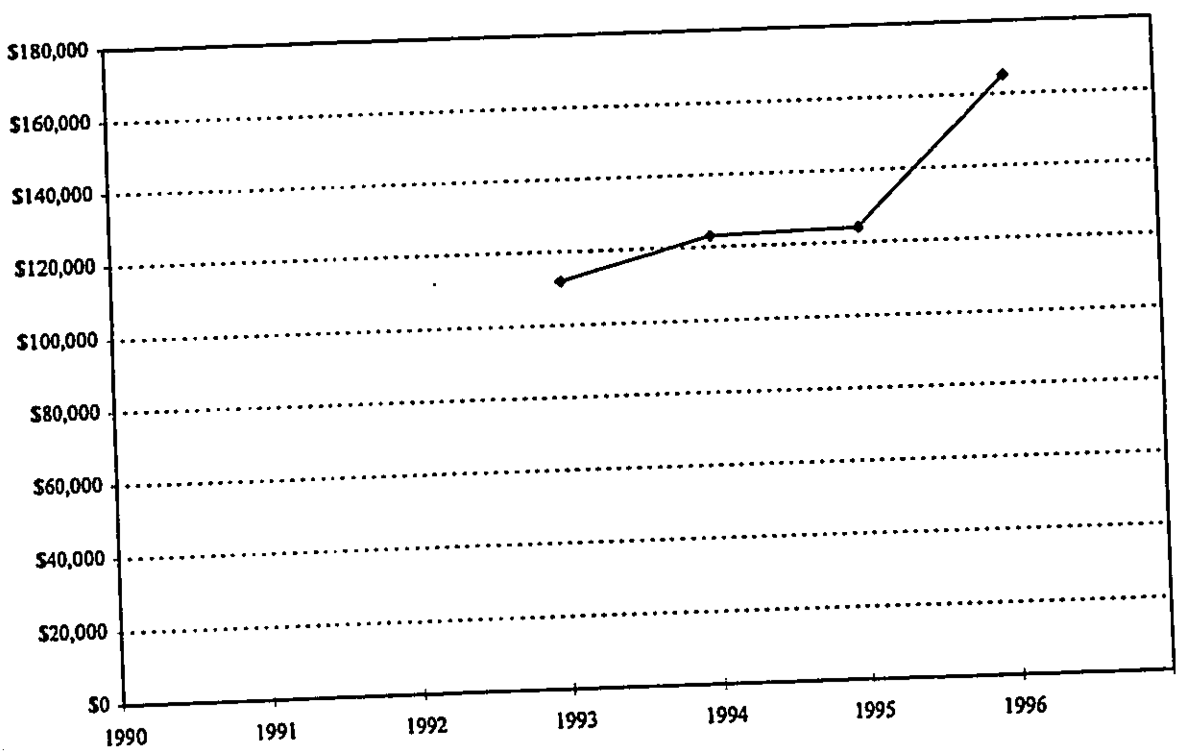
KAPOLEI SINGLE FAMILY MEDIAN NEW SALE PRICE



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure VIII - 5

KAPOLEI MULTI-FAMILY MEDIAN NEW SALE PRICE



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

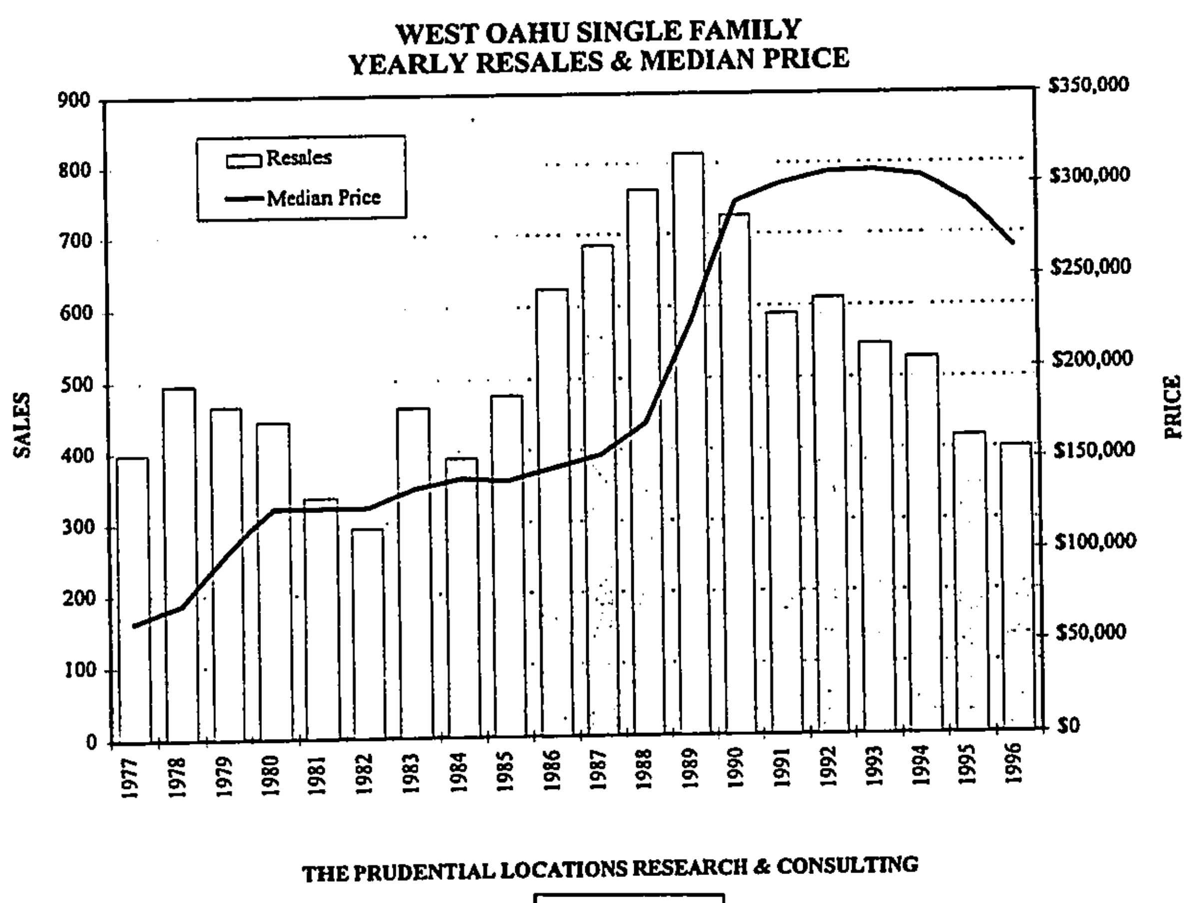
Figure VIII - 6

MLS Resale Summary

	Single Family						Condominium						Single Family		Condominium	
	West Oahu		Ewa DPA		Central Oahu DPA		West Oahu		Ewa DPA		Central Oahu DPA		Kapolei			
Year	Sales	Median	Sales	Median	Sales	Median	Sales	Median	Sales	Median	Sales	Median	Sales	Median	Sales	Median
1977	398	$63,000	188	$57,000	210	$73,875	186	$52,000	37	$45,000	149	$54,000				
1978	495	$72,500	237	$65,000	258	$86,000	418	$56,300	146	$54,250	272	$58,000				
1979	466	$101,500	235	$93,000	231	$120,000	882	$70,750	239	$83,000	643	$62,000				
1980	444	$125,000	185	$110,000	259	$139,000	681	$88,500	186	$93,000	475	$82,000				
1981	336	$125,000	144	$110,000	192	$145,500	438	$98,250	144	$98,750	294	$98,250				
1982	293	$125,000	130	$109,250	163	$145,000	300	$100,000	82	$100,500	218	$97,250				
1983	462	$135,000	161	$115,000	301	$147,500	494	$104,000	159	$108,000	335	$99,000				
1984	390	$140,500	118	$120,000	272	$148,750	394	$99,500	109	$106,000	285	$97,000				
1985	476	$139,000	145	$119,000	333	$145,000	375	$97,000	76	$101,750	299	$97,000				
1986	625	$146,000	154	$127,200	471	$153,000	405	$102,375	87	$108,000	318	$97,000				
1987	685	$152,500	177	$131,500	508	$160,000	439	$100,000	97	$106,500	342	$99,000				
1988	763	$170,000	191	$148,950	572	$177,000	707	$101,000	167	$111,600	540	$98,000				
1989	814	$225,000	222	$200,000	592	$235,000	910	$127,600	201	$138,500	709	$122,000				
1990	726	$290,000	212	$280,000	514	$298,000	972	$179,000	189	$185,000	783	$175,000				
1991	589	$300,000	132	$285,000	457	$305,000	846	$184,000	217	$184,500	629	$183,600	2	$292,500		
1992	611	$306,251	175	$285,000	436	$315,000	919	$189,000	274	$192,000	645	$185,000	5	$352,000		
1993	546	$307,000	137	$283,500	409	$315,000	823	$188,250	277	$190,000	546	$187,000	8	$314,000		
1994	527	$304,000	165	$285,000	382	$312,500	627	$187,000	205	$190,000	422	$185,000	3	$329,000		
1995	417	$290,000	123	$275,000	294	$295,000	472	$175,000	132	$168,000	340	$168,600	5	$276,395		
1996	400	$265,000	145	$247,000	255	$270,000	332	$153,000	94	$150,250	238	$154,500	9	$267,500	5	$143,850

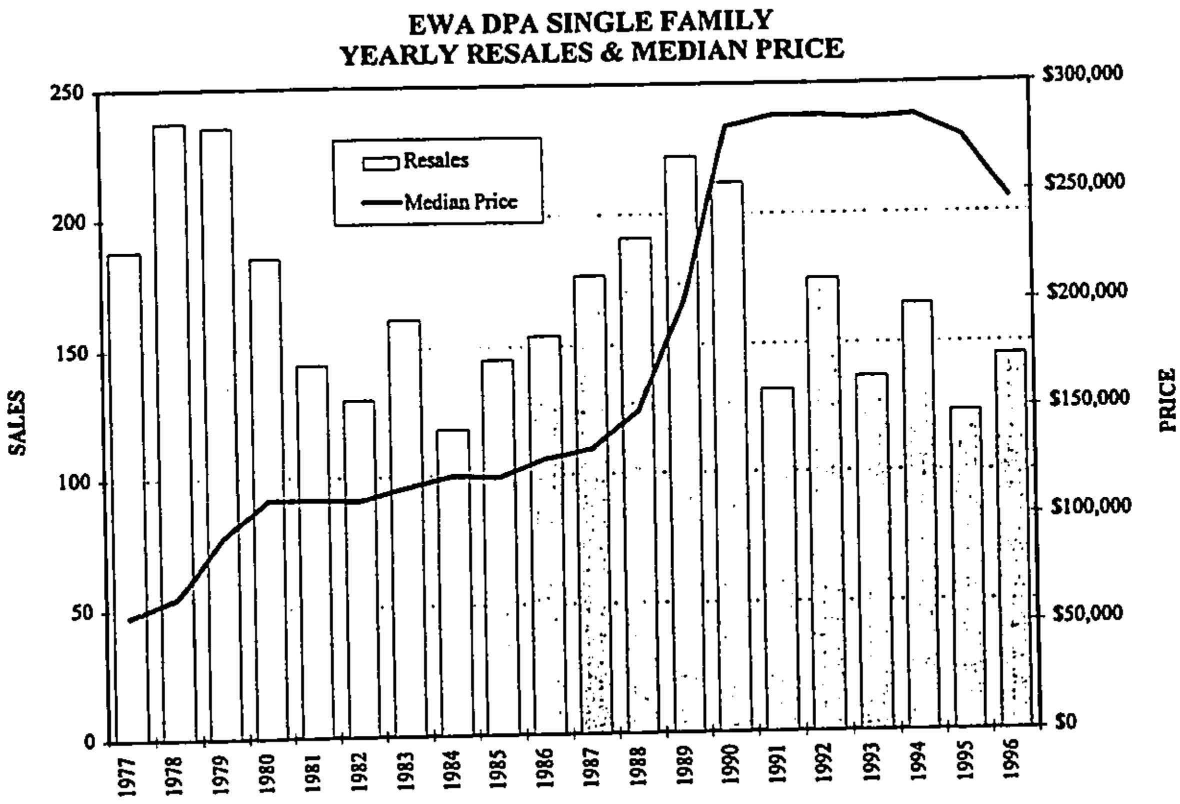
THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure VIII - 7



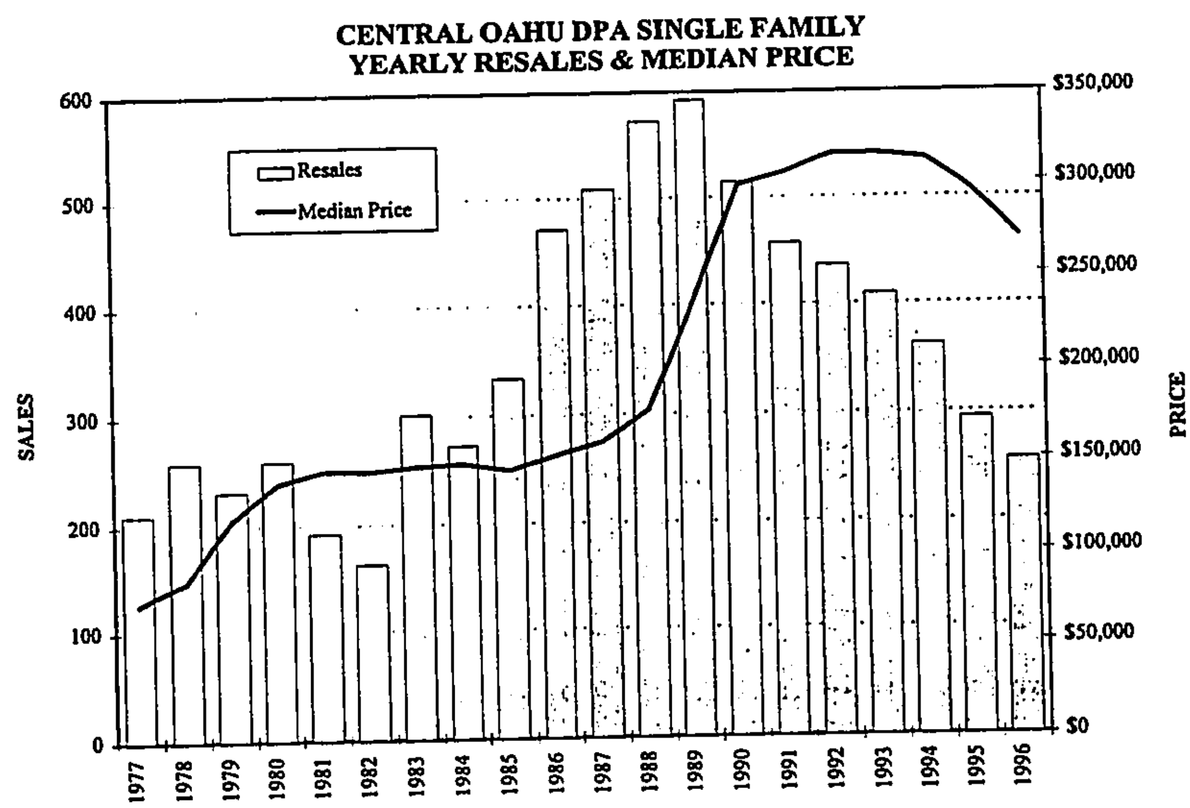
THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure VIII - 8



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

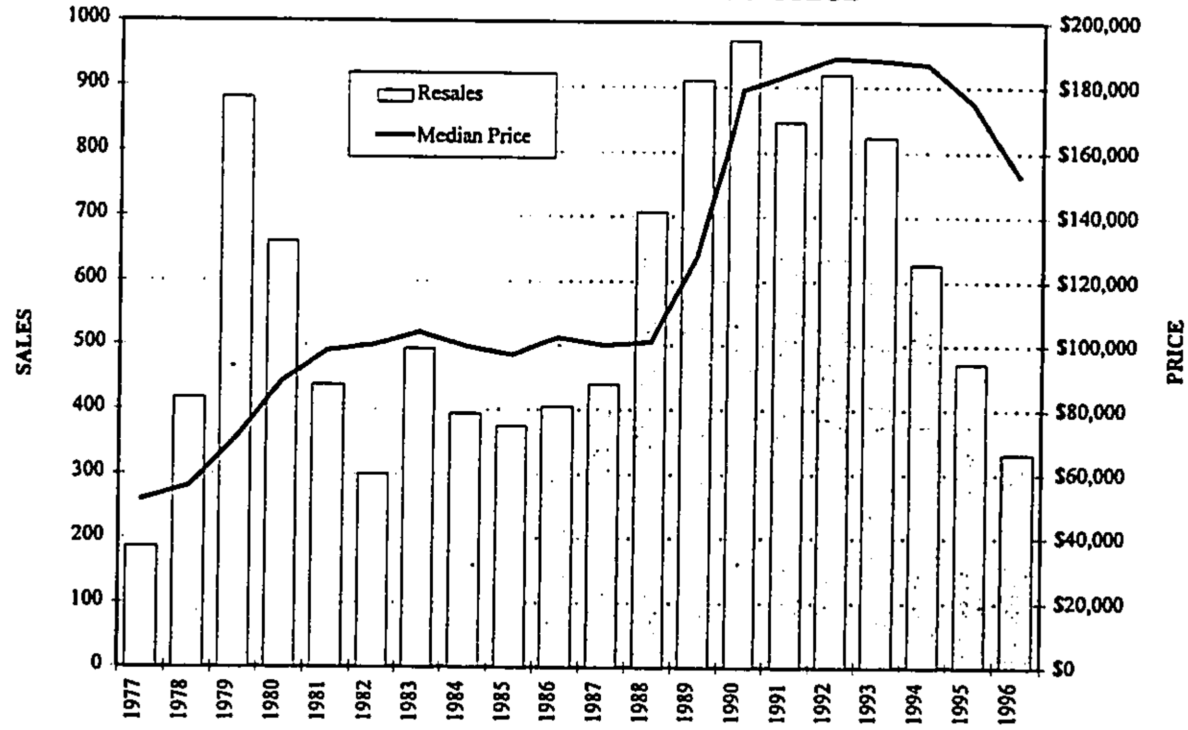
Figure VIII - 9



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure VIII - 10

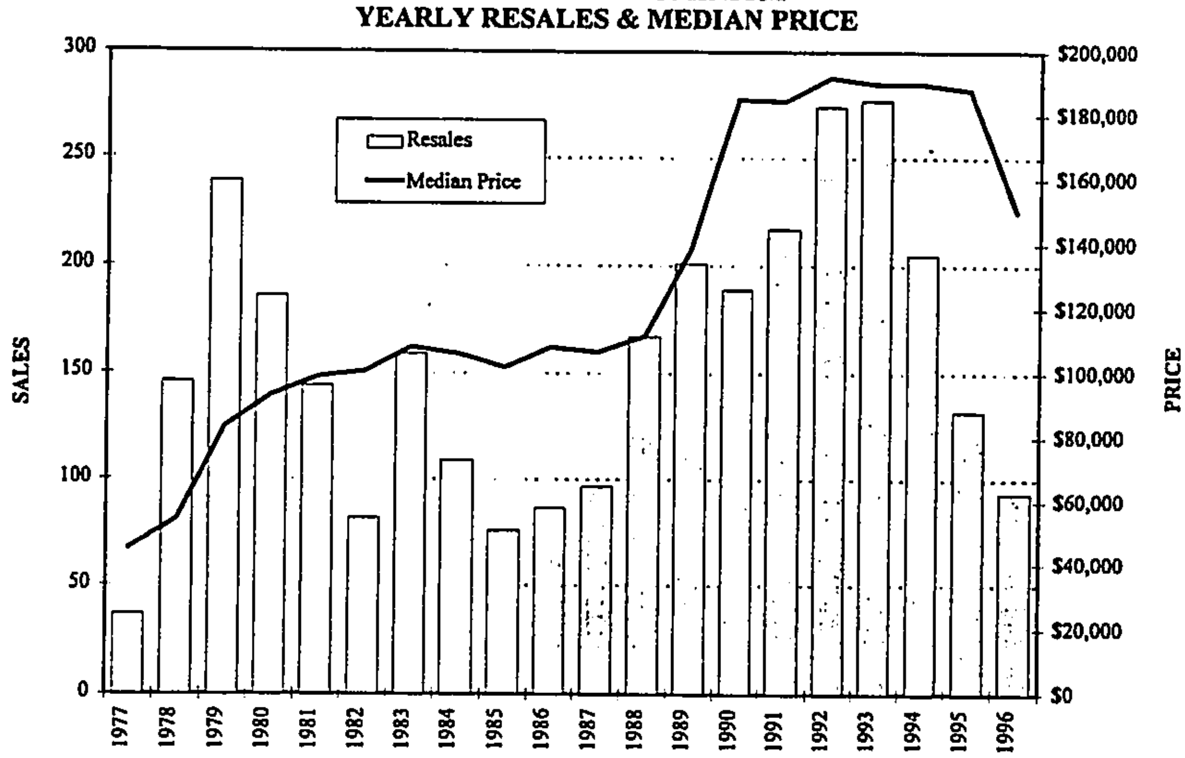
WEST OAHU CONDOMINIUM
YEARLY RESALES & MEDIAN PRICE



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure VIII - 11

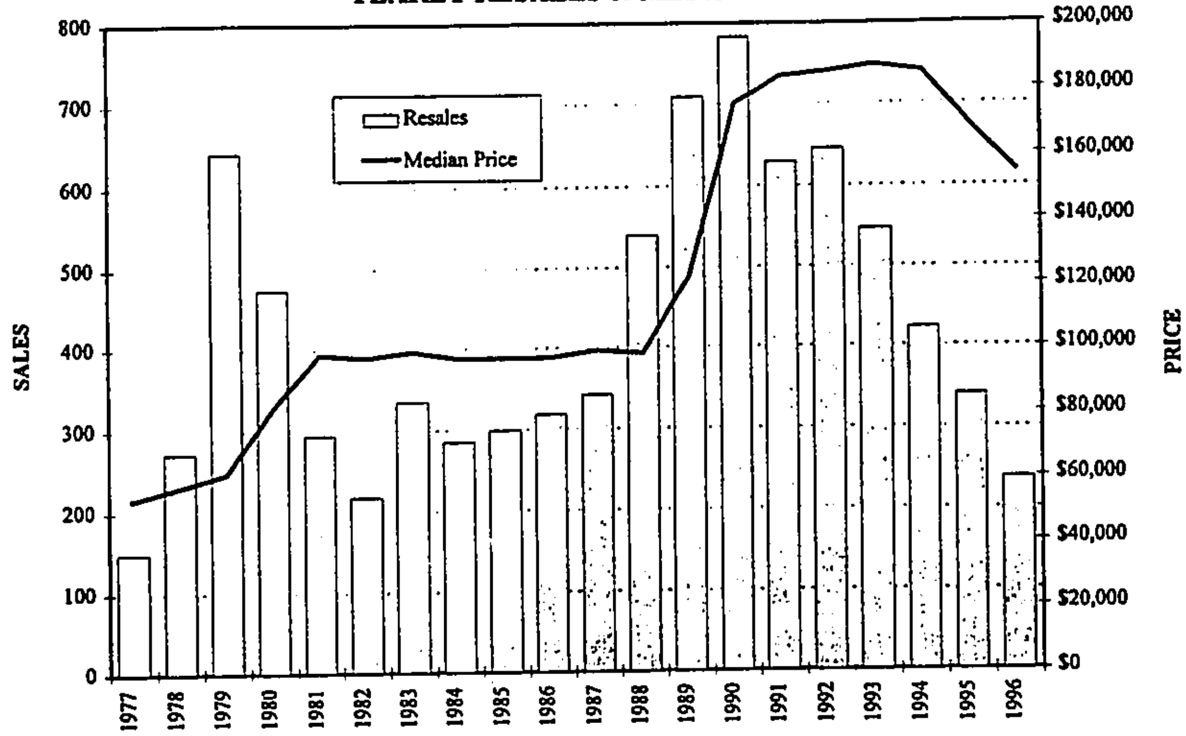
EWA DPA CONDOMINIUM
YEARLY RESALES & MEDIAN PRICE



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure VIII - 12

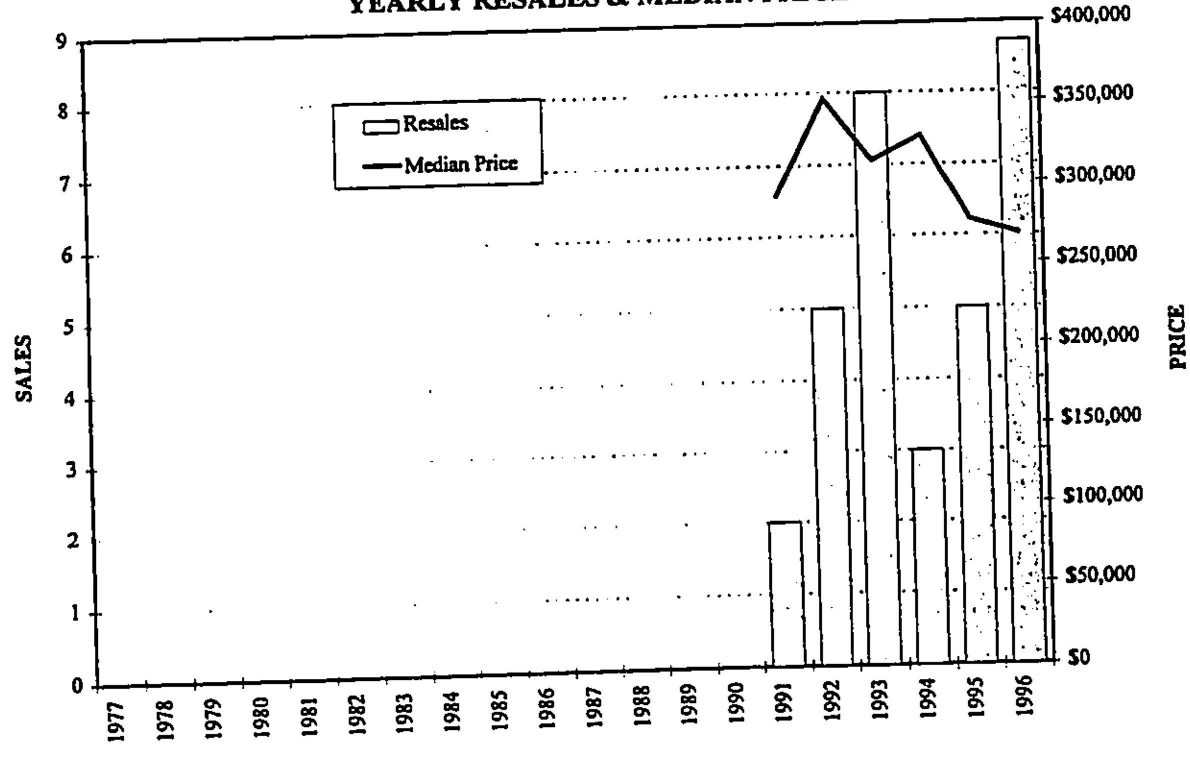
CENTRAL OAHU DPA CONDOMINIUM
YEARLY RESALES & MEDIAN PRICE



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

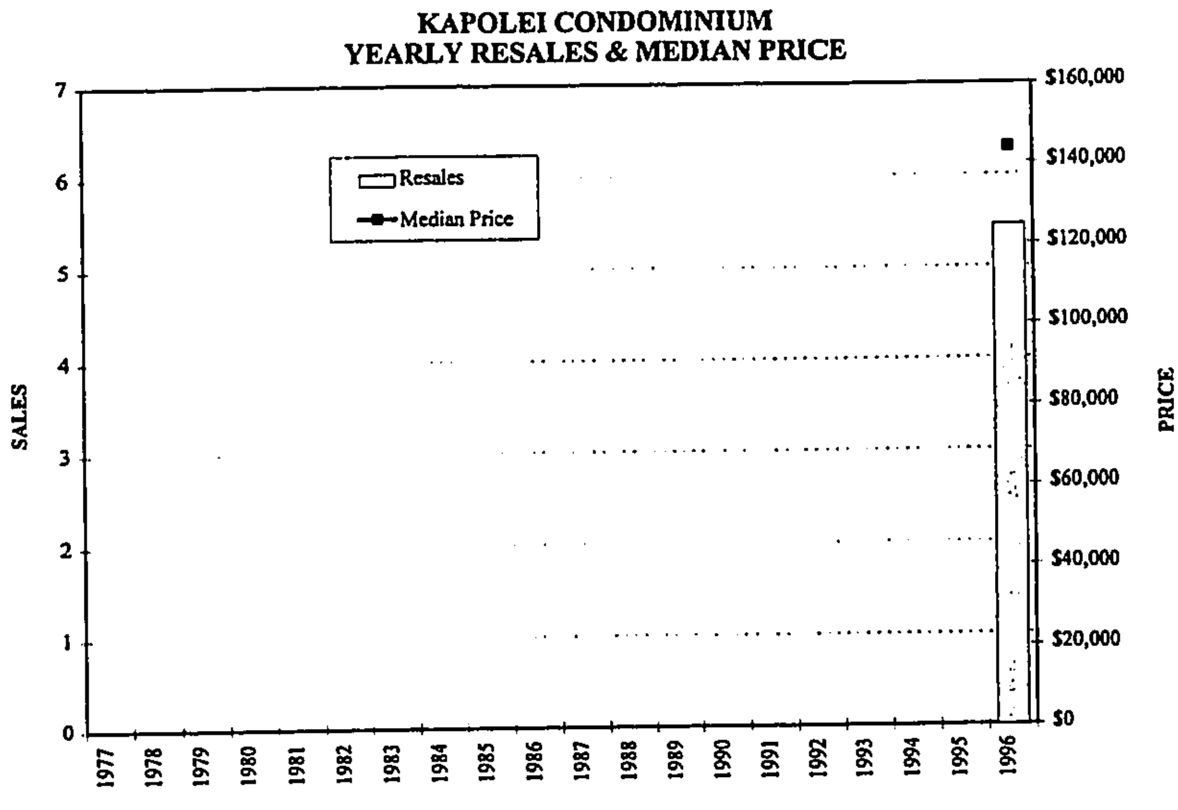
Figure VIII - 13

KAPOLEI SINGLE FAMILY
YEARLY RESALES & MEDIAN PRICE



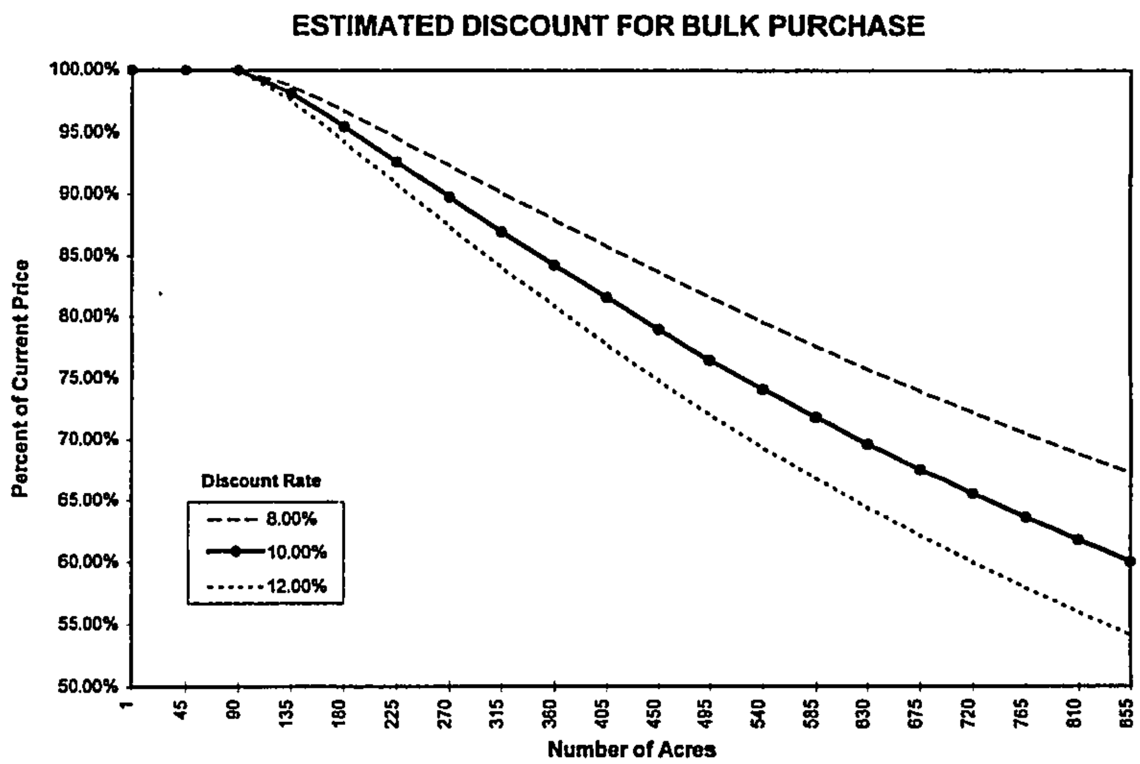
THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure VIII - 14



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure VIII - 15



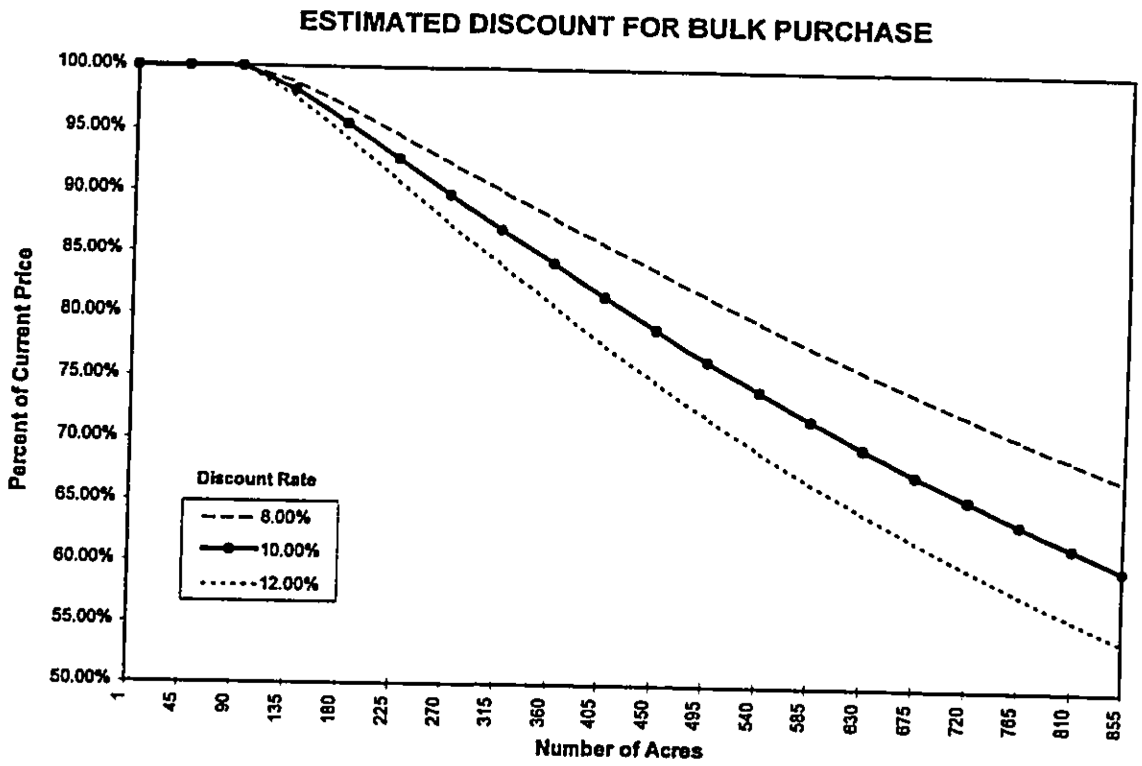


Figure VIII-16

B. Civil Engineering

DRAINAGE MASTER PLAN

DRAFT REPORT for the

EAST KAPOLEI DRAINAGE MASTER PLAN
Ewa, Oahu, Hawaii

JUNE 1998

PREPARED FOR:

Housing Finance and Development Corporation
State of Hawaii

RMTC
R. M. Towill Corporation

420 Waiakamilo Rd., Suite 411
Honolulu, Hawaii 96817-4941
(808) 842-1133 • Fax: (808) 842-1937

EAST KAPOLEI
DRAINAGE MASTER PLAN
Ewa, Oahu, Hawaii

Prepared for:

Housing Finance and Development Corporation
State of Hawaii

Prepared by:

R. M. Towill Corporation
420 Waiakamilo Road, Suite 411
Honolulu, Hawaii 96817

JAMES H. YAMAMOTO
LICENSED PROFESSIONAL ENGINEER
No. 5491-C
HAWAII, U.S.A.

June 22, 1998

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

SECTION 1
INTRODUCTION

1.1 Background

The East Kapolei Project is a master planned residential community and is sponsored by the State of Hawaii's Housing Finance and Development Corporation. The project is located in the Ewa Plains area, above Ewa Villages and is bound by the Villages of Kapolei, Campbell Estate lands and the H-1 Freeway. The project covers approximately 1,300 acres (see Figures 1-1 and 1-2) and consists of residential homes, schools, parks and commercial and civic facilities.

A large portion of the site lies in the Kaloi Stream flood plain. Existing drainage conditions are poor due to the flat topography of the land and inadequate drainage swales, which were primarily used to drain the surrounding sugarcane fields. The proposed North-South road will intersect the existing Kaloi Gulch at two locations and will run down the middle of East Kapolei. The realigned Kaloi is planned to be incorporated into the regional drainage plan for the area.

1.2 Purpose and Scope

This report describes the drainage plan for the East Kapolei project. The purpose of the drainage plan is to improve local drainage as well as provide a regional drainage solution for the Kaloi Stream inadequacies.

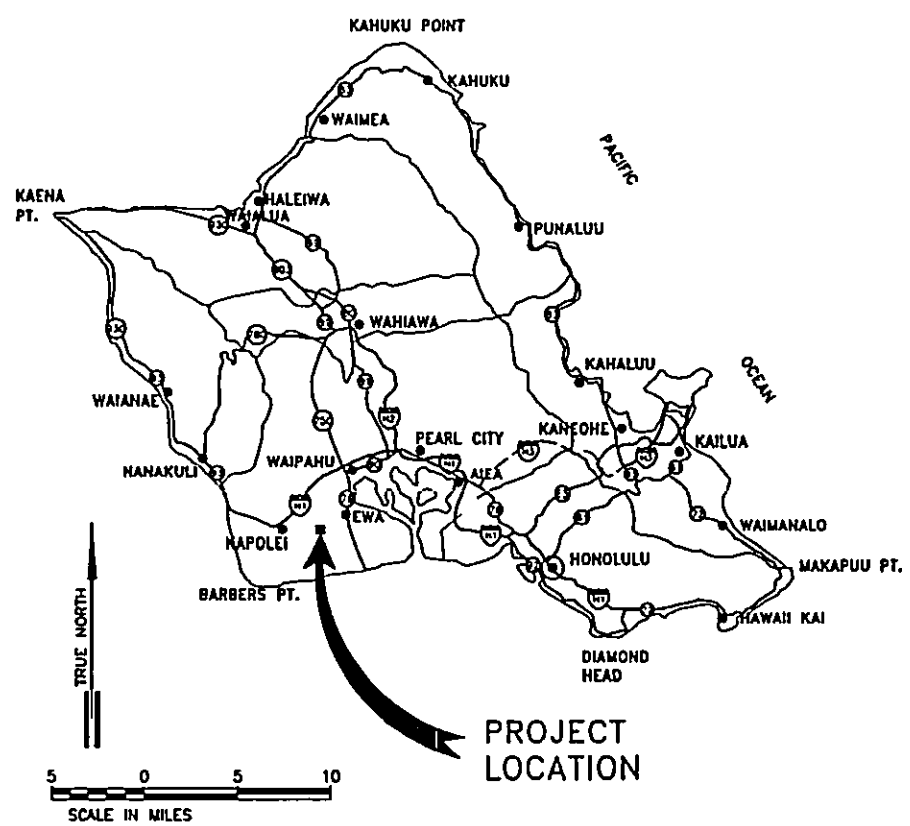
The scope of this master plan includes:

- Assessment of existing drainage conditions.
- Assessment of developed drainage conditions
- Sizing of regional and backbone drainage facilities.

1.3 Related Studies

1.3.1 Ewa Villages Master Plan

The immediate downstream neighbor of East Kapolei is Ewa Villages. The Ewa Villages Revitalization project provides adequate facilities to handle the regional drainage. The *Ewa*



LOCATION & VICINITY MAP

FIGURE 1-1
EAST KAPOLEI DRAINAGE MASTER PLAN
LOCATION AND VICINITY MAP
R. M. TOWILL CORPORATION

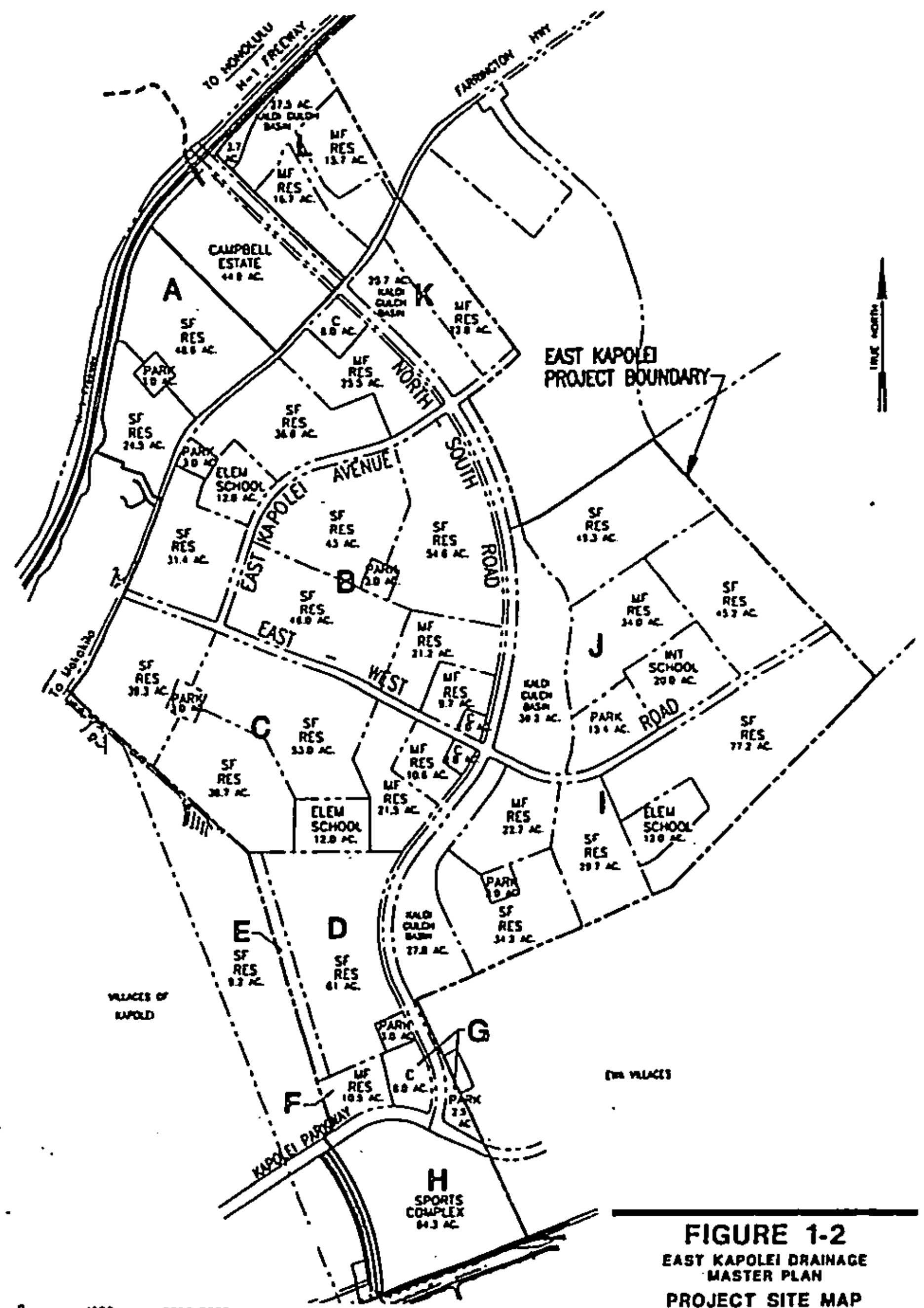


FIGURE 1-2
EAST KAPOLEI DRAINAGE MASTER PLAN
PROJECT SITE MAP
R. M. TOWILL CORPORATION

Villages Master Plan prepared by R. M. Towill Corporation, April 1996 (revised March 1997) discusses improvements that accept runoff from East Kapolei. Runoff is shown to enter the Ewa Villages Golf Course at several locations via several existing culverts. However, the majority of the flow is planned to enter the golf course at the north west corner where Kaloi Stream enters Ewa Villages (Figure 1-3). See Appendix F for excerpts from this report.

1.3.2 Kapolei Village Drainage Master Plan

Directly to the west of the East Kapolei Development is the Villages of Kapolei. The *Kapolei Village Drainage Master Plan*, prepared by R. M. Towill in December 1991, discusses regional drainage improvements that are required for the project. These regional facilities, consisting of the Kapolei Golf Course and the Kapolei Lower Channel, are presently constructed and are designed to serve a portion of land within the East Kapolei development boundary.

1.3.3 Draft Environmental Impact Statement - East Kapolei Project

In January 1996, a Draft EIS for the Schuler Homes' East Kapolei Project was prepared. The project was to be located on Campbell Estate lands just west of Fort Weaver Road. The EIS includes a drainage study prepared by Gray, Hong, Bills & Associates, of the West Loch drainage basin, which is adjacent to the Kaloi drainage basin. The Schuler Homes' East Kapolei Project is no longer active.

1.3.4 Kaloi Gulch Technical Committee Interim Report

The Kaloi Gulch Technical Committee was formed to study and coordinate the drainage requirements and the water quality issues of the projects in the Kaloi Gulch watershed. The members of the committee include engineers for the private developments, representatives for the State and City projects and the representatives from the Drainage Section of the City and County of Honolulu, Department of Public Works.

The report identifies interim and ultimate drainage guidelines for various projects in the area, in order to facilitate improvements and mitigate the impact of conveyance of increased runoff. The interim plan calls for detention and retention facilities in all new projects.

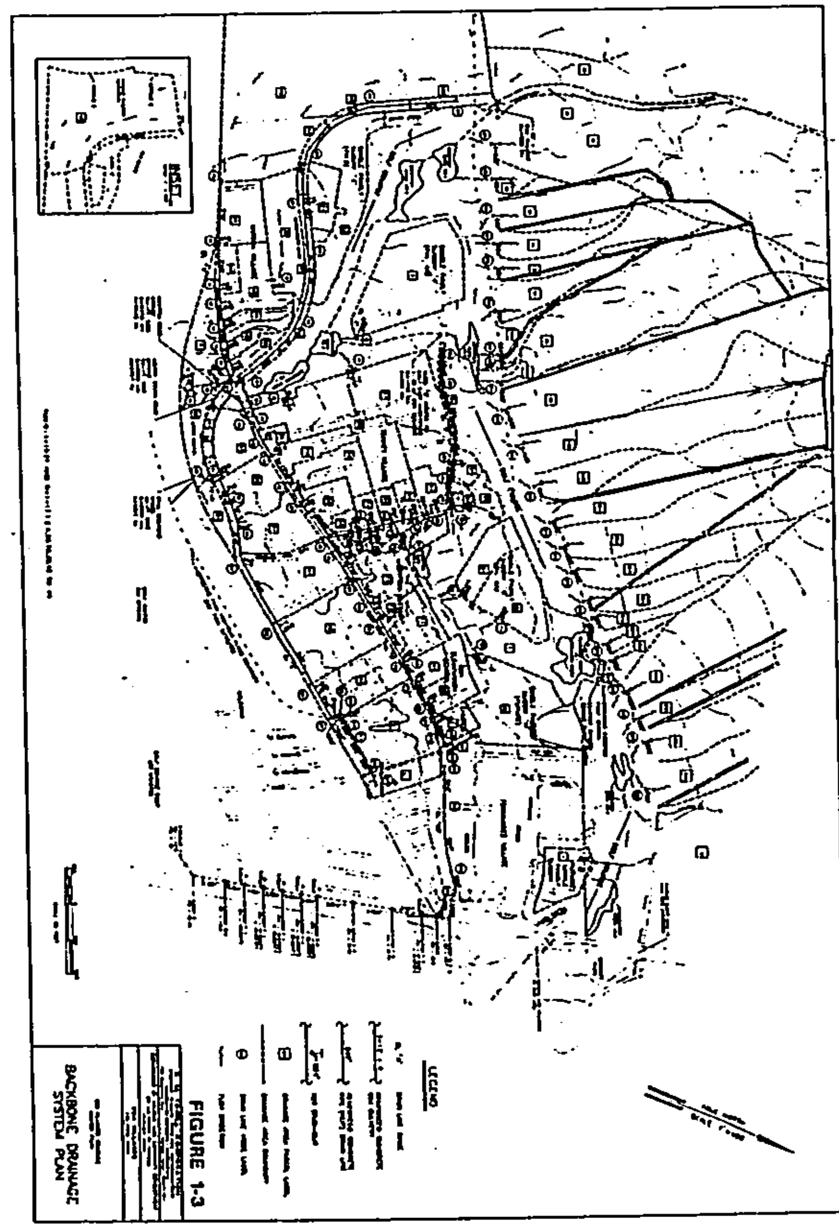


FIGURE 1-3

SECTION 2
CRITERIA AND METHODOLOGY

The criteria used in this study are summarized below. The City and County of Honolulu Storm Drainage Standards provide the general requirements.

- Roadway Bridges and Culverts
  - Capacity = peak discharge from Plate 6 (Reference 1)
  - Sizing Method
    - Culverts: Inlet/Outlet control nomographs, backwater analysis
    - Bridges: HEC-2 backwater analysis (Reference 5)
  - Freeboard: 2 feet min. (and 5 feet) per Plate 7 (Reference 1)
- Flood Routing Method - HEC-1 Storage Indication Method (Reference 4)
- Hydrographs for Existing and Developed Conditions Peak Flows
  - Rainfall Depths = DLNR R-73 (Reference 3)
  - Runoff Curve Numbers = NRCS (Reference 6)
  - Time of Concentration = NRCS (Reference 6)
  - Hydrograph Computation = HEC-1
- Open Channels
  - Capacity = peak discharge from Plate 6 (Reference 1)
  - Sizing Method - HEC-2 backwater analysis (Reference 5)
  - Freeboard: 2 feet min. and varies per Plate 7 (Reference 1)
- Spillways
  - Capacity = peak discharge from Plate 6 (Reference 1)
  - Sizing Method

    Weir Equation $Q = CLH^{3/2}$

Box drain and pipe culvert sizing for the purpose of this master plan is done by hydraulic analyses (by spreadsheet,) as defined in the Storm Drainage Standards. Plate 6 water surface elevations within Kaloi Channel are used as starting hydraulic grades for box drains and culverts. Calculated hydraulic grades at the end of box drains are, in turn, used as starting hydraulic grades for tributary drainage channels.

SECTION 3
PRE-DEVELOPED DRAINAGE CONDITIONS

3.1 Study Area Location

The study area is located in Ewa, Oahu, Hawaii, covering portions of TMK: 9-1-16: 8, 108, 109; 9-1-17: 4 (por.), 71; and 9-1-18: 3 & 5. The vicinity of the site is approximately two miles south of Waipahu and one mile northeast of the Villages of Kapolei. This region of Oahu is commonly referred to as the Ewa Plain. The east Kapolei project covers approximately 1,300 acres, most of which is former sugarcane land. The area is bound on the west by the Villages of Kapolei, on the north by Farrington Highway, to the south by Ewa Villages, and to the east by Campbell Estate land, which was the formerly proposed site of Schuler's East Kapolei Project. A portion of the current project lies between the H-1 Freeway and Farrington Highway (see Figure 1-2) The land is owned by the State of Hawaii.

3.2 Climatology

The area receives only a moderate amount of rainfall from the prevailing northeasterly trade winds. The mean annual rainfall is about 23 inches per year. Most of the rainfall occurs from October through April, during southerly "Kona" storms. In recent years, the *El Niño* pacific meteorological effect has contributed to moister atmospheric conditions.

During the day and early evening hours, the site is relatively warm compared to other locations around Oahu and the state. Late night and early morning periods, however, are generally cooler than other locations. These conditions are a result of the site being on a downwind, or leeward, side of the island. Based on more than 50 years of data collected at the Ewa Plantation, average annual daily minimum and maximum temperatures in the project area are 65°F and 84°F, respectively. Extreme minimum and maximum temperatures were 47°F and 93°F.

3.3 Topography
The study area is located in the mid-to-lower portion of the Kaloi Stream watershed, on the southern slopes of the Waianae Mountain Range. The uppermost portion of the watershed is over 2,200 feet above sea level. For the project site, the average elevation at the lower boundary (Ewa Villages property line) is 65 feet MSL and rises to about 200 feet MSL at the upper boundary. The site is relatively flat with slopes varying between 0.7 and 2 percent. The slopes gradually increase to over 5 percent at the H-1 Freeway. Above the H-1 Freeway, slopes increase considerably in mountainous terrain reaching well over 20 percent in the upper watershed areas.

3.4 Soil Type and Ground Cover
The site contains four general soil types as classified by the Soil Conservation Service, now called the Natural Resource Conservation Service, NRCS. These include Honouliuli (HxA and HxB), Waialua (WkA), Waipahu (WzA and WzB), Mamala (Mcn), Ewa (EwC, EaB), Kunia (KyA), Kawaihapai (KlaB and KlbC), Molokai (MuB and MuC), Mahana (McD2 and MBL) and Stony Steep Land (rSY), with Honouliuli being the predominant type. These are clay soils with moderately low permeability and high shrink-swell potential (Reference 8).

Ground cover conditions within the project site are primarily agricultural. The area was previously used for the cultivation of sugar cane. In the mountainous areas above the H-1 Freeway, ground cover consists of thin stand trees and fallow sugarcane fields.

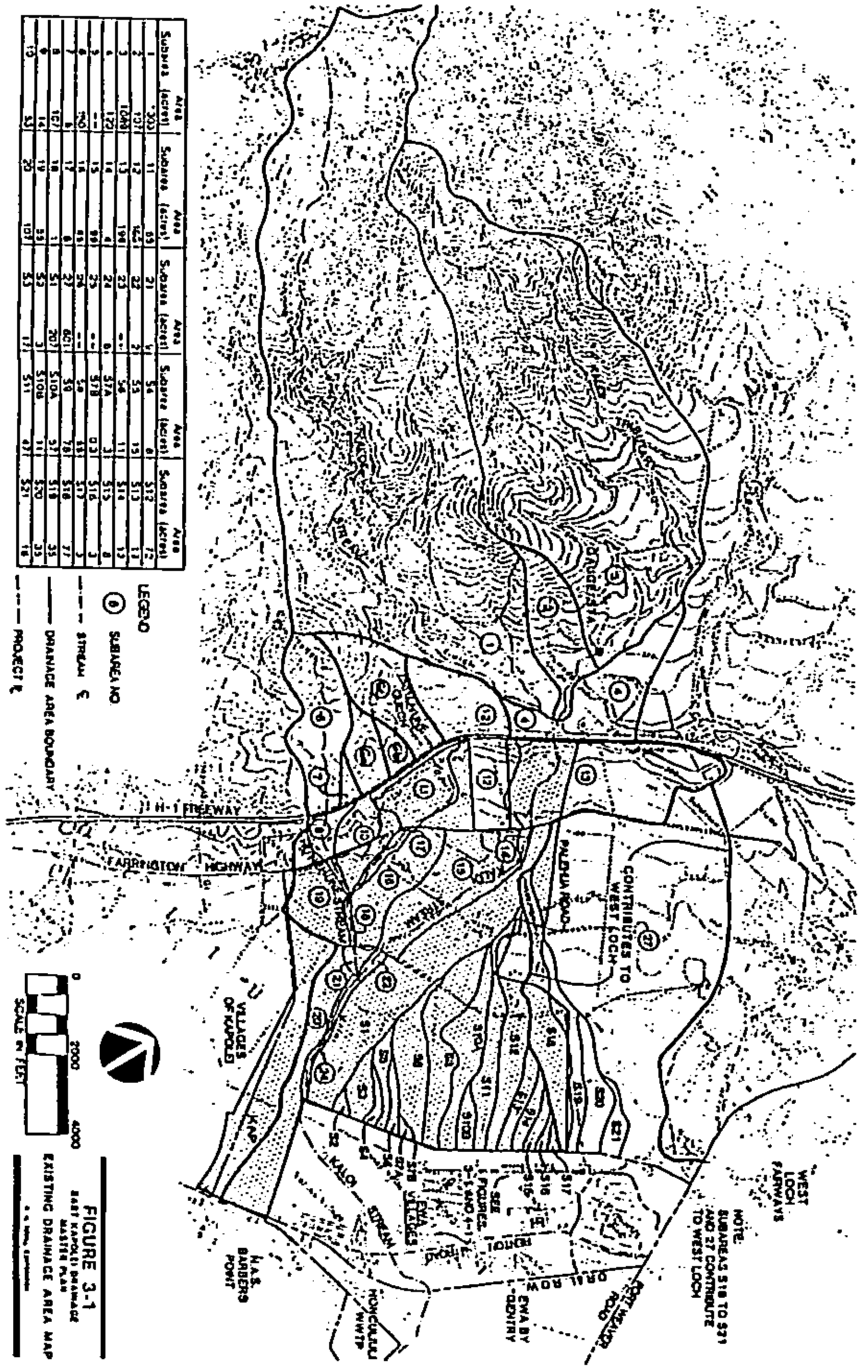
3.5 Pre-developed Drainage Patterns
Runoff from two primary drainage basins flow through the area; the Kaloi Gulch and the Hunehune Gulch. The Kaloi Gulch stream crosses the H-1 Freeway and Farrington Highway, each at one location. The Hunehune Gulch streams cross the H-1 Freeway at six individual locations. These streams then combine and cross the Farrington Highway at two locations. After crossing Farrington Highway, the Hunehune Gulch stream combines with Kaloi to form one stream. The Kaloi Stream flows south through the Ewa Villages Golf Course and then through the Gentry Golf Course. The adjacent watershed to the east is the West Loch basin.

A portion of the East Kapolei project is located in the West Loch basin. Another portion of the project is located in the Kapolei basin, to the west. A smaller portion of the project lies between Varona Village and the Villages of Kapolei, and runoff from this portion flows into the Varona Village drainage system. The drainage areas contributing runoff to the project site are shown on Figure 3-1.

3.5.1 West Loch Watershed
The West Loch watershed consists of subareas S18 through S21 and subarea 27 (Figure 3-1) which has approximately 764 acres. Runoff enters the northeastern portion of Ewa Villages, above Fernandez Village, and continues to an existing detention basin southeast of the West Loch subdivision via the cane haul road underpass, two 54-inch RCP culverts at Fort Weaver Road and shallow box drains. The culverts have a capacity of approximately 500 cfs. Discharge from the basins sheet flow into Pearl Harbor. Existing runoff volume is calculated to be 690 acre-feet, with a Plate 6 peak discharge of 1,100 cfs at the top of the Ewa Villages Golf Course.

3.5.2 Kaloi Watershed
The Kaloi Stream enters the northern portion of the site and continues down into the western corner of the Ewa Villages Golf Course. It is a small ditch with a full bank capacity of less than 1,000 cfs. Numerous road crossings further restrict flow to less than 500 cfs in some locations. Overflows are generally not able to return to the channel. Kaloi Stream was used by Oahu Sugar Company (OSCo) to carry irrigation water down to the lower fields and therefore has built-up banks which are higher than the adjacent ground. The HEC-1 computations incorporate flow diversions caused by restrictions (e.g., culverts at roadways) as well as flow routing in the natural depressions. The existing Kaloi watershed has approximately 3,850 acres. The existing 100-year, 24-hour runoff volume at the upper boundary of the Ewa Villages Golf course is calculated to be 2,816 acre-feet, and the Plate 6 peak discharge is calculated to be 7,075 cfs.

Kaloi Stream is gauged above the H-1 Freeway by the U.S. Geological Survey (Gauge No.16212450 Drainage Area = 1 .70 sq . mi.) .



Subarea	Area (acres)	Subarea	Area (acres)	Subarea	Area (acres)	Subarea	Area (acres)	Subarea	Area (acres)
1	*303	11	85	21	6	S4	8	S12	72
2	107	12	162	22	2	S5	15	S13	13
3	1048	13	194	23	--	S6	11	S14	12
4	172	14	4	24	6	S7A	3	S15	8
5	--	15	99	25	--	S7B	0.3	S16	3
6	290	16	85	26	--	S8	55	S17	3
7	6	17	8	27	601	S9	78	S18	77
8	107	18	1	S1	207	S10A	37	S19	35
9	14	19	55	S2	3	S10B	11	S20	35
10	53	20	107	S3	171	S11	47	S21	16

3.5.3 Kaloi-Ewa Villages Watershed

Drainage subareas S3 through S17 (Figure 3-1) consists of approximately 420 acres and contribute to the runoff into central Ewa Villages, and ultimately to Kaloi Stream. Runoff enters the golf course through several small culvert crossings in the relocated Mango Tree Road, as well as overtopping the road. The calculated 100-year, 24-hour runoff volume is 374 acre-feet and the Plate 6 peak discharge is 1,400 cfs at the top of the golf course.

3.5.4 Varona Village Sub-Watershed

The Varona Village sub-watershed is a part of the Kaloi Watershed, but runoff from this drainage area does not enter the Ewa Villages Golf Course. Drainage subarea 20 contributes to the runoff into Varona Village and ultimately back to Kaloi Stream. The *Ewa Villages Drainage Master Plan* includes the drainage area of the proposed sports complex (Figure 1-2) in its backbone drainage system calculations for Varona Village. The master plan calls for the construction of an 8' x 6' box culvert along Renton Road to convey the tributary offsite flow. In 1996, construction plans for the proposed box drain were approved, but construction was deferred indefinitely. Presently, runoff in this area continues to inundate the unimproved Varona Village.

3.6 Existing Runoff Concerns

The flat topography between the Ewa Villages property line and Farrington Highway make it difficult to determine a clear delineation between watersheds. For purposes of computing Plate 6 flows, the small ridges of high ground as shown on the topographic maps are used to divide the watershed (USGS 1"=2000' and C&C 1"=200'). A photogrammetric topographic survey was prepared in 1996 by R.M. Towill Corporation for the proposed North-South Road planning study at 1:1000 and 1:2000 (metric) scales.

There are several existing sumps within the project site, below Farrington Highway that provide storage of storm runoff. The topography within the Ewa Villages area is relatively flat and ponding has been reported in many areas due to inadequate drainage.

The OR&L Railroad right-of-way is slightly higher than the ground immediately upstream of it and therefore compounds the potential for flooding. A 60-inch culvert was used in the past to carry irrigation flows in Kaloi Stream under the railroad tracks. This culvert is no longer in operation. Presently, there is no structure that will convey storm flows under the railroad for the Kaloi watershed.

The portion of Kaloi Stream below Renton Road has been improved to convey the Plate 6 peak discharge from the Kaloi watershed. It is planned to construct a bridge outlet at the OR&L Railroad which will pass up to 2,500 cfs and will be expandable to pass the entire peak flow.

SECTION 4
PROPOSED DRAINAGE PLAN

4.1 Drainage Plan Concept

The intent of the drainage plan is to control flooding and provide adequate storm water disposal for on-site and off-site generated runoff.

To carry out the plan, "regional" facilities are proposed to address off-site runoff and mitigate flooding from Kaloi Stream. "Backbone" facilities are proposed to address the on-site generated runoff, and feed into the regional facilities. Project areas above Farrington Highway as well as areas west of the proposed North-South Road are planned to feed the regional drainage system. Due to existing topography constraints, project areas below Farrington Highway and east of the proposed North-South Road are not planned to contribute to the "regional" system. These areas are proposed to discharge runoff into the Ewa Villages Golf Course, as they currently do, via on-site backbone facilities. "Backbone" facilities for these areas east of the North-South Road are left as subdivision design items and are not discussed in this master plan.

4.2 Regional Drainage System

Flood control along Kaloi Stream and conveyance of major runoff are handled by the regional drainage system. The primary facilities include the Kaloi Stream channel improvements, detention and retention structures and roadway bridges. Figure 4-1 illustrates the regional drainage system.

The regional facilities were sized using criteria in Section 2. HEC-1 analyses were conducted to determine the increases in runoff and peak flow between the undeveloped and developed conditions as well as to determine detention basin sizes. HEC-2 analyses were performed to determine the size of the proposed Kaloi channel, in order to convey runoff from the entire Kaloi-Hunehune watershed.

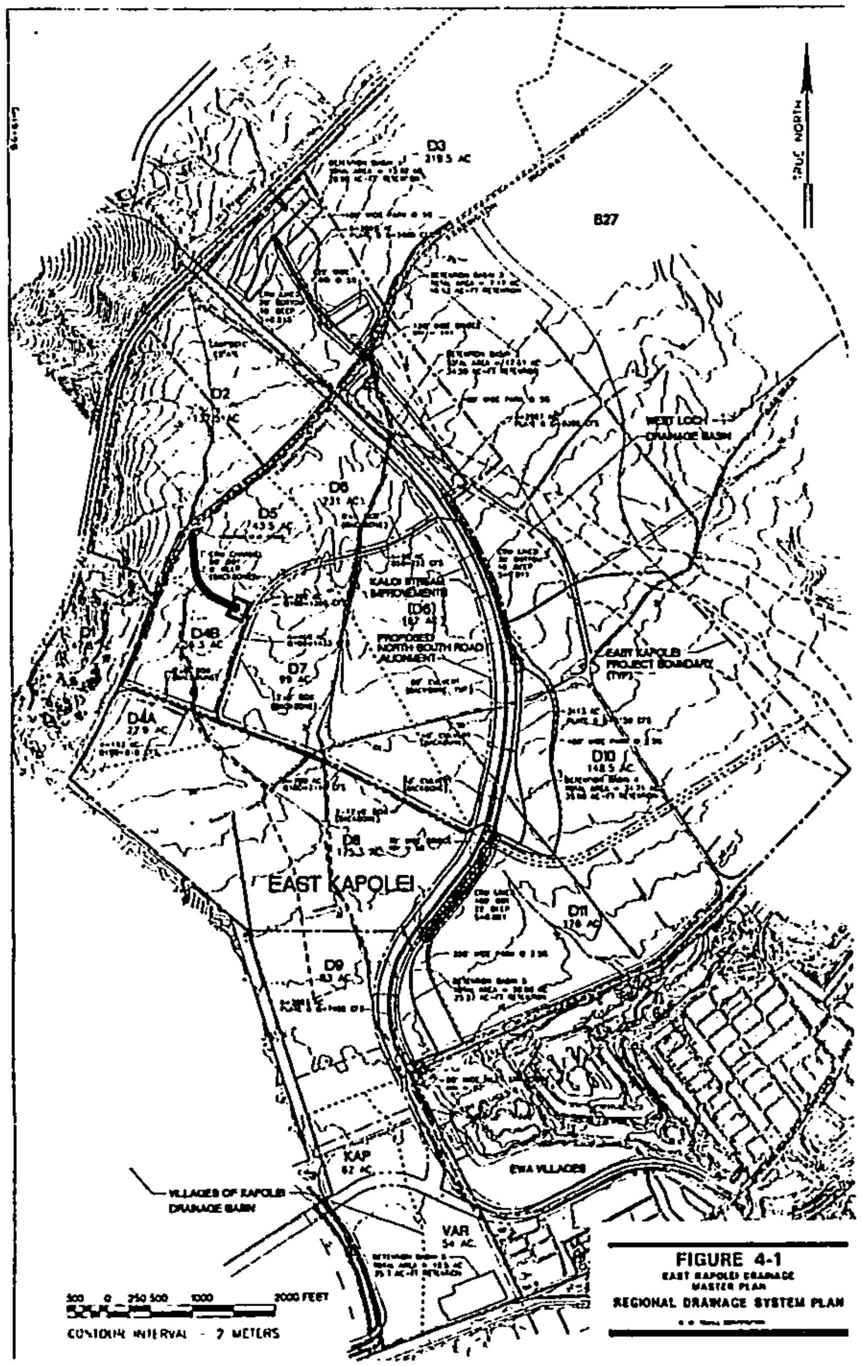


FIGURE 4-1
EAST KAPOLEI DRAINAGE MASTER PLAN
REGIONAL DRAINAGE SYSTEM PLAN

4.2.1 Kaloi Channel Improvements

The Kaloi Channel is the main regional facility. The channel is planned to be constructed along the east-side of the proposed North-South Road, within portions of the right-of-way, from the upper boundary of the Ewa Villages Golf Course to the H-1 Freeway. The channel will be owned and maintained by the State of Hawaii, and improved to convey the City & County's Plate 6 (estimated 100-year storm) flows. Using the City's standards will allow future proposed City drainage facilities to utilize the channel. Improvements include a combination of grass and CRM-lined channels and detention basins to attenuate the peak flows and to store the increase in runoff due to the East Kapolei development. The detention basins will also serve as water features, with the adjacent gradually sloping shoulders serving as a linear parks (Figure 4-2).

The series of detention basins along the Kaloi channel are planned to store the increase in runoff volume due to the East Kapolei development. Excess runoff that is retained in the basins will be slowly discharged via small drainage piping after storms have subsided. Ewa Villages and Ewa by Gentry have constructed similar facilities. All future developments will be required to do the same.

4.2.2 Proposed Bridge Structures and Culverts

The improved Kaloi channel is planned to terminate at the entrance to the Ewa Villages Golf Course. The existing 20' x 8' box culvert at the relocated Mango Tree Road and the Ewa Villages upper boundary line is proposed to be replaced by an 80-foot wide inlet structure leading into the golf course. Mango Tree Road is planned to be abandoned at the time the channel is constructed. If it is later desired to construct a road crossing the channel at this location, it is estimated that six, 15' x 10' box culverts would be required to convey the Plate 6 flow into the golf course without affecting the upstream hydraulic grades.

A 70-foot wide bridge is proposed to be constructed at the master planned East-West Road to allow the Kaloi channel to cross the intersecting road. A 30-foot wide (minimum) bridge is required to replace the existing Kaloi Stream structure on Farrington Highway. The width of the bridge is to be determined during the design phase of the project. Two other existing bridges on Farrington Highway, for the Hunehune Stream crossings, are also planned to be replaced upon widening of the highway. These improvements will be done by various developers, the State or the City. Each of the proposed bridges will be designed to pass the City & County Plate 6 discharge.

The existing dual 12' x 12' box culverts crossing the H-1 Freeway at Kaloi Gulch was looked at to determine its adequacy to convey the City & County Plate 6 flow. It is determined that this culvert is not adequate in passing this flow and excess runoff is calculated to overtop the freeway. This culvert inadequacy should be studied further in order to determine the most feasible solution to convey the appropriate design flows, and improvements should be made during construction of the North-South Road interchange with the H-1 Freeway.

The area on the east side of the North-South Road alignment is master planned to continue to drain in the same patterns as existing. It has been proposed in the *Ewa Villages Drainage Master Plan* to allow the construction of a large box culvert at the low point of the relocated Mango Tree Road upon development of the mauka areas. In this location, the golf course is planned to be able to take the consolidated peak flows from the East Kapolei development. See Figure 4-3. Storage will need to be provided in the backbone infrastructure for this area to ensure that drainage flows into the golf course do not increase above the conditions stated in this master plan.

4.2.3 Ewa Villages Golf Course Channel

According to the *Ewa Villages Drainage Master Plan*, the Ewa Villages Golf Course is designed to accept the Plate 6 flow of 7,075 cfs from Kaloi Stream at the upper boundary. Due to the increase in watershed area for Kaloi Gulch, by the North-South Road alignment, a larger Plate 6 flow of 7,400 cfs is used in this master plan to enter into the golf course. The study is based on both the interim condition, where the OR&L Railroad bridge is not constructed, and the ultimate condition, where the bridge is in. It is determined that the golf course can accommodate the increase in flow for both conditions. There is a calculated increase in water surface elevation of

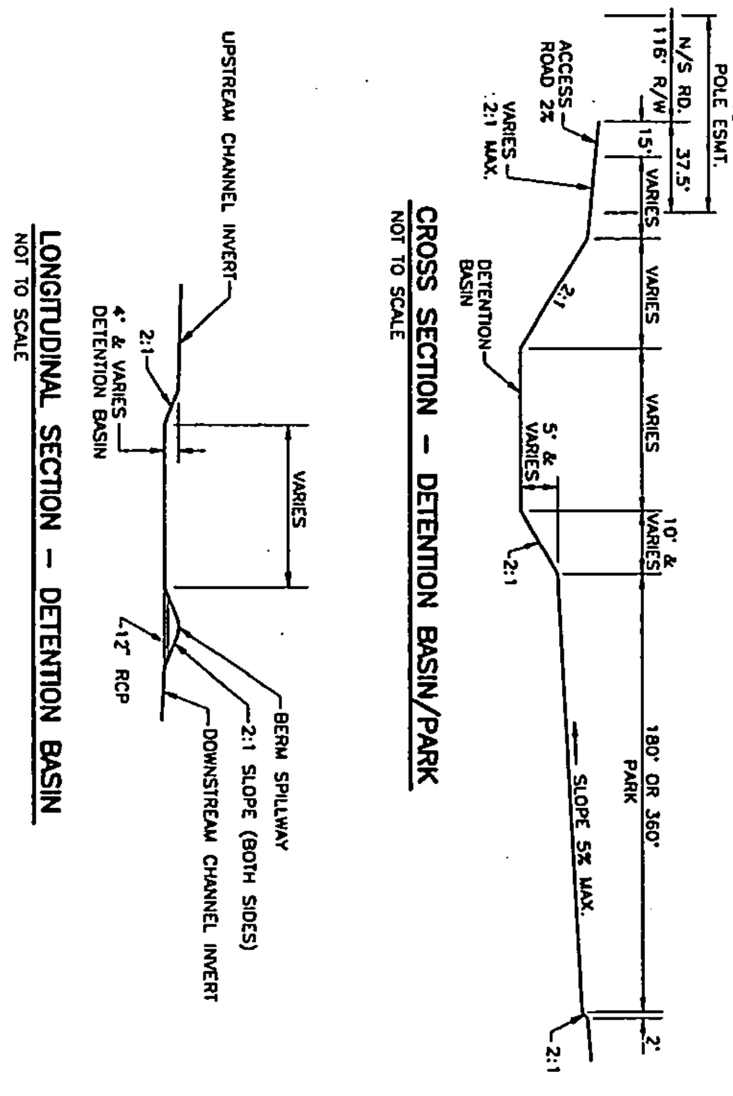


FIGURE 4-2
EAST KAPOLEI DRAINAGE MASTER PLAN
PROPOSED DETENTION BASIN SECTIONS

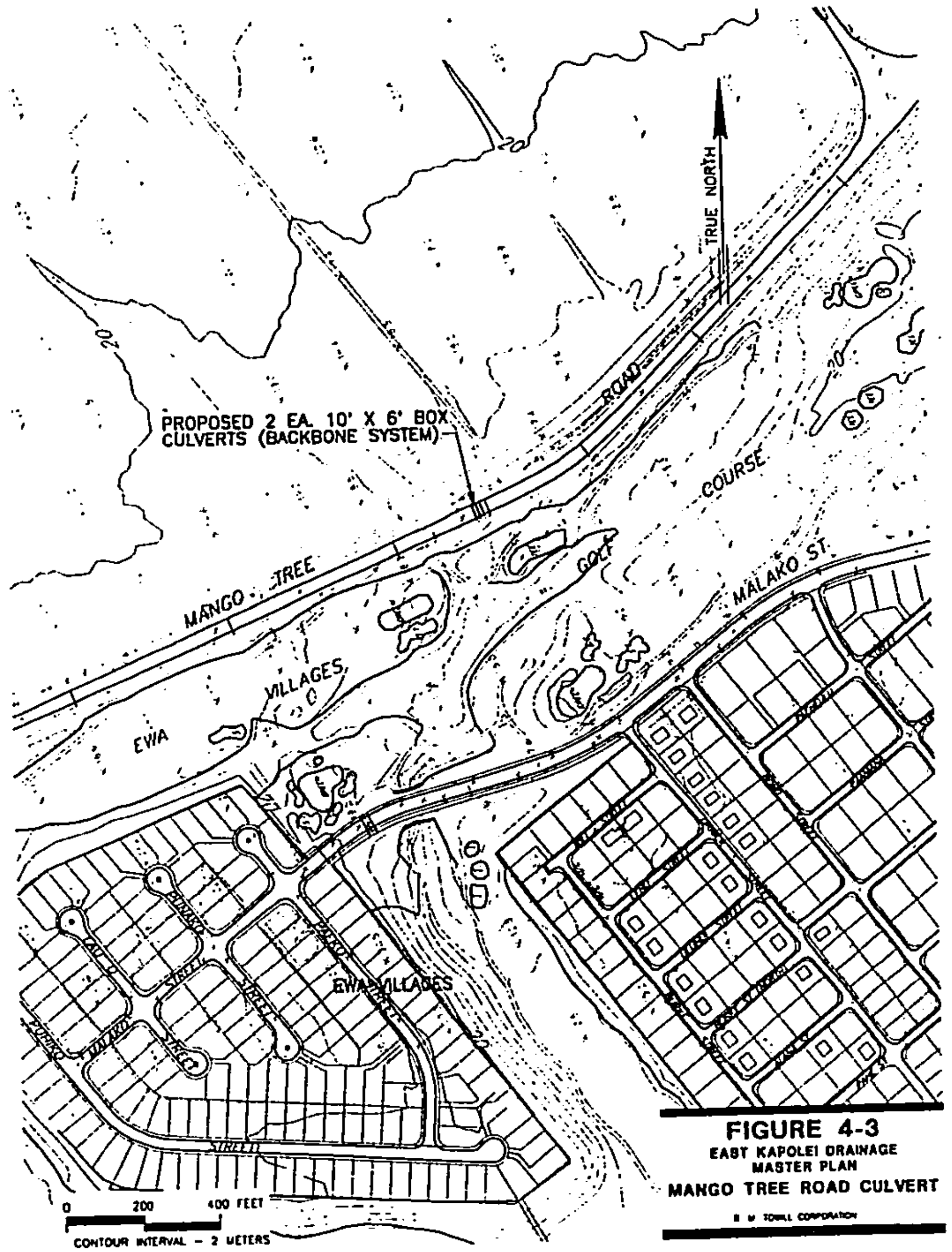


FIGURE 4-3
EAST KAPOLEI DRAINAGE MASTER PLAN
MANGO TREE ROAD CULVERT

approximately 0.45-feet within the golf course due to the additional 325 cfs used in this study.

4.2.4 Sports Complex Detention Basin

The proposed sports complex falls within the existing Varona Village sub-watershed and developed drainage area. A detention basin is proposed within the lower regions of the sports complex which will reduce storm water runoff into Varona Village. Due to the deferral of the Varona Village box drain construction, the detention basin is proposed to store almost all of the runoff volume and decrease the 100-year peak flow to a negligible amount.

4.3 Backbone Drainage System

The backbone system for the project areas west of the North-South Road consists of collector box drains on the planned East-West Road and East Kapolei Avenue, and an on-site drainage channel to re-direct the Hunehune Stream. The box drains are proposed to carry the re-routed Hunehune Stream flows as well as on-site runoff, generated west of North-South Road, to the Kaloi Channel. There are five backbone collector box drains proposed for the project (see Figure 4-4).

The east and west branches of the Hunehune stream are proposed to follow existing drainage patterns from the H-1 Freeway down to Farrington Highway. The flow from the west Hunehune crossing at Farrington Highway is proposed to be carried by a 50' wide CRM-lined channel to the East Kapolei Avenue (Collector Road "A"). A 12' x 8' box drain in East Kapolei Avenue is planned to feed into the proposed box drain along the East-West Road and flows are carried to the Kaloi channel by a 16' x 8' box drain (which is increased to dual 12' x 8' box drains) along the East-West Road.

A smaller 8' x 5' box drain along East Kapolei Avenue, at the North-South Road intersection, is planned to convey runoff from the area between Farrington Highway and East Kapolei Avenue. Two 48" pipe culverts and four 60" pipe culverts are proposed to carry runoff from the area just below East Kapolei Avenue across the North-South Road into the Kaloi channel. Three other box

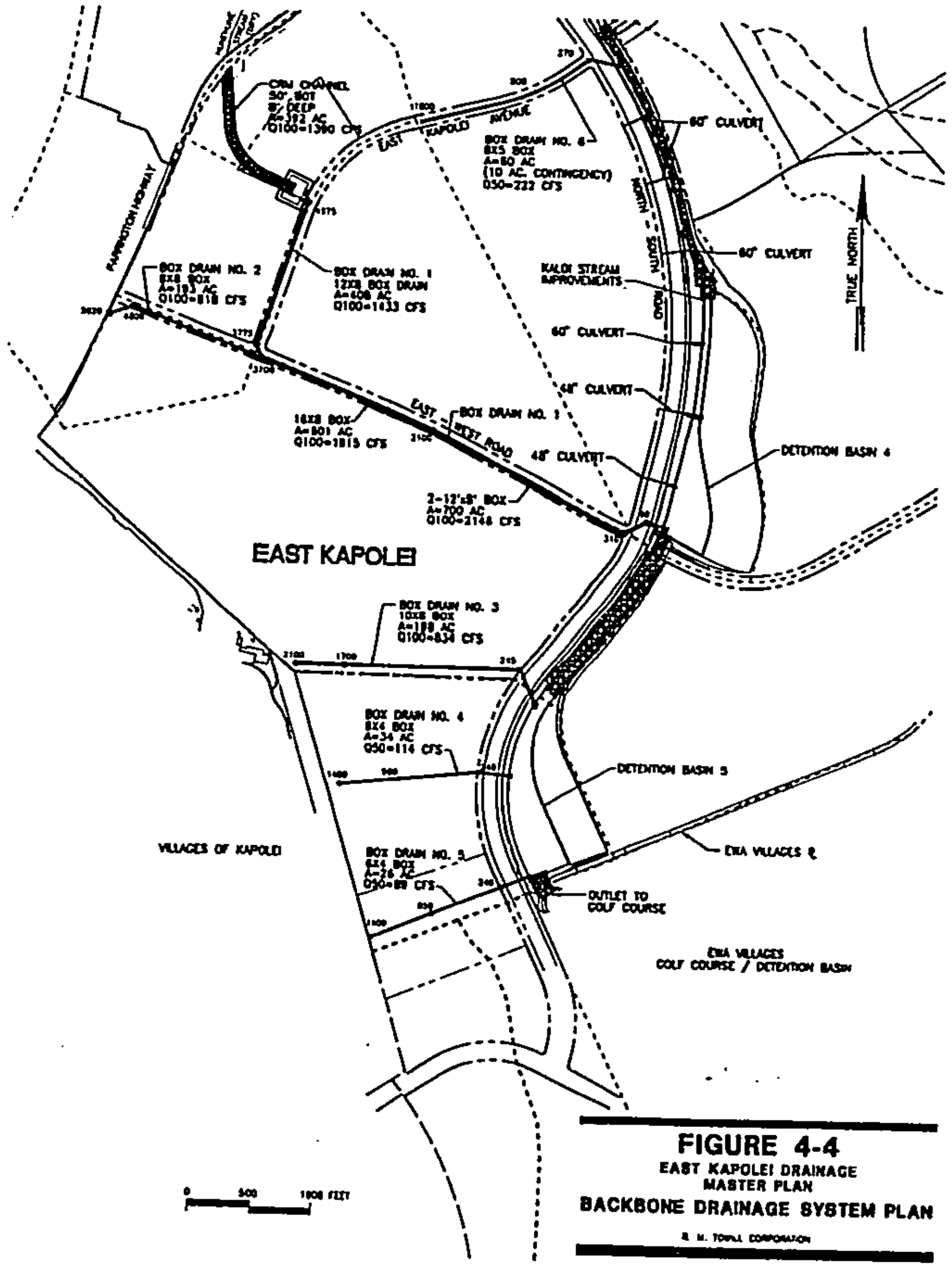


FIGURE 4-4
EAST KAPOLEI DRAINAGE MASTER PLAN
BACKBONE DRAINAGE SYSTEM PLAN
R. M. TOWILL CORPORATION

drains (1 ea. 10' x 6' and 2 ea. 6' x 4') are proposed to convey runoff from the portions of the site below the proposed East-West Road, between North-South Road and the Kapolei watershed.

The backbone drainage system is planned to accommodate the master planned on-site tributary areas. Hydraulic analyses of these box drains were conducted to determine the Plate 6 and 50-year storm hydraulic grades. On-site tributary areas are planned to be able to drain into the backbone system with adequate freeboard. See Appendices C and D for the hydraulic grades along the proposed Kaloi channel and box drains.

The existing drainage structures on Farrington Highway are planned to remain until Farrington Highway is widened. These structures presently cannot accommodate the Plate 6 flows and are proposed to be upgraded in the future as development in these areas progresses.

SECTION 5
RESULTS AND RECOMMENDATIONS

5.1 Increases in runoff

Increase in runoff volume is primarily due to the increase in impermeable ground surface due to development of roofs and pavements. In this study, an increase in runoff is also due to the consolidation of drainage basins, which is the result of the North-South Road alignment. See Table 5-1 for drainage basin areas. The HEC-1 program was used to calculate the 100-year, 24-hour storm increase in runoff due to the development of the East Kapolei project and North-South Road. Table 5-2 lists the computed runoff volumes.

Analyses were done for the existing conditions, developed conditions without storage and developed conditions with storage. With the proposed detention and storage basins considered, the total runoff volume discharged into Ewa Villages is reduced to less than the existing runoff volume. The basins provide a total storage of 178 ac-ft. It is determined that the proposed detention and storage basins are adequate in controlling the increase in runoff due to the East Kapolei Development.

5.2 Increases in peak flow

Although the drainage facilities in Ewa Villages are designed to pass the City & County Plate 6 flows, the *increase* in peak flow due to the East Kapolei project must be considered. Due to the consolidation of drainage basins, it is difficult to analyze increases in peak flows for distinct areas. Similar to the analysis used in the *Ewa Villages Drainage Master Plan*, this study compares the summation of peak flows entering into the Ewa Villages Golf Course. Flows that enter into Ewa Villages are presently consolidated within the golf course and are ultimately discharged at the planned location of the OR&L Railroad bridge.

Detention basins along the Kaloi channel are planned to attenuate the peak flow due to the East Kapolei development. The HEC-1 program was used to compute the increase in peak flow as

well as perform the detention basin routing. Table 5-3 lists the results due to the basins. Due to the implementation of the detention basins, the total developed condition 100-year peak flow entering the golf course is a negligible 31 cfs more than the existing condition 100-year peak flow. With the proposed detention in the Varona Village watershed, there is a net *decrease* in 100-year peak flow into the Kaloi Stream of 153 cfs. It is determined that the proposed Kaloi Channel improvements and detention basins are adequate in controlling the 100-year storm peak flow due to the East Kapolei development, and upon completion of the regional and backbone drainage facilities, the 100-year flood limit is contained within the improved Kaloi Channel.

5.3 Villages of Kapolei Watershed

Approximately 60 acres of the East Kapolei project within the Villages of Kapolei watershed, as defined in the *Kapolei Village Drainage Master Plan*, is planned to continue to drain into the Kapolei regional drainage facilities (see Appendix F). The difference in area, approximately 49 acres, is planned to be redirected into the Kaloi watershed. Due to the diversion of approximately 50 acres of drainage area there is a calculated decrease in runoff volume of 39 acre-feet into the Villages of Kapolei watershed, with an increase in peak flow of only 7 cfs. The Kapolei regional drainage facilities consist of the Kapolei Golf Course, the Kapolei Lower Channel and the Barbers Point Naval Air Station coral pit. These facilities are designed to attenuate the runoff from all tributary areas under developed conditions. It is proposed that developed runoff from this area should be discharged into the existing Kapolei Villages Lower Channel. During the design of the final grades in this area, an evaluation should be made to determine the most appropriate way to convey the developed area runoff through the planned sports complex facility and to the Kapolei Lower Channel.

5.4 Varona Village Watershed

The *Ewa Villages Drainage Master Plan* delineates approximately 66 acres as tributary to the Varona Village backbone drainage system. This drainage area is included in the overall drainage plan for the Kaloi Stream and Ewa Villages regional drainage system (see Appendix F). Due to the East Kapolei project, much of the area tributary to Varona Village is planned to be diverted into the Kaloi channel, resulting in a decrease in runoff to Varona Village. There is a calculated decrease of 46 acre-feet of runoff into Varona Village, due to the diversion of 53 acres of land into the Kaloi watershed. In addition, with the proposed detention planned in the sports complex area, the runoff volume into Varona Village is further decreased by 81 acre-feet. The calculated peak flow is decreased by approximately 184 cfs to a total of 37 cfs.

5.5 West Loch Basin Impact

The areas east of the North-South Road alignment are planned to drain by their current drainage patterns. Thus, the East Kapolei project areas within the West Loch watershed will contribute to increases in runoff to the West Loch basin. The Ewa Villages Golf Course was designed to store the increase in runoff for the Ewa Villages development only (interim condition). The *Ewa Villages Drainage Master Plan* calls for additional storage improvements due to development of the lands mauka of the golf course (ultimate condition). A storage volume of 6 ac-ft is required upon development of the East Kapolei areas within the West Loch basin. The location and type of storage needs to be determined by a future drainage study and when construction plans in this area are developed.

5.6 Recommendations

The HFDC may need to negotiate a drainage plan with Campbell Estate and the City & County to attenuate the increased West Loch basin flows discharged into the golf course, or provide improvements to the golf course. If Campbell Estate does not incorporate the West Loch basin portion of East Kapolei into their drainage plan, East Kapolei will need to provide the storage on-site. Since a portion of Campbell Estate land is located within the Kaloi-Ewa Villages basin, a possible shared drainage system with future Campbell Estate developments could be looked at. This portion of Campbell Estate land will contribute to runoff into the East Kapolei development.

It may be possible to divert the runoff from the East Kapolei lands within the West Loch basin westward into the Kaloi-Ewa Villages watershed during the design phase. A more detailed study will be required once the mass grades and preliminary site layouts are determined.

TABLE 5-1

Summary of Basin Areas

Drainage Basin	Basin Area (Acre)		
	Existing	Developed	Increase
Kaloi Gulch (E.Kapolei)	4,273	4,375	102
Kaloi Gulch (Varona)	107	54	-53
West Loch	764	762	-2
Villages of Kapolei	109	62	-47
Total	5,253	5,253	0

TABLE 5-2

Increase in Runoff Due to Development

Drainage Basin	Runoff Volume (Ac-ft)		
	Existing	Developed	Increase
Kaloi Gulch (E.Kapolei)	3,190	3,359	169
Kaloi Gulch (Varona)	97	51	-46
West Loch	690	696	6
Villages of Kapolei	97	58	-39
Total	4,074	4,164	90

TABLE 5-3

Increases in runoff with Detention Basins

Drainage Basin	Runoff Volume (Ac-ft)		
	Existing	Developed	Increase
Kaloi Gulch (E. Kapolei)	3,190	3,238	48
Kaloi Gulch (Varona)	97	16	-81
West Loch *	690	696	6 *
Villages of Kapolei **	97	58	-39 **
Total	4,074	4,008	-66

* *To be designed in coordination with the Campbell Estate Developments*
** *Runoff accommodated in Kapolei Village Drainage Master Plan*

TABLE 5-4

Increases in 100-year, 24-hour Peak Flows

Drainage Basin	Peak Flow (cfs)		
	Existing	Developed	Increase
Kaloi Gulch (E. Kapolei)	5,643	5,674	31
Kaloi Gulch (Varona)	221	37	-184
West Loch *	1,101	1,105	4 *
Villages of Kapolei **	176	183	7 **

* *To be designed in coordination with the Campbell Estate Developments*
** *Runoff accommodated in Kapolei Village Drainage Master Plan*

TABLE 5-5

City & County Plate 6 Flows at Ewa Villages Upper Boundary

Watershed	Existing Conditions		Developed Conditions	
	Area (Ac.)	Q (cfs)	Area (Ac.)	Q (cfs)
Kaloi Gulch (E. Kapolei)	3,850	7,075	4,051	7,400
Kaloi - (Central Ewa Villages)	420	1,400	324	1,100
West Loch	764	2,100	762	2,100

LIST OF REFERENCES

1. "Storm Drainage Standards," Department of Public Works, City and County of Honolulu, March 1986.

2. King, Horace W. and Brater, Ernest F., Handbook of Hydraulics, McGraw-Hill Book Co., New York, N. Y., c.1963.

3. "Rainfall Frequency Study for Oahu," Report R-73, State of Hawaii, Department of Land and Natural Resources, Division of Land and Water Development, 1984.

4. "HEC-1 Flood Hydrograph Package, Users Manual," Computer Program 723-X6-L2010; U.S. Corps of Engineers, Hydraulic Engineering Center, September 1981 (revised January 1985).

5. "HEC-2 Water Surface Profiles Users Manual," Computer Program 723-X6-L2024, U.S. Army Corps of Engineers, Hydraulic Engineering Center, September 1982.

6. "National Engineering Handbook, Section 4, Hydrology," U.S. Department of Agriculture, Soil Conservation Service, PB86 180494, produced by National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22161, March 1985.

7. "A Guide to Hydrologic Analysis Using SCS Methods," Richard McCuen, Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632.

8. "Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii," United States Department of Agriculture, Soil Conservation Service, August 1982.

9. "Kaloi Gulch Technical Committee Interim Report," prepared by Kaloi Technical Committee, April 29, 1993.

APPENDIX A
REGIONAL HYDROLOGY FOR EXISTING CONDITIONS

- HEC-1 Summary for Existing Conditions
- 100-Year, 24-hour HEC-1 Computations

file: sumexist.wk3

HEC-1 RUNOFF SUMMARY

EXISTING KALOI GULCH (EAST KAPOLEI)

File:	XSEC	Area (Sq.Mi.)	Runoff (Ac-ft)	Peak Q (cfs)
X101.DAT	SEC115	5.69	1,250	866
	SEC01	0.33	1,566	4,095
X101-1.DAT	SECZ	0.079	46	113
X101-2.DAT	SECY	0.537	305	513
X101-3.DAT	SECX	0.04	23	56
		6.68 4,273 Ac.	3,190	5,643

EXISTING KALOI GULCH (VARONA)

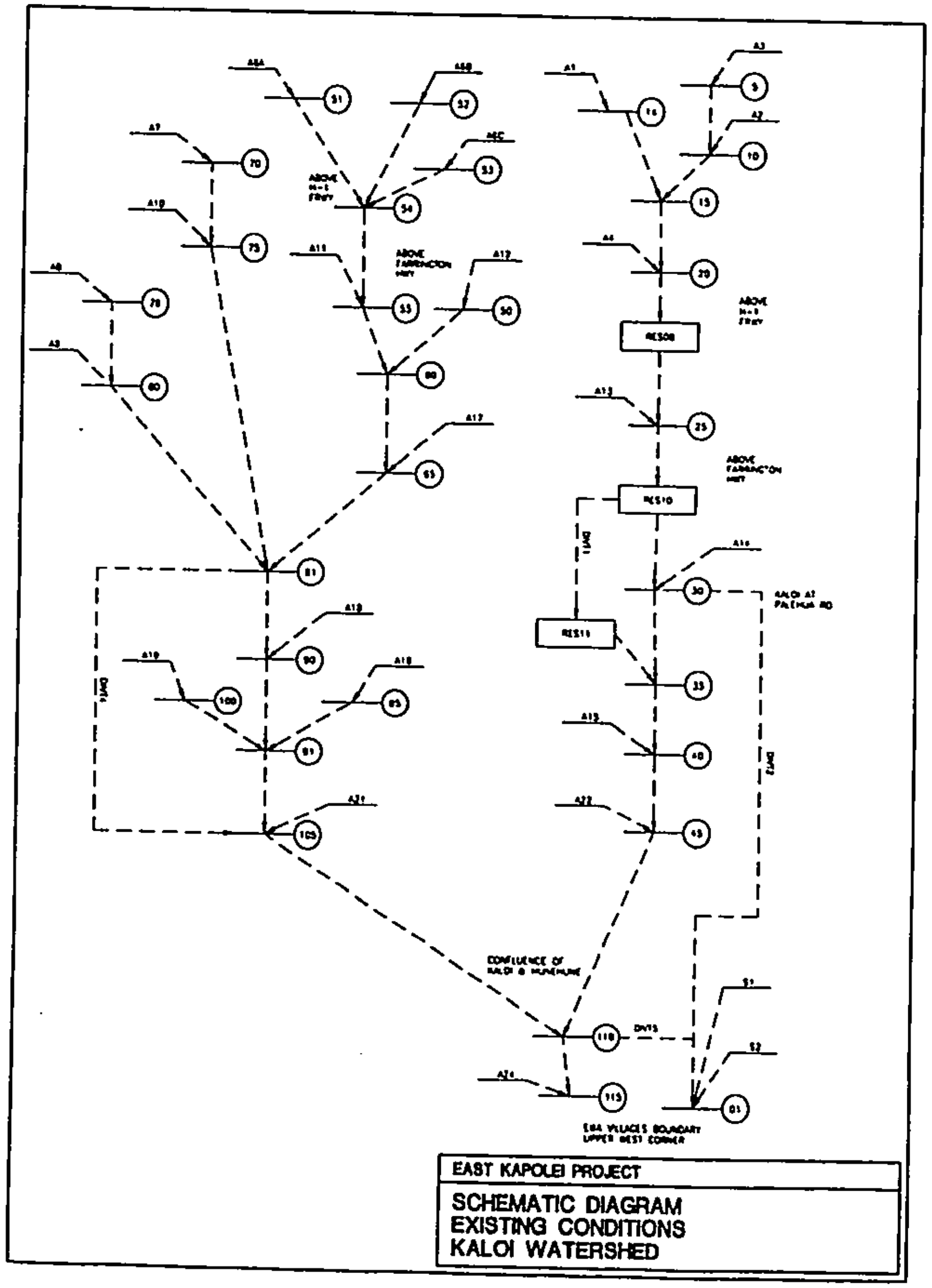
File:	AREA	Area (Sq.Mi.)	Runoff (Ac-ft)	Peak Q (cfs)
X101-C.DAT	VAR	0.167 107 Ac.	97	221

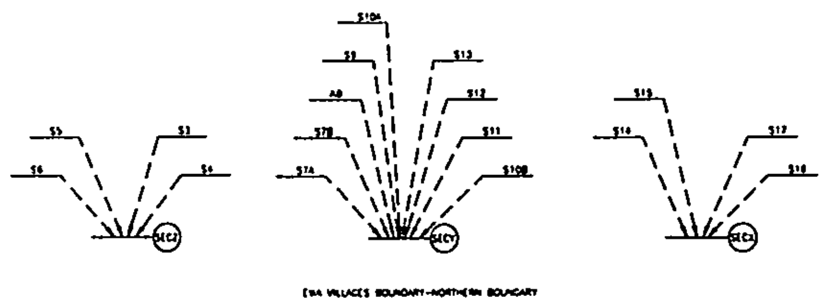
EXISTING VILLAGES OF KAPOLEI

File:	AREA	Area (Sq.Mi.)	Runoff (Ac-ft)	Peak Q (cfs)
X101-C.DAT	KAP	0.170 109 Ac.	97	176

EXISTING WEST LOCH

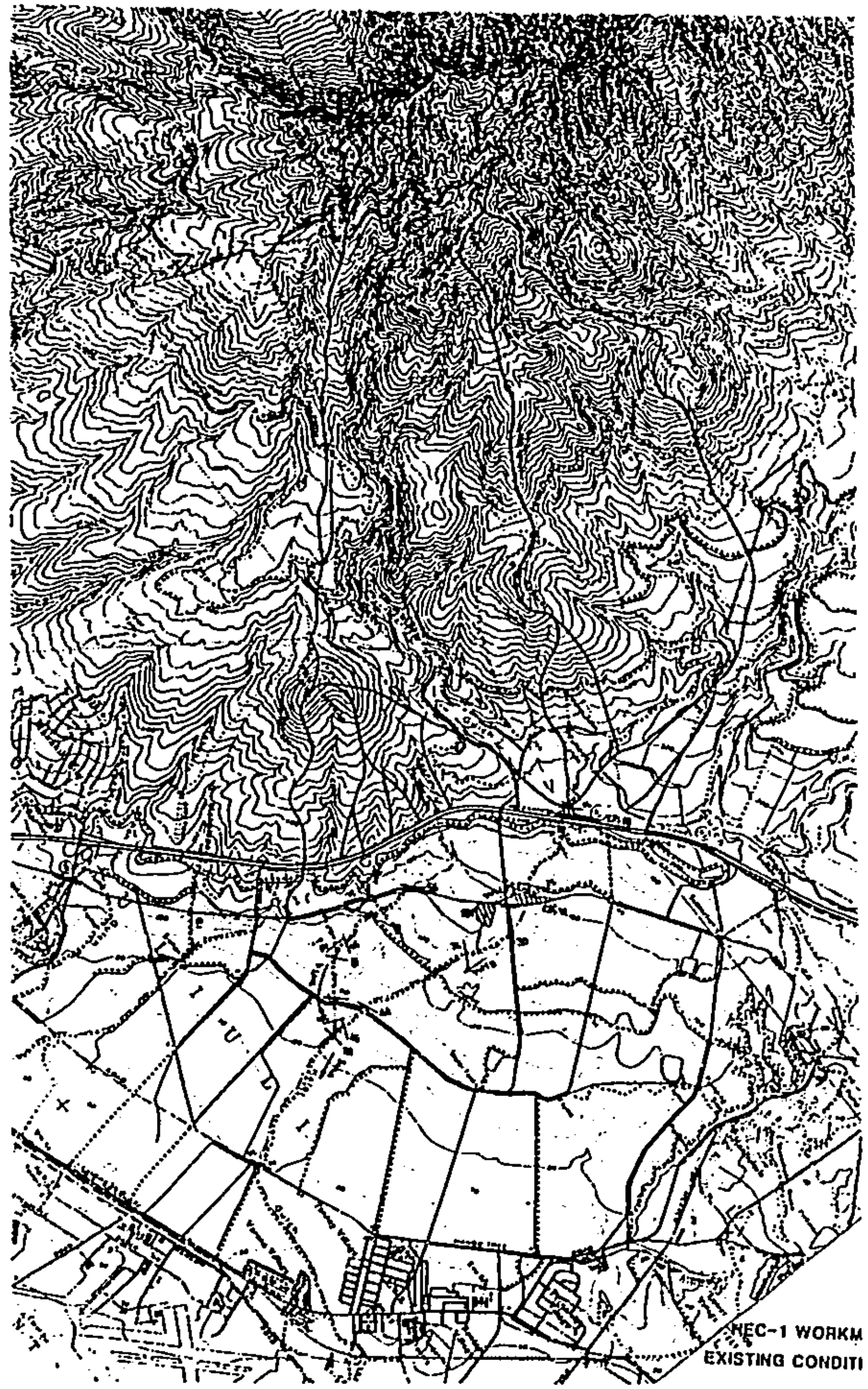
File:	AREA	Area (Sq.Mi.)	Runoff (Ac-ft)	Peak Q (cfs)
X101B.DAT	A27	0.939	542	830
	S18	0.121	70	108
	S19	0.055	32	56
	S20	0.054	31	68
	S21	0.025	15	39
		1.19 764 Ac.	690	1,101





EAST KAPOLEI PROJECT

SCHEMATIC DIAGRAM
EXISTING CONDITIONS
KALOI-EWA VILLAGES WATERSHED



HEC-1 WORKM
EXISTING CONDITI

```
1************************************             ***************************************
*                                    *           *                                       *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1) *           *  U.S. ARMY CORPS OF ENGINEERS         *
*         JUN 09 1992                *           *  HYDROLOGIC ENGINEERING CENTER        *
*         VERSION 4.0.1E             *           *        609 SECOND STREET              *
*                                    *           *     DAVIS, CALIFORNIA 95616           *
* RUN DATE  07/17/97  TIME  11:35:49 *           *        (916) 551-1748                 *
*                                    *           *                                       *
**************************************           *****************************************


                       X     X  XXXXXXX   XXXXX        X
                       X     X  X        X     X      XX
                       X     X  X        X             X
                       XXXXXXX  XXXX     X     XXXXX   X
                       X     X  X        X             X
                       X     X  X        X     X       X
                       X     X  XXXXXXX   XXXXX       XXX


THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                    HEC-1 INPUT                                    PAGE  1

LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1       ID   EWA VILLAGES PROJECT FLOOD (100-YEAR STORM)
  2       ID   FN: X101.DAT
  3       ID   PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
  4       ID                       EAST KAPOLEI - EXISTING CONDITIONS
  5       ID   KALOI - HUNEHUNE NETWORK MODEL
          *DIAGRAM
  6       IT       7 01FEB97    1200     300
  7       IO       5

  8       KK      A3
  9       KM         GENERATE HYDROGRAPH FROM SUBBASIN A3 TO SEC05
 10       KM         UPPERMOST WATERSHED PRECIPITATION DATA
 11       BA   1.701
 12       PH           1.701     .69    1.40    2.60    3.70    4.75    6.85    9.30   12.70
 13       LS       0      68
 14       UD   1.206

 15       KK   SEC10
 16       KM          ROUTE KALOI TRIBUTARY FLOW FROM SEC05 TO SEC10
 17       KM          KALOI STREAM ABOVE CONFLUENCE OF MAIN AND TRIBUTARY
 18       RS       1    FLOW       0
 19       RC   0.035    .035   0.035    2250   0.024     320
 20       RX       0     150     155     165     180     190     195     520
 21       RY     220     218     215     208     208     218     218     220

 22       KK      A2
 23       KM          GENERATE HYDROGRAPH FROM SUBBASIN A2 TO SEC10
 24       KM          UPPERMOST WATERSHED PRECIPITATION DATA
 25       BA   0.167
 26       PH           0.167     .69    1.40    2.60    3.70    4.75    6.85    9.30   12.70
 27       LS       0      66
 28       UD    0.39

 29       KK   SEC10
 30       KM          COMBINE HYDROGRAPHS AT SEC10
 31       HC       2

 32       KK      A1
 33       KM          GENERATE HYDROGRAPH FROM SUBBASIN A1 TO SEC14
 34       KM          UPPERMOST WATERSHED PRECIPITATION DATA
 35       BA   2.036
 36       PH           2.036     .69    1.40    2.60    3.70    4.75    6.85    9.30   12.70
 37       LS       0      70
 38       UD   1.434

 39       KK   SEC15
 40       KM          COMBINE HYDROGRAPHS AT SEC15
 41       HC       2

 42       KK   SEC20
 43       KM          ROUTE KALOI TRIBUTARY FLOW FROM SEC15 TO SEC20
 44       RS       2    FLOW       0
 45       RC    .035    .035    .035     200   0.025     207
 46       RX       0     160     180     190     205     240     400     550
 47       RY     215     215     215     194     194     207     210     215
1                                    HEC-1 INPUT                                    PAGE  2

LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 48       KK      A4
 49       KM          GENERATE HYDROGRAPH FROM SUBBASIN A4 TO SEC20
 50       KM          UPPER WATERSHED PRECIPITATION DATA
 51       KO       3
 52       BA   0.188
 53       PH           0.188     .66    1.35    2.50    3.60    4.65    6.80    9.25   12.50
 54       LS       0      66
 55       UD   0.450

 56       KK   SEC20
 57       KM          COMBINE HYDROGRAPHS AT SEC20
 58       HC       2

 59       KK   RES08
 60       KM          ROUTE FLOW FROM SEC20 THROUGH RES08
 61       RS       1    ELEV   193.5
 62       SV       0     0.1     0.8     3.1     6.9    12.1    18.8    28.5    56.1
 63       SE   193.5     200     202     204     206     208     210     212     215
 64       SQ       0     500     725     964    1285    2099    3121    3561    3906
 65       SE   193.5     200     202     204     206     208     210     212     215

 66       KK   SEC25
 67       KM          ROUTE KALOI TRIBUTARY FLOW FROM RES08 TO SEC25
 68       RS       2    FLOW       0
 69       RC    .035    .035    .035    2350   0.013     165
 70       RX       0     270     330     340     355     640     708     900
 71       RY     170     165     165     158     158     165     167     170

 72       KK     A13
 73       KM          GENERATE HYDROGRAPH FROM SUBBASIN A13 TO SEC25
 74       KM          MID-WATERSHED PRECIPITATION DATA
 75       BA   0.307
 76       PH           0.307     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 77       LS       0      79
 78       UD   2.046

 79       KK   SEC25
 80       KM          COMBINE HYDROGRAPHS AT SEC25
 81       HC       2

 82       KK   RES10
 83       KM          ROUTE FLOW FROM SEC25 THROUGH RES10
 84       RS       1    ELEV     150
 85       SV       0     6.3     9.3    14.8    33.0
 86       SE     150     165     166     167     168
 87       SQ       0       0    2350    6364   16368
 88       SE     150     165     166     167     168

 89       KK   RES10
 90       KM          DIVERT KALOI OVERFLOW FROM RES10 TO RES11
 91       DT   DIVT1
 92       DI       0    2010    2011    2500    3000    3500    4000
 93       DQ       0       0       1     490     990    1490    1990
1                                    HEC-1 INPUT                                    PAGE  3

LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 94       KK   SEC30
 95       KM          ROUTE KALOI TRIBUTARY FLOW FROM RES10 TO SEC30
```

```
RS      2  FLOW     0
RC   .035  .035  .035   850  0.012   155
RX      0   180   310   317    327   336   370   380
RY    154   150   155   148    148   155   147   150

KK    A14
KM       GENERATE HYDROGRAPH FROM SUBBASIN A14 TO SEC30
KM       MID-WATERSHED PRECIPITATION DATA
BA  0.007
PH        0.007   .65  1.32   2.45  3.55  4.60  6.75  9.20  12.30
LS      0    78
UD  0.090

KK  SEC30
KM       COMBINE HYDROGRAPHS AT SEC30
HC      2

KK  SEC30
KM       DIVERT KALOI OVERFLOW FROM SEC30 TO SEC01
DT  DIVT2
DI      0  1393  1394  1500   2050  2500  3030  3500  4000
DQ      0     0     1   107    607  1107  1607  2107  2607

KK  SEC35
KM       ROUTE KALOI TRIBUTARY FLOW FROM SEC30 TO SEC35
RS      2  FLOW     0
RC   .035  .035  .035  1300  0.007   135
RX      0   160   300   305    345   350   520   700
RY    141   140   135   118    118   135   140   135

KK  RES11
KM       RETRIEVE DIVERSION FLOW FROM RES11
DR  DIVT1

KK  RES11
KM       ROUTE FLOW FROM DIVT1 THROUGH RES11
KM       RENTER FLOW TO SEC35
RS      1  ELEV   134
SV      0  13.8  17.6  22.6   27.8  33.2
SE    134   144   145   146    147   148
SQ      0     0     0  1800   6109 12153
SE    134   144   145   146    147   148

KK  SEC35
KM       COMBINE HYDROGRAPHS AT SEC35 (DIVT1 + SEC30)
HC      2
1                              HEC-1 INPUT                                   PAGE 4

LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

KK  SEC40
KM       ROUTE KALOI TRIBUTARY FLOW FROM SEC35 TO SEC40
RS      2  FLOW     0
RC   .035  .035  .035  2780  0.039    90
RX      0   250   320   330    340   350   380   600
RY    105    95    90    80     80    90    95   100

KK    A15
KM       GENERATE HYDROGRAPH FROM SUBBASIN A15 TO SEC40
KM       MID-WATERSHED PRECIPITATION DATA
BA  0.155
PH        0.155   .65  1.32   2.45  3.55  4.60  6.75  9.20  12.30
LS      0    79
UD  0.318

KK  SEC40
KM       COMBINE HYDROGRAPHS AT SEC40
HC      2

KK  SEC45
KM       ROUTE KALOI TRIBUTARY FLOW FROM SEC40 TO SEC45
RS      2  FLOW     0
RC   .035  .035  .035   950   0.01    85
RX      0   200   380   390    400   410   460  1100
RY     90    90    85    77     77    85    87    90

KK    A22
KM       GENERATE HYDROGRAPH FROM SUBBASIN A15 TO SEC40
KM       MID-WATERSHED PRECIPITATION DATA
BA  0.003
PH        0.003 ´ .65  1.32   2.45  3.55  4.60  6.75  9.20  12.30
LS      0    86
UD  0.012

KK  SEC45
KM       COMBINE HYDROGRAPHS AT SEC45
HC      2

KK    A6A
KM       GENERATE HYDROGRAPH FROM SUBBASIN A6A TO SEC51
KM       UPPER WATERSHED PRECIPITATION DATA
BA  0.062
PH                .66  1.35   2.50  3.60  4.65  6.80  9.25  12.50
LS      0    74
UD  0.160

KK    A6B
KM       GENERATE HYDROGRAPH FROM SUBBASIN A6B TO SEC52
KM       UPPER WATERSHED PRECIPITATION DATA
BA  0.027
PH               0.66  1.35   2.50  3.60  4.65  6.80  9.25  12.50
LS      0    77
UD  0.162
1                              HEC-1 INPUT                                   PAGE 5

LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

KK    A6C
KM       GENERATE HYDROGRAPH FROM SUBBASIN A6C TO SEC53
KM       UPPER WATERSHED PRECIPITATION DATA
BA  0.146
PH               0.66  1.35   2.50  3.60  4.65  6.80  9.25  12.50
LS      0    79
UD  0.306

KK  SEC54
KM  COMBINE HYDROGRAPHS AT SECTS4
HC      3

KK  SEC55
KM  ROUTE FLOW FROM SEC54A TO SEC55
RS      2  FLOW     0
RC  0.035 0.035 0.035  2387 0.0249   173
RX      0  15.6  29.3  35.9     38  45.1  54.5  69.3
RY    173 170.6 170.6 170.5  173.5 173.6 173.2 173.2

KK    A11
KM       GENERATE HYDROGRAPH FROM SUBBASIN A11 TO SEC55
KM       MID-WATERSHED PRECIPITATION DATA
BA  0.101
PH        0.101   .65  1.32   2.45  3.55  4.60  6.75  9.20  12.30
LS      0    77
UD  0.690

KK  SEC55
KM       COMBINE HYDROGRAPHS AT SEC55
HC      2

KK    A12
KM       GENERATE HYDROGRAPH FROM SUBBASIN A12 TO SEC50
KM       MID-WATERSHED PRECIPITATION DATA
BA  0.259
PH        0.183   .65  1.32   2.45  3.55  4.60  6.75  9.20  12.30
LS      0    81
UD  0.864

KK  SEC60
KM       COMBINE HYDROGRAPHS AT SEC60
HC      2

KK  SEC65
KM       ROUTE NUNENUNE FLOW FROM SEC60 TO SEC65
RS      2  FLOW     0
RC   .035  .035  .035  2350  0.014   110
RX      0   600   690   700    715   725   890  1370
RY    120   115   110   103    103   110   110   115
1                              HEC-1 INPUT                                   PAGE 6
```

```
LINE            ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 223            KK     A17
 224            KM        GENERATE HYDROGRAPH FROM SUBBASIN A17 TO SEC65
 225            KM        MID-WATERSHED PRECIPITATION DATA
 226            BA   0.039
 227            PH          0.009     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 228            LS       0      78
 229            UD   0.066

 230            KK   SEC65
 231            KM        COMBINE HYDROGRAPHS AT SEC65
 232            HC       2

 233            KK     A7
 234            KM        GENERATE HYDROGRAPH FROM SUBBASIN A7 TO SEC70
 235            KM        UPPER WATERSHED PRECIPITATION DATA
 236            BA   0.009
 237            PH          0.009     .66    1.35    2.50    3.60    4.65    6.80    9.25   12.50
 238            LS       0      52
 239            UD   0.072

 240            KK   SEC75
 241            KM        ROUTE HUNEHUNE FLOW FROM SEC70 TO SEC75
 242            RS       2    FLOW       0
 243            RC    .035    .035    .035    2100   0.025     130
 244            RX       0     210     340     344     348     352     480     600
 245            RY     135     130     130     126     126     130     130     130

 246            KK     A10
 247            KM        GENERATE HYDROGRAPH FROM SUBBASIN A10 TO SEC75
 248            KM        MID-WATERSHED PRECIPITATION DATA
 249            BA   0.082
 250            PH          0.082     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 251            LS       0      76
 252            UD   0.336

 253            KK   SEC75
 254            KM        COMBINE HYDROGRAPHS AT SEC75
 255            HC       2

 256            KK     A8
 257            KM        GENERATE HYDROGRAPH FROM SUBBASIN A8 TO SEC79
 258            KM        UPPER WATERSHED PRECIPITATION DATA
 259            BA   0.168
 260            PH          0.168     .66    1.35    2.50    3.60    4.65    6.80    9.25   12.50
 261            LS       0      64
 262            UD   0.312

 263            KK   SEC80
 264            KM        ROUTE HUNEHUNE FLOW FROM A8 TO SEC80
 265            RS       2    FLOW       0
 266            RC    .035    .035    .035    1040   0.016     110
 267            RX       0     200     400     407     417     424     440     650
 268            RY     110     110     110     103     103     110     110     110
1                                       HEC-1 INPUT                                          PAGE 7

LINE            ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 269            KK     A9
 270            KM        GENERATE HYDROGRAPH FROM SUBBASIN A9 TO SEC80
 271            KM        MID-WATERSHED PRECIPITATION DATA
 272            BA   0.021
 273            PH          0.021     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 274            LS       0      77
 275            UD   0.072

 276            KK   SEC80
 277            KM        COMBINE HYDROGRAPHS AT SEC80
 278            HC       2

 279            KK   SEC81
 280            KM        COMBINE HYDROGRAPHS AT SEC81
 281            HC       3

 282            KK   SEC81
 283            KM        DIVERT KALOI OVERFLOW FROM SEC81 TO SEC105
 284            DT   DIVT4
 285            DI       0    1558    1559    2000    2500    3000    3500    4000
 286            DQ       0       0       1     442     942    1442    1942    2442

 287            KK   SEC90
 288            KM        ROUTE HUNEHUNE FLOW FROM SEC81 TO SEC90
 289            RS       2    FLOW       0
 290            RC    .035    .035    .035    1380   0.007      95
 291            RX       0     280     568     570     580     590     710    1302
 292            RY     100      95      95      85      85      95      95     100

 293            KK     A18
 294            KM        GENERATE HYDROGRAPH FROM SUBBASIN A18 TO SEC90
 295            KM        MID-WATERSHED PRECIPITATION DATA
 296            BA   0.002
 297            PH          0.002     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 298            LS       0      78
 299            UD   0.030

 300            KK   SEC90
 301            KM        COMBINE HYDROGRAPHS AT SEC90
 302            HC       2

 303            KK     A19
 304            KM        GENERATE HYDROGRAPH FROM SUBBASIN A19 TO SEC100
 305            KM        MID-WATERSHED PRECIPITATION DATA
 306            BA   0.087
 307            PH          0.087     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 308            LS       0      84
 309            UD   1.212
1                                       HEC-1 INPUT                                          PAGE 8

LINE            ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 310            KK     A16
 311            KM        GENERATE HYDROGRAPH FROM SUBBASIN A16 TO SEC95
 312            KM        MID-WATERSHED PRECIPITATION DATA
 313            BA   0.133
 314            PH          0.133     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 315            LS       0      85
 316            UD   1.050

 317            KK   SEC91
 318            KM        COMBINE HYDROGRAPHS AT SEC91
 319            HC       3

 320            KK   SEC105
 321            KM        ROUTE HUNEHUNE FLOW FROM SEC91 TO SEC105
 322            RS       2    FLOW       0
 323            RC    .035    .035    .035     820   0.013      85
 324            RX       0     380     570     577     587     594     620    1040
 325            RY      90      90      85      79      79      80      85      90

 326            KK     A21
 327            KM        GENERATE HYDROGRAPH FROM SUBBASIN A21 TO SEC105
 328            KM        MID-WATERSHED PRECIPITATION DATA
 329            BA   0.014
 330            PH          0.014     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 331            LS       0      78
 332            UD   0.150

 333            KK   SEC105
 334            KM        RETRIEVE DIVERSION FLOW FROM SEC81
 335            DR   DIVT4

 336            KK   SEC105
 337            KM        COMBINE HYDROGRAPHS AT SEC105
 338            HC       3

 339            KK   SEC110
 340            KM        COMBINE HYDROGRAPHS AT SEC110
 341            KM        CONFLUENCE OF KALOI AND HUNEHUNE STREAMS
 342            HC       2

 343            KK   SEC110
 344            KM        DIVERT KALOI OVERFLOW FROM SEC110 TO SEC01
 345            DT   DIVT5
 346            DI       0     828     829    1000    1500    2000    2500    3000    3500    4000
 347            DQ       0       0       1     172     672    1172    1672    2172    2672    3172
```

```
 348           KK  SEC115
 349           KM       ROUTE KALOI FLOW FROM SEC110 TO SEC125
 350           RS       2    FLOW       0
 351           RC    .035    .035    .035    3170   .0029      68
 352           RX       5      32      45      60      65      74     106     150
 353           RY      65      66      70      60      60      60      65      65
                                          HEC-1 INPUT                                   PAGE  9

LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 354           KK     A24
 355           KM        GENERATE HYDROGRAPH FROM SUBBASIN A24 TO SEC115
 356           KM        MID-WATERSHED PRECIPITATION DATA
 357           BA   0.010
 358           PH           0.010     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 359           LS       0      89
 360           UD   0.054

 361           KK  SEC115
 362           KM        COMBINE HYDROGRAPHS AT SEC115
 363           KO       1
 364           HC       2

 365           KK      S1
 366           KM        GENERATE HYDROGRAPH FROM SUBBASIN S1
 367           KM        MID-WATERSHED PRECIPITATION DATA
 368           BA   0.324
 369           PH           0.324     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 370           LS       0      87
 371           UD   3.353

 372           KK      S2
 373           KM        GENERATE HYDROGRAPH FROM SUBBASIN S2
 374           KM        MID-WATERSHED PRECIPITATION DATA
 375           BA   0.004
 376           PH           0.004     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 377           LS       0      89
 378           UD   0.309

 379           KK   SEC01
 380           KM        RETRIEVE DIVERSION FROM SEC30
 381           DR   DIVT2

 382           KK   SEC01
 383           KM        RETREIVE DIVERSION FROM SEC110
 384           DR   DIVT5

 385           KK   SEC01
 386           KM        COMBINE HYDROGRAPHS AT SEC01 (TOP OF PROJECT SITE)
 387           HC       4
 388           KO       1
 389           ZZ
1
          SCHEMATIC DIAGRAM OF STREAM NETWORK

INPUT
 LINE     (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

 NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   8        A1
            V
            V
  15      SEC10
            .
            .
  22        .          A2
            .          .
            .          .
  29      SEC10.........
            .
            .
  32        .          A3
            .          .
            .          .
  39      SEC15.........
            V
            V
  42      SEC20
            .
            .
  48        .          A4
            .          .
            .          .
  56      SEC20.........
            V
            V
  59      RES01
            V
            V
  66      SEC25
            .
            .
  72        .          A13
            .          .
            .          .
  79      SEC25.........
            V
            V
  82      RES10
            .
            .
  91        .------->  DIVT1
  89      RES10
            V
            V
  94      SEC30
            .
            .
 100        .          A14
            .          .
            .          .
 107      SEC30.........
            .
            .
 112        .------->  DIVT2
 110      SEC30
            V
            V
 115      SEC35
            .
            .
 122        .          .<-------  DIVT1
 121        .        RES11
            .          V
            .          V
 124        .        RES11
            .          .
            .          .
 132      SEC35.........
            V
            V
 135      SEC40
            .
            .
 141        .          A15
            .          .
            .          .
 148      SEC40.........
            V
            V
 151      SEC45
            .
            .
 157        .          A22
            .          .
            .          .
 164      SEC45.........
            .
            .
 167        .          A6A
            .          .
            .          .
 174        .          .         A6B
            .          .          .
            .          .          .
 181        .          .          .         A6C
            .          .          .          .
            .          .          .          .
 188        .        SEC54.......................
```

```
 191        .     V
                  V
                  SEC55
 197        .     .        A11
 204        .     SEC55.........
 207        .     .        A12
 214        .     SEC60.........
                  V
                  V
 217        .     SEC65
 223        .     .        A17
 230        .     SEC65.........
 233        .     .        A7
                           V
                           V
 240        .     .        SEC75
 246        .     .        .        A10
 253        .     .        SEC75.........
 256        .     .        .        A8
                                    V
                                    V
 263        .     .        .        SEC90
 269        .     .        .        .        A9
 276        .     .        .        SEC90.........
 279        .     SEC91..........................
 284        .     .------->  DIVT4
 282        .     SEC91
                  V
                  V
 287        .     SEC90
 293        .     .        A18
 300        .     SEC90.........
 303        .     .        A19
 310        .     .        .        A16
 317        .     SEC91..................
                  V
                  V
 320        .     SEC105
 326        .     .        A21

 335      .      .      .      .<-------  DIVT6
 333      .      .      .      SEC105
 336      .      SEC105.................
 339      SEC110.........
 345      .------->  DIVT5
 343      SEC110
          V
          V
 348      SEC115
 354      .      A24
 361      SEC115.........
 365      .      S1
 372      .      .      S2
 381      .      .      .      .<-------  DIVT2
 379      .      .      .      SEC01
 384      .      .      .      .      .<-------  DIVT3
 382      .      .      .      .      SEC01
 385      .      SEC01............................

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

```
*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*             JUN 09 1992               *
*            VERSION 4.0.1E             *
*                                       *
*  RUN DATE  07/17/97  TIME  11:35:49   *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*     U.S. ARMY CORPS OF ENGINEERS      *
*    HYDROLOGIC ENGINEERING CENTER      *
*          609 SECOND STREET            *
*      DAVIS, CALIFORNIA 95616          *
*           (916) 551-1748              *
*                                       *
*****************************************
```

```
                  EWA VILLAGES PROJECT FLOOD (100-YEAR STORM)
                  FN: X101.DAT
                  PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
                                      EAST KAPOLEI - EXISTING CONDITIONS
                  KALOI - HUNEHUNE NETWORK MODEL

 7 IO         OUTPUT CONTROL VARIABLES
                   IPRNT          5  PRINT CONTROL
                   IPLOT          0  PLOT CONTROL
                   QSCAL         0.  HYDROGRAPH PLOT SCALE

 IT           HYDROGRAPH TIME DATA
                    NMIN          7  MINUTES IN COMPUTATION INTERVAL
                   IDATE    1FEB97  STARTING DATE
                   ITIME      1200  STARTING TIME
                      NQ       300  NUMBER OF HYDROGRAPH ORDINATES
                  NDDATE    2FEB97  ENDING DATE
                  NDTIME      2353  ENDING TIME
                   ICENT        19  CENTURY MARK

               COMPUTATION INTERVAL    0.12 HOURS
                    TOTAL TIME BASE   34.88 HOURS

        ENGLISH UNITS
            DRAINAGE AREA          SQUARE MILES
```

```
            PRECIPITATION DEPTH   INCHES
            LENGTH, ELEVATION     FEET
            FLOW                  CUBIC FEET PER SECOND
            STORAGE VOLUME        ACRE-FEET
            SURFACE AREA          ACRES
            TEMPERATURE           DEGREES FAHRENHEIT

 VALUE EXCEEDS TABLE IN LOGLOG          24.03336        0.01667        24.00000

 VALUE EXCEEDS TABLE IN LOGLOG          24.03336        0.01667        24.00000
MANE2 NPLAN,NSTM        1      0

 VALUE EXCEEDS TABLE IN LOGLOG          24.03336        0.01667        24.00000
MANE2 NPLAN,NSTM        1      0

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

             **************
             *            *
  48 KK      *        A4  *
             *            *
             **************

  51 KO          OUTPUT CONTROL VARIABLES
                       IPRNT           3  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE

                SUBBASIN RUNOFF DATA

  52 BA          SUBBASIN CHARACTERISTICS
                       TAREA        0.19  SUBBASIN AREA

                 PRECIPITATION DATA

                                      DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
  53 PH                                                                         ............ TP-49 ............
                 ..... HYDRO-35 ......   ................ TP-40 ................   2-DAY   4-DAY   7-DAY  10-DAY
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR    0.00    0.00    0.00    0.00
                  0.66    1.35    2.50    3.60    4.65    6.80    9.25   12.50
                                                     STORM AREA =     0.19

  54 LS          SCS LOSS RATE
                       STRTL        1.03  INITIAL ABSTRACTION
                      CRVNBR       66.00  CURVE NUMBER
                       RTIMP        0.00  PERCENT IMPERVIOUS AREA

  55 UD          SCS DIMENSIONLESS UNITGRAPH
                        TLAG        0.45  LAG
                                                           ***

 VALUE EXCEEDS TABLE IN LOGLOG          24.03336        0.01667        24.00000
                                                      UNIT HYDROGRAPH
                                                 21 END-OF-PERIOD ORDINATES
                 23.       72.      143.      177.      172.      143.       99.       66.       46.       32.
                 22.       15.       10.        7.        5.        3.        2.        2.        1.        1.
                  0.

      ***            ***            ***            ***            ***

                         HYDROGRAPH AT STATION        A4

     TOTAL RAINFALL =   12.50, TOTAL LOSS =    4.58, TOTAL EXCESS =    7.91

   PEAK FLOW      TIME                         MAXIMUM AVERAGE FLOW
                                         6-HR        24-HR       72-HR      34.08-HR
 +   (CFS)        (HR)
                               (CFS)
 +     270.       12.40                   101.          40.         28.          28.
                             (INCHES)    4.950        7.912       7.912        7.912
                              (AC-FT)      50.          79.         79.          79.

                         CUMULATIVE AREA =     0.19 SQ MI

 MANE2 NPLAN,NSTM        1      0

 VALUE EXCEEDS TABLE IN LOGLOG          24.03336        0.01667        24.00000
MANE2 NPLAN,NSTM        1      0

 VALUE EXCEEDS TABLE IN LOGLOG          24.03336        0.01667        24.00000
MANE2 NPLAN,NSTM        1      0
MANE2 NPLAN,NSTM        1      0
 WARNING --- ROUTED OUTFLOW (   2768.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2716.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2926.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2982.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3106.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3161.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3198.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3202.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3191.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3151.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3073.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2973.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2857.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2698.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2494.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2762.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2734.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2857.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2996.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3066.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3162.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3107.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3206.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3193.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3162.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3092.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2994.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2882.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2734.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2539.) IS GREATER THAN MAXIMUM OUTFLOW (   2432.) IN STORAGE-OUTFLOW TABLE
 VALUE EXCEEDS TABLE IN LOGLOG          24.03336        0.01667        24.00000
MANE2 NPLAN,NSTM        1      0
 WARNING --- ROUTED OUTFLOW (   2252.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2866.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2863.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2933.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3101.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
```

```
WARNING --- ROUTED OUTFLOW (   3153.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3256.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3280.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3292.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3279.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3243.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3176.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3074.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2962.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2815.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2623.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2427.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2291.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2154.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2094.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   1992.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   1898.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2186.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2035.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2885.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2908.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3098.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3148.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3247.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3284.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3287.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3284.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3246.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3184.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3081.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2972.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2827.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2630.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2440.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2299.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2203.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2101.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   1999.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   1906.) IS GREATER THAN MAXIMUM OUTFLOW (   1855.) IN STORAGE-OUTFLOW TABLE
VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
```

```
MANE2 NPLAN,NSTM        1      0
 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
MANE2 NPLAN,NSTM        1      0
MANE2 NPLAN,NSTM        1      0
 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
MANE2 NPLAN,NSTM        1      0
 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
MANE2 NPLAN,NSTM        1      0
 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
MANE2 NPLAN,NSTM        1      0
 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
MANE2 NPLAN,NSTM        1      0
 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
MANE2 NPLAN,NSTM        1      0
MANE2 NPLAN,NSTM        1      0
MANE2 NPLAN,NSTM        1      0
 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
MANE2 NPLAN,NSTM        1      0
 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
MANE2 NPLAN,NSTM        1      0
MANE2 NPLAN,NSTM        1      0
 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
MANE2 NPLAN,NSTM        1      0
MANE2 NPLAN,NSTM        1      0
MANE2 NPLAN,NSTM        1      0
 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
 363 KK     *   SEC115   *
            *            *
            **************

 363 KO          OUTPUT CONTROL VARIABLES
                       IPRNT          1  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE

 364 HC          HYDROGRAPH COMBINATION
                       ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                          ***
MANE2 NPLAN,NSTM        1 -    0
***************************************************************************************************************

                                        HYDROGRAPH AT STATION   SEC115
                                           SUM OF  2 HYDROGRAPHS

***************************************************************************************************************
                                      *                                   *                                   *
  DA MON HRMN  ORD        FLOW        *  DA MON HRMN  ORD        FLOW     *  DA MON HRMN  ORD       FLOW      *  DA MON HRMN  ORD       FLOW
                                      *                                   *                                   *
   1 FEB 1200    1          0.        *   1 FEB 2045   76        541.     *   2 FEB 0530  151       830.      *   2 FEB 1415  226       331.
   1 FEB 1207    2          0.        *   1 FEB 2052   77        564.     *   2 FEB 0537  152       820.      *   2 FEB 1422  227       303.
```

1 FEB 1214	3	0.	1 FEB 2059	78	586.	2 FEB 0544	153	830.	2 FEB 1429	228	271.
1 FEB 1221	4	0.	1 FEB 2106	79	610.	2 FEB 0551	154	830.	2 FEB 1436	229	225.
1 FEB 1228	5	0.	1 FEB 2113	80	634.	2 FEB 0558	155	830.	2 FEB 1443	230	186.
1 FEB 1235	6	0.	1 FEB 2120	81	663.	2 FEB 0605	156	830.	2 FEB 1450	231	162.
1 FEB 1242	7	0.	1 FEB 2127	82	694.	2 FEB 0612	157	830.	2 FEB 1457	232	145.
1 FEB 1249	8	0.	1 FEB 2134	83	726.	2 FEB 0619	158	830.	2 FEB 1504	233	131.
1 FEB 1256	9	0.	1 FEB 2141	84	760.	2 FEB 0626	159	830.	2 FEB 1511	234	118.
1 FEB 1303	10	0.	1 FEB 2148	85	792.	2 FEB 0633	160	830.	2 FEB 1518	235	107.
1 FEB 1310	11	0.	1 FEB 2155	86	815.	2 FEB 0640	161	830.	2 FEB 1525	236	97.
1 FEB 1317	12	0.	1 FEB 2202	87	826.	2 FEB 0647	162	830.	2 FEB 1532	237	87.
1 FEB 1324	13	0.	1 FEB 2209	88	830.	2 FEB 0654	163	830.	2 FEB 1539	238	78.
1 FEB 1331	14	0.	1 FEB 2216	89	832.	2 FEB 0701	164	830.	2 FEB 1546	239	70.
1 FEB 1338	15	0.	1 FEB 2223	90	833.	2 FEB 0708	165	830.	2 FEB 1553	240	63.
1 FEB 1345	16	0.	1 FEB 2230	91	833.	2 FEB 0715	166	830.	2 FEB 1600	241	57.
1 FEB 1352	17	0.	1 FEB 2237	92	833.	2 FEB 0722	167	830.	2 FEB 1607	242	50.
1 FEB 1359	18	0.	1 FEB 2244	93	834.	2 FEB 0729	168	830.	2 FEB 1614	243	45.
1 FEB 1406	19	0.	1 FEB 2251	94	834.	2 FEB 0736	169	830.	2 FEB 1621	244	41.
1 FEB 1413	20	0.	1 FEB 2258	95	835.	2 FEB 0743	170	830.	2 FEB 1628	245	35.
1 FEB 1420	21	1.	1 FEB 2305	96	835.	2 FEB 0750	171	830.	2 FEB 1635	246	32.
1 FEB 1427	22	1.	1 FEB 2312	97	834.	2 FEB 0757	172	830.	2 FEB 1642	247	29.
1 FEB 1434	23	1.	1 FEB 2319	98	834.	2 FEB 0804	173	830.	2 FEB 1649	248	26.
1 FEB 1441	24	1.	1 FEB 2326	99	835.	2 FEB 0811	174	830.	2 FEB 1656	249	24.
1 FEB 1448	25	1.	1 FEB 2333	100	836.	2 FEB 0818	175	830.	2 FEB 1703	250	22.
1 FEB 1455	26	1.	1 FEB 2340	101	835.	2 FEB 0825	176	830.	2 FEB 1710	251	20.
1 FEB 1502	27	1.	1 FEB 2347	102	835.	2 FEB 0832	177	830.	2 FEB 1717	252	18.
1 FEB 1509	28	2.	1 FEB 2354	103	840.	2 FEB 0839	178	830.	2 FEB 1724	253	16.
1 FEB 1516	29	2.	2 FEB 0001	104	849.	2 FEB 0846	179	830.	2 FEB 1731	254	15.
1 FEB 1523	30	3.	2 FEB 0008	105	866.	2 FEB 0853	180	830.	2 FEB 1738	255	14.
1 FEB 1530	31	4.	2 FEB 0015	106	850.	2 FEB 0900	181	830.	2 FEB 1745	256	13.
1 FEB 1537	32	6.	2 FEB 0022	107	841.	2 FEB 0907	182	830.	2 FEB 1752	257	11.
1 FEB 1544	33	8.	2 FEB 0029	108	836.	2 FEB 0914	183	830.	2 FEB 1759	258	10.
1 FEB 1551	34	10.	2 FEB 0036	109	835.	2 FEB 0921	184	830.	2 FEB 1806	259	10.
1 FEB 1558	35	13.	2 FEB 0043	110	835.	2 FEB 0928	185	830.	2 FEB 1813	260	9.
1 FEB 1605	36	17.	2 FEB 0050	111	835.	2 FEB 0935	186	830.	2 FEB 1820	261	8.
1 FEB 1612	37	20.	2 FEB 0057	112	835.	2 FEB 0942	187	830.	2 FEB 1827	262	7.
1 FEB 1619	38	24.	2 FEB 0104	113	834.	2 FEB 0949	188	830.	2 FEB 1834	263	6.
1 FEB 1626	39	28.	2 FEB 0111	114	835.	2 FEB 0956	189	830.	2 FEB 1841	264	6.
1 FEB 1633	40	33.	2 FEB 0118	115	835.	2 FEB 1003	190	830.	2 FEB 1848	265	5.
1 FEB 1640	41	37.	2 FEB 0125	116	835.	2 FEB 1010	191	830.	2 FEB 1855	266	4.
1 FEB 1647	42	42.	2 FEB 0132	117	834.	2 FEB 1017	192	830.	2 FEB 1902	267	4.
1 FEB 1654	43	46.	2 FEB 0139	118	834.	2 FEB 1024	193	830.	2 FEB 1909	268	3.
1 FEB 1701	44	50.	2 FEB 0146	119	833.	2 FEB 1031	194	829.	2 FEB 1916	269	3.
1 FEB 1708	45	54.	2 FEB 0153	120	833.	2 FEB 1038	195	829.	2 FEB 1923	270	3.
1 FEB 1715	46	58.	2 FEB 0200	121	833.	2 FEB 1045	196	829.	2 FEB 1930	271	3.
1 FEB 1722	47	61.	2 FEB 0207	122	833.	2 FEB 1052	197	829.	2 FEB 1937	272	2.
1 FEB 1729	48	66.	2 FEB 0214	123	833.	2 FEB 1059	198	829.	2 FEB 1944	273	2.
1 FEB 1736	49	70.	2 FEB 0221	124	833.	2 FEB 1106	199	829.	2 FEB 1951	274	2.
1 FEB 1743	50	74.	2 FEB 0228	125	832.	2 FEB 1113	200	829.	2 FEB 1958	275	2.
1 FEB 1750	51	78.	2 FEB 0235	126	832.	2 FEB 1120	201	829.	2 FEB 2005	276	2.
1 FEB 1757	52	82.	2 FEB 0242	127	832.	2 FEB 1127	202	829.	2 FEB 2012	277	1.
1 FEB 1804	53	86.	2 FEB 0249	128	832.	2 FEB 1134	203	829.	2 FEB 2019	278	1.
1 FEB 1811	54	90.	2 FEB 0256	129	832.	2 FEB 1141	204	829.	2 FEB 2026	279	1.
1 FEB 1818	55	94.	2 FEB 0303	130	832.	2 FEB 1148	205	829.	2 FEB 2033	280	1.
1 FEB 1825	56	99.	2 FEB 0310	131	833.	2 FEB 1155	206	829.	2 FEB 2040	281	1.
1 FEB 1832	57	108.	2 FEB 0317	132	831.	2 FEB 1202	207	829.	2 FEB 2047	282	1.
1 FEB 1839	58	129.	2 FEB 0324	133	831.	2 FEB 1209	208	828.	2 FEB 2054	283	1.
1 FEB 1846	59	172.	2 FEB 0331	134	831.	2 FEB 1216	209	828.	2 FEB 2101	284	1.
1 FEB 1853	60	222.	2 FEB 0338	135	831.	2 FEB 1223	210	828.	2 FEB 2108	285	1.
1 FEB 1900	61	253.	2 FEB 0345	136	831.	2 FEB 1230	211	823.	2 FEB 2115	286	0.
1 FEB 1907	62	270.	2 FEB 0352	137	831.	2 FEB 1237	212	808.	2 FEB 2122	287	0.
1 FEB 1914	63	283.	2 FEB 0359	138	831.	2 FEB 1244	213	783.	2 FEB 2129	288	0.
1 FEB 1921	64	298.	2 FEB 0406	139	831.	2 FEB 1251	214	754.	2 FEB 2136	289	0.
1 FEB 1928	65	314.	2 FEB 0413	140	831.	2 FEB 1258	215	721.	2 FEB 2143	290	0.
1 FEB 1935	66	332.	2 FEB 0420	141	831.	2 FEB 1305	216	687.	2 FEB 2150	291	0.
1 FEB 1942	67	352.	2 FEB 0427	142	831.	2 FEB 1312	217	651.	2 FEB 2157	292	0.
1 FEB 1949	68	374.	2 FEB 0434	143	831.	2 FEB 1319	218	618.	2 FEB 2204	293	0.
1 FEB 1956	69	394.	2 FEB 0441	144	831.	2 FEB 1326	219	581.	2 FEB 2211	294	0.
1 FEB 2003	70	413.	2 FEB 0448	145	831.	2 FEB 1333	220	541.	2 FEB 2218	295	0.
1 FEB 2010	71	432.	2 FEB 0455	146	830.	2 FEB 1340	221	499.	2 FEB 2225	296	0.
1 FEB 2017	72	452.	2 FEB 0502	147	830.	2 FEB 1347	222	461.	2 FEB 2232	297	0.
1 FEB 2024	73	471.	2 FEB 0509	148	830.	2 FEB 1354	223	428.	2 FEB 2239	298	0.
1 FEB 2031	74	497.	2 FEB 0516	149	830.	2 FEB 1401	224	394.	2 FEB 2246	299	0.
1 FEB 2038	75	519.	2 FEB 0523	150	830.	2 FEB 1408	225	361.	2 FEB 2253	300	0.

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.88-HR
(CFS)	(HR)					
		(CFS)				
866.	12.13		835.	632.	435.	435.
		(INCHES)	1.352	4.115	4.132	4.132
		(AC-FT)	411.	1250.	1255.	1255.

CUMULATIVE AREA = 5.69 SQ MI

VALUE EXCEEDS TABLE IN LOGLOG 24.03336 0.01667 24.00000

VALUE EXCEEDS TABLE IN LOGLOG 24.03336 0.01667 24.00000

385 KK SEC01

388 KO OUTPUT CONTROL VARIABLES

IPRNT	1	PRINT CONTROL
IPLOT	0	PLOT CONTROL
QSCAL	0.	HYDROGRAPH PLOT SCALE

387 HC HYDROGRAPH COMBINATION

ICOMP	4	NUMBER OF HYDROGRAPHS TO COMBINE

***

MANE2 NPLAN,NSTM 1 0
MANE2 NPLAN,NSTM 1 0
MANE2 NPLAN,NSTM 1 0

HYDROGRAPH AT STATION SEC01
SUM OF 4 HYDROGRAPHS

DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW
1 FEB 1200	1	0.	1 FEB 2045	76	36.	2 FEB 0530	151	1042.	2 FEB 1415	226	47.
1 FEB 1207	2	0.	1 FEB 2052	77	37.	2 FEB 0537	152	999.	2 FEB 1422	227	46.
1 FEB 1214	3	0.	1 FEB 2059	78	38.	2 FEB 0544	153	958.	2 FEB 1429	228	44.
1 FEB 1221	4	0.	1 FEB 2106	79	39.	2 FEB 0551	154	918.	2 FEB 1436	229	43
1 FEB 1228	5	0.	1 FEB 2113	80	40.	2 FEB 0558	155	879.	2 FEB 1443	230	41.
1 FEB 1235	6	0.	1 FEB 2120	81	42.	2 FEB 0605	156	844.	2 FEB 1450	231	40.
1 FEB 1242	7	0.	1 FEB 2127	82	43.	2 FEB 0612	157	810.	2 FEB 1457	232	39.
1 FEB 1249	8	0.	1 FEB 2134	83	44.	2 FEB 0619	158	777.	2 FEB 1504	233	37.
1 FEB 1256	9	0.	1 FEB 2141	84	46.	2 FEB 0626	159	745.	2 FEB 1511	234	36.
1 FEB 1303	10	0.	1 FEB 2148	85	73.	2 FEB 0633	160	715.	2 FEB 1518	235	34.
1 FEB 1310	11	0.	1 FEB 2155	86	113.	2 FEB 0640	161	687.	2 FEB 1525	236	33.
1 FEB 1317	12	0.	1 FEB 2202	87	156.	2 FEB 0647	162	660.	2 FEB 1532	237	31.
1 FEB 1324	13	0.	1 FEB 2209	88	202.	2 FEB 0654	163	634.	2 FEB 1539	238	30.
1 FEB 1331	14	0.	1 FEB 2216	89	249.	2 FEB 0701	164	609.	2 FEB 1546	239	28.
1 FEB 1338	15	0.	1 FEB 2223	90	300.	2 FEB 0708	165	585.	2 FEB 1553	240	27.
1 FEB 1345	16	0.	1 FEB 2230	91	354.	2 FEB 0715	166	563.	2 FEB 1600	241	26.
1 FEB 1352	17	0.	1 FEB 2237	92	410.	2 FEB 0722	167	542.	2 FEB 1607	242	25.
1 FEB 1359	18	0.	1 FEB 2244	93	467.	2 FEB 0729	168	523.	2 FEB 1614	243	23.
1 FEB 1406	19	0.	1 FEB 2251	94	527.	2 FEB 0736	169	504.	2 FEB 1621	244	22.
1 FEB 1413	20	0.	1 FEB 2258	95	596.	2 FEB 0743	170	486.	2 FEB 1628	245	21.
1 FEB 1420	21	0.	1 FEB 2305	96	673.	2 FEB 0750	171	469.	2 FEB 1635	246	20.
1 FEB 1427	22	0.	1 FEB 2312	97	752.	2 FEB 0757	172	452.	2 FEB 1642	247	19.
1 FEB 1434	23	0.	1 FEB 2319	98	830.	2 FEB 0804	173	437.	2 FEB 1649	248	18.
1 FEB 1441	24	0.	1 FEB 2326	99	907.	2 FEB 0811	174	422.	2 FEB 1656	249	17.
1 FEB 1448	25	0.	1 FEB 2333	100	989.	2 FEB 0818	175	408.	2 FEB 1703	250	16.
1 FEB 1455	26	1.	1 FEB 2340	101	1075.	2 FEB 0825	176	394.	2 FEB 1710	251	15.
1 FEB 1502	27	1.	1 FEB 2347	102	1166.	2 FEB 0832	177	380.	2 FEB 1717	252	14.
1 FEB 1509	28	1.	1 FEB 2354	103	1278.	2 FEB 0839	178	367.	2 FEB 1724	253	13.
1 FEB 1516	29	1.	2 FEB 0001	104	1526.	2 FEB 0846	179	355.	2 FEB 1731	254	12.
1 FEB 1523	30	1.	2 FEB 0008	105	1910.	2 FEB 0853	180	342.	2 FEB 1738	255	12.
1 FEB 1530	31	1.	2 FEB 0015	106	2389.	2 FEB 0900	181	331.	2 FEB 1745	256	11.
1 FEB 1537	32	2.	2 FEB 0022	107	2884.	2 FEB 0907	182	319.	2 FEB 1752	257	10.
1 FEB 1544	33	2.	2 FEB 0029	108	3082.	2 FEB 0914	183	308.	2 FEB 1759	258	10.
1 FEB 1551	34	2.	2 FEB 0036	109	2948.	2 FEB 0921	184	297.	2 FEB 1806	259	9.
1 FEB 1558	35	2.	2 FEB 0043	110	2603.	2 FEB 0928	185	287.	2 FEB 1813	260	9.
1 FEB 1605	36	3.	2 FEB 0050	111	2292.	2 FEB 0935	186	276.	2 FEB 1820	261	8.

1 FEB 1612	37	3.	*	2 FEB 0057	112	3270.	*	2 FEB 0942	187	266.	*	2 FEB 1827	262	8.
1 FEB 1619	38	3.	*	2 FEB 0104	113	3880.	*	2 FEB 0949	188	256.	*	2 FEB 1834	263	7.
1 FEB 1626	39	4.	*	2 FEB 0111	114	3885.	*	2 FEB 0956	189	246.	*	2 FEB 1841	264	7.
1 FEB 1633	40	4.	*	2 FEB 0118	115	3868.	*	2 FEB 1003	190	235.	*	2 FEB 1848	265	7.
1 FEB 1640	41	5.	*	2 FEB 0125	116	4018.	*	2 FEB 1010	191	224.	*	2 FEB 1855	266	6.
1 FEB 1647	42	5.	*	2 FEB 0132	117	4033.	*	2 FEB 1017	192	215.	*	2 FEB 1902	267	6.
1 FEB 1654	43	6.	*	2 FEB 0139	118	4095.	*	2 FEB 1024	193	207.	*	2 FEB 1909	268	6.
1 FEB 1701	44	7.	*	2 FEB 0146	119	4095.	*	2 FEB 1031	194	199.	*	2 FEB 1916	269	5.
1 FEB 1708	45	7.	*	2 FEB 0153	120	4062.	*	2 FEB 1038	195	190.	*	2 FEB 1923	270	5.
1 FEB 1715	46	8.	*	2 FEB 0200	121	4023.	*	2 FEB 1045	196	182.	*	2 FEB 1930	271	5.
1 FEB 1722	47	8.	*	2 FEB 0207	122	3951.	*	2 FEB 1052	197	175.	*	2 FEB 1937	272	4.
1 FEB 1729	48	9	*	2 FEB 0214	123	3864.	*	2 FEB 1059	198	167.	*	2 FEB 1944	273	4.
1 FEB 1736	49	10.	*	2 FEB 0221	124	3718.	*	2 FEB 1106	199	160.	*	2 FEB 1951	274	4.
1 FEB 1743	50	11.	*	2 FEB 0228	125	3607.	*	2 FEB 1113	200	153.	*	2 FEB 1958	275	4.
1 FEB 1750	51	11.	*	2 FEB 0235	126	3443.	*	2 FEB 1120	201	145.	*	2 FEB 2005	276	4.
1 FEB 1757	52	12.	*	2 FEB 0242	127	3236.	*	2 FEB 1127	202	138.	*	2 FEB 2012	277	3.
1 FEB 1804	53	13.	*	2 FEB 0249	128	3021.	*	2 FEB 1134	203	132.	*	2 FEB 2019	278	3.
1 FEB 1811	54	14.	*	2 FEB 0256	129	2864.	*	2 FEB 1141	204	125.	*	2 FEB 2026	279	3.
1 FEB 1818	55	15.	*	2 FEB 0303	130	2752.	*	2 FEB 1148	205	119.	*	2 FEB 2033	280	3.
1 FEB 1825	56	16.	*	2 FEB 0310	131	2637.	*	2 FEB 1155	206	112.	*	2 FEB 2040	281	3.
1 FEB 1832	57	16.	*	2 FEB 0317	132	2517.	*	2 FEB 1202	207	106.	*	2 FEB 2047	282	2.
1 FEB 1839	58	17.	*	2 FEB 0324	133	2404.	*	2 FEB 1209	208	97.	*	2 FEB 2054	283	2.
1 FEB 1846	59	18.	*	2 FEB 0331	134	2291.	*	2 FEB 1216	209	81.	*	2 FEB 2101	284	2.
1 FEB 1853	60	19.	*	2 FEB 0338	135	2182.	*	2 FEB 1223	210	63.	*	2 FEB 2108	285	2.
1 FEB 1900	61	20.	*	2 FEB 0345	136	2079.	*	2 FEB 1230	211	62.	*	2 FEB 2115	286	2.
1 FEB 1907	62	21.	*	2 FEB 0352	137	1981.	*	2 FEB 1237	212	61.	*	2 FEB 2122	287	2.
1 FEB 1914	63	22.	*	2 FEB 0359	138	1879.	*	2 FEB 1244	213	60.	*	2 FEB 2129	288	2.
1 FEB 1921	64	23.	*	2 FEB 0406	139	1764.	*	2 FEB 1251	214	59.	*	2 FEB 2136	289	2.
1 FEB 1928	65	24.	*	2 FEB 0413	140	1669.	*	2 FEB 1258	215	58.	*	2 FEB 2143	290	2.
1 FEB 1935	66	25.	*	2 FEB 0420	141	1595.	*	2 FEB 1305	216	58.	*	2 FEB 2150	291	1.
1 FEB 1942	67	26.	*	2 FEB 0427	142	1517.	*	2 FEB 1312	217	57.	*	2 FEB 2157	292	1.
1 FEB 1949	68	27.	*	2 FEB 0434	143	1446.	*	2 FEB 1319	218	56.	*	2 FEB 2204	293	1.
1 FEB 1956	69	28.	*	2 FEB 0441	144	1379.	*	2 FEB 1326	219	55.	*	2 FEB 2211	294	1.
1 FEB 2003	70	29.	*	2 FEB 0448	145	1316.	*	2 FEB 1333	220	54.	*	2 FEB 2218	295	1.
1 FEB 2010	71	30.	*	2 FEB 0455	146	1252.	*	2 FEB 1340	221	53.	*	2 FEB 2225	296	1.
1 FEB 2017	72	31.	*	2 FEB 0502	147	1193.	*	2 FEB 1347	222	52.	*	2 FEB 2232	297	1.
1 FEB 2024	73	32	*	2 FEB 0509	148	1141.	*	2 FEB 1354	223	51.	*	2 FEB 2239	298	1.
1 FEB 2031	74	33.	*	2 FEB 0516	149	1035.	*	2 FEB 1401	224	49.	*	2 FEB 2246	299	1.
1 FEB 2038	75	34.	*	2 FEB 0523	150	1076.	*	2 FEB 1408	225	48.	*	2 FEB 2253	300	1.

PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	36.88-HR
4095.	13.77	(CFS)	2529.	793.	544.	544.
		(INCHES)	71.094	89.547	89.707	89.707
		(AC-FT)	1244.	1566.	1569.	1569.

CUMULATIVE AREA = 0.33 SQ MI

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	A3	1621.	13.10	939.	384.	263.	1.70		
ROUTED TO	SEC10	1621.	13.42	939.	384.	263.	1.70	213.07	13.42
HYDROGRAPH AT	A2	270.	12.48	91.	36.	25.	0.17		
2 COMBINED AT	SEC10	1726.	13.10	1028.	421.	288.	1.87		
HYDROGRAPH AT	A1	1866.	13.65	1148.	476.	326.	2.04		
2 COMBINED AT	SEC15	3546.	13.42	2174.	896.	615.	3.90		
ROUTED TO	SEC20	3546.	13.42	2174.	896.	615.	3.90	201.34	13.42
HYDROGRAPH AT	A4	270.	12.48	101.	40.	28.	0.19		
2 COMBINED AT	SEC20	3667.	13.42	2273.	936.	642.	4.09		
ROUTED TO	RES20	3573.	13.77	2271.	936.	642.	4.09	212.10	13.77
ROUTED TO	SEC25	3573.	13.77	2271.	936.	642.	4.09	162.17	13.77
HYDROGRAPH AT	A13	257.	14.23	185.	79.	54.	0.31		
2 COMBINED AT	SEC25	3819.	13.88	2455.	1016.	697.	4.40		
ROUTED TO	RES10	3818.	13.88	2455.	1013.	695.	4.40	166.49	13.88
DIVERSION TO	DIVT1	1808.	12.48	617.	154.	105.	4.40		
HYDROGRAPH AT	RES10	2010.	12.48	1837.	859.	589.	4.40		
ROUTED TO	SEC30	2035.	12.48	1838.	859.	589.	4.40	152.03	12.48
HYDROGRAPH AT	A14	21.	12.13	4.	2.	1.	0.01		
2 COMBINED AT	SEC30	2041.	12.48	1841.	861.	591.	4.41		
DIVERSION TO	DIVT2	648.	12.02	454.	113.	77.	4.41		
HYDROGRAPH AT	SEC30	1393.	12.02	1387.	748.	513	4.41		
ROUTED TO	SEC35	1397.	12.02	1387.	748.	513.	4.41	122.11	12.02
HYDROGRAPH AT	RES11	1808.	13.88	617.	154.	105.	0.00		
ROUTED TO	RES11	1809.	13.88	582.	145.	99.	0.00	146.00	13.88
2 COMBINED AT	SEC35	3203.	13.89	1969.	893.	612.	4.41		
ROUTED TO	SEC40	3206.	13.88	1968.	893.	612.	4.41	91.63	13.88
HYDROGRAPH AT	A15	308.	12.37	99.	40.	28.	0.16		
2 COMBINED AT	SEC40	3294.	13.88	2057.	932.	640.	4.56		
ROUTED TO	SEC45	3287.	13.88	2057.	932.	640.	4.56	88.15	13.88
HYDROGRAPH AT	A22	11.	12.13	2.	1.	1.	0.00		

2 COMBINED AT	SEC45	3269.	13.00	2059.	933.	640.	4.56		
HYDROGRAPH AT	A6A	154.	12.25	38.	15.	10.	0.06		
HYDROGRAPH AT	A6B	70.	12.25	17.	7.	5.	0.03		
HYDROGRAPH AT	A6C	303.	12.37	94.	39.	26.	0.15		
3 COMBINED AT	SEC54	489.	12.25	149.	61.	42.	0.23		
ROUTED TO	SEC55	495.	12.37	149.	61.	42.	0.23	172.60	12.37
HYDROGRAPH AT	A11	136.	12.72	63.	25.	17.	0.10		
2 COMBINED AT	SEC55	593.	12.37	211.	86.	59.	0.34		
HYDROGRAPH AT	A12	328.	12.95	167.	69.	47.	0.26		
2 COMBINED AT	SEC60	804.	12.37	378.	155.	106.	0.60		
ROUTED TO	SEC65	813.	12.48	378.	155.	106.	0.60	106.92	12.48
HYDROGRAPH AT	A17	31.	12.13	6.	2.	2.	0.01		
2 COMBINED AT	SEC65	820.	12.48	383.	157.	108.	0.60		
HYDROGRAPH AT	A7	19.	12.13	4.	1.	1.	0.01		
ROUTED TO	SEC75	16.	12.25	4.	1.	1.	0.01	126.72	12.25
HYDROGRAPH AT	A10	153.	12.37	50.	20.	14.	0.08		
2 COMBINED AT	SEC75	165.	12.37	54.	22.	15.	0.09		
HYDROGRAPH AT	A8	273.	12.37	87.	34.	24.	0.17		
ROUTED TO	SEC80	273.	12.37	87.	34.	24.	0.17	105.62	12.37
HYDROGRAPH AT	A9	69.	12.13	13.	5.	4.	0.02		
2 COMBINED AT	SEC80	300.	12.37	100.	40.	27.	0.19		
3 COMBINED AT	SEC81	1263.	12.48	537.	219.	150.	0.88		
DIVERSION TO	DIVT4	0.	12.48	0.	0.	0.	0.88		
HYDROGRAPH AT	SEC81	1261.	12.48	537.	219.	150.	0.88		
ROUTED TO	SEC90	1275.	12.48	537.	219.	150.	0.88	92.67	12.48
HYDROGRAPH AT	A18	7.	12.13	1.	1.	0.	0.01		
2 COMBINED AT	SEC90	1276.	12.48	538.	219.	150.	0.89		
HYDROGRAPH AT	A19	97.	13.30	57.	24.	17.	0.09		
HYDROGRAPH AT	A16	159.	13.18	89.	37.	26.	0.13		
3 COMBINED AT	SEC91	1443.	12.48	684.	281.	193.	1.11		
ROUTED TO	SEC105	1445.	12.48	684.	281.	193.	1.11	83.96	12.48
HYDROGRAPH AT	A21	37.	12.25	9.	4.	3.	0.01		
HYDROGRAPH AT	SEC105	0.	0.00	0.	0.	0.	0.00		
3 COMBINED AT	SEC105	1463.	12.48	692.	284.	195.	1.12		
2 COMBINED AT	SEC110	4140.	13.65	2725.	1216.	835.	5.68		
DIVERSION TO	DIVT5	3312.	9.80	1897.	587.	402.	5.68		
HYDROGRAPH AT	SEC110	828.	9.80	828.	629.	433.	5.68		
ROUTED TO	SEC115	828.	11.08	828.	629.	433.	5.68	46.67	10.95
HYDROGRAPH AT	A20	18.	12.13	7.	3.	2.	0.01		
2 COMBINED AT	SEC115	866.	12.13	835.	632.	435.	5.69		
HYDROGRAPH AT	B1	333.	15.75	194.	92.	64.	0.32		
HYDROGRAPH AT	B2	11.	12.25	3.	1.	1.	0.00		
HYDROGRAPH AT	SEC01	648.	12.48	456.	113.	77.	0.00		
HYDROGRAPH AT	SEC01	3312.	13.65	1897.	587.	402.	0.00		
4 COMBINED AT	SEC01	4095.	13.77	2529.	793.	544.	0.33		

*** NORMAL END OF HEC-1 ***

```
OS
1**************************************
*                                    *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1) *
*            JUN 09 1992             *
*          VERSION 4.0.3E            *
*                                    *
* RUN DATE  06/23/97  TIME  13:33:55 *
*                                    *
**************************************

**************************************
*                                    *
*   U.S. ARMY CORPS OF ENGINEERS     *
*   HYDROLOGIC ENGINEERING CENTER    *
*        609 SECOND STREET           *
*     DAVIS, CALIFORNIA 95616        *
*         (916) 551-1748             *
*                                    *
**************************************

X     X  XXXXXXX   XXXXX        X
X     X  X        X     X      XX
X     X  X        X             X
XXXXXXX  XXXX     X     XXXXX   X
X     X  X        X             X
X     X  X        X     X       X
X     X  XXXXXXX   XXXXX       XXX

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                   HEC-1 INPUT                                           PAGE  1

LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1       ID   EWA VILLAGES PROJECT FLOOD (100-YEAR STORM)
  2       ID   FN: X101-1.DAT
  3       ID   PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
  4       ID                  EAST KAPOLEI - EXISTING CONDITIONS
  5       ID   KALOI - HONOULIULI NETWORK MODEL
          *DIAGRAM
  6       IT       5 01FEB97    1200     300
  7       IO       1

  8       KK      S3
  9       KM        GENERATE HYDROGRAPH FROM SUBBASIN S3
 10       KM        MID-WATERSHED PRECIPITATION DATA
 11       KO        3
 12       BA   0.027
 13       PH           0.027     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 14       LS       0      89
 15       UD   0.599

 16       KK      S4
 17       KM        GENERATE HYDROGRAPH FROM SUBBASIN S4
 18       KM        MID-WATERSHED PRECIPITATION DATA
 19       KO        3
 20       BA   0.012
 21       PH           0.012     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 22       LS       0      89
 23       UD   0.591

 24       KK      S5
 25       KM        GENERATE HYDROGRAPH FROM SUBBASIN S5
 26       KM        MID-WATERSHED PRECIPITATION DATA
 27       KO        3
 28       BA   0.023
 29       PH           0.023     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 30       LS       0      89
 31       UD   0.978

 32       KK      S6
 33       KM        GENERATE HYDROGRAPH FROM SUBBASIN S6
 34       KM        MID-WATERSHED PRECIPITATION DATA
 35       KO        3
```

```
 36       BA   0.017
 37       PH           0.017     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 38       LS       0      89
 39       UD   0.814

 40       KK    SECZ
 41       KO       3
 42       HC       4
 43       ZZ

1
               SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE     (V) ROUTING         (--->) DIVERSION OR PUMP FLOW

 NO.      (.) CONNECTOR       (<---) RETURN OF DIVERTED OR PUMPED FLOW

   8       S3
           .
  16       .       S4
           .       .
  24       .       .       S5
           .       .       .
  32       .       .       .       S6
           .       .       .       .
  40     SECZ.........................

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1**************************************
*                                    *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1) *
*            JUN 09 1992             *
*          VERSION 4.0.3E            *
*                                    *
* RUN DATE  06/23/97  TIME  13:33:55 *
*                                    *
**************************************

**************************************
*                                    *
*   U.S. ARMY CORPS OF ENGINEERS     *
*   HYDROLOGIC ENGINEERING CENTER    *
*        609 SECOND STREET           *
*     DAVIS, CALIFORNIA 95616        *
*         (916) 551-1748             *
*                                    *
**************************************

                      EWA VILLAGES PROJECT FLOOD (100-YEAR STORM)
                      FN: X101-1.DAT
                      PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
                                         EAST KAPOLEI - EXISTING CONDITIONS
                      KALOI - HONOULIULI NETWORK MODEL

  7 IO        OUTPUT CONTROL VARIABLES
                   IPRNT          1  PRINT CONTROL
                   IPLOT          0  PLOT CONTROL
                   QSCAL         0.  HYDROGRAPH PLOT SCALE

    IT        HYDROGRAPH TIME DATA
                   NMIN           5  MINUTES IN COMPUTATION INTERVAL
                   IDATE    1FEB97  STARTING DATE
                   ITIME       1200  STARTING TIME
                      NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                  NDDATE    2FEB97  ENDING DATE
                  NDTIME       1255  ENDING TIME
                   ICENT         19  CENTURY MARK

              COMPUTATION INTERVAL    0.08 HOURS
                   TOTAL TIME BASE   24.92 HOURS

      ENGLISH UNITS
          DRAINAGE AREA          SQUARE MILES
          PRECIPITATION DEPTH    INCHES
          LENGTH, ELEVATION      FEET
          FLOW                   CUBIC FEET PER SECOND
          STORAGE VOLUME         ACRE-FEET
          SURFACE AREA           ACRES
          TEMPERATURE            DEGREES FAHRENHEIT

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
```

```
              *************
 8 KK         *           *
              *    S3     *
              *           *
              *************

                        GENERATE HYDROGRAPH FROM SUBBASIN S3
                        MID-WATERSHED PRECIPITATION DATA

11 KO       OUTPUT CONTROL VARIABLES
                 IPRNT          3  PRINT CONTROL
                 IPLOT          0  PLOT CONTROL
                 QSCAL         0.  HYDROGRAPH PLOT SCALE

            SUBBASIN RUNOFF DATA

12 BA       SUBBASIN CHARACTERISTICS
                 TAREA       0.03  SUBBASIN AREA

            PRECIPITATION DATA

13 PH                      DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
            ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
            5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
             0.65    1.32    2.45    3.55    4.60    6.75    9.20   12.30    0.00    0.00    0.00    0.00

                                  STORM AREA =     0.03

14 LS       SCS LOSS RATE
                 STRTL       0.25  INITIAL ABSTRACTION
                 CRVNBR     89.00  CURVE NUMBER
                 RTIMP       0.00  PERCENT IMPERVIOUS AREA

15 UD       SCS DIMENSIONLESS UNITGRAPH
                 TLAG        0.60  LAG

                                              ***

                                         UNIT HYDROGRAPH
                                   38 END-OF-PERIOD ORDINATES
              1.       3.       6.      10.      15.      19.      20.      20.      19.      18.
             15.      12.      10.       8.       6.       5.       4.       3.       3.       2.
              2.       1.       1.       1.       1.       1.       0.       0.       0.       0.
              0.       0.       0.       0.       0.       0.       0.       0.

  ***          ***          ***          ***          ***

                    HYDROGRAPH AT STATION        S3

 TOTAL RAINFALL =    12.30, TOTAL LOSS =     1.37, TOTAL EXCESS =    10.93

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR        24-HR        72-HR     24.92-HR
+  (CFS)       (HR)
                          (CFS)
+     44.     12.67                   19.           8.           8.           8.
                       (INCHES)     6.436       10.907       10.907       10.907
                        (AC-FT)        9.          16.          16.          16.

                    CUMULATIVE AREA =     0.03 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              *************
16 KK         *           *
              *    S4     *
              *           *
              *************

                        GENERATE HYDROGRAPH FROM SUBBASIN S4
                        MID-WATERSHED PRECIPITATION DATA

19 KO       OUTPUT CONTROL VARIABLES
                 IPRNT          3  PRINT CONTROL
                 IPLOT          0  PLOT CONTROL
                 QSCAL         0.  HYDROGRAPH PLOT SCALE

            SUBBASIN RUNOFF DATA

20 BA       SUBBASIN CHARACTERISTICS
                 TAREA       0.01  SUBBASIN AREA

            PRECIPITATION DATA

21 PH                      DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
            ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
            5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
             0.65    1.32    2.45    3.55    4.60    6.75    9.20   12.30    0.00    0.00    0.00    0.00

                                  STORM AREA =     0.01

22 LS       SCS LOSS RATE
                 STRTL       0.25  INITIAL ABSTRACTION
                 CRVNBR     89.00  CURVE NUMBER
                 RTIMP       0.00  PERCENT IMPERVIOUS AREA

23 UD       SCS DIMENSIONLESS UNITGRAPH
                 TLAG        0.59  LAG

                                              ***

                                         UNIT HYDROGRAPH
                                   37 END-OF-PERIOD ORDINATES
              0.       1.       3.       5.       7.       8.       9.       9.       9.       8.
              7.       5.       4.       3.       3.       2.       2.       1.       1.       1.
              1.       1.       0.       0.       0.       0.       0.       0.       0.       0.
              0.       0.       0.       0.       0.       0.       0.

  ***          ***          ***          ***          ***

                    HYDROGRAPH AT STATION        S4

 TOTAL RAINFALL =    12.30, TOTAL LOSS =     1.37, TOTAL EXCESS =    10.93

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR        24-HR        72-HR     24.92-HR
+  (CFS)       (HR)
                          (CFS)
+     20.     12.67                    8.           4.           3.           3.
                       (INCHES)     6.437       10.908       10.908       10.908
                        (AC-FT)        4.           7.           7.           7.

                    CUMULATIVE AREA =     0.01 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              *************
24 KK         *           *
              *    S5     *
              *           *
              *************

                        GENERATE HYDROGRAPH FROM SUBBASIN S5
                        MID-WATERSHED PRECIPITATION DATA

27 KO       OUTPUT CONTROL VARIABLES
                 IPRNT          3  PRINT CONTROL
                 IPLOT          0  PLOT CONTROL
                 QSCAL         0.  HYDROGRAPH PLOT SCALE

            SUBBASIN RUNOFF DATA

28 BA       SUBBASIN CHARACTERISTICS
                 TAREA       0.02  SUBBASIN AREA

            PRECIPITATION DATA

29 PH                      DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
            ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
            5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
             0.65    1.32    2.45    3.55    4.60    6.75    9.20   12.30    0.00    0.00    0.00    0.00

                                  STORM AREA =     0.02
```

```
30 LS         SCS LOSS RATE
                   STRTL        0.25  INITIAL ABSTRACTION
                  CRVNBR       89.00  CURVE NUMBER
                   RTIMP        0.00  PERCENT IMPERVIOUS AREA

31 UD         SCS DIMENSIONLESS UNITGRAPH
                    TLAG        0.98  LAG

                                                  ***

                                          UNIT HYDROGRAPH
                                      61 END-OF-PERIOD ORDINATES
              0.      1.      2.      2.      4.      5.      7.      8.      9.     10.
             11.     11.     11.     11.     10.      9.      9.      8.      7.      6.
              5.      4.      4.      3.      3.      3.      2.      2.      2.      1.
              1.      1.      1.      1.      1.      1.      1.      1.      0.      0.
              0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
              0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
              0.

     ***          ***          ***          ***          ***

                     HYDROGRAPH AT STATION       S5

  TOTAL RAINFALL =   12.30, TOTAL LOSS =    1.37, TOTAL EXCESS =   10.93

 PEAK FLOW     TIME                       MAXIMUM AVERAGE FLOW
                                   6-HR        24-HR       72-HR     24.92-HR
+  (CFS)       (HR)
                         (CFS)
+    30.      13.00                 16.          7.          6.          6.
                       (INCHES)   6.382      10.832      10.832      10.832
                        (AC-FT)      8.         13.         13.         13.

                     CUMULATIVE AREA =    0.02 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          **************
          *            *
32 KK     *      S6    *
          *            *
          **************
                        GENERATE HYDROGRAPH FROM SUBBASIN S6
                        MID-WATERSHED PRECIPITATION DATA

35 KO          OUTPUT CONTROL VARIABLES
                    IPRNT           3  PRINT CONTROL
                    IPLOT           0  PLOT CONTROL
                    QSCAL          0.  HYDROGRAPH PLOT SCALE

             SUBBASIN RUNOFF DATA

36 BA          SUBBASIN CHARACTERISTICS
                    TAREA        0.02  SUBBASIN AREA

               PRECIPITATION DATA

37 PH                          DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
               ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
               5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                0.65    1.32    2.45    3.55    4.60    6.75    9.20   12.30    0.00    0.00    0.00    0.00

                                          STORM AREA =    0.02

38 LS          SCS LOSS RATE
                    STRTL        0.25  INITIAL ABSTRACTION
                   CRVNBR       89.00  CURVE NUMBER
                    RTIMP        0.00  PERCENT IMPERVIOUS AREA

39 UD          SCS DIMENSIONLESS UNITGRAPH
                     TLAG        0.81  LAG

                                                  ***

                                          UNIT HYDROGRAPH
                                      51 END-OF-PERIOD ORDINATES
              0.      1.      2.      3.      4.      6.      8.      9.      9.     10.
             10.      9.      8.      8.      7.      6.      5.      4.      3.      3.
              3.      2.      2.      2.      1.      1.      1.      1.      1.      1.
              1.      0.      0.      0.      0.      0.      0.      0.      0.      0.
              0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
              0.

     ***          ***          ***          ***          ***

                     HYDROGRAPH AT STATION       S6

  TOTAL RAINFALL =   12.30, TOTAL LOSS =    1.37, TOTAL EXCESS =   10.93

 PEAK FLOW     TIME                       MAXIMUM AVERAGE FLOW
                                   6-HR        24-HR       72-HR     24.92-HR
+  (CFS)       (HR)
                         (CFS)
+    24.      12.83                 13.          5.          5.          5.
                       (INCHES)   6.409      10.869      10.869      10.869
                        (AC-FT)      6.         10.         10.         10.

                     CUMULATIVE AREA =    0.02 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          **************
          *            *
40 KK     *     SEC2   *
          *            *
          **************

41 KO          OUTPUT CONTROL VARIABLES
                    IPRNT           3  PRINT CONTROL
                    IPLOT           0  PLOT CONTROL
                    QSCAL          0.  HYDROGRAPH PLOT SCALE

42 HC          HYDROGRAPH COMBINATION
                    ICOMP           4  NUMBER OF HYDROGRAPHS TO COMBINE

                                                  ***
MAKE2 NPLAN,NSTM      1      0
MAKE2 NPLAN,NSTM      1      0
MAKE2 NPLAN,NSTM      1      0

     ***          ***          ***          ***          ***

                     HYDROGRAPH AT STATION     SEC2

 PEAK FLOW     TIME                       MAXIMUM AVERAGE FLOW
                                   6-HR        24-HR       72-HR     24.92-HR
+  (CFS)       (HR)
                         (CFS)
+   113.      12.75                 54.         23.         22.         22.
                       (INCHES)   6.404      10.877      10.877      10.877
                        (AC-FT)     27.         46.         46.         46.

                     CUMULATIVE AREA =    0.08 SQ MI

1
                                        RUNOFF SUMMARY
                                FLOW IN CUBIC FEET PER SECOND
                              TIME IN HOURS,  AREA IN SQUARE MILES

                                      PEAK   TIME OF    AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN    MAXIMUM    TIME OF
          OPERATION       STATION     FLOW     PEAK                                           AREA     STAGE    MAX STAGE
+                                                        6-HOUR     24-HOUR     72-HOUR

          HYDROGRAPH AT
+                           S3         44.    12.67        19.          8.          6.       0.03

          HYDROGRAPH AT
+                           S4         20.    12.67         8.          4.          3.       0.01

          HYDROGRAPH AT
```

```
                      S5      30.  13.00      16.      7.      6.    0.02

      HYDROGRAPH AT   S6      24.  12.83      12.      5.      5.    0.02

      4 COMBINED AT   SEC2   113.  12.75      56.     23.     22.    0.08


*** NORMAL END OF HEC-1 ***
```

```
*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*            JUN 09 1992                *
*           VERSION 4.0.3E              *
*                                       *
* RUN DATE  06/23/97  TIME  13:35:06    *
*                                       *
*****************************************

*****************************************
*                                       *
*   U.S. ARMY CORPS OF ENGINEERS        *
*   HYDROLOGIC ENGINEERING CENTER       *
*         609 SECOND STREET             *
*     DAVIS, CALIFORNIA 95616           *
*         (916) 551-1748                *
*                                       *
*****************************************

X     X  XXXXXXX   XXXXX        X
X     X  X        X     X      XX
X     X  X        X             X
XXXXXXX  XXXX     X      XXXXX  X
X     X  X        X             X
X     X  X        X     X       X
X     X  XXXXXXX   XXXXX       XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

```
1                                   HEC-1 INPUT                                              PAGE  1

LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1        ID   EWA VILLAGES PROJECT FLOOD (100-YEAR STORM)
  2        ID   FN: X101-2.DAT
  3        ID   PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
  4        ID                       EAST KAPOLEI - EXISTING CONDITIONS
  5        ID   KALOI - HUNEHUNE NETWORK MODEL
           *DIAGRAM
  6        IT       5 01FEB97    1200     300
  7        IO       5

  8        KK     S7A
  9        KM        GENERATE HYDROGRAPH FROM SUBBASIN S7A
 10        KM        MID-WATERSHED PRECIPITATION DATA
 11        KO       3
 12        BA   0.065
 13        PH           0.065     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 14        LS       0      89
 15        UD   0.286

 16        KK     S7B
 17        KM        GENERATE HYDROGRAPH FROM SUBBASIN S7B
 18        KM        MID-WATERSHED PRECIPITATION DATA
 19        KO       3
 20        BA   0.091
 21        PH           0.091     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 22        LS       0      89
 23        UD   0.079

 24        KK      S8
 25        KM        GENERATE HYDROGRAPH FROM SUBBASIN S8
 26        KM        MID-WATERSHED PRECIPITATION DATA
 27        KO       3
 28        BA   0.686
 29        PH           0.686     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 30        LS       0      89
 31        UD   1.694

 32        KK      S9
 33        KM        GENERATE HYDROGRAPH FROM SUBBASIN S9
 34        KM        MID-WATERSHED PRECIPITATION DATA
 35        KO       3
```

```
36          BA  0.122
37          PH        0.122    .65   1.32   2.45   3.55   4.60   6.75   9.20  12.30
38          LS     0     89
39          UD  1.822

40          KK   S10A
41          KM      GENERATE HYDROGRAPH FROM SUBBASIN S10A
42          KM      MID-WATERSHED PRECIPITATION DATA
43          KO      3
44          BA  0.083
45          PH        0.099  . .65   1.32   2.45   3.55   4.60   6.75   9.20  12.30
46          LS     0     89
47          UD  1.630
1                           HEC-1 INPUT                                          PAGE  2

LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

48          KK   S10B
49          KM      GENERATE HYDROGRAPH FROM SUBBASIN S10B
50          KM      MID-WATERSHED PRECIPITATION DATA
51          KO      3
52          BA  0.018
53          PH        0.018    .65   1.32   2.45   3.55   4.60   6.75   9.20  12.30
54          LS     0     89
55          UD  0.474

56          KK   S11
57          KM      GENERATE HYDROGRAPH FROM SUBBASIN S11
58          KM      MID-WATERSHED PRECIPITATION DATA
59          KO      3
60          BA  0.073
61          PH        0.073    .65   1.32   2.45   3.55   4.60   6.75   9.20  12.30
62          LS     0     89
63          UD  1.888

64          KK   S12
65          KM      GENERATE HYDROGRAPH FROM SUBBASIN S12
66          KM      MID-WATERSHED PRECIPITATION DATA
67          KO      3
68          BA  0.113
69          PH        0.113    .65   1.32   2.45   3.55   4.60   6.75   9.20  12.30
70          LS     0     89
71          UD  1.860

72          KK   S13
73          KM      GENERATE HYDROGRAPH FROM SUBBASIN S13
74          KM      MID WATERSHED PRECIPITATION DATA
75          KO      3
76          BA  0.030
77          PH        0.030    .65   1.32   2.45   3.55   4.60   6.75   9.20  12.30
78          LS     0     89
79          UD  0.836

80          KK   SECY
81          KO      3
82          HC      9
83          ZZ
1
            SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
LINE     (V) ROUTING         (--->) DIVERSION OR PUMP FLOW

NO.      (.) CONNECTOR       (<---) RETURN OF DIVERTED OR PUMPED FLOW

  8      S7A
          .
 16       .     S7B
          .      .
 24       .      .      S8
          .      .      .
 32       .      .      .     S9
          .      .      .      .
 40       .      .      .      .     S10A
          .      .      .      .      .
 48       .      .      .      .      .     S10B
          .      .      .      .      .      .
 56       .      .      .      .      .      .     S11
          .      .      .      .      .      .      .
 64       .      .      .      .      .      .      .     S12
          .      .      .      .      .      .      .      .
 72       .      .      .      .      .      .      .      .     S13
          .      .      .      .      .      .      .      .      .
 80     SECY.............................................................

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************          ****************************************
*                                       *          *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *          *  U.S. ARMY CORPS OF ENGINEERS        *
*          JUN 09 1992                  *          *  HYDROLOGIC ENGINEERING CENTER       *
*          VERSION 4.0.1E               *          *        609 SECOND STREET             *
*                                       *          *   DAVIS, CALIFORNIA 95616            *
*  RUN DATE  06/23/97  TIME  13:35:06   *          *       (916) 551-1748                 *
*                                       *          *                                      *
*****************************************          ****************************************


                 EWA VILLAGES PROJECT FLOOD (100-YEAR STORM)
                 FN: X101-2.DAT
                 PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
                                     EAST KAPOLEI - EXISTING CONDITIONS
                 KALOI - HUNEHUNE NETWORK MODEL

  7 IO        OUTPUT CONTROL VARIABLES
                   IPRNT          5  PRINT CONTROL
                   IPLOT          0  PLOT CONTROL
                   QSCAL         0.  HYDROGRAPH PLOT SCALE

  IT          HYDROGRAPH TIME DATA
                   NMIN           5  MINUTES IN COMPUTATION INTERVAL
                   IDATE    1FEB97   STARTING DATE
                   ITIME       1200  STARTING TIME
                   NQ           300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE   2FEB97   ENDING DATE
                   NDTIME      1355  ENDING TIME
                   ICENT         19  CENTURY MARK

               COMPUTATION INTERVAL    0.08 HOURS
                   TOTAL TIME BASE   24.92 HOURS

        ENGLISH UNITS
             DRAINAGE AREA           SQUARE MILES
             PRECIPITATION DEPTH     INCHES
             LENGTH, ELEVATION       FEET
             FLOW                    CUBIC FEET PER SECOND
             STORAGE VOLUME          ACRE-FEET
             SURFACE AREA            ACRES
             TEMPERATURE             DEGREES FAHRENHEIT

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
  8 KK        *    S7A     *
              *            *
              **************

 11 KO        OUTPUT CONTROL VARIABLES
                   IPRNT          3  PRINT CONTROL
                   IPLOT          0  PLOT CONTROL
                   QSCAL         0.  HYDROGRAPH PLOT SCALE

              SUBBASIN RUNOFF DATA

 12 BA        SUBBASIN CHARACTERISTICS
```

```
                 TAREA        0.00  SUBBASIN AREA

             PRECIPITATION DATA

 13 PH                          DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
             ..... HYDRO-35 ......  ................ TP-40 ................  ............ TP-49 ...........
             5-MIN  15-MIN  60-MIN   2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
              0.65    1.32    2.45   3.55    4.60    6.75    9.20   12.30    0.00  . 0.00    0.00    0.00

                                          STORM AREA =    0.00

 14 LS       SCS LOSS RATE
                 STRTL        0.25  INITIAL ABSTRACTION
                 CRVNBR      89.00  CURVE NUMBER
                 RTIMP        0.00  PERCENT IMPERVIOUS AREA

 15 UD       SCS DIMENSIONLESS UNITGRAPH
                 TLAG         0.29  LAG

                                                ***

                                          UNIT HYDROGRAPH
                                     19 END-OF-PERIOD ORDINATES
             1.       4.       7.       7.       6.       5.       3.       2.       1.       1.
             1.       0.       0.       0.       0.       0.       0.       0.       0.

    ***          ***          ***          ***          ***

                      HYDROGRAPH AT STATION      S7A

   TOTAL RAINFALL =   12.30, TOTAL LOSS =    1.37, TOTAL EXCESS =   10.93

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR       72-HR     24.92-HR
 +   (CFS)      (HR)
                             (CFS)
 +      12     12.33                    3.          1.          1.          1.
                          (INCHES)   6.466      10.931      10.931      10.931
                           (AC-FT)      2.          3.          3.          3.

                        CUMULATIVE AREA =    0.00 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              ***************
              *             *
 16 KK        *     S7B     *
              *             *
              ***************

 19 KO       OUTPUT CONTROL VARIABLES
                 IPRNT            3  PRINT CONTROL
                 IPLOT            0  PLOT CONTROL
                 QSCAL           0.  HYDROGRAPH PLOT SCALE

            SUBBASIN RUNOFF DATA

 20 BA       SUBBASIN CHARACTERISTICS
                 TAREA        0.00  SUBBASIN AREA

             PRECIPITATION DATA

 21 PH                          DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
             ..... HYDRO-35 ......  ................ TP-40 ................  ............ TP-49 ...........
             5-MIN  15-MIN  60-MIN   2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
              0.65    1.32    2.45   3.55    4.60    6.75    9.20   12.30    0.00    0.00    0.00    0.00

                                          STORM AREA =    0.00

 22 LS       SCS LOSS RATE
                 STRTL        0.25  INITIAL ABSTRACTION
                 CRVNBR      89.00  CURVE NUMBER
                 RTIMP        0.00  PERCENT IMPERVIOUS AREA

 23 UD       SCS DIMENSIONLESS UNITGRAPH
                 TLAG         0.08  LAG

                                                ***

                                          UNIT HYDROGRAPH
                                     7 END-OF-PERIOD ORDINATES
             3.       3.       1.       0.       0.       0.       0.

    ***          ***          ***          ***          ***

                      HYDROGRAPH AT STATION      S7B

   TOTAL RAINFALL =   12.30, TOTAL LOSS =    1.37, TOTAL EXCESS =   10.93

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR       72-HR     24.92-HR
 +   (CFS)      (HR)
                             (CFS)
 +       1.    12.00                    1.          0.          0.          0.
                          (INCHES)   6.482      10.932      10.932      10.932
                           (AC-FT)      0.          1.          1.          1.

                        CUMULATIVE AREA =    0.00 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              ***************
              *             *
 24 KK        *     S8      *
              *             *
              ***************

 27 KO       OUTPUT CONTROL VARIABLES
                 IPRNT            3  PRINT CONTROL
                 IPLOT            0  PLOT CONTROL
                 QSCAL           0.  HYDROGRAPH PLOT SCALE

            SUBBASIN RUNOFF DATA

 28 BA       SUBBASIN CHARACTERISTICS
                 TAREA        0.09  SUBBASIN AREA

             PRECIPITATION DATA

 29 PH                          DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
             ..... HYDRO-35 ......  ................ TP-40 ................  ............ TP-49 ...........
             5-MIN  15-MIN  60-MIN   2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
              0.65    1.32    2.45   3.55    4.60    6.75    9.20   12.30    0.00    0.00    0.00    0.00

                                          STORM AREA =    0.09

 30 LS       SCS LOSS RATE
                 STRTL        0.25  INITIAL ABSTRACTION
                 CRVNBR      89.00  CURVE NUMBER
                 RTIMP        0.00  PERCENT IMPERVIOUS AREA

 31 UD       SCS DIMENSIONLESS UNITGRAPH
                 TLAG         1.69  LAG

                                                ***

                                          UNIT HYDROGRAPH
                                     104 END-OF-PERIOD ORDINATES
             0.       1.       1.       2.       3.       4.       6.       7.       9.      10.
            13.      15.      17.      19.      20.      21.      22.      23.      24.      24.
            24.      24.      24.      23.      22.      21.      21.      20.      19.      18.
            17.      15.      14.      13.      11.      11.      10.       9.       8.       8.
             7.       7.       6.       6.       5.       5.       5.       4.       4.       4.
             3.       3.       3.       3.       2.       2.       2.       2.       2.       2.
             2.       1.       1.       1.       1.       1.       1.       1.       1.       1.
             1.       1.       1.       1.       1.       0.       0.       0.       0.       0.
             0.       0.       0.       0.       0.       0.       0.       0.       0.       0.
             0.       0.       0.       0.       0.       0.       0.       0.       0.       0.
             0.       0.       0.       0.

    ***          ***          ***          ***          ***
```

```
                    HYDROGRAPH AT STATION       S8

   TOTAL RAINFALL =   12.30, TOTAL LOSS =    1.37, TOTAL EXCESS =   10.93

  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                     6-HR        24-HR       72-HR     24.92-HR
 +  (CFS)       (HR)
                          (CFS)
 +      86.     13.83                 58.          25.         24.          24.
                        (INCHES)    6.219       10.634      10.634       10.634
                         (AC-FT)      29.          49.         49.          49.

                    CUMULATIVE AREA =     0.09 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
  32 KK       *       S9   *
              *            *
              **************

  35 KO          OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE

                 SUBBASIN RUNOFF DATA

  36 BA          SUBBASIN CHARACTERISTICS
                       TAREA        0.12  SUBBASIN AREA

                 PRECIPITATION DATA

  37 PH                                  DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                 ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                  0.65    1.32    2.45    3.55    4.60    6.75    9.20   12.30    0.00    0.00    0.00    0.00

                                          STORM AREA =     0.12

  38 LS          SCS LOSS RATE
                       STRTL        0.25  INITIAL ABSTRACTION
                      CRVNBR       89.00  CURVE NUMBER
                       RTIMP        0.00  PERCENT IMPERVIOUS AREA

  39 UD          SCS DIMENSIONLESS UNITGRAPH
                        TLAG        1.82  LAG

                                                    ***

                                              UNIT HYDROGRAPH
                                          111 END-OF-PERIOD ORDINATES
                 0.        1.        2.        3.        4.        5.        7.        8.       10.       12.
                14.       17.       20.       22.       24.       26.       28.       30.       30.       31.
                31.       32.       32.       31.       31.       30.       29.       28.       27.       26.
                25.       24.       22.       21.       19.       17.       16.       15.       14.       13.
                12.       11.       10.        9.        9.        8.        8.        7.        7.        6.
                 6         5.        5.        5.        4.        4.        4.        3.        3.        3.
                 3.        3.        2.        2.        2.        2.        2.        2.        2.        1.
                 1.        1.        1.        1.        1.        1.        1.        1.        1.        1.
                 1.        1.        1.        1.        0.        0.        0.        0.        0.        0.
                 0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
                 0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
                 0.

      ***            ***            ***            ***            ***

                    HYDROGRAPH AT STATION       S9

   TOTAL RAINFALL =   12.30, TOTAL LOSS =    1.37, TOTAL EXCESS =   10.93

  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                     6-HR        24-HR       72-HR     24.92-HR
 +  (CFS)       (HR)
                          (CFS)
 +     118.     14.03                 81.          35.         33.          33.
                        (INCHES)    6.182       10.595      10.595       10.595
                         (AC-FT)      40.          69.         69.          69.

                    CUMULATIVE AREA =     0.12 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
  40 KK       *      S10A  *
              *            *
              **************

  43 KO          OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE

                 SUBBASIN RUNOFF DATA

  44 BA          SUBBASIN CHARACTERISTICS
                       TAREA        0.09  SUBBASIN AREA

                 PRECIPITATION DATA

  45 PH                                  DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                 ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                  0.65    1.32    2.45    3.55    4.60    6.75    9.20   12.30    0.00    0.00    0.00    0.00

                                          STORM AREA =     0.09

  46 LS          SCS LOSS RATE
                       STRTL        0.25  INITIAL ABSTRACTION
                      CRVNBR       89.00  CURVE NUMBER
                       RTIMP        0.00  PERCENT IMPERVIOUS AREA

  47 UD          SCS DIMENSIONLESS UNITGRAPH
                        TLAG        1.63  LAG

                                                    ***

                                              UNIT HYDROGRAPH
                                          100 END-OF-PERIOD ORDINATES
                 0.        1.        2.        3.        4.        5.        6.        8.       10.       12.
                14.       17.       19.       21.       22.       24.       25.       25.       26.       26.
                26.       25.       25.       24.       23.       22.       21.       20.       19.       18.
                16.       15.       13.       12.       11.       10.        9.        9.        8.        7.
                 7.        6.        6.        5.        5.        5.        4.        4.        4.        3.
                 3.        3.        3.        2.        2.        2.        2.        2.        2.        1.
                 1.        1.        1.        1.        1.        1.        1.        1.        1.        1.
                 1.        1.        1.        0.        0.        0.        0.        0.        0.        0.
                 0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
                 0.        0.        0.        0.        0.        0.        0.        0.        0.        0.

      ***            ***            ***            ***            ***

                    HYDROGRAPH AT STATION     S10A

   TOTAL RAINFALL =   12.30, TOTAL LOSS =    1.37, TOTAL EXCESS =   10.93

  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                     6-HR        24-HR       72-HR     24.92-HR
 +  (CFS)       (HR)
                          (CFS)
 +      91.     13.75                 60.          25.         25.          25.
                        (INCHES)    6.236       10.653      10.653       10.653
                         (AC-FT)      30.          51.         51.          51.

                    CUMULATIVE AREA =     0.09 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
```

```
                    ***************
                    *             *
49 KK               *    S10B     *
                    *             *
                    ***************

51 KO          OUTPUT CONTROL VARIABLES
                     IPRNT          3  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE

             SUBBASIN RUNOFF DATA

52 BA          SUBBASIN CHARACTERISTICS
                     TAREA        0.02  SUBBASIN AREA

             PRECIPITATION DATA

53 PH                              DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
               ..... HYDRO-35 ......  ............... TP-40 ...............  ........... TP-49 ...........
               5-MIN  15-MIN  60-MIN   2-HR   3-HR   6-HR  12-HR  24-HR  2-DAY  4-DAY  7-DAY  10-DAY
                0.65    1.32    2.45   3.55   4.40   6.75   9.20  12.30   0.00   0.00   0.00    0.00

                                           STORM AREA =     0.02

54 LS          SCS LOSS RATE
                     STRTL        0.25  INITIAL ABSTRACTION
                     CRVNBR      89.00  CURVE NUMBER
                     RTIMP        0.00  PERCENT IMPERVIOUS AREA

55 UD          SCS DIMENSIONLESS UNITGRAPH
                     TLAG         0.47  LAG

                                                        ***

                                                  UNIT HYDROGRAPH
                                             30 END-OF-PERIOD ORDINATES
               1.      4.      8.     12.     16.     17.     16.     15.     12.      9.
               7.      5.      4.      3.      2.      2.      1.      1.      1.      1.
               0.      0.      0.      0.      0.      0.      0.      0.      0.      0.

     ***             ***            ***             ***            ***

                    HYDROGRAPH AT STATION      S10B

   TOTAL RAINFALL =   12.30, TOTAL LOSS =    1.37, TOTAL EXCESS =   10.93

   PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
 +  (CFS)        (HR)
                              (CFS)
 +     33.      12.50                    12.          5.          5.          5.
                           (INCHES)   6.449      10.921      10.921      10.921
                            (AC-FT)      6.         10.         10.         10.

                    CUMULATIVE AREA =    0.02 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

                    ***************
                    *             *
56 KK               *     S11     *
                    *             *
                    ***************

59 KO          OUTPUT CONTROL VARIABLES
                     IPRNT          3  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE

             SUBBASIN RUNOFF DATA

60 BA          SUBBASIN CHARACTERISTICS
                     TAREA        0.07  SUBBASIN AREA

             PRECIPITATION DATA

61 PH                              DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
               ..... HYDRO-35 ......  ............... TP-40 ...............  ........... TP-49 ...........
               5-MIN  15-MIN  60-MIN   2-HR   3-HR   6-HR  12-HR  24-HR  2-DAY  4-DAY  7-DAY  10-DAY
                0.65    1.32    2.45   3.55   4.40   6.75   9.20  12.30   0.00   0.00   0.00    0.00

                                           STORM AREA =     0.07

62 LS          SCS LOSS RATE
                     STRTL        0.25  INITIAL ABSTRACTION
                     CRVNBR      89.00  CURVE NUMBER
                     RTIMP        0.00  PERCENT IMPERVIOUS AREA

63 UD          SCS DIMENSIONLESS UNITGRAPH
                     TLAG         1.89  LAG

                                                        ***

                                                  UNIT HYDROGRAPH
                                            115 END-OF-PERIOD ORDINATES
               0.      0.      1.      1.      2.      3.      4.      4.      5.      7.
               8.      9.     11.     12.     13.     15.     16.     17.     17.     18.
              18.     18.     18.     18.     18.     18.     17.     17.     16.     16.
              15.     15.     14.     13.     12.     11.     10.      9.      9.      8.
               8.      7.      7.      6.      6.      5.      5.      5.      4.      4.
               4.      4.      3.      3.      3.      3.      2.      2.      2.      2.
               2.      2.      2.      2.      1.      1.      1.      1.      1.      1.
               1.      1.      1.      1.      1.      1.      1.      1.      1.      0.
               0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
               0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
               0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
               0.      0.      0.      0.      0.

     ***             ***            ***             ***            ***

                    HYDROGRAPH AT STATION      S11

   TOTAL RAINFALL =   12.30, TOTAL LOSS =    1.37, TOTAL EXCESS =   10.93

   PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
 +  (CFS)        (HR)
                              (CFS)
 +     70.      14.00                    46.         21.         20.         20.
                           (INCHES)   6.164      10.575      10.575      10.575
                            (AC-FT)     24.         41.         41.         41.

                    CUMULATIVE AREA =    0.07 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

                    ***************
                    *             *
64 KK               *     S12     *
                    *             *
                    ***************

67 KO          OUTPUT CONTROL VARIABLES
                     IPRNT          3  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE

             SUBBASIN RUNOFF DATA

68 BA          SUBBASIN CHARACTERISTICS
                     TAREA        0.11  SUBBASIN AREA

             PRECIPITATION DATA

69 PH                              DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
               ..... HYDRO-35 ......  ............... TP-40 ...............  ........... TP-49 ...........
               5-MIN  15-MIN  60-MIN   2-HR   3-HR   6-HR  12-HR  24-HR  2-DAY  4-DAY  7-DAY  10-DAY
                0.65    1.32    2.45   3.55   4.60   6.75   9.20  12.30   0.00   0.00   0.00    0.00
```

```
                                        STORM AREA =     0.11

70 LS         SCS LOSS RATE
                  STRTL          0.25  INITIAL ABSTRACTION
                  CRVNBR        89.00  CURVE NUMBER
                  RTIMP          0.00  PERCENT IMPERVIOUS AREA

71 UD         SCS DIMENSIONLESS UNITGRAPH
                  TLAG           1.87  LAG

                                            ***

                                          UNIT HYDROGRAPH
                                      114 END-OF-PERIOD ORDINATES
          0.      1.      1.      2.      3.      4.      6.      7.      9.     11.
         13.     15.     17.     19.     21.     23.     25.     26.     27.     28.
         28.     28.     29.     28.     28.     28.     27.     26.     25.     24.
         21.     22.     21.     20.     19.     17.     16.     14.     13.     12.
         11.     11.     10.      9.      9.      8.      7.      7.      7.      6.
          6.      5.      5.      5.      4.      4.      4.      3.      3.      3.
          3.      3.      2.      2.      2.      2.      2.      2.      2.      1.
          1.      1.      1.      1.      1.      1.      1.      1.      1.      1.
          1.      1.      1.      1.      1.      0.      0.      0.      0.      0.
          0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
          0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
          0.      0.      0.      0.

   ***          ***          ***          ***          ***

                     HYDROGRAPH AT STATION        S12

 TOTAL RAINFALL =   12.30, TOTAL LOSS =     1.37, TOTAL EXCESS =    10.93

 PEAK FLOW     TIME                       MAXIMUM AVERAGE FLOW
                                 6-HR        24-HR        72-HR      24.92-HR
 +  (CFS)      (HR)
                        (CFS)
 +   108.     14.90                75.          32.          31.          31.
                      (INCHES)   6.169       10.581       10.581       10.581
                       (AC-FT)     37.          64.          64.          64.

                    CUMULATIVE AREA =     0.11 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          **************
          *            *
72 KK     *     S13    *
          *            *
          **************

75 KO         OUTPUT CONTROL VARIABLES
                  IPRNT          3  PRINT CONTROL
                  IPLOT          0  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE

             SUBBASIN RUNOFF DATA

76 BA         SUBBASIN CHARACTERISTICS
                  TAREA          0.03  SUBBASIN AREA

              PRECIPITATION DATA

77 PH                             DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
              ..... HYDRO-35 ..... ................ TP-40 ................ ........... TP-49 ...........
              5-MIN  15-MIN  60-MIN   2-HR   3-HR   6-HR  12-HR  24-HR  2-DAY  4-DAY  7-DAY 10-DAY
               0.65    1.32    2.45   3.55   4.60   6.75   9.22  12.30   0.00   0.00   0.00   0.00

                                        STORM AREA =     0.03

78 LS         SCS LOSS RATE
                  STRTL          0.25  INITIAL ABSTRACTION
                  CRVNBR        89.00  CURVE NUMBER
                  RTIMP          0.00  PERCENT IMPERVIOUS AREA

79 UD         SCS DIMENSIONLESS UNITGRAPH
                  TLAG           0.86  LAG

                                            ***

                                          UNIT HYDROGRAPH
                                      52 END-OF-PERIOD ORDINATES
          0.      2.      3.      5.      7.     10.     13.     15.     16.     16.
         16.     16.     15.     14.     12.     11.      9.      7.      6.      5.
          5.      4.      4.      3.      3.      2.      2.      2.      1.      1.
          1.      1.      1.      1.      1.      0.      0.      0.      0.      0.
          0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
          0.      0.

   ***          ***          ***          ***          ***

                     HYDROGRAPH AT STATION        S13

 TOTAL RAINFALL =   12.30, TOTAL LOSS =     1.37, TOTAL EXCESS =    10.93

 PEAK FLOW     TIME                       MAXIMUM AVERAGE FLOW
                                 6-HR        24-HR        72-HR      24.92-HR
 +  (CFS)      (HR)
                        (CFS)
 +    41.     12.92                21.           9.           8.           8.
                      (INCHES)   6.405       10.864       10.864       10.864
                       (AC-FT)     10.          17.          17.          17.

                    CUMULATIVE AREA =     0.03 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          **************
          *            *
80 KK     *    SECY    *
          *            *
          **************

81 KO         OUTPUT CONTROL VARIABLES
                  IPRNT          3  PRINT CONTROL
                  IPLOT          0  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE

82 HC         HYDROGRAPH COMBINATION
                  ICOMP          9  NUMBER OF HYDROGRAPHS TO COMBINE

                                            ***
 HANE2 NPLAN,NSTM      1     0
 HANE2 NPLAN,NSTM      1     0
 HANE2 NPLAN,NSTM      1     0
 HANE2 NPLAN,NSTM      1     0
 HANE2 NPLAN,NSTM      1     0
 HANE2 NPLAN,NSTM      1     0
 HANE2 NPLAN,NSTM      1     0
 HANE2 NPLAN,NSTM      1     0

   ***          ***          ***          ***          ***

                     HYDROGRAPH AT STATION       SECY

 PEAK FLOW     TIME                       MAXIMUM AVERAGE FLOW
                                 6-HR        24-HR        72-HR      24.92-HR
 +  (CFS)      (HR)
                        (CFS)
 +   513.     13.83               357.         156.         148.         148.
                      (INCHES)   6.177       10.635       10.635       10.635
                       (AC-FT)    177.         305.         305.         305.

                    CUMULATIVE AREA =     0.54 SQ MI
1
                                        RUNOFF SUMMARY
                                  FLOW IN CUBIC FEET PER SECOND
                               TIME IN HOURS,  AREA IN SQUARE MILES

                                     PEAK    TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN    MAXIMUM    TIME OF
     OPERATION        STATION        FLOW     PEAK                                             AREA     STAGE    MAX STAGE
```

```
                                   6-HOUR    24-HOUR   72-HOUR
   HYDROGRAPH AT
+                  S7A     12.   12.33      3.        1.        1.     0.00
   HYDROGRAPH AT
+                  S7B      3.   12.08      1.        0.        0.     0.00
   HYDROGRAPH AT
+                  S8      86.   13.83     58.       25.       24.     0.09
   HYDROGRAPH AT
+                  S9     118.   14.00     81.       35.       33.     0.12
   HYDROGRAPH AT
+                  S10A    91.   13.75     60.       25.       25.     0.09
   HYDROGRAPH AT
+                  S10B    33.   12.50     12.        5.        5.     0.02
   HYDROGRAPH AT
+                  S11     70.   16.00     48.       21.       20.     0.07
   HYDROGRAPH AT
+                  S12    108.   14.00     75.       32.       31.     0.11
   HYDROGRAPH AT
+                  S13     41.   12.92     21.        9.        8.     0.03
   9 COMBINED AT
+                  SECY   513.   13.83    357.      154.      148.     0.54

*** NORMAL END OF HEC-1 ***
```

```
*****************************************              *****************************************
*                                       *              *                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *              *   U.S. ARMY CORPS OF ENGINEERS        *
*              JUN 09 1992              *              *   HYDROLOGIC ENGINEERING CENTER       *
*            VERSION 4.0.3E             *              *           609 SECOND STREET           *
*                                       *              *        DAVIS, CALIFORNIA 95616        *
*  RUN DATE  09/12/97  TIME  09:10:33   *              *            (916) 551-1748             *
*                                       *              *                                       *
*****************************************              *****************************************

                 X     X  XXXXXXX   XXXXX          X
                 X     X  X        X     X        XX
                 X     X  X        X               X
                 XXXXXXX  XXXX     X       XXXXX   X
                 X     X  X        X               X
                 X     X  X        X     X         X
                 X     X  XXXXXXX   XXXXX         XXX

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                    HEC-1 INPUT                                          PAGE  1

 LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1       ID  EWA VILLAGES PROJECT FLOOD (100-YEAR STORM)
   2       ID  FN: X101-3.DAT
   3       ID  PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
   4       ID                      EAST KAPOLEI - EXISTING CONDITIONS
   5       ID  KALOI - HUNEHUNE NETWORK MODEL
           *DIAGRAM
   6       IT       6 01FEB97    1200     300
   7       IO       5

   8       KK     S14
   9       KM       GENERATE HYDROGRAPH FROM SUBBASIN S14
  10       KM       MID-WATERSHED PRECIPITATION DATA
  11       KO       3
  12       BA  0.020
  13       PH          0.020     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
  14       LS       0      89
  15       UD  0.728

  16       KK     S15
  17       KM       GENERATE HYDROGRAPH FROM SUBBASIN S15
  18       KM       MID-WATERSHED PRECIPITATION DATA
  19       KO       3
  20       BA  0.012
  21       PH          0.012     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
  22       LS       0      89
  23       UD  0.568

  24       KK     S16
  25       KM       GENERATE HYDROGRAPH FROM SUBBASIN S16
  26       KM       MID-WATERSHED PRECIPITATION DATA
  27       KO       3
  28       BA  0.004
  29       PH          0.004     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
  30       LS       0      89
  31       UD  0.191

  32       KK     S17
  33       KM       GENERATE HYDROGRAPH FROM SUBBASIN S17
  34       KM       MID-WATERSHED PRECIPITATION DATA
```

```
   35          KO      3
   36          BA  0.004
   37          PH           0.004    .65   1.32   2.45   3.55   4.60   6.75   9.20  12.30
   38          LS      0     89
   39          UD  0.191

   40          KK   SECK
   41          KO      3
   42          NC      4
   43          ZZ
1
                SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
LINE      (V) ROUTING           (--->) DIVERSION OR PUMP FLOW

 NO.      (.) CONNECTOR         (<---) RETURN OF DIVERTED OR PUMPED FLOW

  8        S14
           .
 16        .         S15
           .          .
 24        .          .         S16
           .          .          .
 32        .          .          .         S17
           .          .          .          .
 40       SECK.......................................

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

```
*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*              JUN 09 1992              *
*          VERSION 4.0.3E               *
*                                       *
* RUN DATE  09/12/97  TIME  09:10:33    *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*   U.S. ARMY CORPS OF ENGINEERS        *
*   HYDROLOGIC ENGINEERING CENTER       *
*        609 SECOND STREET              *
*     DAVIS, CALIFORNIA 95616           *
*         (916) 551-1748                *
*                                       *
*****************************************
```

```
                EWA VILLAGES PROJECT FLOOD (100-YEAR STORM)
                FN: X101-3.DAT
                PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
                                    EAST KAPOLEI - EXISTING CONDITIONS
                KALOI - MUNEMUNE NETWORK MODEL

  7 IO        OUTPUT CONTROL VARIABLES
                    IPRNT          5  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

  IT          HYDROGRAPH TIME DATA
                    NMIN           6  MINUTES IN COMPUTATION INTERVAL
                    IDATE     1FEB97  STARTING DATE
                    ITIME       1200  STARTING TIME
                    NQ           300  NUMBER OF HYDROGRAPH ORDINATES
                    NDDATE    2FEB97  ENDING DATE
                    NDTIME      1754  ENDING TIME
                    ICENT         19  CENTURY MARK

                COMPUTATION INTERVAL    0.10 HOURS
                    TOTAL TIME BASE    29.90 HOURS

          ENGLISH UNITS
                DRAINAGE AREA          SQUARE MILES
                PRECIPITATION DEPTH    INCHES
                LENGTH, ELEVATION      FEET
                FLOW                   CUBIC FEET PER SECOND
                STORAGE VOLUME         ACRE-FEET
                SURFACE AREA           ACRES
                TEMPERATURE            DEGREES FAHRENHEIT
```

```
*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
  8 KK        *    S14     *
              **************

 11 KO        OUTPUT CONTROL VARIABLES
                    IPRNT          3  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

              SUBBASIN RUNOFF DATA

 12 BA        SUBBASIN CHARACTERISTICS
                    TAREA       0.02  SUBBASIN AREA

              PRECIPITATION DATA

 13 PH                       DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
              ..... HYDRO-35 .....   ............... TP-40 ...............   .......... TP-49 ..........
              5-MIN  15-MIN  60-MIN   2-HR   3-HR   6-HR  12-HR  24-HR   2-DAY  4-DAY  7-DAY  10-DAY
               0.65   1.32    2.45    3.55   4.60   6.75   9.20  12.30    0.00   0.00   0.00   0.00

                                        STORM AREA =   0.02

 14 LS        SCS LOSS RATE
                    STRTL       0.25  INITIAL ABSTRACTION
                    CRVNBR     89.00  CURVE NUMBER
                    RTIMP       0.00  PERCENT IMPERVIOUS AREA

 15 UD        SCS DIMENSIONLESS UNITGRAPH
                    TLAG        0.73  LAG

                                           ***

                                       UNIT HYDROGRAPH
                                 38 END-OF-PERIOD ORDINATES
             1.        2.        4.        6.        9.       11.       12.       12.       12.       11.
            10.        8.        6.        5.        4.        3.        3.        2.        2.        1.
             1.        1.        1.        1.        0.        0.        0.        0.        0.        0.
             0.        0.        0.        0.        0.        0.        0.        0.

    ***          ***          ***          ***          ***

                       HYDROGRAPH AT STATION      S16

      TOTAL RAINFALL =  12.30, TOTAL LOSS =   1.37, TOTAL EXCESS =  10.93

  PEAK FLOW    TIME                          MAXIMUM AVERAGE FLOW
                                  6-HR        24-HR        72-HR      29.90-HR
+  (CFS)       (HR)
                       (CFS)
+     29.      12.80                14.          6.           5.           5.
                     (INCHES)     6.419       10.925       10.931       10.931
                      (AC-FT)        7.          12.          12.          12.

                       CUMULATIVE AREA =   0.02 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
 16 KK        *    S15     *
              **************

 19 KO        OUTPUT CONTROL VARIABLES
                    IPRNT          3  PRINT CONTROL
```

```
                    IPLOT          0  PLOT CONTROL
                    QSCAL          0.  HYDROGRAPH PLOT SCALE

                 SUBBASIN RUNOFF DATA

  20 BA           SUBBASIN CHARACTERISTICS
                    TAREA          0.01  SUBBASIN AREA

                  PRECIPITATION DATA

  21 PH                              DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 ......  ............... TP-40 ...............  ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN   2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                   0.65    1.32    2.45   3.55    4.60    6.75    9.20   12.30    0.00    0.00    0.00    0.00

                                             STORM AREA =     0.01

  22 LS           SCS LOSS RATE
                    STRTL          0.25  INITIAL ABSTRACTION
                    CRVNBR        89.00  CURVE NUMBER
                    RTIMP          0.00  PERCENT IMPERVIOUS AREA

  23 UD           SCS DIMENSIONLESS UNITGRAPH
                    TLAG           0.57  LAG

                                             ***

                                           UNIT HYDROGRAPH
                                      30 END-OF-PERIOD ORDINATES
                  1.      2.      4.      7.      9.      9.      9.      8.      7.      5.
                  4.      3.      2.      2.      1.      1.      1.      1.      0.      0.
                  0.      0.      0.      0.      0.      0.      0.      0.      0.      0.

     ***              ***             ***             ***            ***

                        HYDROGRAPH AT STATION        S15

   TOTAL RAINFALL =    12.30, TOTAL LOSS =     1.37, TOTAL EXCESS =    10.93

   PEAK FLOW      TIME                              MAXIMUM AVERAGE FLOW
                                         6-HR        24-HR        72-HR      29.90-HR
  +  (CFS)        (HR)
                                 (CFS)
  +    20.        12.60                      8.           4.           3.           3.
                               (INCHES)  6.438       10.928       10.932       10.932
                               (AC-FT)       4.           7.           7.           7.

                            CUMULATIVE AREA =     0.01 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

                *************
                *           *
  24 KK         *    S16    *
                *           *
                *************

  27 KO           OUTPUT CONTROL VARIABLES
                    IPRNT          3  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL          0.  HYDROGRAPH PLOT SCALE

                 SUBBASIN RUNOFF DATA

  28 BA           SUBBASIN CHARACTERISTICS
                    TAREA          0.00  SUBBASIN AREA

                  PRECIPITATION DATA

  29 PH                              DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 ......  ............... TP-40 ...............  ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN   2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                   0.65    1.32    2.45   3.55    4.60    6.75    9.20   12.30    0.00    0.00    0.00    0.00

                                             STORM AREA =     0.00

  30 LS           SCS LOSS RATE
                    STRTL          0.25  INITIAL ABSTRACTION
                    CRVNBR        89.00  CURVE NUMBER
                    RTIMP          0.00  PERCENT IMPERVIOUS AREA

  31 UD           SCS DIMENSIONLESS UNITGRAPH
                    TLAG           0.19  LAG

                                             ***

                                           UNIT HYDROGRAPH
                                      12 END-OF-PERIOD ORDINATES
                  3.      8.      7.      4.      2.      1.      1.      0.      0.      0.
                  0.      0.

     ***              ***             ***             ***            ***

                        HYDROGRAPH AT STATION        S16

   TOTAL RAINFALL =    12.30, TOTAL LOSS =     1.37, TOTAL EXCESS =    10.93

   PEAK FLOW      TIME                              MAXIMUM AVERAGE FLOW
                                         6-HR        24-HR        72-HR      29.90-HR
  +  (CFS)        (HR)
                                 (CFS)
  +    11.        12.20                      3.           1.           1.           1.
                               (INCHES)  6.473       10.932       10.932       10.932
                               (AC-FT)       1.           2.           2.           2.

                            CUMULATIVE AREA =     0.00 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

                *************
                *           *
  32 KK         *    S17    *
                *           *
                *************

  35 KO           OUTPUT CONTROL VARIABLES
                    IPRNT          3  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL          0.  HYDROGRAPH PLOT SCALE

                 SUBBASIN RUNOFF DATA

  36 BA           SUBBASIN CHARACTERISTICS
                    TAREA          0.00  SUBBASIN AREA

                  PRECIPITATION DATA

  37 PH                              DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 ......  ............... TP-40 ...............  ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN   2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                   0.65    1.32    2.45   3.55    4.60    6.75    9.20   12.30    0.00    0.00    0.00    0.00

                                             STORM AREA =     0.00

  38 LS           SCS LOSS RATE
                    STRTL          0.25  INITIAL ABSTRACTION
                    CRVNBR        89.00  CURVE NUMBER
                    RTIMP          0.00  PERCENT IMPERVIOUS AREA

  39 UD           SCS DIMENSIONLESS UNITGRAPH
                    TLAG           0.19  LAG

                                             ***
```

```
                                   UNIT HYDROGRAPH
                              12 END-OF-PERIOD ORDINATES
            3.       8.       7.       4.       2.       1.       1.       0.       0.       0.
            0.       0.

     ***          ***          ***          ***          ***

                    HYDROGRAPH AT STATION      S17

     TOTAL RAINFALL =   12.30, TOTAL LOSS =    1.37, TOTAL EXCESS =   10.93

   PEAK FLOW    TIME                        MAXIMUM AVERAGE FLOW
                                  6-HR       24-HR       72-HR     29.90-HR
 +   (CFS)      (HR)
                          (CFS)
 +     11.     12.20                 3.          1.          1.          1.
                        (INCHES)  6.473      10.932      10.932      10.932
                         (AC-FT)     1.          2.          2.          2.

                    CUMULATIVE AREA =     0.00 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

             **************
             *            *
   40 KK     *    SECX    *
             *            *
             **************

   41 KO          OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE

   42 HC          HYDROGRAPH COMBINATION
                       ICOMP          4  NUMBER OF HYDROGRAPHS TO COMBINE

                                                             ***
 NAME2 NPLAN,NSTN      1      0
 NAME2 NPLAN,NSTN      1      0
 NAME2 NPLAN,NSTN      1      0

     ***          ***          ***          ***          ***

                    HYDROGRAPH AT STATION      SECX

   PEAK FLOW    TIME                        MAXIMUM AVERAGE FLOW
                                  6-HR       24-HR       72-HR     29.90-HR
 +   (CFS)      (HR)
                          (CFS)
 +     56.     12.60                28.         12.          9.          9.
                        (INCHES)  6.420      10.925      10.932      10.932
                         (AC-FT)    14.         23.         23.         23.

                    CUMULATIVE AREA =     0.04 SQ MI
1
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	S14	29.	12.80	14.	6.	5.	0.02		
+	HYDROGRAPH AT	S15	20.	12.60	8.	4.	3.	0.01		
+	HYDROGRAPH AT	S16	11.	12.20	3.	1.	1.	0.00		
+	HYDROGRAPH AT	S17	11.	12.20	3.	1.	1.	0.00		
+	4 COMBINED AT	SECX	56.	12.60	28.	12.	9.	0.04		

*** NORMAL END OF HEC-1 ***

```
*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*             JUN 09 1992               *
*           VERSION 4.0.3E              *
*                                       *
* RUN DATE 06/23/97  TIME 13:38:07      *
*                                       *
*****************************************
```

```
***************************************
*                                     *
*   U.S. ARMY CORPS OF ENGINEERS      *
*   HYDROLOGIC ENGINEERING CENTER     *
*         609 SECOND STREET           *
*      DAVIS, CALIFORNIA 95616        *
*          (916) 551-1748             *
*                                     *
***************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X               X
XXXXXXX  XXXX     X       XXXXX   X
X     X  X        X               X
X     X  X        X     X         X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

```
                                  HEC-1 INPUT                                          PAGE  1

LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1      ID   EAST KAPOLEI FLOOD (100-YEAR STORM)
   2      ID   FN: X101B.DAT
   3      ID   PROJECT CONDITIONS: EAST KAPOLEI - EXISTING CONDITIONS
   4      ID                                     FLOW TO WEST LOCH
   5      ID   KALOI - HUNEHUNE NETWORK MODEL
          *DIAGRAM
   6      IT       6 27JAN97    1200     300
   7      IO       5

   8      KK     A27
   9      KM         GENERATE HYDROGRAPH FROM SUBBASIN A27 TO SEC1
  10      KM         UPPERMOST WATERSHED PRECIPITATION DATA
  11      KO       3
  12      BA   0.939
  13      PH                      .64    1.30    2.45    3.50    4.55    6.70    9.30   12.30
  14      LS       0      69
  15      UD   2.174

  16      KK     S18
  17      KM         GENERATE HYDROGRAPH FROM SUBBASIN S18 TO SEC2
  18      KM         UPPERMOST WATERSHED PRECIPITATION DATA
  19      KO       3
  20      BA   0.121
  21      PH                      .65    1.32    2.45    3.55    4.60    6.75     9.2   12.30
  22      LS       0      89
  23      UD   2.174

  24      KK     S19
  25      KM         GENERATE HYDROGRAPH FROM SUBBASIN S19 TO SEC3
  26      KM         UPPERMOST WATERSHED PRECIPITATION DATA
  27      KO       3
  28      BA   0.055
  29      PH                      .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
  30      LS       0      89
  31      UD   1.595

  32      KK     S20
  33      KM         GENERATE HYDROGRAPH FROM SUBBASIN S20 TO SEC4
  34      KM         UPPERMOST WATERSHED PRECIPITATION DATA
  35      KO       3
  36      BA   0.054
  37      PH                      .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
  38      LS       0      89
  39      UD   1.019

  40      KK     S21
  41      KM         GENERATE HYDROGRAPH FROM SUBBASIN S21 TO SEC5
  42      KM         UPPERMOST WATERSHED PRECIPITATION DATA
  43      KO       3
  44      BA    .025
  45      PH                      .65    1.32    2.45    3.55    4.60    6.75     9.2    12.3
  46      LS       0      89
  47      UD   0.627
  48      ZZ
```

```
1
           SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE     (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.     (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   8        A27
             .
             .
  16         .      S18
             .       .
             .       .
  24         .       .       S19
             .       .        .
             .       .        .
  32         .       .        .      S20
             .       .        .       .
             .       .        .       .
  40         .       .        .       .      S21

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

```
*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*             JUN 09 1992               *
*           VERSION 4.0.3E              *
*                                       *
* RUN DATE 06/23/97  TIME 13:38:07      *
*                                       *
*****************************************
```

```
***************************************
*                                     *
*   U.S. ARMY CORPS OF ENGINEERS      *
*   HYDROLOGIC ENGINEERING CENTER     *
*         609 SECOND STREET           *
*      DAVIS, CALIFORNIA 95616        *
*          (916) 551-1748             *
*                                     *
***************************************
```

```
                  EAST KAPOLEI FLOOD (100-YEAR STORM)
                  FN: X101B.DAT
                  PROJECT CONDITIONS: EAST KAPOLEI - EXISTING CONDITIONS
                                                    FLOW TO WEST LOCH
                  KALOI - HUNEHUNE NETWORK MODEL

 7 IO       OUTPUT CONTROL VARIABLES
                 IPRNT          5  PRINT CONTROL
                 IPLOT          0  PLOT CONTROL
                 QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT       HYDROGRAPH TIME DATA
                 NMIN           6  MINUTES IN COMPUTATION INTERVAL
                 IDATE    27JAN97  STARTING DATE
                 ITIME       1200  STARTING TIME
                    NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                 NDDATE   28JAN97  ENDING DATE
                 NDTIME      1754  ENDING TIME
                 ICENT         19  CENTURY MARK

             COMPUTATION INTERVAL    0.10 HOURS
                  TOTAL TIME BASE   29.90 HOURS

      ENGLISH UNITS
          DRAINAGE AREA          SQUARE MILES
          PRECIPITATION DEPTH    INCHES
          LENGTH, ELEVATION      FEET
          FLOW                   CUBIC FEET PER SECOND
          STORAGE VOLUME         ACRE-FEET
          SURFACE AREA           ACRES
```

TEMPERATURE DEGREES FAHRENHEIT

*** ***

```
              **************
              *            *
   8 KK       *    A27     *
              *            *
              **************

  11 KO       OUTPUT CONTROL VARIABLES
                   IPRNT          3  PRINT CONTROL
                   IFLOT          0  PLOT CONTROL
                   QSCAL         0.  HYDROGRAPH PLOT SCALE

              SUBBASIN RUNOFF DATA

  12 BA       SUBBASIN CHARACTERISTICS
                   TAREA       0.94  SUBBASIN AREA

              PRECIPITATION DATA

  13 PH                       DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
              ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
              5-MIN  15-MIN  60-MIN   2-HR   3-HR   6-HR  12-HR  24-HR   2-DAY  4-DAY  7-DAY  10-DAY
               0.64   1.30    2.45    3.50   4.55   6.70   9.10  12.30   0.00   0.00   0.00   0.00

                                         STORM AREA =    0.94

  14 LS       SCS LOSS RATE
                   STRTL       0.25  INITIAL ABSTRACTION
                   CRVNBR     89.00  CURVE NUMBER
                   RTIMP       0.00  PERCENT IMPERVIOUS AREA

  15 UD       SCS DIMENSIONLESS UNITGRAPH
                   TLAG        2.17  LAG
```

***

UNIT HYDROGRAPH
111 END-OF-PERIOD ORDINATES

3.	6.	11.	18.	25.	33.	42.	53.	65.	79.
94.	111.	129.	144.	159.	172.	182.	191.	196.	202.
203.	204.	203.	202.	199.	193.	188.	181.	175.	167.
153.	151.	142.	132.	121.	110.	101.	93.	86.	80.
74.	69.	64.	59.	55.	52.	49.	45.	42.	39.
37.	34.	31.	29.	27.	25.	23.	22.	20.	19.
17.	16.	15.	14.	13.	12.	11.	10.	10.	9.
9.	8.	7.	7.	6.	6.	5.	5.	5.	4.
4.	4.	3.	3.	3.	3.	3.	2.	2.	2.
2.	2.	2.	2.	2.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	0.	0.	0.	0.	0.
0.									

*** *** *** *** ***

```
                 HYDROGRAPH AT STATION       A27

TOTAL RAINFALL =   12.28, TOTAL LOSS =    1.37, TOTAL EXCESS =   10.92

PEAK FLOW     TIME                      MAXIMUM AVERAGE FLOW
                                6-HR      24 HR     72-HR   23.90-HR
+  (CFS)      (HR)
                      (CFS)
+   630.     14.40               607.      273.      221.      221.
                    (INCHES)    6.008    10.830    10.904    10.904
                     (AC-FT)     301.      542.      546.      546.

                 CUMULATIVE AREA =    0.94 SQ MI
```

*** ***

****

```
              *            *
  16 KK       *    S18     *
              *            *
              **************

  19 KO       OUTPUT CONTROL VARIABLES
                   IPRNT          3  PRINT CONTROL
                   IPLOT          0  PLOT CONTROL
                   QSCAL         0.  HYDROGRAPH PLOT SCALE

              SUBBASIN RUNOFF DATA

  20 BA       SUBBASIN CHARACTERISTICS
                   TAREA       0.12  SUBBASIN AREA

              PRECIPITATION DATA

  21 PH                       DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
              ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
              5-MIN  15-MIN  60-MIN   2-HR   3-HR   6-HR  12-HR  24-HR   2-DAY  4-DAY  7-DAY  10-DAY
               0.65   1.32    2.45    3.55   4.60   6.75   9.20  12.30   0.00   0.00   0.00   0.00

                                         STORM AREA =    0.12

  22 LS       SCS LOSS RATE
                   STRTL       0.25  INITIAL ABSTRACTION
                   CRVNBR     89.00  CURVE NUMBER
                   RTIMP       0.00  PERCENT IMPERVIOUS AREA

  23 UD       SCS DIMENSIONLESS UNITGRAPH
                   TLAG        2.17  LAG
```

***

UNIT HYDROGRAPH
111 END-OF-PERIOD ORDINATES

0.	1.	1.	2.	3.	4.	5.	7.	8.	10.
12.	14.	17.	19.	20.	22.	23.	25.	25.	26.
26.	26.	26.	26.	26.	25.	24.	23.	23.	22.
21.	19.	18.	17.	16.	14.	13.	12.	11.	10.
10.	9.	8.	8.	7.	7.	6.	6.	5.	5.
5.	4.	4.	4.	3.	3.	3.	3.	3.	2.
2.	2.	2.	2.	2.	2.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.									

*** *** *** *** *** ***

```
                 HYDROGRAPH AT STATION       S18

TOTAL RAINFALL =   12.30, TOTAL LOSS =    1.37, TOTAL EXCESS =   10.93

PEAK FLOW     TIME                      MAXIMUM AVERAGE FLOW
                                6-HR      24-HR     72-HR   23.90-HR
+  (CFS)      (HR)
                      (CFS)
+   108.     14.40                79.       35.       29.       29.
                    (INCHES)    6.073    10.848    10.910    10.910
                     (AC-FT)      39.       70.       70.       70.

                 CUMULATIVE AREA =    0.12 SQ MI
```

*** ***

```
              **************
              *            *
  24 KK       *    S19     *
              *            *
              **************

  27 KO       OUTPUT CONTROL VARIABLES
                   IPRNT          3  PRINT CONTROL
                   IPLOT          0  PLOT CONTROL
```

```
          QSCAL         0.  HYDROGRAPH PLOT SCALE

       SUBBASIN RUNOFF DATA

 28 BA     SUBBASIN CHARACTERISTICS
              TAREA        0.05  SUBBASIN AREA

           PRECIPITATION DATA

 29 PH                          DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
           ..... HYDRO-35 ......    ............... TP-40 ...............    ........... TP-49 ...........
           5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
            0.65    1.32    2.45    3.55    4.60    6.75    9.20   12.30    0.00    0.00    0.00    0.00

                                          STORM AREA =    0.05

 30 LS     SCS LOSS RATE
              STRTL        0.25  INITIAL ABSTRACTION
              CRVNBR      89.00  CURVE NUMBER
              RTIMP        0.00  PERCENT IMPERVIOUS AREA

 31 UD     SCS DIMENSIONLESS UNITGRAPH
              TLAG         1.60  LAG

                                                 ***

                                            UNIT HYDROGRAPH
                                       82 END-OF-PERIOD ORDINATES
            0.      1.      1.      2.      3.      4.      6.      7.      9.     11.
           12.     14.     15.     16.     16.     16.     16.     16.     15.     15.
           14.     13.     13.     12.     11.      9.      8.      7.      7.      6.
            5.      5.      4.      4.      4.      3.      3.      3.      3.      2.
            2.      2.      2.      2.      1.      1.      1.      1.      1.      1.
            1.      1.      1.      1.      1.      0.      0.      0.      0.      0.
            0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
            0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
            0.      0.

   ***          ***          ***          ***          ***

                   HYDROGRAPH AT STATION       S19

 TOTAL RAINFALL =   12.30, TOTAL LOSS =    1.37, TOTAL EXCESS =   10.93

 PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                  6-HR       24-HR       72-HR    29.90-HR
 +  (CFS)      (HR)
                         (CFS)
 +     56.     13.70                37.         16.         13.         13.
                         (INCHES)  6.283      10.887      10.910      10.910
                         (AC-FT)     18.         32.         32.         32.

                    CUMULATIVE AREA =    0.05 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

           *************
           *           *
 32 KK     *    S20    *
           *           *
           *************

 35 KO       OUTPUT CONTROL VARIABLES
                  IPRNT          3  PRINT CONTROL
                  IPLOT          0  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE

           SUBBASIN RUNOFF DATA

 36 BA       SUBBASIN CHARACTERISTICS
                TAREA        0.05  SUBBASIN AREA

             PRECIPITATION DATA

 37 PH                          DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
             ..... HYDRO-35 ......    ............... TP-40 ...............    ........... TP-49 ...........
             5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
              0.65    1.32    2.45    3.55    4.60    6.75    9.20   12.30    0.00    0.00    0.00    0.00

                                            STORM AREA =    0.05

 38 LS       SCS LOSS RATE
                STRTL        0.25  INITIAL ABSTRACTION
                CRVNBR      89.00  CURVE NUMBER
                RTIMP        0.00  PERCENT IMPERVIOUS AREA

 39 UD       SCS DIMENSIONLESS UNITGRAPH
                TLAG         1.02  LAG

                                                 ***

                                            UNIT HYDROGRAPH
                                       53 END-OF-PERIOD ORDINATES
            1.      2.      4.      7.     10.     14.     18.     21.     23.     24.
           24.     24.     22.     21.     19.     17.     14.     12.     10.      8.
            7.      6.      5.      5.      4.      3.      3.      3.      2.      2.
            2.      1.      1.      1.      1.      1.      1.      1.      0.      0.
            0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
            0.      0.      0.

   ***          ***          ***          ***          ***

                   HYDROGRAPH AT STATION       S20

 TOTAL RAINFALL =   12.30, TOTAL LOSS =    1.37, TOTAL EXCESS =   10.93

 PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                  6-HR       24-HR       72-HR    29.90-HR
 +  (CFS)      (HR)
                         (CFS)
 +     48.     13.10                37.         15.         13.         13.
                         (INCHES)  6.373      10.914      10.931      10.931
                         (AC-FT)     18.         31.         31.         31.

                    CUMULATIVE AREA =    0.05 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

           *************
           *           *
 40 KK     *    S21    *
           *           *
           *************

 43 KO       OUTPUT CONTROL VARIABLES
                  IPRNT          3  PRINT CONTROL
                  IPLOT          0  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE

           SUBBASIN RUNOFF DATA

 44 BA       SUBBASIN CHARACTERISTICS
                TAREA        0.03  SUBBASIN AREA

             PRECIPITATION DATA

 45 PH                          DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
             ..... HYDRO-35 ......    ............... TP-40 ...............    ........... TP-49 ...........
             5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
              0.65    1.32    2.45    3.55    4.60    6.75    9.20   12.30    0.00    0.00    0.00    0.00

                                            STORM AREA =    0.03

 46 LS       SCS LOSS RATE
                STRTL        0.25  INITIAL ABSTRACTION
                CRVNBR      89.00  CURVE NUMBER
                RTIMP        0.00  PERCENT IMPERVIOUS AREA

 47 UD       SCS DIMENSIONLESS UNITGRAPH
                TLAG         0.63  LAG

                                                 ***
```

```
                                   UNIT HYDROGRAPH
                              33 END-OF-PERIOD ORDINATES
     1.      3.      7.     11.     15.     18.     18.     17.     15.     13.
    10.      7.      6.      5.      4.      3.      2.      2.      1.      1.
     1.      1.      1.      0.      0.      0.      0.      0.      0.      0.
     0.      0.      0.

 ***        ***        ***        ***        ***

                   HYDROGRAPH AT STATION      S21

     TOTAL RAINFALL =   12.30, TOTAL LOSS =    1.37, TOTAL EXCESS =   10.93

  PEAK FLOW     TIME                      MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR     29.92-HR
 +  (CFS)       (HR)
                          (CFS)
 +     39.     12.70                17.          7.          6.          6.
                        (INCHES)  6.431      10.927      10.931      10.933
                        (AC-FT)      9.         15.         15.         15.

                   CUMULATIVE AREA =     0.03 SQ MI
1
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+										
+	HYDROGRAPH AT	A27	830.	14.40	607.	273.	221.	0.54		
+	HYDROGRAPH AT	S18	108.	14.40	79.	35.	29.	0.12		
+	HYDROGRAPH AT	S19	56.	13.70	37.	16.	13.	0.05		
+	HYDROGRAPH AT	S20	68.	13.10	37.	16.	13.	0.05		
+	HYDROGRAPH AT	S21	39.	12.70	17.	7.	6.	0.03		

*** NORMAL END OF HEC-1 ***

```
1***************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*            JUN 09 1992               *
*          VERSION 4.0.3E              *
*                                      *
* RUN DATE  09/12/97  TIME  10:25:38   *
*                                      *
****************************************

****************************************
*                                      *
*   U.S. ARMY CORPS OF ENGINEERS       *
*   HYDROLOGIC ENGINEERING CENTER      *
*        609 SECOND STREET             *
*     DAVIS, CALIFORNIA 95616          *
*         (916) 551-1748               *
*                                      *
****************************************

   X     X  XXXXXXX   XXXXX          X
   X     X  X        X     X        XX
   X     X  X        X               X
   XXXXXXX  XXXX     X       XXXXX   X
   X     X  X        X               X
   X     X  X        X     X         X
   X     X  XXXXXXX   XXXXX         XXX

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                     HEC-1 INPUT                                        PAGE  1

 LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1       ID   EAST KAPOLEI FLOOD (100-YEAR STORM)
   2       ID   FN: X101C.DAT
   3       ID   PROJECT CONDITIONS: EAST KAPOLEI - EXISTING CONDITIONS
   4       ID                                     FLOW TO KAPOLEI AND VARONA
   5       ID   KALOI - MAKEKANE NETWORK MODEL
           *DIAGRAM
   6       IT       5 27JAN97    1200     300
   7       IO       5

   8       KK     KAP
   9       KM        GENERATE HYDROGRAPH FROM SUBBASIN KAP TO SEC1
  10       KM        UPPERMOST WATERSHED PRECIPITATION DATA
  11       KO       3
  12       BA   0.170
  13       PH                     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
  14       LS       0      89
  15       UD   1.567

  16       KK     VAR
  17       KM        GENERATE HYDROGRAPH FROM SUBBASIN VAR TO SEC2
  18       KM        UPPERMOST WATERSHED PRECIPITATION DATA
  19       KO       3
  20       BA   0.167
  21       PH                     .65    1.32    2.45    3.55    4.60    6.75     9.2   12.30
  22       LS       0      89
  23       UD   0.917

  24       KK    SEC3
  25       KO       3
  26       HC       2
  27       ZZ
1
          SCHEMATIC DIAGRAM OF STREAM NETWORK

 INPUT
  LINE    (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.     (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW
```

```
  8         KAP
             .
 16          .         VAR
             .           .
 24         SEC1..........

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************
*                                        *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *
*          JUN 09 1992                   *
*        VERSION 4.0.3E                  *
*                                        *
*  RUN DATE  09/12/97  TIME  10:25:38    *
*                                        *
******************************************

******************************************
*                                        *
*   U.S. ARMY CORPS OF ENGINEERS         *
*   HYDROLOGIC ENGINEERING CENTER        *
*        609 SECOND STREET               *
*     DAVIS, CALIFORNIA 95616            *
*         (916) 551-1748                 *
*                                        *
******************************************

             EAST KAPOLEI FLOOD (100-YEAR STORM)
             FN: X101C.DAT
             PROJECT CONDITIONS: EAST KAPOLEI - EXISTING CONDITIONS
                                  FLOW TO KAPOLEI AND VARONA

             KALOI - HUMEHUME NETWORK MODEL

  7 IO       OUTPUT CONTROL VARIABLES
                  IPRNT          5  PRINT CONTROL
                  IPLOT          0  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE

 IT          HYDROGRAPH TIME DATA
                  NMIN           5  MINUTES IN COMPUTATION INTERVAL
                  IDATE    27JAN97  STARTING DATE
                  ITIME       1200  STARTING TIME
                  NQ           300  NUMBER OF HYDROGRAPH ORDINATES
                  NDDATE   28JAN97  ENDING DATE
                  NDTIME      1255  ENDING TIME
                  ICENT         19  CENTURY MARK

             COMPUTATION INTERVAL     0.08 HOURS
                  TOTAL TIME BASE    24.92 HOURS

      ENGLISH UNITS
            DRAINAGE AREA          SQUARE MILES
            PRECIPITATION DEPTH    INCHES
            LENGTH, ELEVATION      FEET
            FLOW                   CUBIC FEET PER SECOND
            STORAGE VOLUME         ACRE-FEET
            SURFACE AREA           ACRES
            TEMPERATURE            DEGREES FAHRENHEIT

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            ***************
            *             *
  8 KK      *     KAP     *
            *             *
            ***************

 11 KO       OUTPUT CONTROL VARIABLES
                  IPRNT          3  PRINT CONTROL
                  IPLOT          C  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE

             SUBBASIN RUNOFF DATA

 12 BA       SUBBASIN CHARACTERISTICS
                  TAREA       0.17  SUBBASIN AREA

             PRECIPITATION DATA

 13 PH                             DEPTHS FOR  0-PERCENT HYPOTHETICAL STORM
            ..... HYDRO-35 ......   .............. TP-40 ..............   .......... TP-49 ..........
            5-MIN  15-MIN  60-MIN   2-HR   3-HR   6-HR  12-HR  24-HR   2-DAY  4-DAY  7-DAY  10-DAY
             0.65   1.32    2.45    3.55   4.60   6.75   9.20  12.30   0.00   0.00   0.00   0.00

                                   STORM AREA =   0.17

 14 LS       SCS LOSS RATE
                  STRTL       0.25  INITIAL ABSTRACTION
                  CRVNBR     89.00  CURVE NUMBER
                  RTIMP       0.00  PERCENT IMPERVIOUS AREA

 15 UD       SCS DIMENSIONLESS UNITGRAPH
                  TLAG        1.57  LAG

                                             ***

                                      UNIT HYDROGRAPH
                                   96 END-OF-PERIOD ORDINATES
        1.      2.      4.      5.      8.     10.     14.     17.     21.     26.
       31.     35.     40.     43.     46.     48.     50.     51.     51.     51.
       51.     49.     48.     46.     44.     42.     40.     37.     35.     31.
       28.     26.     23.     21.     20.     18.     16.     15.     14.     13.
       12.     11.     10.      9.      9.      8.      7.      7.      6.      6.
        5.      5.      4.      4.      4.      3.      3.      3.      3.      2.
        2.      2.      2.      2.      2.      1.      1.      1.      1.      1.
        1.      1.      1.      1.      1.      1.      1.      1.      1.      0.
        0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
        0.      0.      0.      0.      0.      0.

  ***           ***           ***           ***           ***

                  HYDROGRAPH AT STATION      KAP

 TOTAL RAINFALL =   12.30, TOTAL LOSS =    1.37, TOTAL EXCESS =   10.93

 PEAK FLOW     TIME .                  MAXIMUM AVERAGE FLOW
                               6-HR        24-HR        72-HR      24.92-HR
+  (CFS)       (HR)
                      (CFS)
+   176.      13.47               116.          49.          47.          47.
                      (INCHES)   4.251       10.670       10.670       10.670
                      (AC-FT)      57.          97.          97.          97.

                      CUMULATIVE AREA =    0.17 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            ***************
            *             *
 16 KK      *     VAR     *
            *             *
            ***************

 19 KO       OUTPUT CONTROL VARIABLES
                  IPRNT          3  PRINT CONTROL
                  IPLOT          0  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE

             SUBBASIN RUNOFF DATA

 20 BA       SUBBASIN CHARACTERISTICS
                  TAREA       0.17  SUBBASIN AREA

             PRECIPITATION DATA

 21 PH                             DEPTHS FOR  0-PERCENT HYPOTHETICAL STORM
            ..... HYDRO-35 ......   .............. TP-40 ..............   .......... TP-49 ..........
            5-MIN  15-MIN  60-MIN   2-HR   3-HR   6-HR  12-HR  24-HR   2-DAY  4-DAY  7-DAY  10-DAY
             0.65   1.32    2.45    3.55   4.60   6.75   9.20  12.30   0.00   0.00   0.00   0.00
```

STORM AREA = 0.17

```
22 LS        SCS LOSS RATE
                 STRTL       0.25  INITIAL ABSTRACTION
                 CRVNBR     89.00  CURVE NUMBER
                 RTIMP       0.00  PERCENT IMPERVIOUS AREA

23 UD        SCS DIMENSIONLESS UNITGRAPH
                 TLAG        0.92  LAG
```

***

UNIT HYDROGRAPH
57 END-OF-PERIOD ORDINATES

2.	7.	13.	21.	31.	43.	57.	68.	77.	82.
84.	84.	82.	77.	72.	66.	59.	51.	43.	36.
32.	27.	24.	21.	18.	16.	14.	12.	10.	9.
8.	7.	6.	5.	4.	4.	3.	3.	2.	2.
2.	2.	1.	1.	1.	1.	1.	1.	1.	1.
0.	0.	0.	0.	0.	0.	0.			

***   ***   ***   ***   ***

HYDROGRAPH AT STATION VAR

TOTAL RAINFALL = 12.30, TOTAL LOSS = 1.37, TOTAL EXCESS = 10.93

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 221.	13.00		115.	49.	47.	47.
		(INCHES)	6.390	10.844	10.844	10.844
		(AC-FT)	57.	97.	97.	97.

CUMULATIVE AREA = 0.17 SQ MI

*** ***

```
             **************
             *            *
26 KK        *    SEC3    *
             *            *
             **************

25 KO        OUTPUT CONTROL VARIABLES
                 IPRNT          3  PRINT CONTROL
                 IPLOT          0  PLOT CONTROL
                 QSCAL         0.  HYDROGRAPH PLOT SCALE

26 HC        HYDROGRAPH COMBINATION
                 ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE
```

***

UXE2 NPLAN,NSTN 1 0

***   ***   ***   ***   ***

HYDROGRAPH AT STATION SEC3

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
(CFS)	(HR)					
		(CFS)				
375.	13.17		228.	97.	94.	94.
		(INCHES)	6.286	10.756	10.756	10.756
		(AC-FT)	113.	193.	193.	193.

CUMULATIVE AREA = 0.34 SQ MI

RUNOFF SUMMARY

FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+					6-HOUR	24-HOUR	72-HOUR			
+	HYDROGRAPH AT	KAP	176.	13.67	114.	49.	47.	0.17		
+	HYDROGRAPH AT	VAR	221.	13.00	115.	49.	47.	0.17		
+	2 COMBINED AT	SEC3	375.	13.17	228.	97.	94.	0.34		

*** NORMAL END OF HEC-1 ***

APPENDIX B

REGIONAL HYDROLOGY FOR DEVELOPED CONDITIONS

- HEC-1 Summary for Developed Conditions
- 100-Year, 24-hour HEC-1 Computations (Kaloi Watershed)
- 100-Year, 24-hour HEC-1 Computations (West Loch Watershed)
- 100-Year, 24-hour HEC-1 Computations (Kapolei Villages Watershed)

6/17/98
EAST KAPOLEI DRAINAGE MASTER PLAN
SUMMARY OF HEC-1 CALCULATIONS
file: sumdev.wk3

HEC-1 RUNOFF SUMMARY

DEVELOPED KALOI GULCH (EAST KAPOLEI) – NO BASINS

File:	XSEC	Area (Sq.Mi.)	Runoff (Ac-ft)	Peak Q (cfs)
NEW1A2.DAT	SEC420	6.32	3,057	5,507
	SEC10	0.51	302	941
		6.83	3,359	6,448
		4,371 Ac.		

DEVELOPED KALOI GULCH (EAST KAPOLEI)

File:	XSEC	Area (Sq.Mi.)	Runoff (Ac-ft)	Peak Q (cfs)
EASTKAP3.DAT	RES05	6.33	2,936	4,733
	SEC10	0.51	302	941
		6.84	3,238	5,674
		4,378 Ac.		

DEVELOPED KALOI GULCH (VARONA)

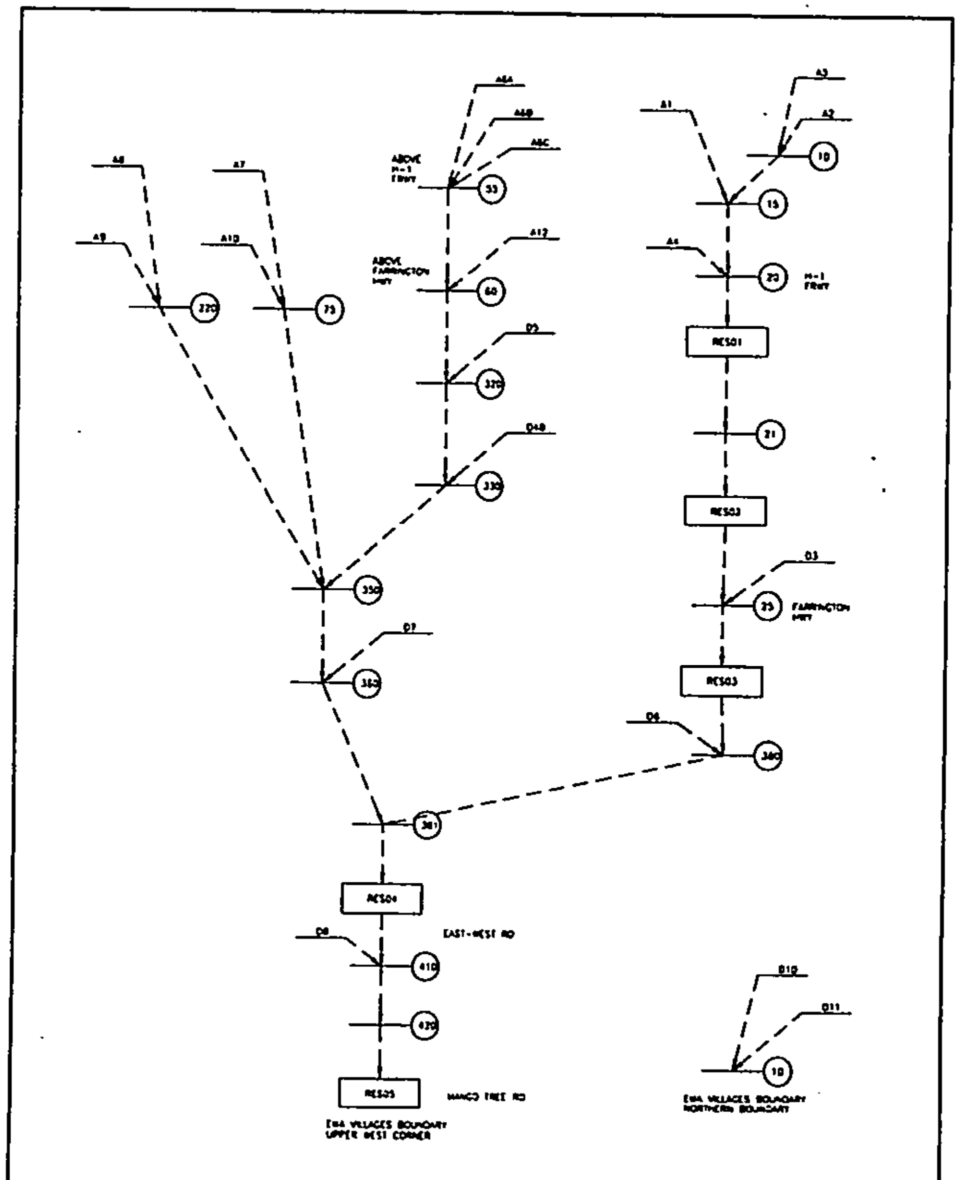
File:	AREA	Area (Sq.Mi.)	Runoff (Ac-ft)	Peak Q (cfs)
NEW1C2.DAT	VAR	0.085	16	37
		54 Ac.		

DEVELOPED VILLAGES OF KAPOLEI

File:	AREA	Area (Sq.Mi.)	Runoff (Ac-ft)	Peak Q (cfs)
NEW1C2.DAT	KAP	0.096	58	183
		61 Ac.		

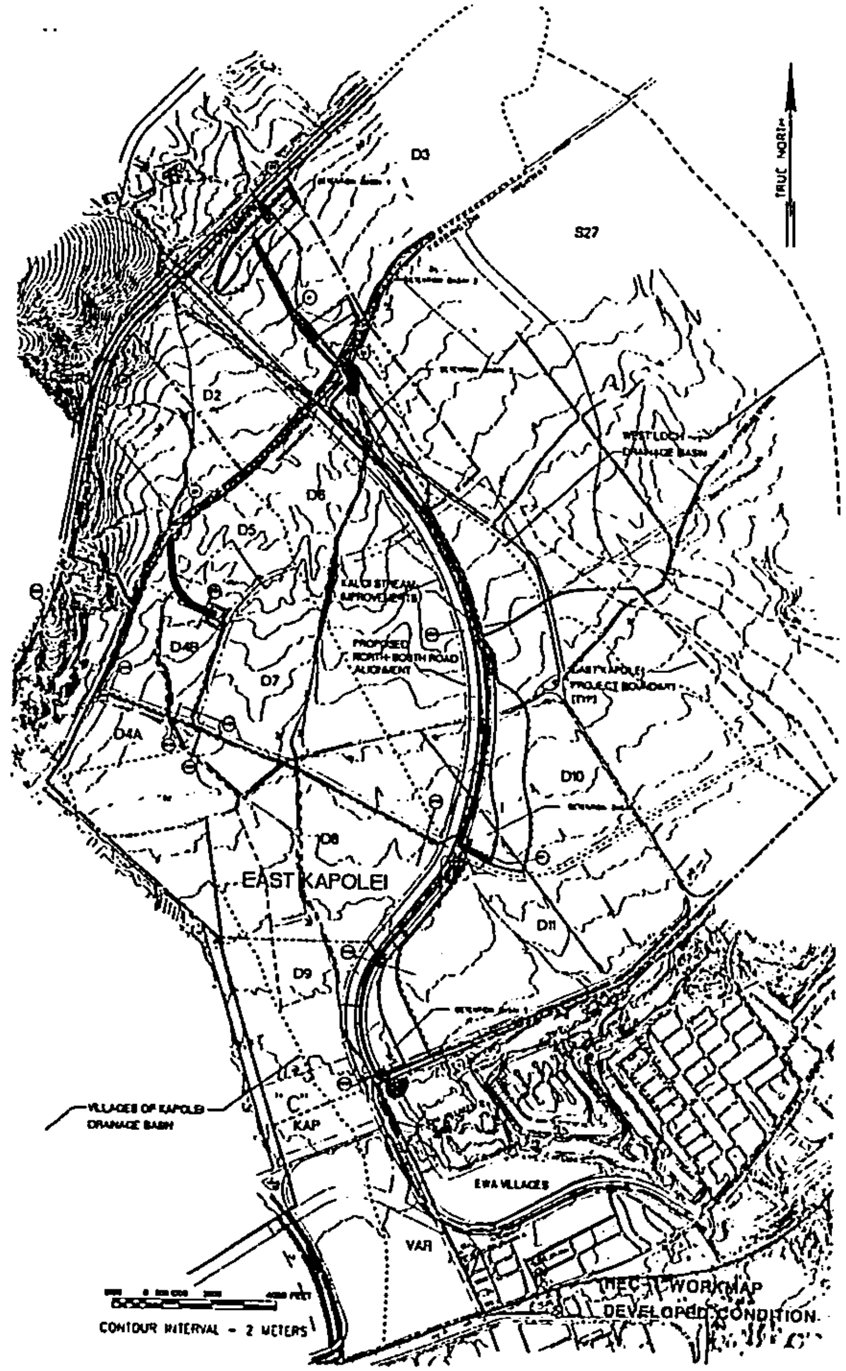
DEVELOPED WEST LOCH

File:	AREA	Area (Sq.Mi.)	Runoff (Ac-ft)	Peak Q (cfs)
NEW1B.DAT	A27	0.939	548	835
	S18	0.119	70	107
	S19	0.055	32	56
	S20	0.054	31	68
	S21	0.025	15	39
		1.192	696	1,105
		763 Ac.		



EAST KAPOLEI PROJECT

SCHEMATIC DIAGRAM
DEVELOPED CONDITIONS
KALOI WATERSHED



6/18/97
EAST KAPOLEI DRAINAGE MASTER PLAN
CURVE NUMBER DETERMINATION - REVISED

DATA:	SOIL GROUP A	B	C	D
PARK	39	61	74	80
SF / MF	77	85	90	92
ROADS	95	95	95	95
OPEN (EXIST.)	68	79	86	89
COMM	89	92	94	95
SCHOOL	49	69	79	84
BAS / CHAN (CRM)	95	95	95	95
BAS / CHAN (GRASS)	39	61	74	80

		AREA	SOIL GROUP A	B	C	D	CN	A x CN	Comp. CN
AREA D1									
EXIST	2080603	47.76		47.76			88.00		88
AREA D2									
PARK		3.00		3.00					
SF	68.5	59.85	8.72	44.24		6.89			
ROADS		6.65		6.65					
EXIST		68.00			27.20	40.80			
TOTAL		137.50	8.72	53.89	27.20	47.69			
SF			8.72				77.00	671.44	
PARK				3			61.00	183	
SF				44.24			85.00	3760.4	
ROADS				6.65			95.00	631.75	
EXIST					27.20		86.00	2339.2	
SF						6.89	92.00	633.88	
EXIST						40.80	89.00	3631.2	
TOTALS			8.72	53.89	27.2	47.69	137.50	11850.87	86

		AREA	SOIL GROUP A	B	C	D	CN	A x CN	Comp. CN
AREA D3									
COMMERCIAL		6.00			4.02	1.98			
MF		30.00		15.00	3.00	12.00			
PARK		7.90		7.90					
CRM CHANNEL	140114 30878	3.93		0.79	3.14				
BASIN		11.54		11.54					
ROADS		3.36		3.36					
EXIST		156.80		156.80					
TOTAL		219.52	0.00	195.38	10.16	13.98	219.52		
MF				15.00			85.00	1275	
PARK				7.90			61.00	481.9	
CRM CHANNEL				0.79			95.00	75.05	
BASIN				11.54			61.00	703.94	
ROADS				3.36			95.00	319.2	
EXIST				156.80			79.00	12387.2	
COMMERCIAL					4.02		94.00	377.88	
MF					3.00		90.00	270	
CRM CHANNEL					3.14		95.00	298.3	
COMMERCIAL						1.98	95.00	188.1	
MF						12.00	92.00	1104	
TOTALS				195.39	10.16	13.98	219.53	17480.57	80
AREA D4A									
ROAD		1.40		2.33		0.65			
SF		21.64		14.22		5.84			
TOTAL		23.04		16.55		6.49	23.04		
SF				14.22			85.00	1208.7	
ROAD				2.33			95.00	221.35	
SF						5.84	92.00	537.28	
ROAD						0.65	95.00	61.75	
TOTALS				16.55		6.49	23.04	2029.08	88
AREA D4B									
ROAD		3.60		5.81		0.65			569.5662
SF		32.45		23.95		5.84			2035.5885
TOTAL		36.25		29.76		6.49			2605.1547
SF				23.95			85.00	2035.75	
ROAD				5.81			95.00	551.95	
SF						5.84	92.00	537.28	
ROAD						0.65	95.00	61.75	
TOTALS				29.76		6.49	36.25	3186.73	88

		SOIL GROUP							
		AREA	A	B	C	D	CN	A x CN	Comp. CN
AREA D5									
SF	28.56	24.00		3.60		20.40			
PARK		3.00		3.00					
SCHOOL		12.00		4.80		7.20			
ROADS		4.56		4.56					
TOTAL		43.56	0.00	15.96	0.00	27.60	43.56		
PARK				3.00			61.00	183	
SF				3.60			85.00	306	
ROADS				4.56			95.00	433.2	
SCHOOL				4.80			69.00	331.2	
SF						20.40	92.00	1876.8	
SCHOOL						7.20	84.00	604.8	
TOTALS				15.96		27.60	43.56	3735.00	86
AREA D6									
SF	95.9	86.31		8.63		77.68			
MF	5.34938	47.20		14.16		33.04			
CRM CHAN	1.57455	6.50				6.50			
BASIN	4.86667	20.00			10.00	10.00			
PARK	7.0371	26.50		13.25		13.25			
COM		7.00				7.00			
ROADS		28.59		28.59					
TOTAL		222.10	0.00	64.63	10.00	147.47	222.10		
PARK				13.25			61.00	808.25	
SF				8.63			85.00	733.55	
MF				14.16			85.00	1203.6	
ROADS				28.59			95.00	2716.05	
BASIN					10.00		74.00	740	
PARK						13.25	80.00	1060	
SF						77.68	92.00	7146.56	
MF						33.04	92.00	3039.68	
COM						7.00	95.00	665	
CRM CHAN						6.50	95.00	617.5	
BASIN						10.00	80.00	800	
TOTALS				64.63	10.00	147.47	222.10	19530.19	88

		SOIL GROUP							
		AREA	A	B	C	D	CN	A x CN	Comp. CN
AREA D7									
PARK	3	3.00				3.00			
MF	15.5	15.50		7.75		7.75			
SF	76.4	68.76		13.75		55.01			
COM	1	1.00				1.00			
ROADS		10.84		10.84					
TOTAL		99.10	0.00	32.34	0.00	66.76	99.10		
SF				13.75			85.00	1168.75	
MF				7.75			85.00	658.75	
ROADS				10.84			95.00	1029.8	
PARK						3.00	80.00	240	
SF						55.01	92.00	5060.92	
MF						7.75	92.00	713	
COM						1.00	95.00	95	
TOTALS				32.34		66.76	99.10	8966.22	90
AREA D8									
PARK	3	3.00				3.00			
COM	2	2.00				2.00			
ES	12	12.00				12.00			
CRM CHAN	1.3	1.30				1.30			
CHAN	4.8	4.80				4.80			
ROADS	10.44	21.52				21.52			
MF	31	31.00		1.55		29.45			
SF	110.76	99.68		19.94		79.75			
TOTAL		175.30	0.00	21.49	0.00	153.81	175.30		
SF				19.94			85.00	1694.9	
MF				1.55			85.00	131.75	
PARK						3.00	80.00	240	
SF						79.75	92.00	7337	
MF						29.45	92.00	2709.4	
ROADS						21.52	95.00	2044.4	
COM						2.00	95.00	190	
CRM CHAN						1.30	95.00	123.5	
CHAN						4.80	80.00	384	
ES						12.00	84.00	1008	
TOTALS				21.49		153.82	175.31	15862.95	90
AREA D9									
PARK		8.60				8.60	80.00	688	
SF	33.4	54.06				47.38	92.00	4358.96	
ROAD	8.4	11.74				18.42	95.00	1749.9	
BASIN		8.50				8.50	80.00	680	
TOTALS		82.90				82.90	82.90	7476.86	90

		SOIL GROUP							
		AREA	A	B	C	D	CN	A x CN	Comp. CN
AREA D10									
SF	95.5	85.95				85.95	92.00	7907.4	
EXIST		23.30				23.30	89.00	2073.7	
PARK		6.50				6.50	80.00	520	
ROADS	2.2	11.75				11.75	95.00	1116.25	
MF		21.00				21.00	92.00	1932	
TOTALS		148.50				148.50	148.50	13549.35	91
AREA D11									
ES		12.00				12.00	84.00	1008	
INT		20.00				20.00	84.00	1680	
SF	109.30	98.37				98.37	92.00	9050.04	
MF		31.00				31.00	92.00	2852	
ROADS	3.7	14.63				14.63	95.00	1389.85	
TOTALS		176.00				176.00	176.00	15979.89	91
"KAP"									
SF	10.3	9.27				9.27	92.00	852.84	
PARK	37.3	37.30				37.30	80.00	2984	
ROADS	3.6	4.63				4.63	95.00	439.85	
MF	10.5	10.50				10.50	92.00	966	
TOTALS		61.70				61.70	61.70	5242.69	85
"VAR"									
PARK	37.0	25.90				25.90	80.00	2072	
SF	3.40	3.06				3.06	92.00	281.52	
COMM	8.0	8.00				8.00	95.00	760	
ROADS	6 0	17.44				17.44	95.00	1656.8	
TOTALS		54.40				54.40	54.40	4770.32	88

```
**************************************
*                                    *
*   FLOOD HYDROGRAPH PACKAGE (HEC-1) *
*             JUN 09 1992            *
*            VERSION 4.0.3E          *
*                                    *
* RUN DATE 06/06/98  TIME 08:33:06   *
*                                    *
**************************************
```

```
**************************************
*                                    *
*   U.S. ARMY CORPS OF ENGINEERS     *
*   HYDROLOGIC ENGINEERING CENTER    *
*        609 SECOND STREET           *
*     DAVIS, CALIFORNIA 95616        *
*         (916) 551-1748             *
*                                    *
**************************************
```

```
X     X  XXXXXXX   XXXXX         X
X     X  X        X     X       XX
X     X  X        X              X
XXXXXXX  XXXX     X      XXXXX   X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX        XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

```
1
                                  HEC-1 INPUT                                          PAGE  1

 LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1        ID   EAST KAPOLEI FLOOD (100-YEAR STORM)
   2        ID   FN: NEW1A2.DAT
   3        ID   PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
   4        ID                        EAST KAPOLEI - DEV. COND. NO BASINS - ADD 47 AC. KAP.
   5        ID   KALOI - HUNEHUNE NETWORK MODEL
            *DIAGRAM
   6        IT        7 05MAY98    1200     300
   7        IO        5

   8        KK       A3
   9        KM          GENERATE HYDROGRAPH FROM SUBBASIN A3 TO SEC05
  10        KM          UPPERMOST WATERSHED PRECIPITATION DATA
  11        BA   1.701
  12        PH            1.701     .69    1.40    2.60    3.70    4.75    6.85    9.30   12.70
  13        LS       0      68
  14        UD   1.206

  15        KK   SEC10
  16        KM          ROUTE KALOI TRIBUTARY FLOW FROM SEC05 TO SEC10
  17        KM          KALOI STREAM ABOVE CONFLUENCE OF MAIN AND TRIBUTARY
  18        RS       1    FLOW       0
  19        RC   0.035    .035   0.035    2250   0.024     220
  20        RX       0     150     155     165     180     190     195     520
  21        RY     220     218     215     208     208     218     218     220

  22        KK       A2
  23        KM          GENERATE HYDROGRAPH FROM SUBBASIN A2 TO SEC10
  24        KM          UPPERMOST WATERSHED PRECIPITATION DATA
  25        BA   0.167
  26        PH            0.167     .69    1.40    2.60    3.70    4.75    6.85    9.30   12.70
  27        LS       0      66
  28        UD   0.39

  29        KK   SEC10
  30        KM          COMBINE HYDROGRAPHS AT SEC10
  31        HC       2

  32        KK       A1
  33        KM          GENERATE HYDROGRAPH FROM SUBBASIN A1 TO SEC14
  34        KM          UPPERMOST WATERSHED PRECIPITATION DATA
```

```
 35        BA   2.036
 36        PH          2.036     .69    1.40    2.60    3.70    4.75    6.85    9.30   12.70
 37        LS       0     70
 38        UD   1.434

 39        KK   SEC15
 40        KM        COMBINE HYDROGRAPHS AT SEC15
 41        HC       2

 42        KK   SEC20
 43        KM        ROUTE KALOI TRIBUTARY FLOW FROM SEC15 TO SEC20
 44        RS       2    FLOW       0
 45        RC    .035    .035    .035     200   0.025     207
 46        RX       0     160     180     190     205     240     400     550
 47        RY     215     215     215     194     194     207     210     215
1                                     HEC-1 INPUT                                           PAGE  2

LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 48        KK      A4
 49        KM        GENERATE HYDROGRAPH FROM SUBBASIN A4 TO SEC20
 50        KM        UPPER WATERSHED PRECIPITATION DATA
 51        BA   0.188
 52        PH          0.188     .66    1.35    2.50    3.60    4.65    6.80    9.25   12.50
 53        LS       0     66
 54        UD   0.450

 55        KK   SEC20
 56        KM        COMBINE HYDROGRAPHS AT SEC20
 57        HC       2

 58        KK   SEC25
 59        KM        ROUTE KALOI TRIBUTARY FLOW FROM SEC20 TO SEC25
 60        RS       2    FLOW       0
 61        RC    .035    .035    .035    1896  0.0006     195
 62        RX       0     100     200     216     296     312     412     512
 63        RY     197     197     197     189     189     197     197     197

 64        KK      D3
 65        KM        GENERATE HYDROGRAPH FROM SUBBASIN D3 TO SEC25
 66        KM        MID-WATERSHED PRECIPITATION DATA
 67        BA    .343
 68        PH                    .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 69        LS       0     80
 70        UD    0.45

 71        KK   SEC25
 72        KM        COMBINE HYDROGRAPHS AT SEC25
 73        HC       2

 74        KK  SEC377
 75        KM         ROUTE SEC25 TO SEC378
 76        RS       2    FLOW       0
 77        RC   0.035   0.035   0.035    1767   .0006     160
 78        RX       0     100     200     230     330     360     460     560
 79        RY     162     162     162     147     147     162     162     162

 80        KK  SEC378
 81        KM         ROUTE SEC377 TO SEC378
 82        RS       2    FLOW       0
 83        RC   0.035   0.025   0.035    1657   0.012     113
 84        RX       0     100     200     230     330     360     460     560
 85        RY     115     115     115     100     100     115     115     115

 86        KK  SEC380
 87        KM        ROUTE SEC378 TO SEC380
 88        RS       2    FLOW   85.96
 89        RC   0.035   0.035   0.035    2437  0.0006   85.96
 90        RX       0     100     200     230     330     360     460     560
 91        RY   87.96   87.96   87.96   72.96   72.96   87.96   87.96   87.96
1                                     HEC-1 INPUT                                           PAGE  3

LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 92        KK      D6
 93        KM         GENERATE HYDROGRAPH FROM SUBBASIN D6 TO SEC380
 94        KM         MID-WATERSHED PRECIPITATION DATA
 95        BA   0.347
 96        PH                    .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 97        LS       0     88
 98        UD    0.45

 99        KK  SEC380
100        KM        COMBINE HYDROGRAPHS AT SEC380
101        HC       2

102        KK     A6A
103        KM        GENERATE HYDROGRAPH FROM SUBBASIN A6A TO SEC51
104        KM        UPPER WATERSHED PRECIPITATION DATA
105        BA   0.062
106        PH                   0.66    1.35    2.50    3.60    4.65    6.80    9.25   12.50
107        LS       0     76
108        UD   0.168

109        KK     A6B
110        KM        GENERATE HYDROGRAPH FROM SUBBASIN A6B TO SEC52
111        KM        UPPER WATERSHED PRECIPITATION DATA
112        BA   0.027
113        PH                   0.66    1.35    2.50    3.60    4.65    6.80    9.25   12.50
114        LS       0     77
115        UD   0.162

116        KK     A6C
117        KM        GENERATE HYDROGRAPH FROM SUBBASIN A6C TO SEC53
118        KM        UPPER WATERSHED PRECIPITATION DATA
119        BA   0.146
120        PH                   0.66    1.35    2.50    3.60    4.65    6.80    9.25   12.50
121        LS       0     79
122        UD   0.306

123        KK   SEC55
124        KM         COMBINE HYDROGRAPHS AT SEC55
125        HC       3

126        KK   SEC60
127        KM   ROUTE FLOW FROM SEC55 TO SEC60
128        RS       2    FLOW       0
129        RC   0.015   0.015   0.015    1820   0.031     192
130        RX       0     100     200     200     215     215     315     415
131        RY   193.0  193.00  193.00  187.00  187.00  193.00  193.00  193.00

132        KK     A12
133        KM        GENERATE HYDROGRAPH FROM SUBBASIN A12 TO SEC50
134        KM        MID-WATERSHED PRECIPITATION DATA
135        BA   0.113
136        PH                    .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
137        LS       0     81
138        UD   0.864
1                                     HEC-1 INPUT                                           PAGE  4

LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


139        KK   SEC60
140        KM        ROUTE A12 TO SEC60
141        RS       2    FLOW       0
142        RC   0.035   0.035   0.035    3041   0.026     156
143        RX       0     216     347     401     432     445     452     749
144        RY   162.4  157.48  154.53  150.92  150.92  154.20  154.20  157.48

145        KK      D2
146        KM        GENERATE HYDROGRAPH FROM SUBBASIN D2 TO SEC60
147        KM        MID-WATERSHED PRECIPITATION DATA
148        BA   0.215
149        PH                    .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
150        LS       0     86
151        UD   0.450

152        KK   SEC60
153        KM        COMBINE HYDROGRAPHS AT SEC60
154        HC       3

155        KK  SEC320
156        KM  ROUTE FLOW FROM SEC60 TO SEC320
```

```
RS      2   FLOW      0
RC  0.035  0.025  0.035    1019  0.002  136.6
RX      0    100    200     218    268    286    386    486
RY 138.26 138.26 138.26  129.26 129.26 138.26 138.26 138.26

KK     D5
KM         GENERATE HYDROGRAPH FROM SUBBASIN D5 TO SEC320
KM         MID-WATERSHED PRECIPITATION DATA
BA  0.068
PH                  .65    1.32   2.45   3.55   4.60   6.75   9.20  12.30
LS      0     86
UD  0.450

KK  SEC320
KM         COMBINE HYDROGRAPHS AT SEC320
NC      2

KK  SEC330
KM   ROUTE FLOW FROM SEC320 TO SEC330
RS      2   FLOW      0
RC  0.015  0.015  0.015    1427  0.005  112.0
RX      0    100    200 200.001 218.001 218.002   352    452
RY 114.00 114.00 114.00  106.00 106.00  114.0  114.0  114.0

KK    D4B
KM         GENERATE HYDROGRAPH FROM SUBBASIN D4B TO SEC330
KM         UPPER WATERSHED PRECIPITATION DATA
BA  0.057
PH                  .66    1.35   2.50   3.60   4.65   6.80   9.25  12.50
LS      0     88
UD  0.450
                         HEC-1 INPUT                                    PAGE 5

LINE   ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

KK  SEC330
KM         COMBINE HYDROGRAPHS AT-SEC330
NC      2

KK     A8
KM         GENERATE HYDROGRAPH FROM SUBBASIN A8 TO SEC80
KM         MID-WATERSHED PRECIPITATION DATA
BA  0.168
PH                  .65    1.32   2.45   3.55   4.60   6.75   9.20  12.30
LS      0     76
UD  0.312

KK     A7
KM         GENERATE HYDROGRAPH FROM SUBBASIN A7 TO SEC70
KM         UPPER WATERSHED PRECIPITATION DATA
BA  0.009
PH                  .66    1.35   2.50   3.60   4.65   6.80   9.25  12.50
LS      0     52
UD  0.072

KK  SEC220
KM         COMBINE HYDROGRAPHS AT SEC220
NC      2

KK  SEC310
KM         ROUTE HYDROGRAPH FORM SEC220 TO SEC310
RS      2   FLOW      0
RC  0.035  0.035  0.035       1  0.055    198
RX      0     60     83     105    122    141    170    180
RY 203.41 199.48 196.85  190.29 190.29 196.85 203.41 209.97

KK     D1
KM         GENERATE HYDROGRAPH FROM SUBBASIN D1 TO SEC310
BA  0.075
PH                  .66    1.35    2.5    3.6   4.65    6.8   9.25   12.5
LS      0     88
UD  0.228

KK  SEC310
KM         COMBINE HYDROGRAPHS
NC      2

KK  SEC340
KM         ROUTE HUMEHUKE FLOW FROM SEC310 TO SEC340
RS      2   FLOW      0
RC   .015   .015   .015    1247  0.018    130
RX      0    100    200 200.001 210.001 210.002   310    410
RY  131.7  131.7  131.7   124.7  124.7  131.7  131.7  131.7
                         HEC-1 INPUT                                    PAGE 6

LINE   ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

KK    D4A
KM         GENERATE HYDROGRAPH FROM SUBBASIN D4A TO SEC340
KM         MID-WATERSHED PRECIPITATION DATA
BA  0.036
PH                  .65    1.32   2.45   3.55   4.60   6.75   9.20  12.30
LS      0     88
UD  0.450

KK  SEC340
KM         COMBINE HYDROGRAPHS AT SEC340
NC      2

KK  SEC350
KM         COMBINE HYDROGRAPHS AT SEC350
NC      2

KK  SEC360
KM         ROUTE FLOW FROM SEC350 TO SEC360
RS      2   FLOW      0
RC   .015   .015   .015    3617   .011     81
RX      0    100    200 200.001 215.001 215.002   315    415
RY     81     81     81      73     73     81     81     81

KK     D7
KM         GENERATE HYDROGRAPH FROM SUBBASIN D7 TO SEC360
KM         MID-WATERSHED PRECIPITATION DATA
BA  0.155
PH                  .65    1.32   2.45   3.55   4.60   6.75   9.20  12.30
LS      0     90
UD  0.450

KK  SEC360
KM         COMBINE HYDROGRAPHS AT SEC360
NC      2

KK  SEC400
KM         COMBINE HYDROGRAPHS AT SEC400
NC      2

KK  SEC410
KM         ROUTE FLOW FROM SEC400 TO SEC410
RS      2   FLOW      0
RC   .035   .035   .035    1400  .0006     64
RX      0    100    130     260    360    390    490    590
RY     66     66     66      51     51     66     66     66

KK     D8
KM         GENERATE HYDROGRAPH FROM SUBBASIN D8 TO SEC410
KM         MI-WATERSHED PRECIPITATION DATA
BA  0.273
PH                 0.65    1.32   2.45   3.55   4.60   6.75    9.2   12.3
LS      0     90
UD  0.450
                         HEC-1 INPUT                                    PAGE 7

LINE   ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

KK  SEC410
KM         COMBINE DYDROGRAPHS AT SEC410
NC      2

KK  SEC420
KM         ROUTE SEC410 TO SEC420
RS      2   FLOW      0
RC  0.035  0.035  0.035    1600 0.0006     64
RX      0    100    200     230    330    360    440    560
```

```
278         RY     66     66     66     51     51     66     66     66

279         KK     D9
280         KM       GENERATE HYDROGRAPH FROM SUBBASIN D9 TO SEC420
281         KM       MID-WATERSHED PRECIPITATION DATA
282         BA   0.130
283         PH                 0.65   1.32   2.45   3.55   4.60   6.75    9.2   12.3
284         LS       0     89
285         UD    0.45

286         KK  SEC420
287         KM       COMBINE HYDROGRAPHS AT SEC420
288         KO       3
289         HC       2

290         KK     D10
291         KM       GENERATE HYDROGRAPH FROM SUBBASIN D10 TO SEC05
292         KM       UPPERMOST WATERSHED PRECIPITATION DATA
293         BA   0.232
294         PH                  .65   1.32   2.50   3.60   4.65   6.80   9.25  12.30
295         LS       0     91
296         UD    0.45

297         KK   SEC10
298         KM       ROUTE FLOW FROM SEC05 TO SEC10
299         RS       1   FLOW      0
300         RC   0.015   .015  0.015   3040  0.010     54
301         RX       0    100    200    200    220    220    320    420
302         RY      55     55     55     47     47     55     55     55

303         KK     D11
304         KM       GENERATE HYDROGRAPH FROM SUBBASIN D11 TO SEC10
305         KM       UPPERMOST WATERSHED PRECIPITATION DATA
306         BA   0.275
307         PH                  .65   1.32   2.50   3.60   4.65   6.80   9.25  12.30
308         LS       0     91
309         UD   0.450

310         KK   SEC10
311         KM       COMBINE HYDROGRAPHS AT SEC10
312         KO       3
313         HC       2
314         ZZ
1
               SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE    (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.    (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   8       A3
           V
           V
  15     SEC10
           .
           .
  22       .        A2
           .        .
           .        .
  29     SEC10.........
           .
           .
  32       .        A1
           .        .
           .        .
  39     SEC15.........
           V
           V
  42     SEC20
           .
           .
  48       .        A4
           .        .
           .        .
  55     SEC20.........
           V
           V
  58     SEC25
           .
  64       .        D3
           .        .
           .        .
  71     SEC25.........
           V
           V
  74     SEC377
           V
           V
  80     SEC378
           V
           V
  86     SEC380
           .
  92       .        D6
           .        .
           .        .
  99     SEC380........
           .
 102       .        A6A
           .        .
 109       .        .        A6B
           .        .        .
 116       .        .        .        A6C
           .        .        .        .
 123       .      SEC55...................
           .        V
           V        V
 126       .      SEC60
           .        .
 132       .        .        A12
           .        .        V
 139       .        .        V
           .        .      SEC60
 145       .        .        .        D2
           .        .        .        .
 152       .      SEC60...................
           .        V
           .        V
 155       .      SEC320
           .        .
 161       .        .        D5
           .        .        .
 168       .      SEC320.......
           .        V
           .        V
 171       .      SEC330
           .        .
 177       .        .        D48
           .        .        .
 184       .      SEC330.......
           .        .
 187       .        .        A8
           .        .        .
 194       .        .        .        A7
           .        .        .        .
 201       .        .      SEC220......
           .        .        V
           .        .        V
 204       .        .      SEC310
```

```
210        .        .        .
           .        .        .      D1
           .        .        .       .
216        .        .     SEC310.........
           .        .        V
           .        .        V
219        .        .     SEC340
           .        .        .
225        .        .        .      D4A
           .        .        .       .
232        .        .     SEC340.........
           .        .        .
235        .     SEC350...........
           .        V
           .        V
238        .     SEC360
           .        .
244        .        .       D7
           .        .        .
251        .     SEC360...........
           .        .
254    SEC400...........
           V
           V
257    SEC410
           .
263        .       D8
           .        .
270    SEC410...........
           V
           V
273    SEC420
           .
279        .       D9
           .        .
286    SEC420...........
           .
290        .      D10
           .        V
           .        V
297        .     SEC10
           .        .
303        .        .      D11
           .        .        .
310        .     SEC10...........

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

```
*****************************************
*                                       *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *
*            JUN 09 1992                *
*         VERSION 4.0.3E                *
*                                       *
*  RUN DATE  06/06/98  TIME  08:33:06   *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*   U.S. ARMY CORPS OF ENGINEERS        *
*   HYDROLOGIC ENGINEERING CENTER       *
*        609 SECOND STREET              *
*     DAVIS, CALIFORNIA 95616           *
*         (916) 551-1748                *
*                                       *
*****************************************
```

EAST KAPOLEI FLOOD (100-YEAR STORM)
FN: NEW1A2.DAT

```
                  PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
                          EAST KAPOLEI - DEV. COND. NO BASINS - ADD 47 AC. KAP.
                  KALOI - HUNEHUNE NETWORK MODEL

 7 IO        OUTPUT CONTROL VARIABLES
                    IPRNT          5  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

 IT          HYDROGRAPH TIME DATA
                    NMIN           7  MINUTES IN COMPUTATION INTERVAL
                    IDATE    5MAY98   STARTING DATE
                    ITIME       1200  STARTING TIME
                    NQ           300  NUMBER OF HYDROGRAPH ORDINATES
                    NDDATE   6MAY98   ENDING DATE
                    NDTIME      2253  ENDING TIME
                    ICENT         19  CENTURY MARK

             COMPUTATION INTERVAL   0.12 HOURS
                  TOTAL TIME BASE  34.88 HOURS

         ENGLISH UNITS
             DRAINAGE AREA          SQUARE MILES
             PRECIPITATION DEPTH    INCHES
             LENGTH, ELEVATION      FEET
             FLOW                   CUBIC FEET PER SECOND
             STORAGE VOLUME         ACRE-FEET
             SURFACE AREA           ACRES
             TEMPERATURE            DEGREES FAHRENHEIT

 VALUE EXCEEDS TABLE IN LOGLOG        24.03336      0.01667      24.00000

 VALUE EXCEEDS TABLE IN LOGLOG        24.03336      0.01667      24.00000
MAKE2 NPLAN,NSTN      1    0

 VALUE EXCEEDS TABLE IN LOGLOG        24.03336      0.01667      24.00000
MAKE2 NPLAN,NSTN      1    0

 VALUE EXCEEDS TABLE IN LOGLOG        24.03336      0.01667      24.00000
MAKE2 NPLAN,NSTN      1    0

 WARNING --- ROUTED OUTFLOW (   1847.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2113.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2374.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2597.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2799.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   2995.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3189.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3366.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3504.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3598.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3651.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3664.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3642.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3587.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3501.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3393.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3269.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3138.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (   3006.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
```

```
WARNING --- ROUTED OUTFLOW (   2876.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2754.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2642.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2540.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2442.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2351.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2264.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2181.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2100.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2021.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   1945.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   1873.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   1806.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   1741.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   1741.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   1984.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2248.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2490.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2702.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2900.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3095.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3280.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3437.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3553.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3626.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3658.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3653.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3614.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3543.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3445.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3329.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3201.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   3070.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2939.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2813.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2696.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2589.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2489.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2395.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (   2306.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2221.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2139.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   2059.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   1982.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   1908.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   1838.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (   1772.) IS GREATER THAN MAXIMUM OUTFLOW (   1720.) IN STORAGE-OUTFLOW TABLE
 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
MAKE2 NPLAN,NSTM       1     0

 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
MAKE2 NPLAN,NSTM       1     0

 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000

 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000

 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
MAKE2 NPLAN,NSTM       1     0
MAKE2 NPLAN,NSTM       1     0

 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000

 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
MAKE2 NPLAN,NSTM       1     0
MAKE2 NPLAN,NSTM       1     0

 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
MAKE2 NPLAN,NSTM       1     0

 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
MAKE2 NPLAN,NSTM       1     0

 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000

 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
MAKE2 NPLAN,NSTM       1     0

 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
MAKE2 NPLAN,NSTM       1     0

 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
MAKE2 NPLAN,NSTM       1     0
MAKE2 NPLAN,NSTM       1     0

 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
MAKE2 NPLAN,NSTM       1     0
MAKE2 NPLAN,NSTM       1     0

 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000
MAKE2 NPLAN,NSTM       1     0

 VALUE EXCEEDS TABLE IN LOGLOG        24.03336       0.01667       24.00000

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

           **************
           *            *
  286 KK   *   SEC420   *
           *            *
           **************

  288 KO        OUTPUT CONTROL VARIABLES
                     IPRNT          3  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE
```

```
289 KC        HYDROGRAPH COMBINATION
                  ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE
                                                    ***

IAME2 NPLAN,NSTN       1      0
      ***          ***          ***          ***          ***

                    HYDROGRAPH AT STATION    SEC420

 PEAK FLOW     TIME                       MAXIMUM AVERAGE FLOW
                               6-HR        24-HR        72-HR      34.88-HR
 + (CFS)       (HR)
                      (CFS)
 +  5507.     12.72              3664.       1547.        1070.       1070.
                      (INCHES)   5.349       9.075        9.156       9.156
                      (AC-FT)    1802.       3057.        3084.       3084.

                    CUMULATIVE AREA =     6.32 SQ MI

VALUE EXCEEDS TABLE IN LOGLOG        24.03336        0.01667        24.00000
VALUE EXCEEDS TABLE IN LOGLOG        24.03336        0.01667        24.00000

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
 310 KK     *    SEC10   *
            *            *
            **************

 312 KO        OUTPUT CONTROL VARIABLES
                    IPRNT          3  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

 313 KC        HYDROGRAPH COMBINATION
                  ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE
                                                    ***

IAME2 NPLAN,NSTN       1      0
      ***          ***          ***          ***          ***

                    HYDROGRAPH AT STATION    SEC10

 PEAK FLOW     TIME                       MAXIMUM AVERAGE FLOW
                               6-HR        24-HR        72-HR      34.88-HR
 + (CFS)       (HR)
                      (CFS)
 +   941.     12.48              360.        153.         105.        105.
                      (INCHES)   6.545      11.180       11.184      11.184
                      (AC-FT)    177.        302.         302.        302.

                    CUMULATIVE AREA =     0.51 SQ MI

1
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	A3	1621.	13.30	939.	384.	263.	1.70		
+	ROUTED TO	SEC10	1621.	13.42	939.	384.	263.	1.70	213.07	13.42
+	HYDROGRAPH AT	A2	270.	12.48	91.	34.	25.	0.17		
+	2 COMBINED AT	SEC10	1726.	13.30	1028.	421.	288.	1.87		
+	HYDROGRAPH AT	A1	1846.	13.65	1148.	476.	326.	2.04		
+	2 COMBINED AT	SEC15	3546.	13.42	2174.	896.	615.	3.90		
+	ROUTED TO	SEC20	3546.	13.42	2174.	896.	615.	3.90	201.34	13.42
+	HYDROGRAPH AT	A4	270.	12.48	101.	40.	28.	0.19		
+	2 COMBINED AT	SEC20	3667.	13.42	2273.	936.	642.	4.09		
+	ROUTED TO	SEC25	3658.	13.53	2272.	936.	642.	4.09	199.02	13.53
+	HYDROGRAPH AT	D3	585.	12.48	221.	90.	62.	0.34		
+	2 COMBINED AT	SEC25	3900.	13.53	2480.	1025.	704.	4.43		
+	ROUTED TO	SEC377	3895.	13.65	2479.	1025.	704.	4.43	155.53	13.65
+	ROUTED TO	SEC378	3895.	13.65	2479.	1025.	704.	4.43	102.89	13.65
+	ROUTED TO	SEC380	3887.	13.77	2478.	1025.	706.	4.43	81.48	13.77
+	HYDROGRAPH AT	D6	632.	12.48	240.	101.	69.	0.35		
+	2 COMBINED AT	SEC380	4124.	13.77	2696.	1122.	775.	4.78		
+	HYDROGRAPH AT	A6A	154.	12.25	38.	15.	10.	0.06		
+	HYDROGRAPH AT	A6B	70.	12.25	17.	7.	5.	0.03		
+	HYDROGRAPH AT	A6C	303.	12.37	94.	39.	26.	0.15		
+	3 COMBINED AT	SEC55	489.	12.25	149.	61.	42.	0.23		
+	ROUTED TO	SEC60	489.	12.37	149.	61.	42.	0.23	188.57	12.37
+	HYDROGRAPH AT	A12	143.	12.95	73.	30.	21.	0.11		
+	ROUTED TO	SEC60	142.	13.07	73.	30.	21.	0.11	151.66	13.07
+	HYDROGRAPH AT	D2	387.	12.48	146.	61.	42.	0.22		
+	3 COMBINED AT	SEC60	918.	12.37	347.	152.	104.	0.56		

ROUTED TO	SEC320	907.	12.48	367.	152.	104.	0.56	132.36	12.48
HYDROGRAPH AT	D5	122.	12.48	46.	19.	13.	0.07		
2 COMBINED AT	SEC320	1029.	12.48	413.	171.	117.	0.63		
ROUTED TO	SEC330	1038.	12.48	413.	171.	117.	0.63	110.11	12.48
HYDROGRAPH AT	D4B	106.	12.48	40.	17.	12.	0.06		
2 COMBINED AT	SEC330	1144.	12.48	453.	188.	129.	0.69		
HYDROGRAPH AT	A8	326.	12.37	103.	42.	29.	0.17		
HYDROGRAPH AT	A7	19.	12.13	4.	1.	1.	0.01		
2 COMBINED AT	SEC220	333.	12.37	107.	43.	29.	0.18		
ROUTED TO	SEC310	333.	12.37	107.	43.	29.	0.18	191.69	12.37
HYDROGRAPH AT	D1	186.	12.25	53.	22.	15.	0.08		
2 COMBINED AT	SEC310	512.	12.37	159.	65.	45.	0.25		
ROUTED TO	SEC340	515.	12.37	159.	65.	45.	0.25	127.37	12.37
HYDROGRAPH AT	D4A	66.	12.48	25.	10.	7.	0.04		
2 COMBINED AT	SEC340	575.	12.37	184.	76.	52.	0.29		
2 COMBINED AT	SEC350	1666.	12.48	637.	264.	181.	0.98		
ROUTED TO	SEC360	1692.	12.48	637.	264.	181.	0.98	78.15	12.48
HYDROGRAPH AT	D7	286.	12.48	109.	46.	32.	0.16		
2 COMBINED AT	SEC360	1978.	12.48	745.	310.	213.	1.13		
2 COMBINED AT	SEC400	4926.	13.65	3401.	1429.	988.	5.91		
ROUTED TO	SEC410	4920.	13.65	3401.	1429.	988.	5.91	59.98	13.65
HYDROGRAPH AT	D8	504.	12.48	191.	81.	56.	0.27		
2 COMBINED AT	SEC410	5331.	12.72	3580.	1509.	1044.	6.19		
ROUTED TO	SEC420	5312.	12.83	3579.	1509.	1044.	6.19	61.21	12.83
HYDROGRAPH AT	D9	239.	12.48	91.	38.	26.	0.13		
2 COMBINED AT	SEC420	5507.	12.72	3664.	1547.	1070.	6.32		
HYDROGRAPH AT	D10	436.	12.48	165.	70.	48.	0.23		
ROUTED TO	SEC10	432.	12.60	165.	70.	48.	0.23	48.69	12.60
HYDROGRAPH AT	D11	517.	12.48	195.	83.	57.	0.28		
2 COMBINED AT	SEC10	941.	12.48	360.	153.	105.	0.51		

*** NORMAL END OF HEC-1 ***

```
1****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*              JUN 09 1992              *
*             VERSION 4.0.3E            *
*                                       *
* RUN DATE  05/14/98  TIME  09:32:26    *
*                                       *
*****************************************

*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*    HYDROLOGIC ENGINEERING CENTER      *
*          609 SECOND STREET            *
*       DAVIS, CALIFORNIA 95616         *
*           (916) 551-1748              *
*                                       *
*****************************************

X     X  XXXXXXX   XXXXX         X
X     X  X        X     X       XX
X     X  X        X              X
XXXXXXX  XXXX     X      XXXXX   X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX        XXX

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                  HEC-1 INPUT                                          PAGE  1

LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1       ID   EAST KAPOLEI FLOOD (100-YEAR STORM)
   2       ID   FN: EASTKAP3.DAT
   3       ID   PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
   4       ID                       EAST KAPOLEI - DEVELOPED CONDITIONS  - ADD 47.0 AC KAP
   5       ID                                      RUN WITH BASINS IN - DROP ELEV BAS. 485
   6       ID   KALOI - MAKEMUKE NETWORK MODEL
           *DIAGRAM
   7       IT       7 05MAY98    1200     300
   8       IO       5

   9       KK      A3
  10       KM         GENERATE HYDROGRAPH FROM SUBBASIN A3 TO SEC05
  11       KM         UPPERMOST WATERSHED PRECIPITATION DATA
  12       BA   1.701
  13       PH          1.701     .69    1.40    2.60    3.70    4.75    6.85    9.30   12.70
  14       LS       0      68
  15       UD   1.206

  16       KK   SEC10
  17       KM         ROUTE KALOI TRIBUTARY FLOW FROM SEC05 TO SEC10
  18       KM         KALOI STREAM ABOVE CONFLUENCE OF MAIN AND TRIBUTARY
  19       RS       1    FLOW       0
  20       RC   0.035    .035   0.035    2250   0.024     220
  21       RX       0     150     155     165     180     190     195     520
  22       RY     220     218     215     208     208     218     218     220

  23       KK      A2
  24       KM         GENERATE HYDROGRAPH FROM SUBBASIN A2 TO SEC10
  25       KM         UPPERMOST WATERSHED PRECIPITATION DATA
  26       BA   0.167
  27       PH          0.167     .69    1.40    2.60    3.70    4.75    6.85    9.30   12.70
  28       LS       0      66
  29       UD    0.39

  30       KK   SEC10
  31       KM         COMBINE HYDROGRAPHS AT SEC10
  32       HC       2

  33       KK      A1
  34       KM         GENERATE HYDROGRAPH FROM SUBBASIN A1 TO SEC14
  35       KM         UPPERMOST WATERSHED PRECIPITATION DATA
  36       BA   2.036
  37       PH          2.036     .69    1.40    2.60    3.70    4.75    6.85    9.30   12.70
  38       LS       0      70
  39       UD   1.434

  40       KK   SEC15
  41       KM         COMBINE HYDROGRAPHS AT SEC15
  42       HC       2
1                                  HEC-1 INPUT                                          PAGE  2

LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  43       KK   SEC20
  44       KM         ROUTE KALOI TRIBUTARY FLOW FROM SEC15 TO SEC20
  45       RS       2    FLOW       0
  46       RC    .035    .035    .035     200   0.025     207
  47       RX       0     160     180     190     205     240     400     550
  48       RY     215     215     215     196     196     207     210     215

  49       KK      A4
  50       KM         GENERATE HYDROGRAPH FROM SUBBASIN A4 TO SEC20
  51       KM         UPPER WATERSHED PRECIPITATION DATA
  52       BA   0.188
  53       PH          0.188     .66    1.35    2.50    3.60    4.65    6.80    9.25   12.50
  54       LS       0      66
  55       UD   0.450

  56       KK   SEC20
  57       KM         COMBINE HYDROGRAPHS AT SEC20
  58       HC       2

  59       KK   RES01
  60       KM         ROUTE FLOW FROM SEC20 THROUGH RES01
  61       KO       3
  62       RS       1    ELEV     170
  63       SV       0    5.80   11.59   17.39   23.18   28.98   42.24   62.13  152.44
  64       SE     170   171.0     172   173.0   174.0     175     177     180  188.65
  65       SS     175      40     3.4     1.5
  66       SL     170   0.785     0.6     0.5

  67       KK   SEC21
  68       KM         ROUTE FLOW FROM RES01 TO SEC21
  69       RS       2    FLOW       0
  70       RC   0.035   0.035   0.035    1215  0.0006     185
  71       RX       0     100     200     230     250     280     460     560
  72       RY     185     185     185     170     170     185     185     185

  73       KK   RES02
  74       KM         ROUTE FLOW FROM SEC21 THROUGH RES02
  75       KO       3
  76       RS       1    ELEV     142
  77       SV       0    1.91    3.82    7.65   11.47   15.30   19.13   33.08   50.13   69.33
  78       SE     142   142.5     143   144.0   145.0     146     147     150     153     156
  79       SS     147      50       3     1.5
  80       SL   142.0   0.785     0.6     0.5

  81       KK   SEC25
  82       KM         ROUTE FLOW FROM RES02 TO SEC25
  83       RS       2    FLOW       0
  84       RC    .035    .035    .035      46  0.0006     159
  85       RX       0     100     200     240     270     310     460     560
  86       RY     159     159     159     139     139     159     159     159
1                                  HEC-1 INPUT                                          PAGE  3

LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  87       KK      D3
  88       KM         GENERATE HYDROGRAPH FROM SUBBASIN D3 TO SEC25
  89       KM         MID-WATERSHED PRECIPITATION DATA
  90       BA    .343
  91       PH                    .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
  92       LS       0      80
  93       UD    0.45

  94       KK   SEC25
```

```
 95           KM        COMBINE HYDROGRAPHS AT SEC25
 96           KC       2

 97           KK   RES03
 98           KM        ROUTE FLOW FROM SEC25 THROUGH RES03
 99           KO       3
100           RS       1    ELEV  115.47
101           SV       0    6.90   13.80   27.60   34.50   82.93  108.59  137.97
102           SE  115.47  116.47  117.47  119.47  120.47  125.47  127.47  129.47
103           SS  120.47      50       3     1.5
104           SL  115.47   0.785     0.6     0.5

105           KK  SEC380
106           KM         ROUTE RES03 TO SEC380
107           RS       2    FLOW       0
108           RC   0.035   0.025   0.035    1657   0.012  130.47
109           RX       0     100     200     230     260     290     380     380
110           RY  130.47  130.47  130.47  115.47  115.47  130.47  130.47  130.47

111           KK      D6
112           KM         GENERATE HYDROGRAPH FROM SUBBASIN D6 TO SEC380
113           KM         MID-WATERSHED PRECIPITATION DATA
114           BA   0.361
115           PH                     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
116           LS       0      88
117           UD    0.45

118           KK  SEC380
119           KM        COMBINE HYDROGRAPHS AT SEC380
120           KC       2

121           KK     A6A
122           KM        GENERATE HYDROGRAPH FROM SUBBASIN A6A TO SEC51
123           KM        UPPER WATERSHED PRECIPITATION DATA
124           BA   0.062
125           PH                    0.66    1.35    2.50    3.60    4.65    6.80    9.25   12.50
126           LS       0      74
127           UD   0.168

128           KK     A6B
129           KM        GENERATE HYDROGRAPH FROM SUBBASIN A6B TO SEC52
130           KM        UPPER WATERSHED PRECIPITATION DATA
131           BA   0.027
132           PH                    0.66    1.35    2.50    3.60    4.65    6.80    9.25   12.50
133           LS       0      77
                                   HEC-1 INPUT                                          PAGE  4

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

134           UD   0.162

135           KK     A6C
136           KM        GENERATE HYDROGRAPH FROM SUBBASIN A6C TO SEC53
137           KM        UPPER WATERSHED PRECIPITATION DATA
138           BA   0.146
139           PH                    0.66    1.35    2.50    3.60    4.65    6.80    9.25   12.50
140           LS       0      79
141           UD   0.306

142           KK   SEC55
143           KM         COMBINE HYDROGRAPHS AT SEC55
144           KC       3

145           KK   SEC60
146           KM   ROUTE FLOW FROM SEC55 TO SEC60
147           RS       2    FLOW       0
148           RC   0.015   0.015   0.015    1820   0.031     192
149           RX       0     100     200     200     215     215     315     415
150           RY   193.0  193.00  193.00  187.00  187.00  193.00  193.00  193.00

151           KK     A12
152           KM        GENERATE HYDROGRAPH FROM SUBBASIN A12 TO SEC50
153           KM        MID-WATERSHED PRECIPITATION DATA
154           BA   0.113
155           PH                     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
156           LS       0      81
157           UD   0.864

158           KK   SEC60
159           KM         ROUTE A12 TO SEC60
160           RS       2    FLOW       0
161           RC   0.035   0.035   0.035    3041   0.026     156
162           RX       0     216     347     401     432     445     452     749
163           RY   162.4  157.48  154.53  150.92  150.92  154.20  154.20  157.48

164           KK      D2
165           KM         GENERATE HYDROGRAPH FROM SUBBASIN D2 TO SEC60
166           KM         MID-WATERSHED PRECIPITATION DATA
167           BA   0.215
168           PH                     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
169           LS       0      86
170           UD    0.45

171           KK   SEC60
172           KM         COMBINE HYDROGRAPHS AT SEC60
173           KC       3

174           KK  SEC320
175           KM   ROUTE FLOW FROM SEC60 TO SEC320
176           RS       2    FLOW       0
177           RC   0.025   0.025   0.025    1614  0.0110   139.3
178           RX       0     100     200     216     266     282     320     420
179           RY   139.3  139.30  139.30  131.30  131.30  139.30  139.30   139.3
                                   HEC-1 INPUT                                          PAGE  5

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

180           KK      D5
181           KM         GENERATE HYDROGRAPH FROM SUBBASIN D5 TO SEC320
182           KM         MID-WATERSHED PRECIPITATION DATA
183           BA   0.068
184           PH                     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
185           LS       0      86
186           UD    0.45

187           KK  SEC320
188           KM         COMBINE HYDROGRAPHS AT SEC320
189           KC       2

190           KK  SEC330
191           KM   ROUTE FLOW FROM SEC320 TO SEC330
192           RS       2    FLOW       0
193           RC   0.013   0.013   0.013    1375   0.005   97.58
194           RX       0     100     200 200.001 212.001 212.002     320     420
195           RY   97.58   97.58   97.58   89.58   89.58   97.58   97.58   97.58

196           KK     D4B
197           KM         GENERATE HYDROGRAPH FROM SUBBASIN D4B TO SEC330
198           KM         UPPER WATERSHED PRECIPITATION DATA
199           BA   0.057
200           PH                     .66    1.35    2.50    3.60    4.65    6.80    9.25   12.50
201           LS       0      88
202           UD   0.450

203           KK  SEC330
204           KM         COMBINE HYDROGRAPHS AT SEC330
205           KC       2

206           KK      A8
207           KM         GENERATE HYDROGRAPH FROM SUBBASIN A8 TO SEC80
208           KM         MID-WATERSHED PRECIPITATION DATA
209           BA   0.168
210           PH                     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
211           LS       0      76
212           UD   0.312

213           KK      A7
214           KM         GENERATE HYDROGRAPH FROM SUBBASIN A7 TO SEC70
215           KM         UPPER WATERSHED PRECIPITATION DATA
216           BA   0.009
217           PH                     .66    1.35    2.50    3.60    4.65    6.80    9.25   12.50
218           LS       0      52
219           UD   0.072

220           KK  SEC220
```

```
KM       COMBINE HYDROGRAPHS AT SEC220
NC      2
                              HEC-1 INPUT                                        PAGE 6

LINE     ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

KK  SEC310
KM       ROUTE HYDROGRAPH FORM SEC220 TO SEC310
RS      2    FLOW       0
RC  0.035   0.035   0.035    1247   0.018     200
RX      0      60      83     105     122     141     170     180
RY 203.41  199.48  196.85  190.29  190.29  196.85  203.41  209.97

KK     D1
KM       GENERATE HYDROGRAPH FROM SUBBASIN D1 TO SEC310
BA  0.075
PH                    .66    1.35     2.5     3.6    4.65     6.8    9.25    12.5
LS      0      88
UD  0.228

KK  SEC310
KM       COMBINE HYDROGRAPHS
NC      2

KK  SEC315
KM       ROUTE NUNEMUNE FLOW FROM SEC310 TO SEC315
RS      2    FLOW       0
RC   .035    .013    .035     220    .009   94.21
RX      0     100     200     200     208     208     300     400
RY  94.21   94.21   94.21   88.21   88.21   94.21   94.21   94.21

KK  SEC340
KM       ROUTE NUNEMUNE FLOW FROM SEC315 TO SEC340
RS      2    FLOW       0
RC   .035    .013    .035    1100   0.004   95.11
RX      0     100     200 200.001 208.001 208.002     310     410
RY  95.11   95.11   95.11   87.11   87.11   95.11   95.11   95.11

KK    D4A
KM       GENERATE HYDROGRAPH FROM SUBBASIN D4A TO SEC340
KM       MID-WATERSHED PRECIPITATION DATA
BA  0.036
PH                    .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
LS      0      88
UD  0.450

KK  SEC340
KM       COMBINE HYDROGRAPHS AT SEC340
NC      2

KK  SEC350
KM       COMBINE HYDROGRAPHS AT SEC350
NC      2

KK  SEC355
KM       ROUTE FLOW FROM SEC350 TO SEC355
RS      2    FLOW       0
RC  0.015    .015    .015    1600    .004   90.71
RX      0     100     200     200     216     216     300     400
RY  90.71   90.71   90.71   82.71   82.71   90.71   90.71   90.71
                              HEC-1 INPUT                                        PAGE 7

LINE     ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

KK  SEC360
KM       ROUTE FLOW FROM SEC355 TO SEC360
RS      2    FLOW       0
RC   .015    .015    .015    2100    .003   84.31
RX      0     100     200 200.001 220.001 220.002     300     400
RY  84.31   84.31   84.31   76.31   76.31   84.31   84.31   84.31

KK     D7
KM       GENERATE HYDROGRAPH FROM SUBBASIN D7 TO SEC360
KM       MID-WATERSHED PRECIPITATION DATA
BA  0.155
PH                    .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
LS      0      90
UD  0.450

KK  SEC360
KM       COMBINE HYDROGRAPHS AT SEC360
NC      2

KK  SEC381
KM       COMBINE HYDROGRAPHS AT SEC381
NC      2

KK   RES04
KM       ROUTE SEC381 THROUGH RES04
KO      3
RS      1    ELEV   53.31
SV      0   58.72   68.29   88.49  127.42  185.10  228.92  276.38  374.73
SE  53.31   61.31   62.33   63.98   66.31   68.90   70.54   72.18   75.46
SS  58.31      50       3     1.5
SL  53.31   0.785     0.6     0.5

KK  SEC410
KM       ROUTE FLOW FROM RES04 TO SEC410
RS      2    FLOW       0
RC   .035    .035    .035    1400   .0006      81
RX      0     100     230     260     360     390     490     590
RY   66.5    66.5    66.5    51.5    51.5    66.5    66.5    66.5

KK     D8
KM       GENERATE HYDROGAPH FROM SUBBASIN D8 TO SEC410
KM       MID-WATERSHED PRECIPITATION DATA
BA  0.273
PH                   0.65    1.32    2.45    3.55    4.60    6.75     9.2    12.3
LS      0      90
UD  0.666

KK  SEC410
KM       COMBINE HYDROGRAPHS AT SEC410
NC      2
* SEC420
*        ROUTE SEC410 TO SEC420
*       2    FLOW       0
* 0.035   0.035   0.035    1600  0.0006      71
*       0     100     200     230     330     360     460     560
*    66.5    66.5    66.5    51.5    51.5    66.5    66.5    66.5
                              HEC-1 INPUT                                        PAGE 8

LINE     ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

KK     D9
KM       GENERATE HYDROGRAPH FROM SUBBASIN D9 TO SEC420
KM       MID-WATERSHED PRECIPITATION DATA
BA  0.130
PH                   0.65    1.32    2.45    3.55    4.60    6.75     9.2    12.3
LS      0      89
UD   0.45

KK  SEC420
KM       COMBINE HYDROGRAPHS AT SEC420
NC      2

KK  RES05
KM  ROUTE SECT420 THROUGH RES05
KO      3
RS      1    ELEV    51.5       0
SV      0    8.09   16.48   44.11   55.20   78.85  108.01  138.95
SE   51.5    52.5    53.5   56.50    57.4    59.0    60.7    62.3
SS   54.5     110       3     1.5
SL   51.5   0.785     0.6     0.5

KK    D10
KM       GENERATE HYDROGRAPH FROM SUBBASIN D10 TO SEC05
KM       UPPERMOST WATERSHED PRECIPITATION DATA
BA  0.232
PH                    .65    1.32    2.50    3.64    4.65    6.80    9.25   12.30
LS      0      91
UD   0.45
```

```
 337         KK  SEC10
 338         KM      ROUTE FLOW FROM SEC05 TO SEC10
 339         RS     1    FLOW      0
 340         RC  0.015   .015  0.015   .3040  0.010    54
 341         RX      0    100    200    200    220    220    320    420
 342         RY     55     55     55     47     47     55     55     55

 343         KK    D11
 344         KM      GENERATE HYDROGRAPH FROM SUBBASIN D11 TO SEC10
 345         KM      UPPERMOST WATERSHED PRECIPITATION DATA
 346         BA  0.275
 347         PH                  .65   1.32   2.50   3.60   4.65   6.80   9.25  12.30
 348         LS      0     91
 349         UD  0.450

 350         KK  SEC10
 351         KM      COMBINE HYDROGRAPHS AT SEC10
 352         KO      3
 353         HC      2
 354         ZZ
1
          SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE     (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.     (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   9        A3
            V
            V
  16      SEC10
            .
            .
  23        .        A2
            .        .
            .        .
  30      SEC10.........
            .
            .
  33        .        A1
            .        .
            .        .
  40      SEC15.........
            V
            V
  43      SEC20
            .
            .
  49        .        A4
            .        .
            .        .
  56      SEC20.........
            V
            V
  59      RES01
            V
            V
  67      SEC21
            V
            V
  73      RES02
            V
            V
  81      SEC25
            .
            .
  87        .        D3
            .        .
            .        .
  94      SEC25.........
            V
            V
  97      RES03
            V
            V
 105     SEC380
            .
            .

 111        .        D6
            .        .
 118     SEC380.........
            .
 121        .       A6A
            .        .
 128        .        .       A6B
            .        .        .
 135        .        .        .       A6C
            .        .        .        .
 142        .      SEC55...................
            .        V
            V        V
 145        .      SEC60
            .        .
 151        .        .       A12
            .        .        V
            .        .        V
 158        .        .      SEC60
            .        .        .
 164        .        .        .        D2
            .        .        .        .
 171        .      SEC60...................
            .        V
            .        V
 174        .     SEC320
            .        .
 180        .        .        D5
            .        .        .
 187        .     SEC320.........
            .        V
            .        V
 190        .     SEC330
            .        .
 196        .        .       D4B
            .        .        .
 203        .     SEC330.........
            .        .
 206        .        .        A8
            .        .        .
 213        .        .        .        A7
            .        .        .        .
 220        .        .     SEC220.........
            .        .        V
            .        .        V
 223        .        .     SEC310
            .        .        .
 229        .        .        .        D1
            .        .        .        .
 235        .        .     SEC310.........
            .        .        V
            .        .        V
 238        .        .     SEC315
            .        .        V
            .        .        V
 244        .        .     SEC340
            .        .        .
 250        .        .        .       D4A
            .        .        .        .
```

```
257        .        .    SEC340............
                    .              .
260        .      SEC350...........
                    V
                    V
263        .      SEC355
                    V
                    V
269        .      SEC360
                    .
                    .
275        .        .          D7
                    .          .
                    .          .
282        .      SEC360...........
           .        .
           .        .
285      SEC381.............
           V
           V
288      RES04
           V
           V
296      SEC410
           .
           .
302        .          D8
           .          .
           .          .
309      SEC410...........
           .
           .
312        .          D9
           .          .
           .          .
319      SEC420...........
           V
           V
322      RES05
           .
           .
330        .          D10
           .           V
           .           V
337        .         SEC10
           .           .
           .           .
343        .           .        D11
           .           .        .
           .           .        .
350        .         SEC10..........

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

```
FLOOD HYDROGRAPH PACKAGE  (HEC-1)
         JUN 09 1992
        VERSION 4.0.3E

RUN DATE  05/14/98  TIME  09:32:26
```

```
U.S. ARMY CORPS OF ENGINEERS
HYDROLOGIC ENGINEERING CENTER
      609 SECOND STREET
   DAVIS, CALIFORNIA 95616
       (916) 551-1748
```

```
EAST KAPOLEI FLOOD (100-YEAR STORM)
FN: EASTKAP3.DAT
PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
                    EAST KAPOLEI - DEVELOPED CONDITIONS  - ADD 47.0 AC KAP
                                 RUN WITH BASINS IN - DROP ELEV BAS. 465

KALOI - HONEHUNE NETWORK MODEL

8 IO      OUTPUT CONTROL VARIABLES
              IPRNT          5  PRINT CONTROL
              IPLOT          0  PLOT CONTROL
```

```
                   QSCAL          0.  HYDROGRAPH PLOT SCALE

IT          HYDROGRAPH TIME DATA
                 NMIN          7  MINUTES IN COMPUTATION INTERVAL
                IDATE     5MAY98  STARTING DATE
                ITIME       1200  STARTING TIME
                   NQ        300  NUMBER OF HYDROGRAPH ORDINATES
               NDDATE     6MAY98  ENDING DATE
               NDTIME       2253  ENDING TIME
                ICENT         19  CENTURY MARK

          COMPUTATION INTERVAL    0.12 HOURS
               TOTAL TIME BASE   34.88 HOURS

        ENGLISH UNITS
            DRAINAGE AREA          SQUARE MILES
            PRECIPITATION DEPTH    INCHES
            LENGTH, ELEVATION      FEET
            FLOW                   CUBIC FEET PER SECOND
            STORAGE VOLUME         ACRE-FEET
            SURFACE AREA           ACRES
            TEMPERATURE            DEGREES FAHRENHEIT

VALUE EXCEEDS TABLE IN LOGLOG          24.03336     0.01667     24.00000

VALUE EXCEEDS TABLE IN LOGLOG          24.03336  -  0.01667     24.00000
NAME2 NPLAN,NSTH      1     0

VALUE EXCEEDS TABLE IN LOGLOG          24.03336     0.01667     24.00000
NAME2 NPLAN,NSTH      1     0

VALUE EXCEEDS TABLE IN LOGLOG          24.03336     0.01667     24.00000
NAME2 NPLAN,NSTH      1     0

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          **************
59 KK     *    RES01   *
          **************

61 KO        OUTPUT CONTROL VARIABLES
                 IPRNT          3  PRINT CONTROL
                 IPLOT          0  PLOT CONTROL
                 QSCAL          0.  HYDROGRAPH PLOT SCALE

             HYDROGRAPH ROUTING DATA

62 RS        STORAGE ROUTING
                 NSTPS          1  NUMBER OF SUBREACHES
                 ITYP        ELEV  TYPE OF INITIAL CONDITION
                 RSVRIC    170.00  INITIAL CONDITION
                     X       0.00  WORKING R AND D COEFFICIENT

63 SV         STORAGE       0.0     5.8    11.6    17.4    23.2    29.0    42.2    62.1   152.4

64 SE       ELEVATION    170.00  171.00  172.00  173.00  174.00  175.00  177.00  180.00  188.65

66 SL        LOW-LEVEL OUTLET
                 ELEVL     170.00  ELEVATION AT CENTER OF OUTLET
                 CAREA       0.79  CROSS-SECTIONAL AREA
                 COOL        0.60  COEFFICIENT
                 EXPL        0.50  EXPONENT OF HEAD

65 SS        SPILLWAY
                 CREL      175.00  SPILLWAY CREST ELEVATION
                 SPWID      40.00  SPILLWAY WIDTH
                 COQW        3.40  WEIR COEFFICIENT
                 EXPW        1.50  EXPONENT OF HEAD

                                   ***

                           COMPUTED OUTFLOW-ELEVATION DATA
```

OUTFLOW	0.00	2.67	2.92	3.22	3.59	4.05	4.66	5.48	6.65	8.45
ELEVATION	170.00	170.50	170.60	170.72	170.90	171.15	171.52	172.10	173.09	175.00
OUTFLOW	15.63	64.51	196.07	451.30	871.18	1496.69	2368.82	3528.57	5016.95	6874.95
ELEVATION	175.14	175.55	176.23	177.19	178.42	179.92	181.69	183.74	186.06	188.65

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	0.00	2.89	3.45	4.20	5.23	5.80	6.67	8.82	11.59	12.18
OUTFLOW	0.00	2.67	2.92	3.22	3.59	3.78	4.05	4.66	5.34	5.48
ELEVATION	170.00	170.50	170.60	170.72	170.90	171.00	171.15	171.52	172.00	172.10
STORAGE	17.39	17.94	23.18	28.98	29.90	32.63	37.17	42.24	43.51	51.66
OUTFLOW	6.54	6.65	7.55	8.45	15.63	64.51	196.07	394.66	451.30	871.18
ELEVATION	173.00	173.09	174.00	175.00	175.14	175.55	176.23	177.00	177.19	178.42
STORAGE	61.61	62.13	79.83	101.19	125.39	152.44				
OUTFLOW	1496.68	1532.47	2368.82	3528.57	5016.95	6874.95				
ELEVATION	179.92	180.00	181.69	183.74	186.06	188.65				

*** *** *** *** ***

HYDROGRAPH AT STATION RES01

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	34.88-HR
+ (CFS)	(HR)					
		(CFS)				
+ 3605.	13.65		2270.	922.	633.	633.
		(INCHES)	5.115	8.352	8.366	8.366
		(AC-FT)	1116.	1823.	1826.	1826.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	34.88-HR
+ (AC-FT)	(HR)				
102.	13.65	77.	51.	38.	38.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	34.88-HR
+ (FEET)	(HR)				
183.86	13.65	181.39	178.10	176.12	176.12

CUMULATIVE AREA = 4.09 SQ MI

WARNING --- ROUTED OUTFLOW (3365.) IS GREATER THAN MAXIMUM OUTFLOW (3286.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (3479.) IS GREATER THAN MAXIMUM OUTFLOW (3286.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (3558.) IS GREATER THAN MAXIMUM OUTFLOW (3286.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (3600.) IS GREATER THAN MAXIMUM OUTFLOW (3286.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (3602.) IS GREATER THAN MAXIMUM OUTFLOW (3286.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (3567.) IS GREATER THAN MAXIMUM OUTFLOW (3286.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (3504.) IS GREATER THAN MAXIMUM OUTFLOW (3286.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (3420.) IS GREATER THAN MAXIMUM OUTFLOW (3286.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (3318.) IS GREATER THAN MAXIMUM OUTFLOW (3286.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (3330.) IS GREATER THAN MAXIMUM OUTFLOW (3286.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (3453.) IS GREATER THAN MAXIMUM OUTFLOW (3286.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (3541.) IS GREATER THAN MAXIMUM OUTFLOW (3286.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (3592.) IS GREATER THAN MAXIMUM OUTFLOW (3286.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (3604.) IS GREATER THAN MAXIMUM OUTFLOW (3286.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (3578.) IS GREATER THAN MAXIMUM OUTFLOW (3286.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (3521.) IS GREATER THAN MAXIMUM OUTFLOW (3286.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (3442.) IS GREATER THAN MAXIMUM OUTFLOW (3286.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (3344.) IS GREATER THAN MAXIMUM OUTFLOW (3286.) IN STORAGE-OUTFLOW TABLE

*** ***

```
              **************
              *            *
 73 KX        *   RES02    *
              *            *
              **************

 75 KO          OUTPUT CONTROL VARIABLES
                      IPRNT          3  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

                HYDROGRAPH ROUTING DATA

 76 RS          STORAGE ROUTING
                      NSTPS          1  NUMBER OF SUBREACHES
                       ITYP       ELEV  TYPE OF INITIAL CONDITION
                     RSVRIC     142.00  INITIAL CONDITION
                          X       0.00  WORKING R AND D COEFFICIENT
```

77 SV	STORAGE	0.0	1.9	3.8	7.7	11.5	15.3	19.1	33.1	50.1	69.3
78 SE	ELEVATION	142.00	142.50	143.00	144.00	145.00	146.00	147.00	150.00	153.00	156.00

```
 80 SL          LOW-LEVEL OUTLET
                      ELEVL     142.00  ELEVATION AT CENTER OF OUTLET
                      CAREA       0.79  CROSS-SECTIONAL AREA
                       COQL       0.60  COEFFICIENT
                       EXPL       0.50  EXPONENT OF HEAD

 79 SS          SPILLWAY
                       CREL     147.00  SPILLWAY CREST ELEVATION
                      SPWID      50.00  SPILLWAY WIDTH
                       COQW       3.00  WEIR COEFFICIENT
                       EXPW       1.50  EXPONENT OF HEAD
```

***

COMPUTED OUTFLOW-ELEVATION DATA

OUTFLOW	0.00	2.67	2.92	3.22	3.59	4.05	4.66	5.48	6.65	8.45
ELEVATION	142.00	142.50	142.60	142.72	142.90	143.15	143.52	144.10	145.09	147.00
OUTFLOW	12.71	41.64	119.42	270.25	518.33	887.84	1402.98	2087.94	2966.92	4064.13
ELEVATION	147.09	147.36	147.81	148.45	149.26	150.25	151.41	152.76	154.29	156.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	0.00	1.90	2.28	2.77	3.44	3.82	4.40	5.81	7.65	8.04
OUTFLOW	0.00	2.67	2.92	3.22	3.59	3.78	4.05	4.66	5.34	5.48
ELEVATION	142.00	142.50	142.60	142.72	142.90	143.00	143.15	143.52	144.00	144.10
STORAGE	11.47	11.83	15.30	19.13	19.56	20.82	22.92	25.85	29.62	33.08
OUTFLOW	6.54	6.65	7.55	8.45	12.71	41.64	119.42	270.25	518.33	790.11
ELEVATION	145.00	145.09	146.00	147.00	147.09	147.36	147.81	148.45	149.26	150.00
STORAGE	34.47	41.12	48.79	50.13	58.40	69.33				
OUTFLOW	887.84	1402.98	2087.94	2217.07	2966.92	4064.13				
ELEVATION	150.25	151.41	152.76	153.00	154.29	156.00				

*** *** *** *** ***

HYDROGRAPH AT STATION RES02

PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW			
		6-HR	24-HR	72-HR	34.88-HR
+ (CFS)	(HR)				

```
                              (CFS)
  +    3584.     13.88                   2268.      913.      627.       627.
                           (INCHES)      5.111     8.269     8.277      8.277
                            (AC-FT)      1115.     1805.     1806.      1806.

   PEAK STORAGE    TIME                        MAXIMUM AVERAGE STORAGE
                                         6-HR      24-HR     72-HR   34.88-HR
  +  (AC-FT)       (HR)
       65.        13.88                   51.        33.       24.        24.

   PEAK STAGE      TIME                        MAXIMUM AVERAGE STAGE
                                         6-HR      24-HR     72-HR   34.88-HR
  +  (FEET)        (HR)
     155.25       13.88                 152.99    149.88    147.74     147.74

                          CUMULATIVE AREA =    4.09 SQ MI

 VALUE EXCEEDS TABLE IN LOGLOG         24.03336       0.01667       24.00000
 MANE2 NPLAN,NSTN          1     0

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

               ***************
               *             *
  97 KK        *    RES03    *
               *             *
               ***************

  99 KO         OUTPUT CONTROL VARIABLES
                      IPRNT          3  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

               HYDROGRAPH ROUTING DATA

 100 RS         STORAGE ROUTING
                      NSTPS          1  NUMBER OF SUBREACHES
                      ITYP        ELEV  TYPE OF INITIAL CONDITION
                      RSVRIC    115.47  INITIAL CONDITION
                      X           0.00  WORKING R AND D COEFFICIENT

 101 SV         STORAGE        0.0      6.9     13.8     27.6     34.5     82.9    108.6    138.0

 102 SE         ELEVATION   115.47   116.47   117.47   119.47   120.47   125.47   127.47   129.47

 104 SL         LOW-LEVEL OUTLET
                      ELEVL     115.47  ELEVATION AT CENTER OF OUTLET
                      CAREA       0.79  CROSS-SECTIONAL AREA
                      COQL        0.60  COEFFICIENT
                      EXPL        0.50  EXPONENT OF HEAD

 103 SS         SPILLWAY
                      CREL      120.47  SPILLWAY CREST ELEVATION
                      SPWID      50.00  SPILLWAY WIDTH
                      COQW        3.00  WEIR COEFFICIENT
                      EXPW        1.50  EXPONENT OF HEAD

                                                ***

                             COMPUTED OUTFLOW-ELEVATION DATA

       OUTFLOW      0.00     2.67     2.92     3.22     3.59     4.05     4.66     5.48     6.65     8.45
     ELEVATION    115.47   115.97   116.07   116.19   116.37   116.62   116.99   117.57   118.56   120.47

       OUTFLOW     12.71    41.64   119.42   270.25   518.33   887.84  1402.98  2087.94  2966.92  4064.13
     ELEVATION    120.56   120.83   121.28   121.92   122.73   123.72   124.88   126.23   127.76   129.47

                         COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

       STORAGE      0.00     3.44     4.11     5.00     6.22     6.90     7.94    10.49    13.80    14.51
       OUTFLOW      0.00     2.67     2.92     3.22     3.59     3.78     4.05     4.66     5.34     5.48
     ELEVATION    115.47   115.97   116.07   116.19   116.37   116.47   116.62   116.99   117.47   117.57

       STORAGE     21.35    27.60    34.50    35.39    38.02    42.39    48.50    56.35    65.94    77.26
       OUTFLOW      6.65     7.55     8.45    12.71    41.64   119.42   270.25   518.33   887.84  1402.98
     ELEVATION    118.56   119.47   120.47   120.56   120.83   121.28   121.92   122.73   123.72   124.88

       STORAGE     82.93    92.73   108.59   112.88   137.97
       OUTFLOW   1689.00  2087.94  2791.12  2966.92  4064.13
     ELEVATION    125.47   126.23   127.47   127.76   129.47

     ***            ***            ***            ***            ***

                          HYDROGRAPH AT STATION    RES03

   PEAK FLOW       TIME                        MAXIMUM AVERAGE FLOW
                                         6-HR      24-HR     72-HR   34.88-HR
  +  (CFS)         (HR)
                              (CFS)
  +    3708.     14.12                   2465.      985.      676.       676.
                           (INCHES)      5.125     8.231     8.242      8.242
                            (AC-FT)      1212.     1947.     1950.      1950.

   PEAK STORAGE    TIME                        MAXIMUM AVERAGE STORAGE
                                         6-HR      24-HR     72-HR   34.88-HR
  +  (AC-FT)       (HR)
      130.        14.12                  101.        65.       47.        47.

   PEAK STAGE      TIME                        MAXIMUM AVERAGE STAGE
                                         6-HR      24-HR     72-HR   34.88-HR
  +  (FEET)        (HR)
     128.92       14.12                 126.83    123.50    121.34     121.34

                          CUMULATIVE AREA =    4.43 SQ MI

 VALUE EXCEEDS TABLE IN LOGLOG         24.03336       0.01667       24.00000
 MANE2 NPLAN,NSTN          1     0

 VALUE EXCEEDS TABLE IN LOGLOG         24.03336       0.01667       24.00000

 VALUE EXCEEDS TABLE IN LOGLOG         24.03336       0.01667       24.00000

 VALUE EXCEEDS TABLE IN LOGLOG         24.03336       0.01667       24.00000
 MANE2 NPLAN,NSTN          1     0
 MANE2 NPLAN,NSTN          1     0

 VALUE EXCEEDS TABLE IN LOGLOG         24.03336       0.01667       24.00000

 VALUE EXCEEDS TABLE IN LOGLOG         24.03336       0.01667       24.00000
 MANE2 NPLAN,NSTN          1     0
 MANE2 NPLAN,NSTN          1     0

 VALUE EXCEEDS TABLE IN LOGLOG         24.03336       0.01667       24.00000
 MANE2 NPLAN,NSTN          1     0

 VALUE EXCEEDS TABLE IN LOGLOG         24.03336       0.01667       24.00000
 MANE2 NPLAN,NSTN          1     0

 VALUE EXCEEDS TABLE IN LOGLOG         24.03336       0.01667       24.00000

 VALUE EXCEEDS TABLE IN LOGLOG         24.03336       0.01667       24.00000
 MANE2 NPLAN,NSTN          1     0

 VALUE EXCEEDS TABLE IN LOGLOG         24.03336       0.01667       24.00000
 MANE2 NPLAN,NSTN          1     0

 VALUE EXCEEDS TABLE IN LOGLOG         24.03336       0.01667       24.00000
 MANE2 NPLAN,NSTN          1     0
 MANE2 NPLAN,NSTN          1     0

 VALUE EXCEEDS TABLE IN LOGLOG         24.03336       0.01667       24.00000
 MANE2 NPLAN,NSTN          1     0
 MANE2 NPLAN,NSTN          1     0

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** **

               ***************
```

```
288 KK      **************
            *            *
            *   RES04    *
            *            *
            **************

290 KO       OUTPUT CONTROL VARIABLES
                  IPRNT          3  PRINT CONTROL
                  IPLOT          0  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE

             HYDROGRAPH ROUTING DATA

291 RS       STORAGE ROUTING
                  NSTPS          1  NUMBER OF SUBREACHES
                  ITYP        ELEV  TYPE OF INITIAL CONDITION
                  RSVRIC     53.31  INITIAL CONDITION
                  X           0.00  WORKING R AND D COEFFICIENT

292 SV        STORAGE       0.0     58.7    68.3    88.5   127.4   185.1   228.9   276.4   374.7

293 SE      ELEVATION     53.31    61.31   62.33   63.98   66.31   68.90   70.54   72.18   75.46

295 SL       LOW-LEVEL OUTLET
                  ELEVL      53.31  ELEVATION AT CENTER OF OUTLET
                  CAREA       0.79  CROSS-SECTIONAL AREA
                  COQL        0.60  COEFFICIENT
                  EXPL        0.50  EXPONENT OF HEAD

294 SS       SPILLWAY
                  CREL       58.31  SPILLWAY CREST ELEVATION
                  SPWID      50.00  SPILLWAY WIDTH
                  COQW        3.00  WEIR COEFFICIENT
                  EXPW        1.50  EXPONENT OF HEAD

                                        ***

                             COMPUTED OUTFLOW-ELEVATION DATA

        OUTFLOW      0.00     2.67     2.92     3.22     3.59     4.05     4.66     5.48     6.65     8.45
      ELEVATION     53.31    53.81    53.91    54.03    54.21    54.46    54.83    55.41    56.40    58.31

        OUTFLOW     19.51    95.17   299.14   695.12  1346.81  2317.94  3672.20  5473.34  7785.08 10671.16
      ELEVATION     58.48    59.00    59.86    61.06    62.61    64.49    66.72    69.29    72.20    75.46

                         COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

        STORAGE      0.00     3.66     4.37     5.32     6.62     8.45    11.16    15.43    22.72    36.70
        OUTFLOW      0.00     2.67     2.92     3.22     3.59     4.05     4.66     5.48     6.65     8.45
      ELEVATION     53.31    53.81    53.91    54.03    54.21    54.46    54.83    55.41    56.40    58.31

        STORAGE     37.98    41.77    48.08    56.90    58.72    68.29    71.66    88.49    97.04   127.42
        OUTFLOW     19.51    95.17   299.16   695.12   790.11  1220.36  1346.81  2037.53  2317.93  3407.73
      ELEVATION     58.48    59.00    59.86    61.06    61.31    62.33    62.61    63.98    64.49    66.31

        STORAGE    136.55   185.10   195.55   228.92   276.38   277.11   374.73
        OUTFLOW   3672.20  5184.26  5473.34  6431.19  7764.70  7785.08 10671.16
      ELEVATION     66.72    68.90    69.29    70.54    72.18    72.20    75.46

   ***          ***          ***          ***          ***

                    HYDROGRAPH AT STATION    RES04

  PEAK FLOW      TIME                         MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR       72-HR     34.88-HR

+   (CFS)        (HR)
                          (CFS)
+   4513.       14.23                 3369.       1379.        948.        948.
                        (INCHES)      5.242       8.621       8.647       8.647
                         (AC-FT)      1657.       2725.       2733.       2733.

  PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                      6-HR        24-HR       72-HR     34.88-HR

+  (AC-FT)       (HR)
      164.      14.23                  128.         75.         57.         57.

  PEAK STAGE     TIME                        MAXIMUM AVERAGE STAGE
                                      6-HR        24-HR       72-HR     34.88-HR

+  (FEET)        (HR)
     67.93      14.23                 66.17       62.21       60.27       60.27

                          CUMULATIVE AREA =     5.93 SQ MI

 VALUE EXCEEDS TABLE IN LOGLOG         24.03336      0.01667     24.00000
 NAMEZ NPLAN,NSTN      1      0

 VALUE EXCEEDS TABLE IN LOGLOG         24.03336      0.01667     24.00000
 NAMEZ NPLAN,NSTN      1      0

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
322 KK      *   RES05    *
            *            *
            **************

324 KO       OUTPUT CONTROL VARIABLES
                  IPRNT          3  PRINT CONTROL
                  IPLOT          0  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE

             HYDROGRAPH ROUTING DATA

325 RS       STORAGE ROUTING
                  NSTPS          1  NUMBER OF SUBREACHES
                  ITYP        ELEV  TYPE OF INITIAL CONDITION
                  RSVRIC     51.50  INITIAL CONDITION
                  X           0.00  WORKING R AND D COEFFICIENT

326 SV        STORAGE       0.0      8.1    16.5    44.1    55.2    78.8   108.0   138.9

327 SE      ELEVATION     51.50    52.50   53.50   56.50   57.40   59.00   60.70   62.30

329 SL       LOW-LEVEL OUTLET
                  ELEVL      51.50  ELEVATION AT CENTER OF OUTLET
                  CAREA       0.79  CROSS-SECTIONAL AREA
                  COQL        0.60  COEFFICIENT
                  EXPL        0.50  EXPONENT OF HEAD

328 SS       SPILLWAY
                  CREL       54.50  SPILLWAY CREST ELEVATION
                  SPWID     110.00  SPILLWAY WIDTH
                  COQW        3.00  WEIR COEFFICIENT
                  EXPW        1.50  EXPONENT OF HEAD

                                        ***

                             COMPUTED OUTFLOW-ELEVATION DATA

        OUTFLOW      0.00     2.64     2.85     3.10     3.40     3.76     4.21     4.78     5.52     6.54
      ELEVATION     51.50    51.99    52.07    52.17    52.31    52.49    52.74    53.10    53.64    54.50

        OUTFLOW     13.97    64.93   202.44   469.51   909.13  1564.34  2478.13  3693.52  5253.54  7201.21
      ELEVATION     54.58    54.81    55.20    55.75    56.45    57.31    58.32    59.49    60.82    62.30

                         COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

        STORAGE      0.00     3.95     4.61     5.45     6.55     8.02    10.11    13.11    16.48    17.74
        OUTFLOW      0.00     2.64     2.85     3.10     3.40     3.76     4.21     4.78     5.34     5.52
      ELEVATION     51.50    51.99    52.07    52.17    52.31    52.49    52.74    53.10    53.50    53.64

        STORAGE     25.69    26.42    28.58    32.18    37.21    43.68    44.11    54.10    55.20    68.87
        OUTFLOW      6.54    13.97    64.93   202.44   469.51   909.14   941.83  1564.34  1638.89  2478.13
      ELEVATION     54.50    54.58    54.81    55.20    55.75    56.45    56.50    57.31    57.40    58.32

        STORAGE     78.85    87.32   108.01   110.31   138.95
        OUTFLOW   3160.51  3693.52  5105.96  5253.54  7201.20
      ELEVATION     59.00    59.49    60.70    60.82    62.30

   ***          ***          ***          ***          ***
```

HYDROGRAPH AT STATION RES05

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	34.88-HR
(CFS)	(HR)					
		(CFS)				
4733.	14.47		3620.	1486.	1021.	1021.
		(INCHES)	5.273	8.698	8.719	8.719
		(AC-FT)	1780.	2936.	2943.	2943.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	34.88-HR
(AC-FT)	(HR)				
103.	14.47	86.	52.	40.	40.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	34.88-HR
(FEET)	(HR)				
60.38	14.47	59.38	56.93	55.67	55.67

CUMULATIVE AREA = 6.33 SQ MI

VALUE EXCEEDS TABLE IN LOGLOG 24.03336 0.01667 24.00000

VALUE EXCEEDS TABLE IN LOGLOG 24.03336 0.01667 24.00000

*** ***

350 KK SEC10

352 KO OUTPUT CONTROL VARIABLES
IPRNT 3 PRINT CONTROL
IPLOT 0 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

353 HC HYDROGRAPH COMBINATION
ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

***

MAKE2 NPLAN,NSTM 1 0

*** *** *** *** ***

HYDROGRAPH AT STATION SEC10

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	34.88-HR
(CFS)	(HR)					
		(CFS)				
941.	12.48		360.	153.	105.	105.
		(INCHES)	6.545	11.180	11.184	11.184
		(AC-FT)	177.	302.	302.	302.

CUMULATIVE AREA = 0.51 SQ MI

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	A3	1621.	13.30	939.	384.	263.	1.70		
ROUTED TO	SEC10	1621.	13.42	939.	384.	263.	1.70	213.07	13.42
HYDROGRAPH AT	A2	270.	12.48	91.	36.	25.	0.17		
2 COMBINED AT	SEC10	1726.	13.30	1028.	421.	288.	1.87		
HYDROGRAPH AT	A1	1846.	13.65	1148.	476.	326.	2.04		
2 COMBINED AT	SEC15	3546.	13.42	2174.	896.	615.	3.90		
ROUTED TO	SEC20	3546.	13.42	2174.	896.	615.	3.90	201.34	13.42
HYDROGRAPH AT	A4	270.	12.48	101.	40.	28.	0.19		
2 COMBINED AT	SEC20	3667.	13.42	2273.	936.	642.	4.09		
ROUTED TO	RES01	3605.	13.65	2270.	922.	633.	4.09	183.86	13.65
ROUTED TO	SEC21	3604.	13.77	2270.	922.	633.	4.09	185.70	13.77
ROUTED TO	RES02	3584.	13.88	2268.	913.	627.	4.09	155.25	13.88
ROUTED TO	SEC25	3584.	13.88	2268.	913.	627.	4.09	152.96	13.88
HYDROGRAPH AT	D3	585.	12.48	221.	90.	62.	0.34		
2 COMBINED AT	SEC25	3798.	13.88	2470.	1000.	688.	4.43		
ROUTED TO	RES03	3708.	14.12	2465.	985.	676.	4.43	128.92	14.12
ROUTED TO	SEC380	3708.	14.12	2465.	985.	676.	4.43	120.90	14.12
HYDROGRAPH AT	D6	658.	12.48	250.	105.	72.	0.36		
2 COMBINED AT	SEC380	3918.	14.12	2685.	1083.	748.	4.80		
HYDROGRAPH AT	A6A	156.	12.25	38.	15.	10.	0.06		
HYDROGRAPH AT	A6B	70.	12.25	17.	7.	5.	0.03		
HYDROGRAPH AT	A6C	303.	12.37	94.	39.	26.	0.15		
3 COMBINED AT	SEC55	489.	12.25	149.	61.	42.	0.23		
ROUTED TO	SEC60	489.	12.37	149.	61.	42.	0.23	188.57	12.37
HYDROGRAPH AT	A12	143.	12.95	73.	30.	21.	0.11		
ROUTED TO									

	SEC60	142.	13.07	73.	30.	21.	0.11	151.66	13.07
HYDROGRAPH AT	D2	387.	12.48	146.	61.	42.	0.22		
3 COMBINED AT	SEC60	918.	12.37	367.	152.	104.	0.56		
ROUTED TO	SEC320	913.	12.37	367.	152.	104.	0.56	133.17	12.37
HYDROGRAPH AT	D5	122.	12.48	46.	19.	13.	0.07		
2 COMBINED AT	SEC320	1024.	12.48	413.	171.	117.	0.63		
ROUTED TO	SEC330	1035.	12.48	413.	171.	117.	0.63	94.91	12.48
HYDROGRAPH AT	D4B	106.	12.48	40.	17.	12.	0.06		
2 COMBINED AT	SEC330	1141.	12.48	453.	188.	129.	0.69		
HYDROGRAPH AT	A8	326.	12.37	103.	42.	29.	0.17		
HYDROGRAPH AT	A7	19.	12.13	4.	1.	1.	0.01		
2 COMBINED AT	SEC220	333.	12.37	107.	43.	29.	0.18		
ROUTED TO	SEC310	327.	12.37	107.	43.	29.	0.18	192.19	12.37
HYDROGRAPH AT	D1	186.	12.25	53.	22.	15.	0.08		
2 COMBINED AT	SEC310	507.	12.37	159.	65.	45.	0.25		
ROUTED TO	SEC315	507.	12.37	159.	65.	45.	0.25	91.96	12.37
ROUTED TO	SEC340	507.	12.37	159.	65.	45.	0.25	92.22	12.37
HYDROGRAPH AT	D4A	66.	12.48	25.	10.	7.	0.04		
2 COMBINED AT	SEC340	567.	12.37	184.	76.	52.	0.29		
2 COMBINED AT	SEC350	1679.	12.48	637.	264.	181.	0.98		
ROUTED TO	SEC355	1700.	12.48	637.	264.	181.	0.98	89.73	12.48
ROUTED TO	SEC360	1711.	12.48	637.	264.	181.	0.98	82.67	12.48
HYDROGRAPH AT	D7	286.	12.48	109.	46.	32.	0.16		
2 COMBINED AT	SEC360	1997.	12.48	745.	310.	213.	1.13		
2 COMBINED AT	SEC381	4616.	13.88	3380.	1389.	961.	5.93		
ROUTED TO	RES04	4513.	14.23	3369.	1379.	948.	5.93	67.93	14.23
ROUTED TO	SEC410	4512.	14.35	3369.	1379.	948.	5.93	60.79	14.35
HYDROGRAPH AT	D8	419.	12.72	191.	81.	56.	0.27		
2 COMBINED AT	SEC410	4681.	14.23	3544.	1455.	1004.	6.20		
HYDROGRAPH AT	D9	239.	12.48	91.	38.	26.	0.13		
2 COMBINED AT	SEC420	4753.	14.23	3625.	1491.	1030.	6.33		
ROUTED TO	RES05	4733.	14.47	3620.	1486.	1021.	6.33	60.38	14.47
HYDROGRAPH AT	D10	436.	12.48	165.	70.	48.	0.23		
ROUTED TO	SEC10	432.	12.60	165.	70.	48.	0.23	48.69	12.60
HYDROGRAPH AT	D11	517.	12.48	195.	83.	57.	0.28		
2 COMBINED AT	SEC10	941.	12.48	360.	153.	105.	0.51		

*** NORMAL END OF HEC-1 ***

```
*****************************************
*                                       *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *
*           JUN 09 1992                 *
*         VERSION 4.0.3E                *
*                                       *
*  RUN DATE  05/14/98  TIME  10:45:58   *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*    HYDROLOGIC ENGINEERING CENTER      *
*         609 SECOND STREET             *
*      DAVIS, CALIFORNIA 95616          *
*          (916) 551-1748               *
*                                       *
*****************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X               X
XXXXXXX  XXXX     X       XXXXX   X
X     X  X        X               X
X     X  X        X     X         X
X     X  XXXXXXX   XXXXX         XXX
```

```
THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM
```

```
1                                    HEC-1 INPUT                                         PAGE  1

 LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1          ID   EAST KAPOLEI FLOOD (100-YEAR STORM)
   2          ID   FN: NEW1C2.DAT
   3          ID   PROJECT CONDITIONS: EAST KAPOLEI - DEVELOPED CONDITIONS
                                                      FLOW TO KAPOLEI AND VARONA (SP COMP.BASIN)
   4          ID
   5          ID   KALO1 - NUMENUME NETWORK MODEL
              *DIAGRAM
   6          IT       5 14MAY98    1200     300
   7          IO       5

   8          KK     KAP
   9          KM        GENERATE HYDROGRAPH FROM SUBBASIN KAP TO SEC1
  10          KM        UPPERMOST WATERSHED PRECIPITATION DATA
  11          KO       3
  12          BA   0.096
  13          PH                    .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
  14          LS       0      92
  15          UD     .45

  16          KK     VAR
  17          KM        GENERATE HYDROGRAPH FROM SUBBASIN VAR TO SEC2
  18          KM        UPPERMOST WATERSHED PRECIPITATION DATA
  19          KO       3
  20          BA   0.085
  21          PH                    .65    1.32    2.45    3.55    4.60    6.75     9.2   12.30
  22          LS       0      92
  23          UD   0.225

  24          KK   RES01
  25          KM    ROUTE VAR THROUGH RES01
  26          KM    SPORTS COMPLEX SUMP - NO OUTLET
  27          KO       3
  28          RS       1    ELEV    43.0
  29          SV       0    0.97    2.80    6.12    11.0   17.47   25.29   35.74      40
  30          SE      43      44      45      46      47      48      49      50      51
  31          SS    50.0     400       3     1.5

  32          KK    SEC3
  33          KO       3
  34          HC       2
  35          ZZ
```

```
1
           SCHEMATIC DIAGRAM OF STREAM NETWORK

INPUT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   8       KAP
            .
  16        .         VAR
            .          V
            .          V
  24        .        RES01
            .          .
            .          .
  32       SEC3.........

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

```
*****************************************
*                                       *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *
*           JUN 09 1992                 *
*         VERSION 4.0.3E                *
*                                       *
*  RUN DATE  05/14/98  TIME  10:45:58   *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*    HYDROLOGIC ENGINEERING CENTER      *
*         609 SECOND STREET             *
*      DAVIS, CALIFORNIA 95616          *
*          (916) 551-1748               *
*                                       *
*****************************************
```

```
                EAST KAPOLEI FLOOD (100-YEAR STORM)
                FN: NEW1C2.DAT
                PROJECT CONDITIONS: EAST KAPOLEI - DEVELOPED CONDITIONS
                                                 FLOW TO KAPOLEI AND VARONA (SP COMP.BASIN)

                KALO1 - NUMENUME NETWORK MODEL

  7 IO       OUTPUT CONTROL VARIABLES
                   IPRNT           5  PRINT CONTROL
                   IPLOT           0  PLOT CONTROL
                   QSCAL          0.  HYDROGRAPH PLOT SCALE

  IT         HYDROGRAPH TIME DATA
                   NMIN            5  MINUTES IN COMPUTATION INTERVAL
                   IDATE     14MAY98  STARTING DATE
                   ITIME        1200  STARTING TIME
                   NQ            300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE    15MAY98  ENDING DATE
                   NDTIME       1255  ENDING TIME
                   ICENT          19  CENTURY MARK

              COMPUTATION INTERVAL    0.08 HOURS
                   TOTAL TIME BASE   24.92 HOURS

         ENGLISH UNITS
              DRAINAGE AREA           SQUARE MILES
              PRECIPITATION DEPTH     INCHES
              LENGTH, ELEVATION       FEET
              FLOW                    CUBIC FEET PER SECOND
              STORAGE VOLUME          ACRE-FEET
              SURFACE AREA            ACRES
              TEMPERATURE             DEGREES FAHRENHEIT

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

             **************
             *            *
  8 KK       *    KAP     *
             *            *
             **************

 11 KO        OUTPUT CONTROL VARIABLES
                   IPRNT           3  PRINT CONTROL
```

```
              IPLOT          0  PLOT CONTROL
              QSCAL          0.  HYDROGRAPH PLOT SCALE

          SUBBASIN RUNOFF DATA

  12 BA     SUBBASIN CHARACTERISTICS
              TAREA          0.10  SUBBASIN AREA

            PRECIPITATION DATA

  13 PH                         DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
            ..... HYDRO-35 ......  .............. TP-40 ..............  ........... TP-49 ...........
            5-MIN  15-MIN  60-MIN   2-HR   3-HR   6-HR  12-HR  24-HR  2-DAY  4-DAY  7-DAY  10-DAY
             0.65   1.32    2.45    3.55   4.60   6.75   9.20  12.30   0.00   0.00   0.00   0.00

                                        STORM AREA =    0.10

  14 LS     SCS LOSS RATE
              STRTL          0.17  INITIAL ABSTRACTION
              CRVNBR        92.00  CURVE NUMBER
              RTIMP          0.00  PERCENT IMPERVIOUS AREA

  15 UD     SCS DIMENSIONLESS UNITGRAPH
              TLAG           0.45  LAG

                                          ***

                                      UNIT HYDROGRAPH
                                  29 END-OF-PERIOD ORDINATES
          7.      22.     46.     74.     91.     94.     89.     77.     61.     44.
         33.      25.     19.     15.     11.      9.      6.      5.      4.      3.
          2.       2.      1.      1.      1.      1.      0.      0.      0.

    ***        ***        ***        ***        ***

                    HYDROGRAPH AT STATION        KAP

   TOTAL RAINFALL =   12.30, TOTAL LOSS =     0.99, TOTAL EXCESS =    11.31

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR       72-HR      24.92-HR
 +  (CFS)       (HR)
                            (CFS)
 +   183.      12.50                   68.         29.         28.         28.
                          (INCHES)    6.565      11.304      11.304      11.304
                           (AC-FT)     34.         58.         58.         58.

                         CUMULATIVE AREA =     0.10 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

           **************
           *            *
  16 KK    *     VAR    *
           *            *
           **************

  19 KO     OUTPUT CONTROL VARIABLES
              IPRNT          3  PRINT CONTROL
              IPLOT          0  PLOT CONTROL
              QSCAL          0.  HYDROGRAPH PLOT SCALE

          SUBBASIN RUNOFF DATA

  20 BA     SUBBASIN CHARACTERISTICS
              TAREA          0.09  SUBBASIN AREA

            PRECIPITATION DATA

  21 PH                         DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
            ..... HYDRO-35 ......  .............. TP-40 ..............  ........... TP-49 ...........
            5-MIN  15-MIN  60-MIN   2-HR   3-HR   6-HR  12-HR  24-HR  2-DAY  4-DAY  7-DAY  10-DAY
             0.65   1.32    2.45    3.55   4.60   6.75   9.20  12.30   0.00   0.00   0.00   0.00

                                        STORM AREA =    0.09

  22 LS     SCS LOSS RATE
              STRTL          0.17  INITIAL ABSTRACTION
              CRVNBR        92.00  CURVE NUMBER
              RTIMP          0.00  PERCENT IMPERVIOUS AREA

  23 UD     SCS DIMENSIONLESS UNITGRAPH
              TLAG           0.22  LAG

                                          ***

                                      UNIT HYDROGRAPH
                                  15 END-OF-PERIOD ORDINATES
         32.     108.     153.     138.      93.      53.      33.      20.      12.       7.
          4.       3.       2.       1.       0.

    ***        ***        ***        ***        ***

                    HYDROGRAPH AT STATION        VAR

   TOTAL RAINFALL =   12.30, TOTAL LOSS =     0.99, TOTAL EXCESS =    11.31

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR       72-HR      24.92-HR
 +  (CFS)       (HR)
                            (CFS)
 +   222.      12.25                   60.         26.         25.         25.
                          (INCHES)    6.586      11.313      11.313      11.313
                           (AC-FT)     30.         51.         51.         51.

                         CUMULATIVE AREA =     0.09 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

           **************
           *            *
  24 KK    *    RES01   *
           *            *
           **************

  27 KO     OUTPUT CONTROL VARIABLES
              IPRNT          3  PRINT CONTROL
              IPLOT          0  PLOT CONTROL
              QSCAL          0.  HYDROGRAPH PLOT SCALE

          HYDROGRAPH ROUTING DATA

  28 RS     STORAGE ROUTING
              NSTPS          1  NUMBER OF SUBREACHES
              ITYP        ELEV  TYPE OF INITIAL CONDITION
              RSVRIC     43.00  INITIAL CONDITION
              X           0.00  WORKING R AND D COEFFICIENT

  29 SV        STORAGE      0.0      1.0      2.8      6.1     11.0     17.5     25.3     35.7     40.0

  30 SE      ELEVATION    43.00    44.00    45.00    46.00    47.00    48.00    49.00    50.00    51.00

  31 SS       SPILLWAY
              CREL       50.00  SPILLWAY CREST ELEVATION
              SPWID     400.00  SPILLWAY WIDTH
              COQW        3.00  WEIR COEFFICIENT
              EXPW        1.50  EXPONENT OF HEAD

                                          ***

                                COMPUTED OUTFLOW-ELEVATION DATA

     OUTFLOW      0.00     0.00     0.21     1.65     5.56    13.17    25.72    44.44    70.58   105.35
   ELEVATION     43.00    50.00    50.00    50.01    50.03    50.05    50.08    50.11    50.15    50.20

     OUTFLOW    150.00   205.76   273.87   355.56   452.06   564.61   694.44   842.80  1010.91  1200.00
   ELEVATION     50.25    50.31    50.37    50.44    50.52    50.60    50.69    50.79    50.89    51.00
```

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	0.00	0.97	2.80	6.12	11.00	17.47	25.29	35.74	35.79	35.86
OUTFLOW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.65	5.56
ELEVATION	43.00	44.00	45.00	46.00	47.00	48.00	49.00	50.00	50.01	50.03
STORAGE	35.95	36.07	36.21	36.38	36.58	36.81	37.05	37.33	37.63	37.96
OUTFLOW	13.17	25.72	44.44	70.58	105.35	150.00	205.76	273.87	355.55	452.06
ELEVATION	50.05	50.08	50.11	50.15	50.20	50.25	50.31	50.37	50.44	50.52
STORAGE	38.32	38.70	39.11	39.54	40.00					
OUTFLOW	564.61	694.44	842.80	1010.91	1200.00					
ELEVATION	50.60	50.69	50.79	50.87	51.00					

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN 356. TO 1200.
THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

```
    ***          ***          ***          ***          ***

                 HYDROGRAPH AT STATION    RES01

 PEAK FLOW    TIME                       MAXIMUM AVERAGE FLOW
                                6-HR      24-HR      72-HR     24.92-HR
+  (CFS)      (HR)
                      (CFS)
+    37.     14.75                22.         8.         8.          8.
                   (INCHES)    2.438      3.421      3.421       3.421
                    (AC-FT)      11.        16.        16.         16.

 PEAK STORAGE TIME                       MAXIMUM AVERAGE STORAGE
                                6-HR      24-HR      72-HR     24.92-HR
+  (AC-FT)    (HR)
     36.     14.75                36.        21.        21.         21.

 PEAK STAGE   TIME                       MAXIMUM AVERAGE STAGE
                                6-HR      24-HR      72-HR     24.92-HR
+  (FEET)     (HR)
    50.10    14.75              50.07      47.83      47.65       47.65

                 CUMULATIVE AREA =     0.09 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
 32 KK        *    SEC3    *
              *            *
              **************

 33 KO         OUTPUT CONTROL VARIABLES
                    IPRNT          3  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

 34 HC         HYDROGRAPH COMBINATION
                    ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                  ***
4AVE2 NPLAN,NSTN        1      0
    ***          ***          ***          ***          ***

                 HYDROGRAPH AT STATION    SEC3

 PEAK FLOW    TIME                       MAXIMUM AVERAGE FLOW
                                6-HR      24-HR      72-HR     24.92-HR
+  (CFS)      (HR)
                      (CFS)
+   183.     12.50                77.        37.        36.         36.
                   (INCHES)    3.960      7.602      7.602       7.602
                    (AC-FT)      38.        73.        73.         73.

                 CUMULATIVE AREA =     0.18 SQ MI
```

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	KAP	183.	12.50	68.	29.	28.	0.10		
+	HYDROGRAPH AT	VAR	222.	12.25	60.	26.	25.	0.09		
+	ROUTED TO	RES01	37.	14.75	22.	8.	8.	0.09		
+									50.10	14.75
+	2 COMBINED AT	SEC3	183.	12.50	77.	37.	36.	0.18		

*** NORMAL END OF HEC-1 ***

```
**************************************
*                                    *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1) *
*          JUN 09 1992               *
*        VERSION 4.0.3E              *
*                                    *
* RUN DATE  09/15/97  TIME  13:29:58 *
*                                    *
**************************************
```

```
**************************************
*                                    *
*    U.S. ARMY CORPS OF ENGINEERS    *
*   HYDROLOGIC ENGINEERING CENTER    *
*        609 SECOND STREET           *
*     DAVIS, CALIFORNIA 95616        *
*         (916) 551-1748             *
*                                    *
**************************************
```

```
X     X  XXXXXXX   XXXXX        X
X     X  X        X     X      XX
X     X  X        X             X
XXXXXXX  XXXX     X     XXXXX   X
X     X  X        X             X
X     X  X        X     X       X
X     X  XXXXXXX   XXXXX       XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

```
1
                                  HEC-1 INPUT                                          PAGE  1

 LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1        ID  EAST KAPOLEI FLOOD (100-YEAR STORM)
   2        ID  FN: NEW18.DAT
   3        ID  PROJECT CONDITIONS: EAST KAPOLEI - DEVELOPED CONDITIONS
   4        ID                                     FLOW TO WEST LOCH
   5        ID  KALOI - MUNEMUNE NETWORK MODEL
            *DIAGRAM
   6        IT      6 27JAN97    1200     300
   7        IO      5

   8        KK    A27
   9        KM        GENERATE HYDROGRAPH FROM SUBBASIN A27 TO SEC1
  10        KM        UPPERMOST WATERSHED PRECIPITATION DATA
  11        KO      3
  12        BA  0.939
  13        PH                    .44    1.30    2.45    3.50    4.55    6.70    9.10   12.30
  14        LS      0      90
  15        UD  2.174

  16        KK    S18
  17        KM        GENERATE HYDROGRAPH FROM SUBBASIN S18 TO SEC2
  18        KM        UPPERMOST WATERSHED PRECIPITATION DATA
  19        KO      3
  20        BA  0.119
  21        PH                    .65    1.32    2.45    3.55    4.60    6.75     9.2   12.30
  22        LS      0      90
  23        UD  2.174

  24        KK    S19
  25        KM        GENERATE HYDROGRAPH FROM SUBBASIN S19 TO SEC3
  26        KM        UPPERMOST WATERSHED PRECIPITATION DATA
  27        KO      3
  28        BA  0.055
  29        PH                    .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
  30        LS      0      89
  31        UD  1.595

  32        KK    S20
  33        KM        GENERATE HYDROGRAPH FROM SUBBASIN S20 TO SEC4
  34        KM        UPPERMOST WATERSHED PRECIPITATION DATA

  35        KO      3
  36        BA  0.056
  37        PH                    .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
  38        LS      0      89
  39        UD  1.019

  40        KK    S21
  41        KM        GENERATE HYDROGRAPH FROM SUBBASIN S21 TO SEC5
  42        KM        UPPERMOST WATERSHED PRECIPITATION DATA
  43        KO      3
  44        BA   .025
  45        PH                    .65    1.32    2.45    3.55    4.60    6.75     9.2    12.3
  46        LS      0      89
  47        UD  0.627
  48        ZZ
```

```
1
                       SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
 LINE       (V) ROUTING           (--->) DIVERSION OR PUMP FLOW

  NO.       (.) CONNECTOR         (<---) RETURN OF DIVERTED OR PUMPED FLOW

   8        A27
             .
  16         .     S18
             .      .
  24         .      .      S19
             .      .       .
  32         .      .       .      S20
             .      .       .       .
  40         .      .       .       .      S21

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

```
**************************************
*                                    *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1) *
*          JUN 09 1992               *
*        VERSION 4.0.3E              *
*                                    *
* RUN DATE  09/15/97  TIME  13:29:58 *
*                                    *
**************************************
```



```
**************************************
*                                    *
*    U.S. ARMY CORPS OF ENGINEERS    *
*   HYDROLOGIC ENGINEERING CENTER    *
*        609 SECOND STREET           *
*     DAVIS, CALIFORNIA 95616        *
*         (916) 551-1748             *
*                                    *
**************************************
```



```
                       EAST KAPOLEI FLOOD (100-YEAR STORM)
                       FN: NEW18.DAT
                       PROJECT CONDITIONS: EAST KAPOLEI - DEVELOPED CONDITIONS
                                                          FLOW TO WEST LOCH
                       KALOI - MUNEMUNE NETWORK MODEL

  7 IO          OUTPUT CONTROL VARIABLES
                     IPRNT          5  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE

  IT            HYDROGRAPH TIME DATA
                     NMIN           6  MINUTES IN COMPUTATION INTERVAL
                     IDATE    27JAN97  STARTING DATE
                     ITIME       1200  STARTING TIME
                     NQ           300  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE   28JAN97  ENDING DATE
                     NDTIME      1754  ENDING TIME
                     ICENT         19  CENTURY MARK

                 COMPUTATION INTERVAL    0.10 HOURS
                      TOTAL TIME BASE   29.90 HOURS

        ENGLISH UNITS
             DRAINAGE AREA         SQUARE MILES
             PRECIPITATION DEPTH   INCHES
```

```
LENGTH, ELEVATION    FEET
FLOW                 CUBIC FEET PER SECOND
STORAGE VOLUME       ACRE-FEET
SURFACE AREA         ACRES
TEMPERATURE          DEGREES FAHRENHEIT

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

             *************
             *           *
   8 KK      *    A27    *
             *           *
             *************

  11 KO        OUTPUT CONTROL VARIABLES
                    IPRNT          3  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

               SUBBASIN RUNOFF DATA

  12 BA        SUBBASIN CHARACTERISTICS
                    TAREA       0.94  SUBBASIN AREA

               PRECIPITATION DATA

  13 PH                              DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
               ..... HYDRO-35 ......   .............. TP-40 ..............   ........... TP-49 ...........
               5-MIN  15-MIN  60-MIN    2-HR   3-HR   6-HR  12-HR  24-HR   2-DAY  4-DAY  7-DAY 10-DAY
                0.64    1.30    2.45    3.50   4.55   6.70   9.10  12.30    0.00   0.00   0.00   0.00

                                             STORM AREA =    0.94

  14 LS        SCS LOSS RATE
                    STRTL       0.22  INITIAL ABSTRACTION
                    CRVNBR     90.00  CURVE NUMBER
                    RTIMP       0.00  PERCENT IMPERVIOUS AREA

  15 UD        SCS DIMENSIONLESS UNITGRAPH
                    TLAG        2.17  LAG

                                            ***

                                       UNIT HYDROGRAPH
                                 111 END-OF-PERIOD ORDINATES
          3.        6.       11.       18.       25.       33.       42.       53.       65.       79.
         94.      111.      129.      144.      159.      172.      182.      191.      196.      202.
        203.      204.      203.      202.      199.      193.      188.      181.      175.      167.
        160.      151.      142.      132.      121.      110.      101.       93.       86.       80.
         74.       69.       64.       59.       55.       52.       49.       45.       42.       39.
         37.       34.       31.       29.       27.       25.       23.       22.       20.       19.
         17.       16.       15.       14.       13.       12.       11.       10.       10.        9.
          8.        8.        7.        7.        6.        6.        5.        5.        5.        4.
          4.        4.        3.        3.        3.        3.        3.        2.        2.        2.
          2.        2.        2.        2.        2.        1.        1.        1.        1.        1.
          1.        1.        1.        1.        1.        0.        0.        0.        0.        0.
          0.

   ***         ***         ***         ***         ***

                          HYDROGRAPH AT STATION       A27

  TOTAL RAINFALL =   12.28, TOTAL LOSS =    1.24, TOTAL EXCESS =   11.04

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR        72-HR      29.90-HR
   (CFS)        (HR)
                            (CFS)
    835.       14.40                  611.         277.         224.         224.
                          (INCHES)   6.046       10.952       11.033       11.033
                           (AC-FT)    303.         548.         553.         553.

                          CUMULATIVE AREA =    0.94 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

             *************
             *           *
  16 KK      *    S18    *
             *           *
             *************

  19 KO        OUTPUT CONTROL VARIABLES
                    IPRNT          3  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

               SUBBASIN RUNOFF DATA

  20 BA        SUBBASIN CHARACTERISTICS
                    TAREA       0.12  SUBBASIN AREA

               PRECIPITATION DATA

  21 PH                              DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
               ..... HYDRO-35 ......   .............. TP-40 ..............   ........... TP-49 ...........
               5-MIN  15-MIN  60-MIN    2-HR   3-HR   6-HR  12-HR  24-HR   2-DAY  4-DAY  7-DAY 10-DAY
                0.65    1.32    2.45    3.55   4.60   6.75   9.20  12.30    0.00   0.00   0.00   0.00

                                             STORM AREA =    0.12

  22 LS        SCS LOSS RATE
                    STRTL       0.22  INITIAL ABSTRACTION
                    CRVNBR     90.00  CURVE NUMBER
                    RTIMP       0.00  PERCENT IMPERVIOUS AREA

  23 UD        SCS DIMENSIONLESS UNITGRAPH
                    TLAG        2.17  LAG

                                            ***

                                       UNIT HYDROGRAPH
                                 111 END-OF-PERIOD ORDINATES
          0.        1.        1.        2.        3.        4.        5.        7.        8.       10.
         12.       14.       16.       18.       20.       22.       23.       24.       25.       26.
         24.       26.       26.       26.       25.       25.       24.       23.       22.       21.
         20.       19.       18.       17.       15.       14.       13.       12.       11.       10.
          9.        9.        8.        8.        7.        7.        6.        6.        5.        5.
          5.        4.        4.        4.        3.        3.        3.        3.        3.        2.
          2.        2.        2.        2.        2.        2.        1.        1.        1.        1.
          1.        1.        1.        1.        1.        1.        1.        1.        1.        1.
          1.        0.        0.        0.        0.        0.        0.        0.        0.        0.
          0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
          0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
          0.

   ***         ***         ***         ***         ***

                          HYDROGRAPH AT STATION       S18

  TOTAL RAINFALL =   12.30, TOTAL LOSS =    1.24, TOTAL EXCESS =   11.06

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR        72-HR      29.90-HR
+  (CFS)        (HR)
                            (CFS)
+   107.       14.40                   78.          35.          28.          28.
                          (INCHES)   6.112       10.971       11.046       11.046
                           (AC-FT)     39.          70.          70.          70.

                          CUMULATIVE AREA =    0.12 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
```

```
24 KK     **************
          *            *
          *    S19     *
          *            *
          **************

27 KO         OUTPUT CONTROL VARIABLES
                  IPRNT         3  PRINT CONTROL
                  IPLOT         0  PLOT CONTROL
                  QSCAL        0.  HYDROGRAPH PLOT SCALE

          SUBBASIN RUNOFF DATA

28 BA         SUBBASIN CHARACTERISTICS
                  TAREA        0.05  SUBBASIN AREA

              PRECIPITATION DATA

29 PH                          DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
              ..... HYDRO-35 ......  ............... TP-40 ...............  ........... TP-49 ...........
              5-MIN  15-MIN  60-MIN   2-HR   3-HR   6-HR  12-HR  24-HR   2-DAY  4-DAY  7-DAY 10-DAY
               0.65   1.32    2.45    3.55   4.60   6.75   9.20  12.30    0.00   0.00   0.00   0.00
                                             STORM AREA =    0.05

30 LS         SCS LOSS RATE
                  STRTL        0.25  INITIAL ABSTRACTION
                  CRVNBR      89.00  CURVE NUMBER
                  RTIMP        0.00  PERCENT IMPERVIOUS AREA

31 UD         SCS DIMENSIONLESS UNITGRAPH
                  TLAG         1.60  LAG

                                              ***

                                       UNIT HYDROGRAPH
                                  82 END-OF-PERIOD ORDINATES
           0.      1.      1.      2.      3.      4.      6.      7.      9.     11.
          12.     14.     15.     16.     16.     16.     16.     16.     15.     15.
          14.     13.     13.     12.     11.      9.      8.      7.      7.      6.
           5.      5.      4.      4.      4.      3.      3.      3.      3.      2.
           2.      2.      2.      2.      1.      1.      1.      1.      1.      1.
           1.      1.      1.      1.      1.      0.      0.      0.      0.      0.
           0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
           0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
           0.      0.

  ***         ***         ***         ***         ***

                         HYDROGRAPH AT STATION       S19

  TOTAL RAINFALL =   12.30, TOTAL LOSS =    1.37, TOTAL EXCESS =    10.93

  PEAK FLOW      TIME                            MAXIMUM AVERAGE FLOW
                                     6-HR        24-HR       72-HR      29.90-HR
+  (CFS)         (HR)
                             (CFS)
+     56.        13.70                 37.         16.         13.         13.
                             (INCHES)  6.243      10.887      10.930      10.930
                             (AC-FT)   18.         32.         32.         32.

                         CUMULATIVE AREA =     0.05 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          **************
          *            *
32 KK     *    S20     *
          *            *
          **************

35 KO         OUTPUT CONTROL VARIABLES
                  IPRNT         3  PRINT CONTROL
                  IPLOT         0  PLOT CONTROL
                  QSCAL        0.  HYDROGRAPH PLOT SCALE

          SUBBASIN RUNOFF DATA

36 BA         SUBBASIN CHARACTERISTICS
                  TAREA        0.05  SUBBASIN AREA

              PRECIPITATION DATA

37 PH                          DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
              ..... HYDRO-35 ......  ............... TP-40 ...............  ........... TP-49 ...........
              5-MIN  15-MIN  60-MIN   2-HR   3-HR   6-HR  12-HR  24-HR   2-DAY  4-DAY  7-DAY 10-DAY
               0.65   1.32    2.45    3.55   4.60   6.75   9.20  12.30    0.00   0.00   0.00   0.00
                                             STORM AREA =    0.05

38 LS         SCS LOSS RATE
                  STRTL        0.25  INITIAL ABSTRACTION
                  CRVNBR      89.00  CURVE NUMBER
                  RTIMP        0.00  PERCENT IMPERVIOUS AREA

39 UD         SCS DIMENSIONLESS UNITGRAPH
                  TLAG         1.02  LAG

                                              ***

                                       UNIT HYDROGRAPH
                                  53 END-OF-PERIOD ORDINATES
           1.      2.      4.      7.     10.     14.     18.     21.     23.     24.
          24.     24.     22.     21.     19.     17.     14.     12.     10.      8.
           7.      6.      5.      5.      4.      3.      3.      3.      2.      2.
           2.      1.      1.      1.      1.      1.      1.      1.      0.      0.
           0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
           0.      0.      0.

  ***         ***         ***         ***         ***

                         HYDROGRAPH AT STATION       S20

  TOTAL RAINFALL =   12.30, TOTAL LOSS =    1.37, TOTAL EXCESS =    10.93

  PEAK FLOW      TIME                            MAXIMUM AVERAGE FLOW
                                     6-HR        24-HR       72-HR      29.90-HR
+  (CFS)         (HR)
                             (CFS)
+     68.        13.10                 37.         16.         13.         13.
                             (INCHES)  6.373      10.914      10.931      10.931
                             (AC-FT)   18.         31.         31.         31.

                         CUMULATIVE AREA =     0.05 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          **************
          *            *
40 KK     *    S21     *
          *            *
          **************

43 KO         OUTPUT CONTROL VARIABLES
                  IPRNT         3  PRINT CONTROL
                  IPLOT         0  PLOT CONTROL
                  QSCAL        0.  HYDROGRAPH PLOT SCALE

          SUBBASIN RUNOFF DATA

44 BA         SUBBASIN CHARACTERISTICS
                  TAREA        0.03  SUBBASIN AREA

              PRECIPITATION DATA

45 PH                          DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
```

```
..... HYDRO-35 ......   ............... TP-40 ...............   .......... TP-49 ..........
5-MIN  15-MIN  60-MIN    2-HR   3-HR   6-HR  12-HR  24-HR   2-DAY  4-DAY  7-DAY  10-DAY
 0.65    1.32    2.45    3.55   4.60   6.75   9.20  12.30    0.00   0.00   0.00    0.00

                              STORM AREA =    0.03

46 LS       SCS LOSS RATE
                 STRTL        0.25  INITIAL ABSTRACTION
                 CRVNBR      89.00  CURVE NUMBER
                 RTIMP        0.00  PERCENT IMPERVIOUS AREA

47 UD       SCS DIMENSIONLESS UNITGRAPH
                 TLAG         0.63  LAG

                                    ***

                              UNIT HYDROGRAPH
                          33 END-OF-PERIOD ORDINATES
        1.      3.      7.     11.     15.     18.     18.     17.     15.     13.
       10.      7.      6.      5.      4.      3.      2.      2.      1.      1.
        1.      1.      1.      0.      0.      0.      0.      0.      0.      0.
        0.      0.      0.

   ***        ***        ***        ***        ***

                 HYDROGRAPH AT STATION      S21

  TOTAL RAINFALL =   12.30, TOTAL LOSS =    1.37, TOTAL EXCESS =   10.93

 PEAK FLOW    TIME                      MAXIMUM AVERAGE FLOW
                                 6-HR       24-HR       72-HR     29.90-HR
+  (CFS)      (HR)
                        (CFS)
+    39.     12.70                17.          7.          6.          6.
                      (INCHES)  6.431      10.927      10.931      10.931
                       (AC-FT)     9.         15.         15.         15.

                   CUMULATIVE AREA =    0.03 SQ MI

1
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

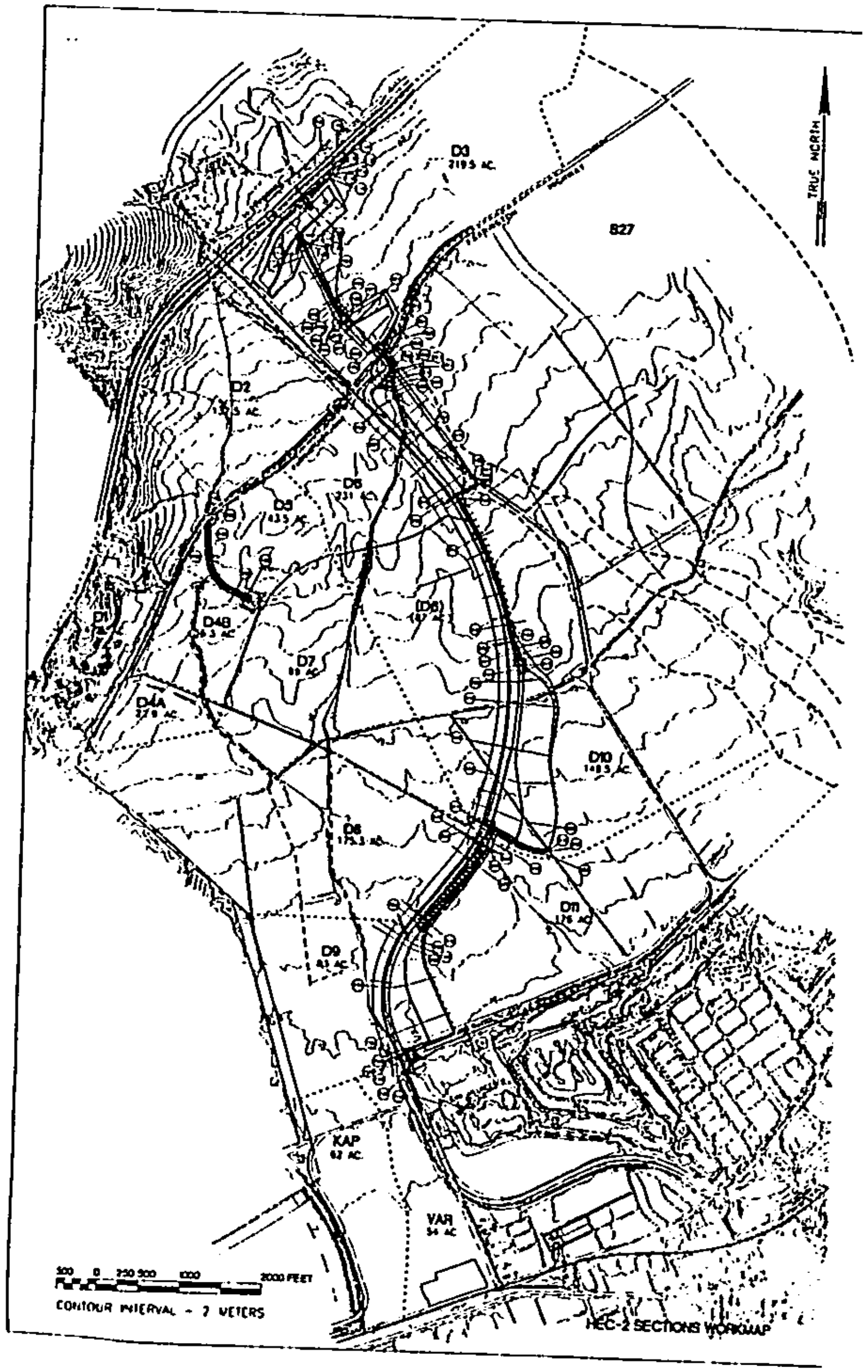
	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	A27	835.	14.40	611.	277.	224.	0.94		
+	HYDROGRAPH AT	S18	107.	14.40	78.	35.	28.	0.12		
+	HYDROGRAPH AT	S19	56.	13.70	37.	16.	13.	0.05		
+	HYDROGRAPH AT	S20	68.	13.10	37.	16.	13.	0.05		
+	HYDROGRAPH AT	S21	39.	12.70	17.	7.	6.	0.03		

*** NORMAL END OF HEC-1 ***

APPENDIX C

REGIONAL DRAINAGE SYSTEM HYDRAULIC SIZING

- HEC-2 Computations
- Kaloi Channel Hydraulic Grades
- Detention Basin Hydraulic Data




```
                HEC-RAS Version 2.0 April 1997
                U.S. Army Corp of Engineers
                Hydrologic Engineering Center
                609 Second Street, Suite D
                Davis, California 95616-4687
                (916) 756-1104

X     X  XXXXXX   XXXX        XXXX     XX     XXXX
X     X  X       X    X       X   X   X  X   X
X     X  X       X            X   X  X    X  X
XXXXXXX  XXXX    X      XXX   XXXX   XXXXXX   XXXX
X     X  X       X            X X    X    X       X
X     X  X       X    X       X  X   X    X       X
X     X  XXXXXX   XXXX        X   X  X    X  XXXXX

PROJECT DATA
Project Title: Eastkap2
Project File : eastkap2.prj
Run Date and Time: 5/6/98 11:44:32 AM

Project in English units

Project Description:
Kaloi Channel Realignment - Ewa, Oahu, Hawaii
Kaloi Channel Realignment -
Lower Basin 4 HGL


PLAN DATA

Plan Title: Imported Plan 01
Plan File : c:\hec\ras\eastkap2.p01

         Geometry Title: Imported Geom 01
         Geometry File : c:\hec\ras\eastkap2.g01

         Flow Title     : Imported Flow 01
         Flow File      : c:\hec\ras\eastkap2.f01

Plan Summary Information:
Number of:  Cross Sections =  145    Mulitple Openings =   0
            Culverts       =    4    Inline Weirs      =   0
            Bridges        =    4

Computational Information
    Water surface calculation tolerance =  0.01
    Critical depth calculaton tolerance =  0.01
    Maximum number of interations       =  20
    Maximum difference tolerance        =  0.3
    Flow tolerance factor               =  0.001

Computational Flow Regime: Mixed Flow
```

KALOI CHANNEL IMPROVEMENTS - PLATE 6 FLOOD PROFILE
(SECTIONS 140 TO 730 FROM EWA VILLAGES DRAINAGE MASTER PLAN, Rev. 3/97)

SUMMARY OF CROSS SECTIONS

C	114	
C	140	GENTRY SUBDIVISION (Q=8800)
C	150	DOWNSTR. FACE OF BRIDGE AT ORBL ROW
C	160	DOWNSTR. EDGE OF BRIDGE AT ORBL ROW
C	170	UPSTR. EDGE OF BRIDGE AT ORBL ROW
C	180	UPSTR. FACE OF BRIDGE AT ORBL ROW (CHANNEL)
C	190	CHANNEL SECTION
C	200	SECTION LEFT TRANSITION FROM CONC TO CRM RIGHT CRM (Q=8500)
C	210	SECTION LEFT CONC RIGHT TRAN FROM CONC TO CRM
C	220	SECTION LEFT TRAN FROM CONC TO CRM RIGHT CONC
C	230	SECTION LEFT CRM RIGHT CONC
C	240	SECTION LEFT CRM RIGHT TRAN CONC TO CRM
C	250	SECTION CRM LEFT AND RIGHT
C	260	SECTION CHANNEL WIDEST POINT CRM LEFT AND RIGHT
C	270	DOWNSTR. FACE OF BRIDGE AT N-S ROAD (CHANNEL)
C	280	DOWNSTR. EDGE OF BRIDGE AT N-S ROAD
C	290	UPSTR. EDGE OF BRIDGE AT N-S ROAD
C	300	UPSTR. FACE OF BRIDGE AT N-S ROAD (CHANNEL)
C	310	DOWNSTR. FACE OF BRIDGE AT RENTON ROAD (CHANNEL)
C	320	DOWNSTR. EDGE OF BRIDGE AT RENTON ROAD (Q=8350)
C	330	UPSTR. EDGE OF BRIDGE AT RENTON ROAD
C	340	UPSTR. FACE OF BRIDGE AT RENTON ROAD (GOLF COURSE)
C	350	GOLF COURSE CHANNEL
C	360	GOLF COURSE CHANNEL
C	370	BASIN #4 CULVERT OUTLET
C	380	BASIN #4 CULVERT INLET
C	390	GOLF COURSE CHANNEL
C	400	GOLF COURSE CHANNEL
C	410	#4 TA
C	420	GOLF COURSE CHANNEL
C	430	BASIN #3 CULVERT OUTLET
C	440	BASIN #3 CULVERT INLET
C	450	GOLF COURSE CHANNEL
C	460	GOLF COURSE CHANNEL
C	470	GOLF COURSE CHANNEL (Q=8000)
C	480	GOLF COURSE CHANNEL (Q=7700)
C	490	GOLF COURSE CHANNEL
C	500	GOLF COURSE CHANNEL
C	510	GOLF COURSE CHANNEL
C	520	GOLF COURSE CHANNEL
C	530	GOLF COURSE CHANNEL
C	540	GOLF COURSE CHANNEL
C	550	#4 GREEN
C	560	GOLF COURSE CHANNEL (Q=7600)
C	570	BASIN #2 CULVERT OUTLET
C	580	BASIN #2 CULVERT INLET
C	590	#5 TA
C	600	#6 GREEN
C	610	GOLF COURSE CHANNEL
C	620	GOLF COURSE CHANNEL
C	630	#6 TB
C	640	BASIN #1 CULVERT OUTLET (Q=7550)
C	650	BASIN #1 CULVERT INLET
C	660	#5 GREEN
C	670	GOLF COURSE CHANNEL
C	680	DRIVING RANGE TB
C	690	GOLF COURSE CHANNEL (Q=7400)
C	700	GOLF COURSE CHANNEL
C	710	DOWNSTREAM OF BRIDGE AT CURVE "A"
C	720	UPSTREAM OF BRIDGE AT CURVE "A"
C	730	CRM CHANNEL SECTION
C	740	SECTION AT BOTTOM OF BERM
C	750	SECTION TOP OF BERM
C	760	SECTION AT FULL WIDTH CHANNEL W/ 2.5% PARK
C	770	SECTION AT FULL WIDTH CHANNEL W/ 2.5% PARK
C	780	TRANSITION CHANNEL SECTION
C	790	TRANSITION CHANNEL SECTION
C	800	TRANSITION CHANNEL SECTION
C	810	CHANNEL SECTION TO POND
C	820	END CRM CHANNEL SECTION
C	830	CRM CHANNEL SECTION
C	840	DOWNSTREAM FACE OF BRIDGE
C	850	UPSTREAM FACE OF BRIDGE
C	855	SECTION THROUGH CRM
C	860	SECTION AT BOTTOM OF BERM, CRM
C	870	SECTION AT TOP OF BERM, CRM
C	880	SECTION THROUGH WIDEST POND SECTION W/ 2.5% PARK (Q=6150)
C	890	SECTION THROUGH TYPICAL CHANNEL SECTION W/ 2.5% PARK
C	900	SECTION THROUGH CHANNEL SECTION W/ 2.5% PARK
C	910	CHANNEL SECTION,THROUGH 2.5% PARK
C	920	TYPICAL CHANNEL SECTION, END CRM & BEGIN PARK
C	925	TYPICAL CHANNEL SECTION, CRM
C	930	BEGIN TYP CHANNEL SECTION, CRM
C	940	END NARROW CRM SECTION
C	945	SECTION, NARROW CRM CHANNEL
C	950	BEGIN NARROW CRM SECTION (BOTTOM OF BERM) (Q=6000)
C	955	TOP OF BERM (RESERVOIR 3)
C	960	SECTION, TRANSITION FROM PARK SECTION TO NARROW CRM SECTION
C	970	TYPICAL PARK SECTION
C	975	TYPICAL PARK SECTION, END CRM
C	977	TYPICAL PARK SECTION AT BOTTOM OF BERM
C	980	TYPICAL PARK SECTION AT TOP OF BERM, BEGIN CRM
C	984	BEGIN TYPICAL PARK SECTION
C	985	SECTION THROUGH POND AND PARK
C	990	SECTION THROUGH POND AND PARK
C	1000	SECTION THROUGH WIDEST PART OF POND AND PARK
C	1010	SECTION END CRM
C	1020	TYPICAL CHANNEL SECTION, CRM
C	1030	DOWNSTREAM FACE OF BRIDGE (Q=5900)
C	1040	UPSTREAM FACE OF BRIDGE
C	1045	SECTION AT BOTTOM OF BERM
C	1050	SECTION AT TOP OF BERM
C	1060	SECTION THROUGH POND
C	1070	SECTION AT BEGINNING OF CRM
C	1080	SECTION THROUGH CRM SECTION
C	1090	SECTION THROUGH TYPICAL CRM SECTION
C	1100	SECTION THROUGH TYPICAL CRM SECTION
C	1105	SECTION THROUGH BOTTOM OF BERM
C	1110	SECTION THROUGH PARK SECTION, TOP OF BERM
C	1120	SECTION THROUGH PARK SECTION
C	1130	SECTION THROUGH CRM CHANNEL
C	1135	SECTION THROUGH CRM CHANNEL AT HEADWALL
C	1140	SECTION AT DOWSTREAM FACE OF DBL 12X12 BOX (Q=5300)
C	1150	SECTION AT UPSTREAM FACE OF DBL 12X12 BOX
C	1160	SECTION ABOVE INVT

```
FLOW DATA

Flow Title: Imported Flow 01
Flow File : c:\hec\ras\eastkmp2.f01

Flow Data (cfs)

  River        Reach        RS          PF#1
  1            1            1160        5300
  1            1            1135        5900
  1            1            1045        5900
  1            1            1020        6000
  1            1            960         6000
  1            1            950         6000
  1            1            945         6150
  1            1            870         7400
  1            1            680         7550
  1            1            630         7600
  1            1            550         7700
  1            1            470         8000
  1            1            460         8350
  1            1            310         8500
  1            1            190         8800

Boundary Conditions

  River        Reach        Profile               Upstream        Downstream

  1            1            PF#1                  Critical        Known WS = 33.8


GEOMETRY DATA

Geometry Title: Imported Geom 01
Geometry File : c:\hec\ras\eastkmp2.g01

CROSS SECTION          RIVER: 1
REACH: 1                 RS: 1160

INPUT
Description: 1160  ABOVE X-1 FREEWAY
Station Elevation Data      num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   28.48  216.54  273.83  209.97  446.78  203.41  490.36  200.79  528.02  203.41
  580.47  205.05  659.86   207.5  738.59  209.97  952.59  211.61 1121.89  216.54

Manning's n Values          num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
   28.48    .035  273.83    .035  738.59    .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
        273.83  738.59                 149    165     241               .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                 RS: 1150

INPUT
Description: 1150  UPSTREAM FACE OF DBL 12X12 CULV
Station Elevation Data      num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   75.24  209.74  526.85  206.24     659  204.84  689.97   189.5  702.76   189.5
  703.77   189.5  716.83   189.5     747  204.84  842.66  206.24 1147.51  209.97

Manning's n Values          num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
   75.24    .025     659    .015     747    .025

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
           659     747              131.82 131.82  131.82               .3       .5

BRIDGE                 RIVER: 1
REACH: 1                 RS: 1145

INPUT
Description: Bridge # 11

Distance from Upstream XS =       0
Deck/Roadway Width        =  131.82
Weir Coefficient          =     2.6
Bridge Deck/Roadway Skew  =
Upstream  Deck/Roadway Coordinates
   num=      12
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
   75.24  209.77  209.77  526.85  206.24  206.24     659  204.84  204.84
  689.97  204.84   189.5  689.97  204.84   201.5  702.76  204.84   201.5
  702.76  204.84   189.5  703.77  206.84   189.5  703.77  204.84   201.5
  716.83  204.84   201.5  716.83  204.84   189.5     747  204.84  204.84

Upstream Bridge Cross Section Data
Station Elevation Data      num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   75.24  209.74  526.85  206.24     659  204.84  689.97   189.5  702.76   189.5
  703.77   189.5  716.83   189.5     747  204.84  842.66  206.24 1147.51  209.97

Manning's n Values          num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
   75.24    .025     659    .015     747    .025

Bank Sta: Left   Right     Coeff Contr.   Expan.
           659     747               .3       .5

Downstream  Deck/Roadway Coordinates
   num=      14
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
   41.35  209.97  209.97  591.86  206.24  206.24   763.2  204.74  204.74
  763.21  204.74     189  763.21  204.74     201  776.29  204.74     201
  776.29  204.74     189  777.29  204.74     189  777.29  204.74     201
  790.22  204.74     201  790.22  204.74     189  790.23  204.74  204.74
  912.98  206.24  206.24 1279.54  209.97  209.97

Downstream Bridge Cross Section Data
Station Elevation Data      num=      12
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   41.35  209.97  591.86  206.24   763.2  204.74  763.21     189  776.29     189
   776.3     189  777.28     189  777.29     189  790.22     189  790.23  204.74
  912.98  206.24 1279.54  209.97

Manning's n Values          num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
   41.35    .025   763.2    .015  790.23    .025

Bank Sta: Left   Right     Coeff Contr.   Expan.
         763.2  790.23               .3       .5
Ineffective Flow      num=      2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
   41.35   763.2  204.74  790.23 1279.54  204.74

Upstream Embankment side slope                 =         horiz. to 1.0 vertical
Downstream Embankment side slope               =         horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =      .95
Elevation at which weir flow begins            =
Energy head used in spillway design            =
Spillway height used in design                 =
Weir crest shape                               = Broad Crested

Number of Bridge Coefficient Sets =  1

Low Flow Methods and Data
       Energy
Selected Low Flow Methods = Energy

High Flow Method
       Energy Only

Additional Bridge Parameters
       Add Friction component to Momentum
       Do not add Weight component to Momentum
       Class B flow critical depth computations use critical depth
           inside the bridge at the downstream end
       Criteria to check for pressure flow = Upstream water surface

CROSS SECTION          RIVER: 1
REACH: 1                 RS: 1140
```

```
INPUT
Description: 1140  DOWNSTREAM FACE OF DBL. 12X12 CULV
Station Elevation Data     num=      12
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
   41.35   209.97   591.86   206.24    763.2   204.74   763.21      189   776.29      189
   776.3      189   777.28      189   777.29      189   790.22      189   790.23   204.74
  912.98   206.24  1279.54   209.97

Manning's n Values          num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
   41.35     .025    763.2     .015   790.23     .025

Bank Sta: Left    Right     Lengths: Left Channel    Right     Coeff Contr.    Expan.
         763.2   790.23               25.4    25.4    25.4               .3        .5
Ineffective Flow     num=        2
   Sta L    Sta R     Elev    Sta L    Sta R     Elev
   41.35    763.2   204.74   790.23  1279.54   204.74

CROSS SECTION            RIVER: 1
REACH: 1                    RS: 1135

INPUT
Description: 1135  CRM CHANNEL AT TOP SLOPE
Station Elevation Data     num=       6
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0   201.77    19.68   191.92    19.68      187    53.68      187    53.68   191.92
   73.36   201.77

Manning's n Values          num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .025        0     .025    73.36     .025

Bank Sta: Left    Right     Lengths: Left Channel    Right     Coeff Contr.    Expan.
             0    73.36               25.4    25.4    25.4               .2        .4

CROSS SECTION            RIVER: 1
REACH: 1                    RS: 1134

INPUT
Description: 1134 CRM MID-SLOPE
Station Elevation Data     num=       6
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0   200.13    22.96   188.65    22.96   183.72    56.96   183.72    56.96   188.65
   79.92   200.13

Manning's n Values          num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .025        0     .025    79.92     .025

Bank Sta: Left    Right     Lengths: Left Channel    Right     Coeff Contr.    Expan.
             0    79.92               50.8    50.8    50.8               .1        .3

CROSS SECTION            RIVER: 1
REACH: 1                    RS: 1132

INPUT
Description: 1132 CRM MID-SLOPE
Station Elevation Data     num=       6
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0   200.13    39.37   180.45    39.37   177.16    73.37   177.16    73.37   180.45
  112.74   200.13

Manning's n Values          num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .025        0     .025   112.74     .025

Bank Sta: Left    Right     Lengths: Left Channel    Right     Coeff Contr.    Expan.
             0   112.74              56.75   56.75   56.75               .1        .3

CROSS SECTION            RIVER: 1
REACH: 1                    RS: 1130

INPUT
Description: 1130  BOTTOM SLOPE INTO BASIN 1
Station Elevation Data     num=       4
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     400      190      440      170      474      170      514      190
```

```
Manning's n Values          num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
     400     .025      400     .025      514     .025

Bank Sta: Left    Right     Lengths: Left Channel    Right     Coeff Contr.    Expan.
           400      514                 20      20      20               .1        .3

CROSS SECTION            RIVER: 1
REACH: 1                    RS: 1125

INPUT
Description: 1125 BEYOND BOTTOM SLOPE BASIN 1
Station Elevation Data     num=       4
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0      190       40      170      105      170      145      190

Manning's n Values          num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .035        0     .035      145     .035

Bank Sta: Left    Right     Lengths: Left Channel    Right     Coeff Contr.    Expan.
             0      145                500     108      20               .1        .3

CROSS SECTION            RIVER: 1
REACH: 1                    RS: 1120

INPUT
Description: 1120  TYPICAL SECTION BASIN 1
Station Elevation Data     num=       9
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0      190        2      189      182      180      192      175      202      170
     364      170      374      175      384      180      424      200

Manning's n Values          num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .035      182     .035      384     .035

Bank Sta: Left    Right     Lengths: Left Channel    Right     Coeff Contr.    Expan.
           182      384                240     240     240               .1        .3

CROSS SECTION            RIVER: 1
REACH: 1                    RS: 1119

INPUT
Description: 1119 BASIN 1 SECTION
Station Elevation Data     num=       5
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0      189      180      180      200      170      362      170   428.82    203.4

Manning's n Values          num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .035      180     .035   428.82     .035

Bank Sta: Left    Right     Lengths: Left Channel    Right     Coeff Contr.    Expan.
           180   428.82                 30     118     350               .1        .3

CROSS SECTION            RIVER: 1
REACH: 1                    RS: 1117

INPUT
Description: 1117 BASIN 1 CHANNEL SECTION
Station Elevation Data     num=       6
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0      187      164   181.26   187.28   169.62   207.28   169.62   228.04      180
  419.47   185.36

Manning's n Values          num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .035      164     .035   228.04     .035

Bank Sta: Left    Right     Lengths: Left Channel    Right     Coeff Contr.    Expan.
           164   228.04                 85      85      85               .1        .3

CROSS SECTION            RIVER: 1
REACH: 1                    RS: 1115

INPUT
Description: 1115 UPSTREAM BOTTOM WEIR
```

```
Station Elevation Data      num=      5
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  185.36   33.65  168.53   53.65  168.53   84.03  183.72     207     187

Manning's n Values          num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035       0    .025   84.03    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0   84.03               10      10      10               .1       .3

CROSS SECTION               RIVER: 1
REACH: 1                    RS: 1110

INPUT
Description: 1110  TOP WEIR BASIN 1
Station Elevation Data      num=      4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  186.18   22.36     175   72.36     175    93.1  185.37

Manning's n Values          num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035       0    .025    93.1    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0    93.1               10      10      10               .1       .3

CROSS SECTION               RIVER: 1
REACH: 1                    RS: 1105

INPUT
Description: 1105  DOWNSTREAM BOTTOM WEIR BASIN 1
Station Elevation Data      num=      4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0     187      38     168      58     168   92.73  185.37

Manning's n Values          num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035       0    .025   92.73    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0   92.73            45.75   45.75   45.75               .1       .3

CROSS SECTION               RIVER: 1
REACH: 1                    RS: 1100

INPUT
Description: 1100  CRM CHANNEL SECTION
Station Elevation Data      num=      4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0     190   45.73  167.42   65.73  167.42   104.9     187

Manning's n Values          num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035       0    .025   104.9    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0   104.9              355     355     355               .1       .3

CROSS SECTION               RIVER: 1
REACH: 1                    RS: 1095

INPUT
Description: 1095 CRM CHANNEL SECTION
Station Elevation Data      num=      4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  180.44   35.62  162.65   55.62  162.65   91.25  180.44

Manning's n Values          num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035       0    .025   91.25    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0   91.25              350     350     350               .1       .3

CROSS SECTION               RIVER: 1
REACH: 1                    RS: 1090

INPUT
Description: 1090  CRM SECTION TOP OF SLOPE
Station Elevation Data      num=      6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0     177      20     172      48     158      68     158      96     172
     116  177.82

Manning's n Values          num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035      20    .025      96    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
            20      96               40      40      40               .1       .3

CROSS SECTION               RIVER: 1
REACH: 1                    RS: 1088

INPUT
Description: 1088 CRM MID-SLOPE INTO BASIN 2
Station Elevation Data      num=      4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   170.6    29.5  155.84    56.1  155.84    95.5   175.5

Manning's n Values          num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035       0    .025    95.5    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0    95.5               30      30      30               .1       .3

CROSS SECTION               RIVER: 1
REACH: 1                    RS: 1087

INPUT
Description: 1087 CRM MID-SLOPE INTO BASIN 2
Station Elevation Data      num=      4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   170.6   32.81   154.2    65.6   154.2     105  173.88

Manning's n Values          num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035       0    .025     105    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0     105               60      60      60               .1       .3

CROSS SECTION               RIVER: 1
REACH: 1                    RS: 1085

INPUT
Description: 1085 CRM SECTION MID-SLOPE INTO BASIN 2
Station Elevation Data      num=      4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  168.96      36  150.92      81  150.92  120.37   170.6

Manning's n Values          num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035       0    .025  120.37    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0  120.37               60      60      60               .1       .3

CROSS SECTION               RIVER: 1
REACH: 1                    RS: 1084

INPUT
Description: 1084 CRM MID-SLOPE INTO BASIN 2
Station Elevation Data      num=      4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  167.32   39.37  147.64   97.21  147.64     140     169

Manning's n Values          num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035       0    .025     140    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0     140               60      60      60               .1       .3
```

```
CROSS SECTION            RIVER: 1
REACH: 1                    RS: 1082

INPUT
Description: 1082 CRM MID-SLOPE INTO BASIN 2
Station Elevation Data      num=        4
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
       0  167.32       46  144.35      116  144.35   165.22     169

Manning's n Values          num=        3
     Sta   n Val      Sta   n Val      Sta   n Val
       0    .035        0    .025   165.22    .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0  165.22                 44      44      44               .1       .3

CROSS SECTION            RIVER: 1
REACH: 1                    RS: 1080

INPUT
Description: 1080  CRM BOTTOM SLOPE BASIN 2
Station Elevation Data      num=        6
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
       0  168.96       32     153    69.73  152.55    90.86     142   170.86     142
  221.52  167.32

Manning's n Values          num=        3
     Sta   n Val      Sta   n Val      Sta   n Val
       0    .035    69.73    .025   221.52    .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
         69.73  221.52                 40      20      20               .2       .4

CROSS SECTION            RIVER: 1
REACH: 1                    RS: 1079

INPUT
Description: 1079 BELOW BOTTOM SLOPE INTO BASIN 2
Station Elevation Data      num=        7
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
       0     169     8.84  164.58       32     153    83.84  150.92   101.69     142
  101.69     142   232.35  167.32

Manning's n Values          num=        3
     Sta   n Val      Sta   n Val      Sta   n Val
       0    .035    83.84    .025   232.35    .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
         83.84  232.35                100      70      70               .1       .3

CROSS SECTION            RIVER: 1
REACH: 1                    RS: 1077

INPUT
Description: 1077 UPSTREAM BOTTOM BERM - CRM SLOPE
Station Elevation Data      num=        6
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
       0   170.6     35.2     153    237.7  147.96    249.7     142    329.7     142
  380.34  167.32

Manning's n Values          num=        3
     Sta   n Val      Sta   n Val      Sta   n Val
       0    .035    237.7    .025   380.34    .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
         237.7  380.34                100      10      10               .1       .3
Ineffective Flow     num=        1
   Sta L   Sta R    Elev
       0     197   170.6

CROSS SECTION            RIVER: 1
REACH: 1                    RS: 1075

INPUT
Description: 1075  TOP OF BERM BASIN 2 - CRM SLOPE
Station Elevation Data      num=        6
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
       0     172       40     153      430     147      530     147      556     160
     576     164

Manning's n Values          num=        3
     Sta   n Val      Sta   n Val      Sta   n Val
       0    .035      430    .025      556    .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
           430     556                 10      10      10               .3       .5
Ineffective Flow     num=        1
   Sta L   Sta R    Elev
       0     380     160

CROSS SECTION            RIVER: 1
REACH: 1                    RS: 1070

INPUT
Description: 1070  DOWNSTREAM BOTTOM BERM - CRM SLOPE
Station Elevation Data      num=        6
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
       0  172.49       40     153      470     147      480     142      560     142
     604     164

Manning's n Values          num=        3
     Sta   n Val      Sta   n Val      Sta   n Val
       0    .035      470    .025      604    .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
           470     604                235     235     235               .1       .3
Ineffective Flow     num=        1
   Sta L   Sta R    Elev
       0     410     160

CROSS SECTION            RIVER: 1
REACH: 1                    RS: 1060

INPUT
Description: 1060  FULL WIDTH BASIN 2
Station Elevation Data      num=        6
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
       0   172.2       60  171.04      118     142      672     142      706     159
  716.42     164

Manning's n Values          num=        3
     Sta   n Val      Sta   n Val      Sta   n Val
       0    .035       60    .035   716.42    .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
            60  716.42                128     128     128               .1       .3
Ineffective Flow     num=        1
   Sta L   Sta R    Elev
       0     500     170

CROSS SECTION            RIVER: 1
REACH: 1                    RS: 1055

INPUT
Description: 1055 UPSTREAM BOTTOM WEIR BASIN 2
Station Elevation Data      num=        8
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
       0  157.48       28  157.48       28  150.91       50     142      120     142
     142  150.91      142  157.48      170  157.48

Manning's n Values          num=        3
     Sta   n Val      Sta   n Val      Sta   n Val
       0    .035       28    .025      142    .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
            28     142                 10      10      10               .1       .3

CROSS SECTION            RIVER: 1
REACH: 1                    RS: 1050

INPUT
Description: 1050  TOP WEIR BASIN 2
Station Elevation Data      num=        6
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
       0  157.48       30  157.48       30     147       80     147       80  157.48
     140  157.48
```

```
Manning's n Values          num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .035       30     .025       80     .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
            30      80                  10      10      10              .3       .5

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 1045

INPUT
Description: 1045  DOWNSTREAM BOTTOM OF WEIR BASIN 2
Station Elevation Data      num=        6
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0   157.48       30   157.48       30      142       80      142       80   157.48
     140   157.48

Manning's n Values          num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .035       30     .025       80     .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
            30      80                  25      25      25              .3       .5

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 1040

INPUT
Description: 1040 CRM CHANNEL UNDER FARR. HWY
Station Elevation Data      num=        6
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0   160.76    39.37   141.08    62.37   141.08    66.37   141.08    89.37   141.08
  128.74   160.76

Manning's n Values          num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .015        0     .015   128.74     .015

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0  128.74                94.5    94.5    94.5              .3       .5
Blocked Obstructions        num=        1
   Sta L    Sta R     Elev
   62.37    66.37   160.76

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 1035

INPUT
Description: 1035 CRM CHANNEL UNDER FARR. HWY
Station Elevation Data      num=        6
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0   160.76    42.65   139.44    65.65   139.44    69.65   139.44    92.65   139.44
  138.58    162.4

Manning's n Values          num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .015        0     .015   138.58     .015

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0  138.58                94.5    94.5    94.5              .1       .3
Blocked Obstructions        num=        1
   Sta L    Sta R     Elev
   65.65    69.65    162.4

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 1030

INPUT
Description: 1030  CRM CHANNEL UNDER FARR. HWY
Station Elevation Data      num=        5
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0   152.56    19.68   142.72    19.68    137.8    69.68    137.8   105.76   155.84

Manning's n Values          num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .035    19.68     .025   105.76     .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
         19.68  105.76                 100      76      50              .3       .5

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 1025

INPUT
Description: 1025 CRM MID-SLOPE INTO BASIN 3
Station Elevation Data      num=        5
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0   150.92       25   138.45       25   132.87       84   132.87      130   155.84

Manning's n Values          num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .035       25     .025      130     .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
            25     130                  70      58      45              .1       .3

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 1020

INPUT
Description: 1020  CRM MID-SLOPE INTO BASIN 3
Station Elevation Data      num=        5
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0   149.28     29.5    134.5     29.5   129.25     97.1   129.25   146.97    154.2

Manning's n Values          num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .035        0     .025   146.97     .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0  146.97                  46      46      46              .1       .3

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 1015

INPUT
Description: 1015 CRM MID-SLOPE INTO BASIN 3
Station Elevation Data      num=        5
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0   149.28    34.77   131.89    34.77   126.31   108.46   126.31   164.23    154.2

Manning's n Values          num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .035    34.77     .025   164.23     .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
         34.77  164.23                  50      50      50              .1       .3

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 1012

INPUT
Description: 1012 CRM MID-SLOPE INTO BASIN 3
Station Elevation Data      num=        6
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0   149.28    39.37    129.6    70.54    128.6    70.54      123      165      123
  227.34    154.2

Manning's n Values          num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .035    70.54     .025   227.34     .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
         70.54  227.34               62.33   62.33   62.33              .1       .3

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 1010

INPUT
Description: 1010  BASIN 3 MID CRM SLOPE
Station Elevation Data      num=        6
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0   149.28    39.37   129.47   118.77   124.67   118.77    118.9   254.68    118.9
  328.56   155.84

Manning's n Values          num=        3
```

```
     Sta   n Val      Sta   n Val     Sta   n Val
       0    .035        0    .025  328.56    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0  328.56                 55      55      55             .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 1005

INPUT
Description: 1005 BASIN 3 BOTTOM SLOPE CRM CHANNEL
Station Elevation Data     num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  149.28   39.37  129.47  150.23     123  159.81  115.47  336.19  115.47
  416.96  155.83

Manning's n Values         num=       3
     Sta   n Val      Sta   n Val     Sta   n Val
       0    .035        0    .025  416.96    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0  416.96                 20      50      50             .1       .3
Ineffective Flow     num=        1
   Sta L   Sta R    Elev
       0     130  149.28

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 1000

INPUT
Description: 1000  BASIN 3 BELOW CRM SLOPE
Station Elevation Data     num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  149.28   39.64  129.47  185.47  122.21  198.99  115.47  422.55  115.47
  503.32  155.84

Manning's n Values         num=       3
     Sta   n Val      Sta   n Val     Sta   n Val
       0    .035        0    .025  503.32    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0  503.32                 48     165     423             .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 990

INPUT
Description: 990  FULL WIDTH BASIN 3 (5% PARK)
Station Elevation Data     num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   154.2  108.76  150.92  162.66  144.85  189.44  129.47  369.44  120.47
  379.44  115.47  604.44  115.47  632.44  129.47   702.5   150.9

Manning's n Values         num=       3
     Sta   n Val      Sta   n Val     Sta   n Val
       0    .035   162.66    .035   702.5    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        162.66   702.5                235     284     312             .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 985

INPUT
Description: 985  BASIN 3 SECTION (5% PARK)
Station Elevation Data     num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  150.92  122.13   143.3  149.79  129.47  329.79  120.47  339.79  115.47
   531.3  115.47   559.3  129.47  608.79  143.55

Manning's n Values         num=       3
     Sta   n Val      Sta   n Val     Sta   n Val
       0    .035   122.13    .035  608.79    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        122.13  608.79                300     300     300             .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 980

INPUT
Description: 980  BASIN 3 SECTION (5% PARK)
Station Elevation Data     num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  146.52   80.25  134.29   89.89  129.47  269.89  120.47  279.89  115.47
     439  115.47     467  129.47     517     141

Manning's n Values         num=       3
     Sta   n Val      Sta   n Val     Sta   n Val
       0    .035    80.25    .035     517    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         80.25     517                300     300     300             .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 975

INPUT
Description: 975  BASIN 3 SECTION (5% PARK)
Station Elevation Data     num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   145.9   96.99  134.08  106.25  129.47  286.25  120.47  296.25  115.47
  427.25  115.47  455.25  129.47     489  139.67

Manning's n Values         num=       3
     Sta   n Val      Sta   n Val     Sta   n Val
       0    .035    96.99    .035     489    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         96.99     489                399     392     382             .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 970

INPUT
Description: 970  BASIN 3 SECTION (5% PARK)
Station Elevation Data     num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     129   139.5     149  129.47     329  120.47     339  115.47   451.5  115.47
   461.5  120.47   479.5  129.47     506  137.43

Manning's n Values         num=       3
     Sta   n Val      Sta   n Val     Sta   n Val
     129    .035      149    .035     506    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           149     506                106     106     106             .1       .3
Ineffective Flow     num=        1
   Sta L   Sta R    Elev
     129     250  141.08

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 960

INPUT
Description: 960  BASIN 3 SECTION ABOVE WEIR
Station Elevation Data     num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  139.47      20  129.47     100  125.47     180  120.47     190  115.47
     309  115.47     337  129.47     366  137.79

Manning's n Values         num=       3
     Sta   n Val      Sta   n Val     Sta   n Val
       0    .035        0    .025     366    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0     366                 65      65      65             .1       .3
Ineffective Flow     num=        1
   Sta L   Sta R    Elev
       0     200  139.47

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 958

INPUT
Description: 958 UPSTREAM BOTTOM WEIR
```

```
Station Elevation Data    num=     6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  136.15       0  124.67    18.5  115.47    68.5  115.47    90.2  126.31
   118.2  136.15

Manning's n Values        num=     3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035       0    .025   118.2    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   118.2               10      10      10              .3       .5
Ineffective Flow    num=     1
   Sta L   Sta R    Elev
    90.2   118.2  136.15

CROSS SECTION          RIVER: 1
REACH: 1                 RS: 957

INPUT
Description: 957 TOP WEIR
Station Elevation Data    num=     4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0     134       0  120.47      50  120.47      50     134

Manning's n Values        num=     3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035       0    .025      50    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0      50               10      10      10              .3       .5

CROSS SECTION          RIVER: 1
REACH: 1                 RS: 955

INPUT
Description: 955  DOWNSTREAM BOTTOM WEIR
Station Elevation Data    num=     7
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0     134     120     134     120  120.47     130  115.47     160  115.47
     170  120.47     170     134

Manning's n Values        num=     3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035     120    .025     170    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           120     170             54.6    54.6    54.6              .3       .5

CROSS SECTION          RIVER: 1
REACH: 1                 RS: 950

INPUT
Description: 950  CRM CHANNEL JUST BELOW WEIR
Station Elevation Data    num=     4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  136.15    40.5  114.83    70.5  114.83  121.88  136.43

Manning's n Values        num=     3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035       0    .025  121.88    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0  121.88            526.7   526.7   526.7              .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                 RS: 945

INPUT
Description: 945  CRM CHANNEL SECTION
Station Elevation Data    num=     4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  129.59   38.75  109.26   68.75  109.26  117.21  129.59

Manning's n Values        num=     3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035       0    .025  117.21    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0  117.21             1168    1168    1168              .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                 RS: 940

INPUT
Description: 940  CRM CHANNEL SECTION
Station Elevation Data    num=     4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   114.6   36.55   95.96   66.55   95.96  112.48   114.6

Manning's n Values        num=     3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035       0    .025  112.48    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0  112.48              180     180     180              .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                 RS: 930

INPUT
Description: 930 CRM CHANNEL TOP SLOPE
Station Elevation Data    num=     4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  111.54      35      94      65      94  104.64  113.82

Manning's n Values        num=     3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035       0    .025  104.64    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0  104.64               60      60      60              .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                 RS: 929

INPUT
Description: 929 CRM MID-SLOPE INTO BASIN 4
Station Elevation Data    num=     4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  109.91   42.65   88.58      82   88.58  127.93  111.55

Manning's n Values        num=     3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035       0    .025  127.93    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0  127.93            70.75   70.75   70.75              .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                 RS: 928

INPUT
Description: 928 CRM CHANNEL MID-SLOPE
Station Elevation Data    num=     4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  109.91   55.78   82.02  103.78   82.02  159.56  109.91

Manning's n Values        num=     3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035       0    .025  159.56    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0  159.56            70.75   70.75   70.75              .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                 RS: 927

INPUT
Description: 927 CRM MID-SLOPE INTO BASIN 4
Station Elevation Data    num=     4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  108.27   65.62    75.5  124.28    75.5  193.18  109.91

Manning's n Values        num=     3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035       0    .025  193.18    .035
```

```
Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0  193.18              70.75   70.75   70.75               .1       .3

CROSS SECTION            RIVER: 1
REACH: 1                 RS: 926

INPUT
Description: 926 CRM MID-SLOPE INTO BASIN 4
Station Elevation Data      num=       4
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0   106.63     75.5     68.9    144.4     68.9   223.14   108.27

Manning's n Values          num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .035        0     .025   223.14     .035

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0  223.14              81.43   81.43   81.43               .1       .3

CROSS SECTION            RIVER: 1
REACH: 1                 RS: 925

INPUT
Description: 925  CRM CHANNEL BOTTOM SLOPE
Station Elevation Data      num=       6
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0   106.62    80.63    63.51    90.63    58.51   170.63    58.51   180.63    63.51
  261.26   106.62

Manning's n Values          num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .035        0     .025   261.26     .035

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0  261.26                 55      50      50               .1       .3

CROSS SECTION            RIVER: 1
REACH: 1                 RS: 923

INPUT
Description: 923 BEYOND BOTTOM SLOPE INTO BASIN 4
Station Elevation Data      num=       6
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0       90       51    64.67      185    61.31      201    53.51      249    53.51
     322       90

Manning's n Values          num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .035        0     .025      322     .035

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0     322                200     154     150               .1       .3

CROSS SECTION            RIVER: 1
REACH: 1                 RS: 920

INPUT
Description: 920  END CRM (GUESS) TOP OF BASIN 4
Station Elevation Data      num=       6
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0       84    33.23    67.31   277.23    61.31   293.23    53.31   341.23    53.31
     404       84

Manning's n Values          num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .035        0     .025      404     .035

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0     404                416     300     270               .1       .3

CROSS SECTION            RIVER: 1
REACH: 1                 RS: 910

INPUT
Description: 910  BASIN 4 (2.5% PARK)
Station Elevation Data      num=       7
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0       86    28.66    72.31   212.66    66.31   412.66    61.31   428.66    53.31
```

```
  476.66    53.31   532.66    81.31

Manning's n Values          num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .035        0     .035   532.66     .035

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0  532.66                615     595     567               .1       .3

CROSS SECTION            RIVER: 1
REACH: 1                 RS: 900

INPUT
Description: 900  BASIN 4 (2.5% PARK)
Station Elevation Data      num=       7
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0    88.58       25    76.31      225    71.31      425    61.31      441    53.31
     489    53.31      535       76

Manning's n Values          num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .035        0     .035      535     .035

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0     535                331     381     381               .1       .3

CROSS SECTION            RIVER: 1
REACH: 1                 RS: 890

INPUT
Description: 890  BASIN 4 (2.5% PARK)
Station Elevation Data      num=       9
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
   35.29    84.64    47.95    81.31    57.95    72.31   257.95    66.31   457.95    61.31
  473.95    53.31    665.2    53.31    721.2    81.31    771.2    91.45

Manning's n Values          num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
   35.29     .035    47.95     .035    721.2     .035

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
         47.95   721.2                548  426.11  426.11               .1       .3

CROSS SECTION            RIVER: 1
REACH: 1                 RS: 880

INPUT
Description: 880  FULL WIDTH OF BASIN 4 (2.5% PARK)
Station Elevation Data      num=       7
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0    81.31       10    72.31      410    61.31      426    53.31      793    53.31
     851    81.31      904    88.98

Manning's n Values          num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .035        0     .035      851     .035

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0     851                290  199.27     187               .1       .3
Ineffective Flow      num=       1
   Sta L   Sta R    Elev
       0     600   81.31

CROSS SECTION            RIVER: 1
REACH: 1                 RS: 875

INPUT
Description: 875  UPSTREAM BOTTOM WEIR
Station Elevation Data      num=       7
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0    81.31       10    72.31      410    61.31      426    53.31    796.5    53.31
   816.5    53.31    862.3    81.31

Manning's n Values          num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .035        0     .025    862.3     .035

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
```

```
        0   862.3              10     10     10            .3     .5
Ineffective Flow     num=       1
   Sta L   Sta R   Elev
       0   726.5   81.31

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 870

INPUT
Description: 870  TOP OF WEIR
Station Elevation Data     num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   81.31       0   76.31      35   76.31      35   58.31      85   58.31
      85   76.31     120   76.31     120   81.31

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .025       0    .025     120    .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0     120                10      10      10               .3       .5

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 860

INPUT
Description: 860  DOWNSTREAM BOTTOM OF WEIR
Station Elevation Data     num=       5
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     265   80.38  309.46    58.2  367.46    58.2  411.92   80.38     430      82

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     265    .035     265    .015  411.92    .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
           265  411.92                39      39      39               .3       .5

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 850

INPUT
Description: 850  CHANNEL UNDER EAST-WEST RD

Station Elevation Data     num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0    82.4  683.94   80.38   728.7    57.8   755.7    57.8   759.7    57.8
   786.7    57.8  831.46   80.38  894.61   86.94

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035  683.94    .015  831.46    .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
        683.94  831.46               100     100     100               .3       .5
Blocked Obstructions       num=       1
   Sta L   Sta R   Elev
   755.7   759.7   80.38

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 840

INPUT
Description: 840  CHANNEL UNDER EAST-WEST RD
Station Elevation Data     num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   82.84  726.67   80.38  773.59    56.8  799.59    56.8  803.59    56.8
  829.59    56.6  876.51   80.38  931.56   86.93

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035  726.67    .015  876.51    .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
        726.67  876.51                71      71      71               .3       .5
Blocked Obstructions       num=       1
   Sta L   Sta R   Elev
  799.59  803.59   80.38

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 835

INPUT
Description: 835  CRM CHANNEL ABOVE DROP
Station Elevation Data     num=       5
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100   78.74  143.48   56.73  243.48   56.73  286.96   78.74   307.5    86.9

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100    .035     100    .015  286.96    .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
           100  286.96                .5      .5      .5               .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 830

INPUT
Description: 830  CRM CHANNEL BELOW DROP
Station Elevation Data     num=       5
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   159.7   78.74     285   78.74   328.5   56.73   428.5   56.73     472   78.74

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   159.7    .035     285    .025     472    .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
           285     472                20      20      20               .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 829

INPUT
Description: 829 BEYOND DROP TOP OF BASIN 5
Station Elevation Data     num=       4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   78.74    43.5    56.7   143.5    56.7     187   78.74

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035       0    .025     187    .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0     187                20      20      20               .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 827

INPUT
Description: 827 BEYOND DROP TOP OF BASIN 5
Station Elevation Data     num=       4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   78.74    43.5   56.69   143.5   56.69     187   78.74

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035       0    .025     187    .035

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0     187               220     220     220               .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 820

INPUT
Description: 820  CRM CHANNEL
Station Elevation Data     num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   73.16  327.85   78.74  371.63   56.47  471.63   56.47  512.13    77.1
  532.85   85.11

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .035  327.85    .025  512.13    .035
```

```
Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       327.85  512.13                 940     940     940               .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 810

INPUT
Description: 810  CRM CHANNEL
Station Elevation Data    num=       6
     Sta     Elev     Sta    Elev     Sta     Elev     Sta    Elev     Sta    Elev
       0       78   251.5    77.1   294.7     55.5   390.7    55.5   433.9    77.1
  454.75    80.26

Manning's n Values        num=       3
     Sta    n Val     Sta   n Val     Sta    n Val
       0     .035   251.5    .025   433.9     .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          251.5  433.9                100     100     100               .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 805

INPUT
Description: 805  GRASSED CHANNEL
Station Elevation Data    num=       6
     Sta     Elev     Sta    Elev     Sta     Elev     Sta    Elev     Sta    Elev
     100    75.45     136   57.41  150.82     56.5  160.82    51.5  260.82    51.5
     312     77.1

Manning's n Values        num=       3
     Sta    n Val     Sta   n Val     Sta    n Val
     100     .035     100    .035     312     .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
            100    312                128     160     168               .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 800

INPUT
Description: 800  TRANSITION CHANNEL SECTION
Station Elevation Data    num=       8
     Sta     Elev     Sta    Elev     Sta     Elev     Sta    Elev     Sta    Elev
  170.62     71.5  181.62    60.5     280     56.5     290    51.5     390    51.5
     400     56.5     440    71.5  462.13    77.58

Manning's n Values        num=       3
     Sta    n Val     Sta   n Val     Sta    n Val
  170.62     .035  170.62    .035     440     .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         170.62    440                 72   76.51      83               .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 790

INPUT
Description: 790  TRANSITION CHANNEL SECTION
Station Elevation Data    num=       8
     Sta     Elev     Sta    Elev     Sta     Elev     Sta    Elev     Sta    Elev
  100.22     71.5  111.22    60.5     248     56.5     258    51.5     358    51.5
     398     71.5   426.2    76.5  448.42     77.5

Manning's n Values        num=       3
     Sta    n Val     Sta   n Val     Sta    n Val
  100.22     .035  100.22    .035   426.2     .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         100.22  426.2                 60   62.72      67               .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 780

INPUT
Description: 780  TRANSITION CHANNEL SECTION
Station Elevation Data    num=       8
     Sta     Elev     Sta    Elev     Sta     Elev     Sta    Elev     Sta    Elev
   83.97     71.5     112    60.5  268.58     56.5  278.58    51.5  378.58    51.5
  388.58     56.5  428.58    71.5  448.42    76.46

Manning's n Values        num=       3
     Sta    n Val     Sta   n Val     Sta    n Val
   83.97     .035   83.97    .035  428.58     .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          83.97  428.58               458   556.7     599               .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 770

INPUT
Description: 770  FULL WIDTH OF BASIN 5  (2.5% PARK)
Station Elevation Data    num=       8
     Sta     Elev     Sta    Elev     Sta     Elev     Sta    Elev     Sta    Elev
      66     71.5      80    64.5     400     56.5     410    51.5  627.53    51.5
  637.53     56.5  667.18   71.32  700.53    71.99

Manning's n Values        num=       3
     Sta    n Val     Sta   n Val     Sta    n Val
      66     .035      66    .035  667.18     .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             66  667.18               556  557.69     591               .1       .3

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 760

INPUT
Description: 760  FULL WIDTH OF BASIN 5 (2.5% PARK)
Station Elevation Data    num=       8
     Sta     Elev     Sta    Elev     Sta     Elev     Sta    Elev     Sta    Elev
      66     71.5      80    64.5     400     56.5     410    51.5   756.5    51.5
   766.5     56.5   786.5    66.5   796.5     71.5

Manning's n Values        num=       3
     Sta    n Val     Sta   n Val     Sta    n Val
      66     .035      66    .035   796.5     .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             66  796.5                257   255.7     257               .1       .3
Ineffective Flow     num=        1
   Sta L   Sta R    Elev
      66     450    66.5

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 755

INPUT
Description: 755 BOTTOM OF WEIR - UPSTREAM
Station Elevation Data    num=       5
     Sta     Elev     Sta    Elev     Sta     Elev     Sta    Elev     Sta    Elev
       0    67.25     495   65.61  523.22     51.5  653.22    51.5  681.45   65.61

Manning's n Values        num=       3
     Sta    n Val     Sta   n Val     Sta    n Val
       0     .035     495    .035  681.45     .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
            495  681.45                10      10      10               .3       .5

CROSS SECTION          RIVER: 1
REACH: 1                   RS: 750

INPUT
Description: 750  TOP OF WEIR
Station Elevation Data    num=       8
     Sta    Elev.     Sta    Elev     Sta     Elev     Sta    Elev     Sta    Elev
       0    66.44    49.9    66.5    51.9     65.5   495.3    63.5   495.3    54.5
   605.3     54.5   605.3    66.5   635.3     71.5

Manning's n Values        num=       3
     Sta    n Val     Sta   n Val     Sta    n Val
       0     .035   495.3    .025   605.3     .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
```

```
        495.3   605.3               10      10      10              .3      .5

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 740

INPUT
Description: 740 BOTTOM OF WEIR
Station Elevation Data    num=       9
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
       0    66.44   43.45     66.5   45.35     65.5  129.08    64.45  473.11    64.45
  500.31    50.85  590.31    50.85  618.09    64.74  667.52     65.7

Manning's n Values        num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
       0     .035   45.35     .025  618.09     .035

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.    Expan.
         45.35   618.09                 16   20.83       24                .3        .5

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 730

INPUT
Description: 730
Station Elevation Data    num=       7
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
       0     66.4   42.43    66.57  466.75       64  493.05    50.85  583.06    50.85
  609.86    64.25  666.24    65.39

Manning's n Values        num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
       0     .035  466.75     .025  609.86     .035

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.    Expan.
        466.75   609.86                 16   41.04       71                .3        .5

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 720

INPUT
Description: 720
Station Elevation Data    num=       9
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
       0    66.11     137    65.94  293.16    65.52  450.68     64.6  478.18    50.85
  563.18    50.85  590.68     64.6  697.43    64.42  745.85    63.88

Manning's n Values        num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
       0     .025  450.68     .015  590.68     .025

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.    Expan.
        450.68   590.68                 40      40       40                .3        .5

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 710

INPUT
Description: 710
Station Elevation Data    num=       9
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
       0    66.11     137    65.94  331.41    65.62  468.51     64.5     495     50.5
     575     50.5     601    63.65  701.93    64.02  750.44    63.75

Manning's n Values        num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
       0     .025  468.51     .015     601     .025

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.    Expan.
        468.51      601                350     350      350                .6        .8

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 700

INPUT
Description: 700
Station Elevation Data    num=      16
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
      20       64      30       62      50       60      70       58     100       56
     195       54     320       52     380       50     390     48.5     425       50
     435       52     480       54     565       56     585       60     645       62
     655       64

Manning's n Values        num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
      20     .055     320     .035     480     .055

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.    Expan.
           320      480                120     140      140                .6        .8

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 690

INPUT
Description: 690
Station Elevation Data    num=      20
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
      25       64      40       62      60       60      80       58     100       56
     140       54     260       52     335       50     400       48     450       47
     520       48     535       50     580       52     585       54     630       56
     635       58     640       60     695       62     700       64     785       64

Manning's n Values        num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
      25     .055     260     .035     580     .055

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.    Expan.
           260      580                130     150      140                .6        .8

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 680

INPUT
Description: 680
Station Elevation Data    num=      24
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
      25       64      40       62      60       60      80       58      90       56
     110       54     120       52     170       52     230       52     340       50
     380       48     480       46     590       45     670       46     675       48
     685       50     715       52     730       54     765       56     775       58
     780       60     790       62     805       64     925       64

Manning's n Values        num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
      25     .055     380     .035     675     .055

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.    Expan.
           380      675                670     150      140                .6        .8

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 670

INPUT
Description: 670
Station Elevation Data    num=      30
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
       0       62      15       60      35       58      50       56      65       54
      95       52     125       50     200       48     280       46     510       44
     615       40     660       44     670       46     675       48     690       50
     705       52     720       54     745       56     750       58     760       60
     770       62     775       64     780       66     790       68     810       70
     825       68     835       66     840       64     870       62     880       62

Manning's n Values        num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
       0     .055     280     .035     675     .055

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.    Expan.
           280      675                120     125       80                .6        .8

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 660

INPUT
Description: 660
Station Elevation Data    num=      27
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
```

0	66	10	64	20	62	30	60	40	58
50	56	65	54	80	52	110	50	130	48
230	46	340	44	640	40	675	44	680	46
690	48	695	50	700	52	720	54	730	56
735	58	740	60	750	62	760	64	780	64
790	60	900	62						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.055	230	.035	700	.055

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
230	700	530	90	110	.6	.8

CROSS SECTION RIVER: 1
REACH: 1 RS: 650

INPUT
Description: 650
Station Elevation Data num= 60

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	66	7	64	15	62	25	60	40	58
74	56	128	54	160	53	186	54	241	55
286	54	304	52.5	321	50	421	50	438	52.5
445	52	453	54	494	56	504	56.5	514	56
555	54	630	54	638	56	645	58	653	60
658	60.5	663	60	678	58	688	56	701	54
723	54	738	54.5	745	54	765	52	785	50
795	52.5	812	50	1012	50	1029	52.5	1042	52
1059	53	1159	53	1199	52.5	1229	48	1256.3	44
1269.7	44	1307	48	1337	52.5	1355	52	1358	54
1363	56	1367	58	1378	60	1395	62	1405	63
1415	62	1425	60	1505	60	1525	62	1535	64

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.035	1229	.025	1307	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
1229	1307	38	38	38	.6	.8

Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
0	1229	48	1307	1535	48

CULVERT RIVER: 1
REACH: 1 RS: 645

INPUT
Description: Culvert # 4 (4 1.5' Pipes)
Distance from Upstream XS = 0
Deck/Roadway Width = 38
Weir Coefficient = 2.64
Bridge Deck/Roadway Skew =
Upstream Deck/Roadway Coordinates
num= 53

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	66	43.6	7	64	43.6	15	62	43.6
25	60	43.6	40	58	43.6	74	56	43.6
128	54	43.6	160	53	43.6	186	54	43.6
241	55	43.6	286	54	43.6	304	52	43.6
321	50	43.6	421	50	43.6	438	52	43.6
445	52	43.6	453	54	43.6	494	56	43.6
504	56.5	43.6	514	56	43.6	555	54	43.6
630	54	43.6	638	56	43.6	645	58	43.6
653	60	43.6	658	60.5	43.6	663	60	43.6
678	58	43.6	688	56	43.6	701	54	43.6
723	54	43.6	738	54.5	43.6	745	54	43.6
765	52	43.6	785	50	43.6	795	52.5	43.6
812	50	43.6	1012	50	43.6	1029	52.5	43.6
1042	52	43.6	1059	53	43.6	1159	53	43.6
1199	52.5	43.6	1229	48	43.6	1307	48	43.6
1337	52.5	43.6	1355	52	43.6	1358	54	43.6
1363	56	43.6	1367	58	43.6	1378	60	43.6
1395	62	43.6	1405	63	43.6			

Upstream Bridge Cross Section Data
Station Elevation Data num= 60

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	66	7	64	15	62	25	60	40	58
74	56	128	54	160	53	186	54	241	55
286	54	304	52.5	321	50	421	50	438	52.5
445	52	453	54	494	56	504	56.5	514	56
555	54	630	54	638	56	645	58	653	60
658	60.5	663	60	678	58	688	56	701	54
723	54	738	54.5	745	54	765	52	785	50
795	52.5	812	50	1012	50	1029	52.5	1042	52
1059	53	1159	53	1199	52.5	1229	48	1256.3	44
1269.7	44	1307	48	1337	52.5	1355	52	1358	54
1363	56	1367	58	1378	60	1395	62	1405	63
1415	62	1425	60	1505	60	1525	62	1535	64

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.035	1229	.025	1307	.035

Bank Sta: Left	Right	Coeff Contr.	Expan.
1229	1307	.6	.8

Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
0	1229	48	1307	1535	48

Downstream Deck/Roadway Coordinates
num= 53

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	66	43.6	7	64	43.6	15	62	43.6
25	60	43.6	40	58	43.6	74	56	43.6
128	54	43.6	160	53	43.6	186	54	43.6
241	55	43.6	286	54	43.6	304	52	43.6
321	50	43.6	421	50	43.6	438	52	43.6
445	52	43.6	453	54	43.6	494	56	43.6
504	56.5	43.6	514	56	43.6	555	54	43.6
630	54	43.6	638	56	43.6	645	58	43.6
653	60	43.6	658	60.5	43.6	663	60	43.6
678	58	43.6	688	56	43.6	701	54	43.6
723	54	43.6	738	54.5	43.6	745	54	43.6
765	52	43.6	785	50	43.6	795	52.5	43.6
812	50	43.6	1012	50	43.6	1029	52.5	43.6
1042	52	43.6	1059	53	43.6	1159	53	43.6
1199	52.5	43.6	1229	48	43.6	1307	48	43.6
1337	52.5	43.6	1355	52	43.6	1358	54	43.6
1363	56	43.6	1367	58	43.6	1378	60	43.6
1395	62	43.6	1405	63	43.6			

Downstream Bridge Cross Section Data
Station Elevation Data num= 60

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	66	7	64	15	62	25	60	40	58
74	56	128	54	160	53	186	54	241	55
286	54	304	52.5	321	50	421	50	438	52.5
445	52	453	54	494	56	504	56.5	514	56
555	54	630	54	638	56	645	58	653	60
658	60.5	663	60	678	58	688	56	701	54
723	54	738	54.5	745	54	765	52	785	50
795	52.5	812	50	1012	50	1029	52.5	1042	52
1059	53	1159	53	1199	52.5	1229	48	1256	43.6
1269.7	43.6	1307	48	1337	52.5	1355	52	1358	54
1363	56	1367	58	1378	60	1395	62	1405	63
1415	62	1425	60	1505	60	1525	62	1535	64

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.035	1229	.025	1307	.035

Bank Sta: Left	Right	Coeff Contr.	Expan.
1229	1307	.6	.8

Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
0	1229	48	1307	1535	48

Upstream Embankment side slope = horiz. to 1.0 vertical
Downstream Embankment side slope = horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .95
Elevation at which weir flow begins = 48
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Culverts = 1

Culvert Name	Shape	Rise	Span
Culvert # 1	Circular	1.5	1.5

FHWA Chart # 1 - Concrete Pipe Culvert
FHWA Scale # 1 - Square edge entrance with headwall
Solution Criteria = Highest U.S. EG

Culvert Upstrm Dist	Length	n Value	Entrance Loss Coef	Exit Loss Coef
0	38	.015	.1	0

Number of Barrels = 4
Upstream Elevation = 44
Centerline Stations

Sta.	Sta.	Sta.	Sta.
1265.75	1267.25	1268.75	1270.25

Downstream Elevation = 43.6
Centerline Stations

Sta.	Sta.	Sta.	Sta.
1265.75	1267.25	1268.75	1270.25

CROSS SECTION RIVER: 1
REACH: 1 RS: 640

INPUT
Description: 640
Station Elevation Data num= 60

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	66	7	64	15	62	25	60	40	58
74	56	128	54	160	53	186	54	241	55
286	54	304	52.5	321	50	421	50	438	52.5
445	52	453	54	494	56	504	56.5	514	56
555	54	630	54	638	56	645	58	653	60
658	60.5	663	60	678	58	688	56	701	54
723	54	738	54.5	745	54	765	52	785	50
795	52.5	812	50	1012	50	1029	52.5	1042	52
1059	53	1159	53	1199	52.5	1229	48	1256	43.6
1269.7	43.6	1307	48	1337	52.5	1355	52	1358	54
1363	56	1367	58	1378	60	1395	62	1405	63
1415	62	1425	60	1505	60	1525	62	1535	64

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.035	1229	.025	1307	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
1229	1307	60	60	75	.6	.8

Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
0	1229	48	1307	1535	48

CROSS SECTION RIVER: 1
REACH: 1 RS: 630

INPUT
Description: 630
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
5	60	20	58	30	56	40	54	120	52
165	50	300	48	420	50	510	50	530	48
540	46	570	43	600	39	630	43	640	44
655	46	670	48	700	50	720	52	730	54
750	56	800	58	870	60	885	62	895	64
910	66	925	66	935	64	950	62	1000	60

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
5	.055	530	.035	700	.055

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
530	700	270	170	180	.6	.8

CROSS SECTION RIVER: 1
REACH: 1 RS: 620

INPUT
Description: 620
Station Elevation Data num= 20

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
45	56	55	58	70	58	80	56	85	54
95	52	110	50	120	48	125	46	145	43
310	39	555	43	580	44	620	46	645	48
675	50	730	52	770	54	900	56	940	58

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
45	.055	120	.035	620	.055

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
120	620	30	100	70	.6	.8

CROSS SECTION RIVER: 1
REACH: 1 RS: 610

INPUT
Description: 610
Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
60	56	70	58	85	58	90	56	100	54
110	52	120	50	130	48	140	46	150	43
200	39	450	43	490	44	510	46	545	48
590	50	630	52	670	54	690	56	705	56
785	56	795	58						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
60	.055	130	.035	510	.055

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
130	510	50	110	60	.6	.8

CROSS SECTION RIVER: 1
REACH: 1 RS: 600

INPUT
Description: 600
Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
25	54	30	52	40	50	50	48	55	46
80	43	130	39	260	43	275	44	300	46
370	46	450	46	480	48	540	50	585	52
600	54	620	56	635	58				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
25	.055	55	.035	370	.055

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
55	370	350	260	70	.6	.8

CROSS SECTION RIVER: 1
REACH: 1 RS: 590

INPUT
Description: 590
Station Elevation Data num= 25

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
5	68	10	66	15	64	20	62	30	60
60	58	65	56	160	54	190	52	200	50
210	48	230	44	235	43	290	39	315	43
330	44	770	46	840	46	940	46	970	48
990	50	1000	52	1015	54	1035	56	1050	58

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
5	.055	210	.035	840	.055

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
210	840	100	80	100	.6	.8

CROSS SECTION RIVER: 1
REACH: 1 RS: 580

INPUT
Description: 580
Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	68	25	62	50	66	80	56	85	55

120	55	158	54	165	53	197	53	206	52
255	51.5	300	47	332.3	43	345.7	43	378	47
398	49	758	49	783	51.5	808	52	898	54
905	56	917	58						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.035	300	.025	378	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
300	378	38	38	38	.6	.8

Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
0	300	47	378	917	47

CULVERT RIVER: 1
REACH: 1 RS: 575

INPUT
Description: Culvert # 3 (4 1.5' Pipes)
Distance from Upstream XS = 0
Deck/Roadway Width = 38
Weir Coefficient = 2.64
Bridge Deck/Roadway Skew =
Upstream Deck/Roadway Coordinates
num= 20

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	68	42.6	25	62	42.6	50	66	42.6
80	56	42.6	85	55	42.6	120	55	42.6
158	54	42.6	165	53	42.6	197	53	42.6
206	52	42.6	255	51.5	42.6	300	47	42.6
378	47	42.6	398	49	42.6	758	49	42.6
783	51.5	42.6	808	52	42.6	898	54	42.6
905	56	42.6	917	58	42.6			

Upstream Bridge Cross Section Data
Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	68	25	62	50	66	80	56	85	55
120	55	158	54	165	53	197	53	206	52
255	51.5	300	47	332.3	43	345.7	43	378	47
398	49	758	49	783	51.5	808	52	898	54
905	56	917	58						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.035	300	.025	378	.035

Bank Sta: Left	Right	Coeff Contr.	Expan.
300	378	.6	.8

Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
0	300	47	378	917	47

Downstream Deck/Roadway Coordinates
num= 20

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	68	42.6	25	62	42.6	50	66	42.6
80	56	42.6	85	55	42.6	120	55	42.6
158	54	42.6	165	53	42.6	197	53	42.6
206	52	42.6	255	51.5	42.6	300	47	42.6
378	47	42.6	398	49	42.6	758	49	42.6
783	51.5	42.6	808	52	42.6	898	54	42.6
905	56	42.6	917	58	42.6			

Downstream Bridge Cross Section Data
Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	68	25	62	50	66	80	56	85	55
120	55	158	54	165	53	197	53	206	52
255	51.5	300	47	332.3	42.6	345.7	42.6	378	47
398	49	758	49	783	51.5	808	52	898	54
905	56	917	58						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.035	300	.025	378	.035

Bank Sta: Left	Right	Coeff Contr.	Expan.
300	378	.6	.8

Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
0	300	47	378	917	47

Upstream Embankment side slope = horiz. to 1.0 vertical
Downstream Embankment side slope = horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .95
Elevation at which weir flow begins = 47
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Culverts = 1

Culvert Name	Shape	Rise	Span
Culvert # 1	Circular	1.5	1.5

FHWA Chart # 1 - Concrete Pipe Culvert
FHWA Scale # 1 - Square edge entrance with headwall
Solution Criteria = Highest U.S. EG

Culvert Upstrm Dist	Length	n Value	Entrance Loss Coef	Exit Loss Coef
0	38	.015	.1	0

Number of Barrels = 4
Upstream Elevation = 43
Centerline Stations

Sta.	Sta.	Sta.	Sta.
336.75	338.25	339.75	341.25

Downstream Elevation = 42.6
Centerline Stations

Sta.	Sta.	Sta.	Sta.
336.75	338.25	339.75	341.25

CROSS SECTION RIVER: 1
REACH: 1 RS: 570

INPUT
Description: 570
Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	68	25	62	50	66	80	56	85	55
120	55	158	54	165	53	197	53	206	52
255	51.5	300	47	332.3	42.6	345.7	42.6	378	47
398	49	758	49	783	51.5	808	52	898	54
905	56	917	58						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.035	300	.025	378	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
300	378	110	150	510	.6	.8

Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
0	300	47	378	917	47

CROSS SECTION RIVER: 1
REACH: 1 RS: 560

INPUT
Description: 560
Station Elevation Data num= 29

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1	68	5	66	10	64	15	62	25	64
35	64	50	62	70	60	110	60	150	60
160	58	165	56	175	54	180	52	190	50
205	48	235	46	250	42	260	40	280	39
310	40	320	42	330	44	335	46	345	48
355	50	365	52	375	54	385	56		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1	.055	250	.035	310	.055

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
250	310	160	160	160	.6	.8

CROSS SECTION RIVER: 1

REACH: 1 RS: 550

INPUT
Description: 550
Station Elevation Data num= 27

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1	66	5	62	15	64	25	64	30	62
35	60	45	58	55	56	65	54	140	52
200	50	215	48	225	46	245	44	255	42
265	38	280	37	290	38	300	40	305	42
310	44	315	46	325	48	335	50	340	52
350	54	360	56						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1	.055	255	.035	310	.055

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
255	310	110	110	110	.6	.8

CROSS SECTION RIVER: 1
REACH: 1 RS: 540

INPUT
Description: 540
Station Elevation Data num= 25

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1	66	5	64	10	62	15	62	25	62
30	60	40	58	53	56	60	54	75	52
100	50	130	48	160	46	230	44	240	42
265	38	270	36.5	280	38	285	40	295	42
310	46	320	48	330	50	350	52	360	54

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1	.055	240	.035	285	.055

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
240	285	45	40	45	.6	.8

CROSS SECTION RIVER: 1
REACH: 1 RS: 530

INPUT
Description: 530
Station Elevation Data num= 25

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
5	66	10	64	15	62	20	60	30	58
35	56	40	54	45	52	50	50	55	48
45	46	100	44	165	42	195	40	240	38
260	36	270	38	280	40	290	44	300	46
310	48	320	50	330	52	350	54	360	56

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
5	.055	100	.035	290	.055

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
100	290	190	190	200	.6	.8

CROSS SECTION RIVER: 1
REACH: 1 RS: 520

INPUT
Description: 520
Station Elevation Data num= 26

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
10	66	20	64	30	62	40	60	45	58
50	56	55	54	65	52	75	50	80	48
85	46	90	44	100	42	110	40	125	38
220	36	250	35	265	36	270	38	280	40
290	44	300	46	310	48	320	50	335	52
350	54								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
10	.055	90	.035	280	.055

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
90	280	170	170	170	.6	.8

CROSS SECTION RIVER: 1
REACH: 1 RS: 510

INPUT
Description: 510
Station Elevation Data num= 28

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1	66	5	64	10	62	15	60	20	58
25	56	30	54	35	52	40	50	45	48
50	46	60	44	70	42	75	40	80	38
85	36	245	34	265	34	275	36	290	38
295	40	305	42	310	44	315	46	320	48
325	50	335	52	340	54				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1	.055	70	.035	290	.055

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
70	290	210	210	210	.6	.8

CROSS SECTION RIVER: 1
REACH: 1 RS: 500

INPUT
Description: 500
Station Elevation Data num= 27

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
10	64	15	62	20	60	25	58	30	55
35	54	40	52	45	50	50	48	55	46
60	44	70	42	80	40	85	38	95	36
100	34	240	32	245	34	255	38	265	40
270	42	275	44	280	46	290	48	295	50
315	52	325	54						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
10	.055	85	.035	255	.055

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
85	255	120	110	110	.6	.8

CROSS SECTION RIVER: 1
REACH: 1 RS: 490

INPUT
Description: 490
Station Elevation Data num= 27

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
15	64	30	62	40	60	50	58	60	56
70	54	77	52	85	50	95	48	105	46
115	44	125	42	135	40	145	38	150	36
155	34	190	32	230	31	250	32	260	36
265	38	270	40	275	42	280	44	285	46
290	48	295	50						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
15	.055	150	.035	270	.055

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
150	270	120	120	120	.6	.8

CROSS SECTION RIVER: 1
REACH: 1 RS: 480

INPUT
Description: 480
Station Elevation Data num= 28

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	50	5	48	10	46	20	44	30	42
40	40	50	38	60	36	70	34	80	32
90	30	120	30	300	30	315	30	330	32
340	34	350	36	355	38	370	40	380	42
380	44	400	46	415	48	430	50	460	50

470	48	485	46	490	46

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.055	70	.035	340	.055

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
70	340	210	200	200	.6	.8

CROSS SECTION RIVER: 1
REACH: 1 RS: 470

INPUT
Description: 470
Station Elevation Data num= 29

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
8	48	15	46	25	44	30	42	40	40
55	38	75	36	100	34	165	34	180	36
200	38	220	36	235	34	250	32	260	30
275	28	290	27	560	27	590	28	620	30
660	31	680	32	695	34	710	36	720	38
730	40	740	42	750	44	765	46		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
8	.055	165	.035	660	.055

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
165	660	170	120	30	.6	.8

CROSS SECTION RIVER: 1
REACH: 1 RS: 460

INPUT
Description: 460
Station Elevation Data num= 26

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
5	46	25	44	30	42	40	40	58	38
68	36	95	34	130	32	151	31	170	30
185	28	200	27	480	27	500	28	525	30
580	31	605	32	620	34	635	36	645	38
655	40	662	42	670	44	685	46		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
5	.055	151	.035	580	.055

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
151	580	170	130	130	.6	.8

CROSS SECTION RIVER: 1
REACH: 1 RS: 450

INPUT
Description: 450
Station Elevation Data num= 25

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
10	46	20	44	30	44	75	44	180	42
190	40	200	38	215	36	225	35	235	34
245	32	255	30	265	28	275	27	370	27
382	28	394	30	406	32	486	34	496	36
506	38	518	40	530	42	540	44	555	46

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
10	.055	225	.035	394	.055

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
225	394	70	70	70	.6	.8

CROSS SECTION RIVER: 1
REACH: 1 RS: 440

INPUT
Description: 440
Station Elevation Data num= 26

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
5	48	12	46	25	44	42	46	50	48
55	50	65	51	75	50	85	48	100	46
140	44	190	42	206	40	225	41.5	258.3	36.5
275.3	36.5	285.3	35.5	299	32	327.6	32	341.3	35.5
351.3	36.5	451.3	36.5	484.6	41.5	517.6	42	580.6	44
604.6	46								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
5	.035	285.3	.025	341.3	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
285.3	341.3	38	38	38	.6	.8

Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
5	285.3	35.5	341.3	604.6	35.5

CULVERT RIVER: 1
REACH: 1 RS: 435

INPUT
Description: Culvert # 2 (8 1.5' Pipes)
Distance from Upstream XS = 0
Deck/Roadway Width = 38
Weir Coefficient = 2.64
Bridge Deck/Roadway Skew =
Upstream Deck/Roadway Coordinates
num= 24

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
5	46	31.6	12	44	31.6	25	44	31.6
42	46	31.6	50	48	31.6	55	50	31.6
65	51	31.6	75	50	31.6	85	48	31.6
100	46	31.6	140	44	31.6	190	42	31.6
206	40	31.6	225	41.5	31.6	258	36.5	31.6
275.3	36.5	31.6	285.5	35.5	31.6	341	35.5	31.6
351.3	36.5	31.6	451.3	36.5	31.6	484.6	41.5	31.6
517.6	42	31.6	580	44	31.6	604.6	46	31.6

Upstream Bridge Cross Section Data
Station Elevation Data num= 26

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
5	48	12	46	25	44	42	46	50	48
55	50	65	51	75	50	85	48	100	46
140	44	190	42	206	40	225	41.5	258.3	36.5
275.3	36.5	285.3	35.5	299	32	327.6	32	341.3	35.5
351.3	36.5	451.3	36.5	484.6	41.5	517.6	42	580.6	44
604.6	46								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
5	.035	285.3	.025	341.3	.035

Bank Sta: Left	Right	Coeff Contr.	Expan.
285.3	341.3	.6	.8

Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
5	285.3	35.5	341.3	604.6	35.5

Downstream Deck/Roadway Coordinates
num= 24

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
5	46	31.6	12	44	31.6	25	44	31.6
42	46	31.6	50	48	31.6	55	50	31.6
65	51	31.6	75	50	31.6	85	48	31.6
100	46	31.6	140	44	31.6	190	42	31.6
206	40	31.6	225	41.5	31.6	258	36.5	31.6
275.3	36.5	31.6	285.5	35.5	31.6	341	35.5	31.6
351.3	36.5	31.6	451.3	36.5	31.6	484.6	41.5	31.6
517.6	42	31.6	580	44	31.6	604.6	46	31.6

Downstream Bridge Cross Section Data
Station Elevation Data num= 26

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
5	46	12	44	25	44	42	46	50	48
55	50	65	51	75	50	85	48	100	46
140	44	190	42	206	40	225	41.5	258.3	36.5
275.3	36.5	285.3	35.5	299	31.6	327.6	31.6	341.3	35.5
351.3	36.5	451.3	36.5	484.6	41.5	517.6	42	580.6	44
604.6	46								

```
Manning's n Values          num=      3
     Sta    n Val     Sta    n Val     Sta    n Val
       5     .035   285.3     .025   341.3     .035

Bank Sta: Left   Right    Coeff Contr.   Expan.
        285.3    341.3              .6       .8
Ineffective Flow      num=       2
    Sta L    Sta R    Elev   Sta L   Sta R    Elev
        5    285.3    35.5   341.3   604.6    35.5

Upstream Embankment side slope                  =         horiz. to 1.0 vertical
Downstream Embankment side slope                =         horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =      .95
Elevation at which weir flow begins             =     35.5
Energy head used in spillway design             =
Spillway height used in design                  =
Weir crest shape                                = Broad Crested

Number of Culverts =  1

Culvert Name       Shape       Rise    Span
Culvert # 1      Circular      1.5     1.5
FHWA Chart # 1 - Concrete Pipe Culvert
FHWA Scale # 1 - Square edge entrance with headwall
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    n Value  Entrance Loss Coef   Exit Loss Coef
                  0      38       .015                  .1                0
Number of Barrels =  8
Upstream   Elevation =  32
Centerline Stations
    Sta.     Sta.     Sta.     Sta.     Sta.     Sta.     Sta.     Sta.
  308.05   309.55   311.05   312.55   314.05   315.55   317.05   318.55
Downstream Elevation =  31.6
Centerline Stations
    Sta.     Sta.     Sta.     Sta.     Sta.     Sta.     Sta.     Sta.
  308.05   309.55   311.05   312.55   314.05   315.55   317.05   318.55

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 430

INPUT
Description: 430
Station Elevation Data      num=      26
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       5       46       12       44       25       44       42       46       50       48
      55       50       65       51       75       50       85       48      100       46
     140       44      190       42      206       40      225     41.5    258.3     36.5
   275.3     36.5    285.3     35.5      299     31.6    327.6     31.6    341.3     35.5
   351.3     36.5    451.3     36.5    484.6     41.5    517.6       42    580.6       44
   604.6       46

Manning's n Values          num=      3
     Sta    n Val     Sta    n Val     Sta    n Val
       5     .035   285.3     .025   341.3     .035

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
        285.3    341.3              110      80     110               .6       .8
Ineffective Flow      num=       2
    Sta L    Sta R    Elev   Sta L   Sta R    Elev
        5    285.3    35.5   341.3   604.6    35.5

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 420

INPUT
Description: 420
Station Elevation Data      num=      27
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0       46       10       44       25       44       40       46       50       48
      90       46      100       44      105       42      115       40      120       38
     125       36      127       34      137       32      147       30      150       27
     180       27      195       28      200       30      210       32      215       33
     220       34      265       36      285       38      295       40      305       42
     310       44      325       46

Manning's n Values          num=      3
     Sta    n Val     Sta    n Val     Sta    n Val
       0     .055      50     .035     215     .055

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
           50      215              180     100     110               .6       .8

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 410

INPUT
Description: 410
Station Elevation Data      num=      21
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       5       44       25       42       35       40       45       38       55       36
      65       34       70       32       80       30       85       28       90       27
     235       27      240       28      250       30      260       32      265       34
     270       36      345       38      370       40      390       42      400       44
     420       46

Manning's n Values          num=      3
     Sta    n Val     Sta    n Val     Sta    n Val
       5     .055      70     .035     265     .055

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
           70      265              120     120     120               .6       .8

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 400

INPUT
Description: 400
Station Elevation Data      num=      22
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       5       44       20       44       45       42       70       40       80       38
      90       36      100       34      110       32      118       30      125       28
     132       27      340       27      350       28      355       30      365       32
     375       34      382       36      390       38      398       40      402       42
     410       44      445       46

Manning's n Values          num=      3
     Sta    n Val     Sta    n Val     Sta    n Val
       5     .055     110     .035     355     .055

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
          110      355              270     245     240               .6       .8

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 390

INPUT
Description: 390
Station Elevation Data      num=      21
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       5       44       12       42       20       40       28       38       40       36
      55       34       65       32       70       31       80       30       92       28
     100       27      220       27      230       28      240       30      250       32
     258       34      265       36      272       38      288       40      305       42
     320       44

Manning's n Values          num=      3
     Sta    n Val     Sta    n Val     Sta    n Val
       5     .055      70     .035     250     .055

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
           70      250               30      25      35               .6       .8

CROSS SECTION            RIVER: 1
REACH: 1                     RS: 380

INPUT
Description: 380
Station Elevation Data      num=      14
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       4       44       15       42       22       41       55       36      115       36
     125       35    138.7     31.5    167.3     31.5      181       35      191       36
     261       36      294       41      300       42      308       44

Manning's n Values          num=      3
     Sta    n Val     Sta    n Val     Sta    n Val
       4     .035     125     .025     181     .035
```

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

Left	Right	Left	Channel	Right	Coeff Contr.	Expan.
125	181	38	38	38	.6	.8

Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
4	125	35	181	308	35

CULVERT RIVER: 1
REACH: 1 RS: 375

INPUT
Description: Culvert # 1 (8 1.5' Pipes)
Distance from Upstream XS = 0
Deck/Roadway Width = 38
Weir Coefficient = 2.64
Bridge Deck/Roadway Skew =
Upstream Deck/Roadway Coordinates
num= 12

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
4	44	31.1	15	42	31.1	22	41	31.1
55	36	31.1	115	36	31.1	125	35	31.1
181	35	31.1	191	36	31.1	261	36	31.1
294	41	31.1	300	42	31.1	308	44	31.1

Upstream Bridge Cross Section Data
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
4	44	15	42	22	41	55	36	115	36
125	35	138.7	31.5	167.3	31.5	181	35	191	36
261	36	294	41	300	42	308	44		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
4	.035	125	.025	181	.035

Bank Sta: Left	Right	Coeff Contr.	Expan.
125	181	.6	.8

Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
4	125	35	181	308	35

Downstream Deck/Roadway Coordinates
num= 12

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
4	44	31.1	15	42	31.1	22	41	31.1
55	36	31.1	115	36	31.1	125	35	31.1
181	35	31.1	191	36	31.1	261	36	31.1
294	41	31.1	300	42	31.1	308	44	31.1

Downstream Bridge Cross Section Data
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
4	44	15	42	22	41	55	36	115	36
125	35	138.7	31.1	167.3	31.1	181	35	191	36
261	36	294	41	300	42	308	44		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
4	.035	125	.025	181	.035

Bank Sta: Left	Right	Coeff Contr.	Expan.
125	181	.6	.8

Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
4	125	35	181	308	35

Upstream Embankment side slope = horiz. to 1.0 vertical
Downstream Embankment side slope = horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .95
Elevation at which weir flow begins = 33.7
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Culverts = 1

Culvert Name	Shape	Rise	Span
Culvert # 1	Circular	1.5	1.5

FHWA Chart # 1 - Concrete Pipe Culvert
FHWA Scale # 1 - Square edge entrance with headwall
Solution Criteria = Highest U.S. EG

Culvert	Upstrm Dist	Length	n Value	Entrance Loss Coef	Exit Loss Coef
	0	38	.015	.1	0

Number of Barrels = 8
Upstream Elevation = 31.5
Centerline Stations

Sta.	Sta.	Sta.	Sta.	Sta.	Sta.	Sta.	Sta.
147.75	149.25	150.75	152.25	153.75	155.25	156.75	158.25

Downstream Elevation = 31
Centerline Stations

Sta.	Sta.	Sta.	Sta.	Sta.	Sta.	Sta.	Sta.
147.75	149.25	150.75	152.25	153.75	155.25	156.75	158.25

CROSS SECTION RIVER: 1
REACH: 1 RS: 370

INPUT
Description: 370
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
4	44	15	42	22	41	55	36	115	36
125	35	138.7	31.1	167.3	31.1	181	35	191	36
261	36	294	41	300	42	308	44		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
4	.035	125	.025	181	.035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

Left	Right	Left	Channel	Right	Coeff Contr.	Expan.
125	181	55	20	55	.6	.8

Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
4	125	35	181	308	35

CROSS SECTION RIVER: 1
REACH: 1 RS: 360

INPUT
Description: 360
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
5	44	20	42	25	40	40	38	45	36
58	34	63	32	70	30.5	210	30.5	220	32
235	34	242	36	250	38	265	40	275	42
300	44								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
5	.055	40	.035	250	.055

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

Left	Right	Left	Channel	Right	Coeff Contr.	Expan.
40	250	40	40	40	.3	.5

CROSS SECTION RIVER: 1
REACH: 1 RS: 350

INPUT
Description: 350
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	44	55	42	60	40	65	38	72	36
77	34	83	32	88	30	185	30	190	32
200	34	204	36	208	38	214	40	220	42
228	44								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.055	55	.035	228	.035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

Left	Right	Left	Channel	Right	Coeff Contr.	Expan.
55	228	25	30	25	.3	.5

CROSS SECTION RIVER: 1
REACH: 1 RS: 340

INPUT
Description: 340

Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	42	6.18	40	11.53	38	17.51	36	22.01	34
25.38	32	29.65	30	76.33	29.77	126.64	30	130.41	32
139.71	34	143.61	36	147.35	38	154.49	40	162.87	42

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.025	0	.025	162.87	.025

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	162.87	20	20	20	.3	.5

CROSS SECTION RIVER: 1
REACH: 1 RS: 330

INPUT
Description: 330
Station Elevation Data num= 8

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	45.7	0	29.7	45	29.7	45	41.91	46.5	41.91
46.5	29.7	91.5	29.7	91.5	45.7				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.015	0	.015	91.5	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	91.5	83.25	83.25	83.25	.3	.5

BRIDGE RIVER: 1
REACH: 1 RS: 327.5

INPUT
Description: Bridge # 3
Distance from Upstream XS = 0
Deck/Roadway Width = 83.25
Weir Coefficient = 2.6
Bridge Deck/Roadway Skew =
Upstream Deck/Roadway Coordinates
num= 2

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	46.14	41.91	91.5	46.14	41.91

Upstream Bridge Cross Section Data
Station Elevation Data num= 8

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	45.7	0	29.7	45	29.7	45	41.91	46.5	41.91
46.5	29.7	91.5	29.7	91.5	45.7				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.015	0	.015	91.5	.035

Bank Sta: Left	Right	Coeff Contr.	Expan.
0	91.5	.3	.5

Downstream Deck/Roadway Coordinates
num= 2

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	46.14	41.91	91.5	46.14	41.91

Downstream Bridge Cross Section Data
Station Elevation Data num= 8

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	45.46	0	29.46	45	29.46	45	41.91	46.5	41.91
46.5	29.46	91.5	29.46	91.5	45.46				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.015	0	.015	91.5	.035

Bank Sta: Left	Right	Coeff Contr.	Expan.
0	91.5	.3	.5

Upstream Embankment side slope = horiz. to 1.0 vertical
Downstream Embankment side slope = horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .95

Elevation at which weir flow begins = 46.14
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data
Energy
Selected Low Flow Methods = Energy

High Flow Method
Energy Only

Additional Bridge Parameters
Add Friction component to Momentum
Do not add Weight component to Momentum
Class B flow critical depth computations use critical depth inside the bridge at the downstream end
Criteria to check for pressure flow = Upstream water surface

CROSS SECTION RIVER: 1
REACH: 1 RS: 320

INPUT
Description: 320
Station Elevation Data num= 8

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	45.46	0	29.46	45	29.46	45	41.91	46.5	41.91
46.5	29.46	91.5	29.46	91.5	45.46				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.015	0	.015	91.5	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	91.5	124.17	80	32.97	.3	.5

CROSS SECTION RIVER: 1
REACH: 1 RS: 310

INPUT
Description: 310
Station Elevation Data num= 5

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	45.27	0	29.27	77	29.27	91.5	29.27	91.5	45.27

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.015	0	.015	91.5	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	91.5	82.21	82.21	82.21	.3	.5

CROSS SECTION RIVER: 1
REACH: 1 RS: 300

INPUT
Description: 300
Station Elevation Data num= 5

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	45.08	0	29.08	77	29.08	91.5	29.08	91.5	45.08

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.015	0	.015	91.5	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	91.5	20	20	20	.3	.5

CROSS SECTION RIVER: 1
REACH: 1 RS: 290

INPUT
Description: 290
Station Elevation Data num= 8

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	45.03	0	29.03	45	29.03	45	40.86	46.5	40.86

```
 46.5  29.03   91.5  29.03   91.5  45.03

Manning's n Values          num=      3
     Sta    n Val    Sta    n Val    Sta    n Val
      0     .015      0     .015     91.5   .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
            0     91.5             121.86  121.86  121.86          .1        .1

BRIDGE              RIVER: 1
REACH: 1              RS: 287.5

INPUT
Description: Bridge # 2
Distance from Upstream XS  =       0
Deck/Roadway Width         =   121.86
Weir Coefficient           =      2.6
Bridge Deck/Roadway Skew   =
Upstream  Deck/Roadway Coordinates
    num=       2
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
      0   46.08   40.86      91.5   46.08   40.86

Upstream Bridge Cross Section Data
Station Elevation Data      num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      0    45.03      0    29.03      45   29.03      45   40.86    46.5   40.86
    46.5   29.03    91.5   29.03    91.5   45.03

Manning's n Values          num=      3
     Sta    n Val    Sta    n Val    Sta    n Val
      0     .015      0     .015     91.5   .035

Bank Sta: Left   Right    Coeff Contr.   Expan.
            0     91.5          .1         .1

Downstream  Deck/Roadway Coordinates
    num=       2
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
      0   46.08   40.86      91.5   46.08   40.86

Downstream Bridge Cross Section Data
Station Elevation Data      num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      0    44.74      0    28.74      45   28.74      45   40.86    46.5   40.86
    46.5   28.74    91.5   28.74    91.5   44.74

Manning's n Values          num=      3
     Sta    n Val    Sta    n Val    Sta    n Val
      0     .015      0     .015     91.5   .035

Bank Sta: Left   Right    Coeff Contr.   Expan.
            0     91.5          .1         .1

Upstream Embankment side slope                 =         horiz. to 1.0 vertical
Downstream Embankment side slope               =         horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =      .95
Elevation at which weir flow begins            =   46.08
Energy head used in spillway design            =
Spillway height used in design                 =
Weir crest shape                               = Broad Crested

Number of Bridge Coefficient Sets =  1

Low Flow Methods and Data
        Energy
Selected Low Flow Methods = Energy

High Flow Method
        Energy Only

Additional Bridge Parameters
        Add Friction component to Momentum
        Do not add Weight component to Momentum
        Class B flow critical depth computations use critical depth
            inside the bridge at the downstream end
        Criteria to check for pressure flow = Upstream water surface

CROSS SECTION         RIVER: 1
REACH: 1                RS: 280

INPUT
Description: 280
Station Elevation Data      num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      0    44.74      0    28.74      45   28.74      45   40.86    46.5   40.86
    46.5   28.74    91.5   28.74    91.5   44.74

Manning's n Values          num=      3
     Sta    n Val    Sta    n Val    Sta    n Val
      0     .015      0     .015     91.5   .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
            0     91.5              47.39     80  112.55          .1        .1

CROSS SECTION         RIVER: 1
REACH: 1                RS: 270

INPUT
Description: 270
Station Elevation Data      num=       5
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      0    45.09   33.08   28.55   79.29   28.55  124.29   28.55  156.29   45.02

Manning's n Values          num=      3
     Sta    n Val    Sta    n Val    Sta    n Val
      0     .018      0     .018   156.29   .018

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
            0   156.29              73.92 156.56  228.64          .3        .5

CROSS SECTION         RIVER: 1
REACH: 1                RS: 260

INPUT
Description: 260
Station Elevation Data      num=       5
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      0    44.18      32   28.18     102   28.18     142   28.18     174   44.18

Manning's n Values          num=      3
     Sta    n Val    Sta    n Val    Sta    n Val
      0     .018      0     .018     174    .018

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
            0      174             162.21 180.91  195.02          .3        .5

CROSS SECTION         RIVER: 1
REACH: 1                RS: 250

INPUT
Description: 250
Station Elevation Data      num=       5
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      0    43.75      32   27.75     102   27.75     142   27.75     174   44.5

Manning's n Values          num=      3
     Sta    n Val    Sta    n Val    Sta    n Val
      0     .018      0     .018     174    .018

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
            0      174              89.48 109.03  125.11          .3        .5

CROSS SECTION         RIVER: 1
REACH: 1                RS: 240

INPUT
Description: 240
Station Elevation Data      num=       5
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      0    43.56      0    27.49   97.68   27.49     110   27.49     110   43.49

Manning's n Values          num=      3
     Sta    n Val    Sta    n Val    Sta    n Val
      0     .015      0     .015     110    .035
```

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	110	78.85	93.67	101.8	.3	.5

CROSS SECTION RIVER: 1
REACH: 1 RS: 230

INPUT
Description: 230
Station Elevation Data num= 5

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	43.5	0	27.27	87.13	27.27	110	27.27	110	43.27

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.015	0	.015	110	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	110	109.61	111.91	114.49	.3	.5

CROSS SECTION RIVER: 1
REACH: 1 RS: 220

INPUT
Description: 220
Station Elevation Data num= 5

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	43.01	0	27.01	45	27.01	110	27.01	110	43.01

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.015	0	.015	110	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	110	177.44	180.4	180.82	.3	.5

CROSS SECTION RIVER: 1
REACH: 1 RS: 210

INPUT
Description: 210
Station Elevation Data num= 5

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	42.58	0	26.58	45	26.58	110	26.58	110	42.58

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.015	0	.015	110	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	110	37.84	32.77	25	.3	.5

CROSS SECTION RIVER: 1
REACH: 1 RS: 200

INPUT
Description: 200
Station Elevation Data num= 5

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	42.5	5	26.5	46.25	26.5	113	26.5	118	42.5

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.015	0	.015	118	.015

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	118	178.95	121.02	72.15	.3	.5

CROSS SECTION RIVER: 1
REACH: 1 RS: 190

INPUT
Description: 190
Station Elevation Data num= 5

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	42.25	32.05	26.22	86.05	26.22	135.87	26.22	167.92	42.25

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.018	0	.018	167.92	.018

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	167.92	33.94	28.66	25.2	.3	.5

CROSS SECTION RIVER: 1
REACH: 1 RS: 180

INPUT
Description: 180
Station Elevation Data num= 5

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	42.15	32	26.15	87	26.15	137	26.15	169	42.15

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.018	0	.018	169	.018

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	169	20	20	20	.3	.5

CROSS SECTION RIVER: 1
REACH: 1 RS: 170

INPUT
Description: 170
Station Elevation Data num= 45

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	42.1	6.8	38.7	6.8	40	8.3	40	8.3	37.95
23.3	30.45	23.3	40	24.8	40	24.8	29.7	32	26.1
39.9	26.1	39.9	40	41.4	40	41.4	26.1	56.3	26.1
56.3	40	57.8	40	57.8	26.1	72.7	26.1	72.7	40
74.2	40	74.2	26.1	87	26.1	89.1	26.1	89.1	40
90.6	40	90.6	26.1	105.4	26.1	105.4	40	106.9	40
106.9	26.1	121.5	26.1	121.5	40	123	40	123	26.1
137	26.1	137.9	26.55	137.9	40	139.4	40	139.4	27.3
154.1	34.65	154.1	40	155.6	40	155.6	35.4	169	42.1

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.018	0	.018	169	.018

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	169	27.13	27.13	27.13	.3	.5

BRIDGE RIVER: 1
REACH: 1 RS: 167.5

INPUT
Description: Bridge # 1
Distance from Upstream XS = 0
Deck/Roadway Width = 27.13
Weir Coefficient = 2.6
Bridge Deck/Roadway Skew =
Upstream Deck/Roadway Coordinates
num= 2

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	42.83	40.08	169	42.83	40.08

Upstream Bridge Cross Section Data
Station Elevation Data num= 45

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	42.1	6.8	38.7	6.8	40	8.3	40	8.3	37.95
23.3	30.45	23.3	40	24.8	40	24.8	29.7	32	26.1
39.9	26.1	39.9	40	41.4	40	41.4	26.1	56.3	26.1
56.3	40	57.8	40	57.8	26.1	72.7	26.1	72.7	40
74.2	40	74.2	26.1	87	26.1	89.1	26.1	89.1	40
90.6	40	90.6	26.1	105.4	26.1	105.4	40	106.9	40
106.9	26.1	121.5	26.1	121.5	40	123	40	123	26.1
137	26.1	137.9	26.55	137.9	40	139.4	40	139.4	27.3
154.1	34.65	154.1	40	155.6	40	155.6	35.4	169	42.1

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.018	0	.018	169	.018

Bank Sta: Left	Right	Coeff Contr.	Expan.
0	169	.3	.5

Downstream Deck/Roadway Coordinates

num= 2

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	42.83	40	169	42.83	40

Downstream Bridge Cross Section Data

Station Elevation Data num= 45

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	42.1	6.8	38.7	6.8	40	8.3	40	8.3	37.95
23.3	30.45	23.3	40	24.8	40	24.8	29.7	32	26.1
39.9	26.1	39.9	40	41.4	40	41.4	26.1	56.3	26.1
56.3	40	57.8	40	57.8	26.1	72.7	26.1	72.7	40
74.2	40	74.2	26.1	87	26.1	89.1	26.1	89.1	40
90.6	40	90.6	26.1	105.4	26.1	105.4	40	106.9	40
106.9	26.1	121.5	26.1	121.5	40	123	40	123	26.1
137	26.1	137.9	26.55	137.9	40	139.4	40	139.4	27.3
154.1	34.65	154.1	40	155.6	40	155.6	35.4	169	42.1

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.018	0	.018	169	.018

Bank Sta: Left	Right	Coeff Contr.	Expan.
0	169	.3	.5

Upstream Embankment side slope = horiz. to 1.0 vertical
Downstream Embankment side slope = horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .95
Elevation at which weir flow begins = 42.83
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data
Energy
Selected Low Flow Methods = Energy

High Flow Method
Energy Only

Additional Bridge Parameters
Add Friction component to Momentum
Do not add Weight component to Momentum
Class B flow critical depth computations use critical depth
inside the bridge at the downstream end
Criteria to check for pressure flow = Upstream water surface

CROSS SECTION RIVER: 1
REACH: 1 RS: 160

INPUT
Description: 160
Station Elevation Data num= 45

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	42.1	6.8	38.7	6.8	40	8.3	40	8.3	37.95
23.3	30.45	23.3	40	24.8	40	24.8	29.7	32	26.1
39.9	26.1	39.9	40	41.4	40	41.4	26.1	56.3	26.1
56.3	40	57.8	40	57.8	26.1	72.7	26.1	72.7	40
74.2	40	74.2	26.1	87	26.1	89.1	26.1	89.1	40
90.6	40	90.6	26.1	105.4	26.1	105.4	40	106.9	40
106.9	26.1	121.5	26.1	121.5	40	123	40	123	26.1
137	26.1	137.9	26.55	137.9	40	139.4	40	139.4	27.3
154.1	34.65	154.1	40	155.6	40	155.6	35.4	169	42.1

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.018	0	.018	169	.018

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	169	80	80	80	.3	.5

CROSS SECTION RIVER: 1
REACH: 1 RS: 150

INPUT
Description: 150

Station Elevation Data num= 5

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	42.06	32	26.06	87	26.06	137	26.06	169	42.06

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.033	0	.033	169	.033

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	169	50	50	50	.3	.5

CROSS SECTION RIVER: 1
REACH: 1 RS: 140

INPUT
Description: 140
Station Elevation Data num= 76

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
30	41.9	100	40.9	190	40	260	40	270	41.2
350	41.2	365	40	425	40	445	41.6	525	41.6
600	39	610	40	660	40.7	690	41.6	710	41.6
730	41.5	740	42.3	820	42.3	850	40	865	38.9
890	40	980	42	1015	42.2	1020	41.8	1060	40.4
1080	40.5	1100	40.3	1130	40	1165	40	1210	40.8
1255	40.9	1290	41.1	1400	42	1490	42	1510	40.9
1580	42	1620	43.2	1730	42	1820	41.9	1920	41
1945	42	2000	41	2050	42	2135	44	2190	44.6
2290	43	2400	43.5	2480	43	2600	42	2670	42
2680	38	2686	36	2730	34	2738	32	2774	32
2798	42	2816	44	2820	44	2830	26	2856	26
2878	26	2882	26	2898	26	2905	26	2915	26
2945	26	3045	26	3065	26	3210	26	3220	40
3280	35	3360	35	3400	40	3420	42	3470	42
3970	41.8								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
30	.055	2820	.035	3220	.055

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
2820	3220	.1	.1	.1	.6	.8

Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
30	2820	44	3220~	3970	40

EASTKAP2.PRJ PLATE 6 FLOWS: MIXED FLOW REGIMES 5-5-98

HEC-RAS Plan: Kaloi River: 1 Reach: 1

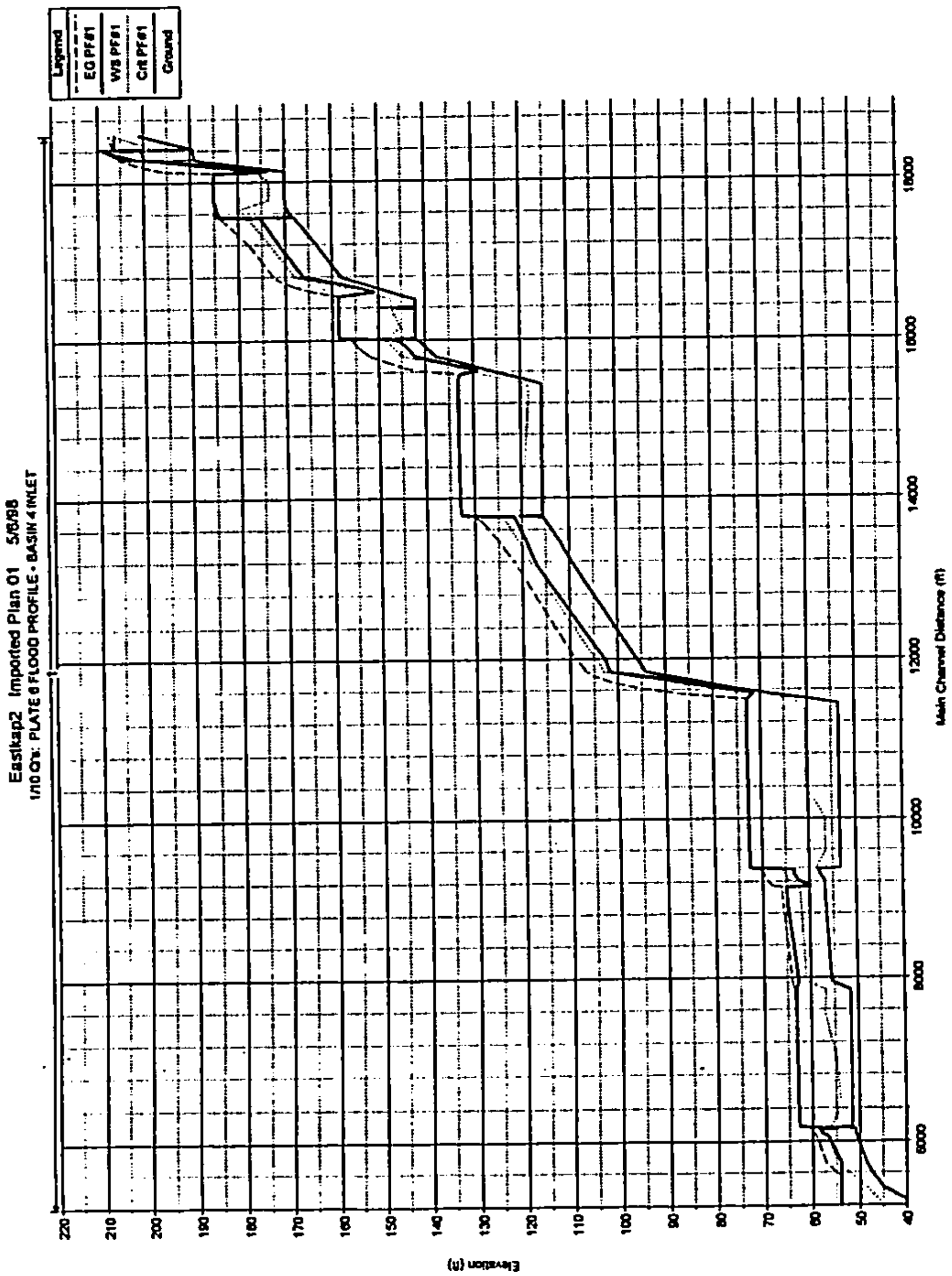
Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	Length Chnl (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	1160	5300.00	200.79	165.00	206.37	206.37	207.57	0.013574	8.79	603.29	254.80	1.01
1	1150	5300.00	189.50	0.00	206.45	198.06	206.84	0.000111	5.07	1234.51	360.01	0.26
1	1145	Bridge										
1	1140	5300.00	189.00	25.40	198.81	199.82	205.06	0.004244	20.40	259.78	27.02	1.16
1	1135	5900.00	187.00	25.40	193.83	196.92	203.75	0.024910	25.53	231.08	40.82	1.89
1	1134	5900.00	183.72	50.80	189.71	193.65	202.46	0.033912	28.68	205.88	38.24	2.18
1	1132	5900.00	177.18	56.75	182.14	186.63	199.77	0.057441	33.69	175.12	40.77	2.86
1	1130	5900.00	170.00	20.00	173.80	178.23	195.47	0.087482	37.36	157.93	49.18	3.87
1	1125	5900.00	170.00	108.00	184.92	175.95	185.19	0.000407	4.17	1414.54	124.66	0.22
1	1120	5900.00	170.00	240.00	185.05	173.40	185.11	0.000068	2.01	3119.63	313.03	0.09
1	1118	5900.00	170.00	118.00	185.03	173.39	185.09	0.000072	2.00	3114.56	312.68	0.10
1	1117	5900.00	169.82	65.00	184.42	179.65	185.01	0.001150	6.78	1187.34	312.44	0.36
1	1115	5900.00	168.53	10.00	184.04	178.56	184.90	0.000850	7.46	783.03	93.37	0.42
1	1110	5900.00	176.00	10.00	181.86	181.86	184.69	0.005431	13.61	438.79	77.42	1.00
1	1105	5900.00	168.00	45.75	175.20	178.00	184.01	0.020149	23.82	247.66	48.80	1.86
1	1100	5900.00	167.42	355.00	174.81	177.42	182.94	0.018076	22.88	257.88	49.78	1.77
1	1095	5900.00	162.65	350.00	170.73	172.65	177.05	0.012778	20.18	292.41	52.37	1.50
1	1090	5900.00	158.00	40.00	166.02	168.00	172.49	0.013185	20.42	288.93	52.07	1.53
1	1088	5900.00	155.84	30.00	161.58	164.93	171.47	0.023484	24.72	238.68	51.17	2.02
1	1087	5900.00	154.20	60.00	159.32	162.57	170.47	0.032528	26.80	220.14	53.37	2.32
1	1085	5900.00	150.92	60.00	154.77	158.15	167.88	0.048350	29.05	203.08	60.40	2.79
1	1084	5900.00	147.64	60.00	150.74	153.97	164.41	0.063967	29.67	198.86	70.27	3.11
1	1082	5900.00	144.35	44.00	158.58	150.04	158.86	0.000219	4.21	1401.13	128.91	0.22
1	1080	5900.00	142.00	20.00	158.67	147.28	158.81	0.000084	3.03	2107.48	183.59	0.14
1	1078	5900.00	142.00	70.00	158.68	147.28	158.83	0.000079	2.87	2210.65	194.41	0.14
1	1077	5900.00	142.00	10.00	158.67	147.26	158.80	0.000074	2.92	2191.77	339.20	0.14
1	1075	5900.00	147.00	10.00	158.63	150.83	158.79	0.000148	3.42	1859.83	525.10	0.19
1	1070	5900.00	142.00	235.00	158.66	147.32	158.78	0.000064	2.71	2425.82	564.92	0.13
1	1060	5900.00	147.00	128.00	158.64	145.29	158.73	0.000053	1.68	3148.22	620.66	0.06
1	1055	5900.00	142.00	10.00	158.52	147.82	158.71	0.000113	3.48	1745.48	170.00	0.18
1	1050	5900.00	147.00	10.00	154.55	154.55	158.34	0.006640	15.63	377.45	60.00	1.00
1	1045	5900.00	142.00	25.00	146.72	149.55	158.42	0.028128	25.00	236.03	50.00	2.03
1	1040	5900.00	141.08	94.50	145.28	148.22	155.71	0.015083	25.94	227.43	82.74	2.40
1	1035	5900.00	139.44	94.50	143.59	146.58	154.22	0.015458	26.18	225.57	87.62	2.43
1	1030	5900.00	137.80	78.00	142.11	145.02	151.98	0.031881	25.21	234.07	58.62	2.27
1	1025	5900.00	132.87	58.00	136.27	139.39	148.28	0.049815	27.79	212.30	65.81	2.73
1	1020	6000.00	129.25	46.00	137.22	135.34	144.98	0.061517	28.67	209.31	73.53	2.99
1	1015	6000.00	126.31	50.00	129.04	132.05	141.91	0.068267	28.80	208.35	79.14	3.13
1	1012	6000.00	123.00	62.33	132.77	127.92	133.24	0.000529	5.63	1142.87	151.49	0.33
1	1010	6000.00	118.90	55.00	133.03	122.79	133.12	0.000070	2.30	2607.00	250.68	0.13
1	1005	6000.00	115.47	60.00	133.06	118.74	133.10	0.000020	1.61	3738.65	338.16	0.07
1	1000	6000.00	115.47	165.00	133.08	118.26	133.09	0.000011	1.09	5507.00	425.35	0.05
1	990	6000.00	115.47	284.00	133.08	118.25	133.09	0.000020	1.02	5900.92	461.07	0.05
1	985	6000.00	115.47	300.00	133.07	118.56	133.09	0.000025	1.13	5310.11	429.34	0.06
1	980	6000.00	115.47	300.00	133.05	118.94	133.08	0.000034	1.27	4738.83	398.83	0.06
1	975	6000.00	115.47	392.00	133.03	118.41	133.06	0.000044	1.42	4232.12	367.84	0.07
1	970	6000.00	115.47	106.00	132.99	118.90	133.04	0.000058	1.84	3288.34	349.24	0.09
1	960	6000.00	115.47	65.00	132.82	119.95	133.03	0.000068	2.71	2214.72	335.90	0.12
1	958	6000.00	115.47	10.00	132.70	122.40	133.00	0.000180	4.44	1351.24	108.38	0.20
1	957	6000.00	120.47	10.00	128.11	128.11	131.84	0.006627	15.71	381.91	50.00	1.00
1	955	6000.00	115.47	54.60	121.50	124.10	130.33	0.020905	23.85	251.59	60.00	1.87
1	950	6000.00	114.63	526.70	121.11	123.49	128.87	0.018043	21.99	272.86	58.87	1.77
1	945	6150.00	109.26	1168.00	117.06	118.04	121.48	0.008396	16.86	364.78	83.48	1.24
1	940	6150.00	95.96	180.00	102.78	104.69	108.90	0.013647	19.96	308.07	80.22	1.56
1	930	6150.00	84.00	60.00	101.61	102.88	106.57	0.009613	17.88	343.95	80.40	1.32
1	929	6150.00	84.56	70.75	93.19	98.48	104.89	0.036772	27.44	224.10	57.80	2.48
1	928	6150.00	82.02	70.75	85.54	89.20	101.15	0.064548	31.71	193.97	62.08	3.18
1	927	6150.00	75.50	70.75	78.37	81.97	95.61	0.084778	33.33	184.54	70.14	3.62
1	926	6150.00	68.90	81.43	71.39	74.81	88.64	0.103825	33.36	184.34	78.68	3.85
1	925	6150.00	58.51	50.00	72.76	63.93	73.01	0.000190	4.01	1534.61	134.59	0.21
1	923	6150.00	53.51	154.00	72.88	60.67	72.95	0.000049	2.00	2945.83	253.28	0.11
1	920	6150.00	53.31	300.00	72.89	60.48	72.93	0.000038	1.66	3705.98	358.16	0.08
1	910	6150.00	53.31	593.00	72.88	60.48	72.92	0.000078	1.52	4042.85	488.33	0.08
1	900	6150.00	53.31	381.00	72.78	60.49	72.85	0.000159	2.12	2903.28	362.24	0.13
1	890	6150.00	53.31	476.11	72.80	56.45	72.82	0.000019	0.90	6853.12	646.78	0.05
1	880	6150.00	53.31	189.27	72.77	56.45	72.80	0.000027	1.48	4147.84	823.82	0.06
1	875	6150.00	53.31	10.00	72.64	58.48	72.79	0.000083	3.01	2045.86	838.50	0.13
1	870	7400.00	58.31	10.00	67.09	67.09	71.50	0.008875	18.85	439.18	50.00	1.00

HEC-RAS Plan: Kaloi River: 1 Reach: 1

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	Length Chnl (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	860	7400.00	58.20	39.00	63.20	65.48	70.55	0.007052	21.76	340.10	78.04	1.84
1	850	7400.00	57.80	100.00	63.36	65.38	69.87	0.006875	20.48	361.38	78.04	1.68
1	840	7400.00	56.80	71.00	62.43	64.51	69.14	0.006483	20.78	356.07	74.42	1.67
1	835	7400.00	54.73	0.50	59.78	62.06	68.00	0.013500	23.04	321.20	111.87	2.40
1	830	7400.00	54.73	20.00	59.78	62.06	68.01	0.037803	23.06	320.93	111.97	2.40
1	829	7400.00	56.70	20.00	64.89	62.03	65.90	0.001231	7.87	964.57	132.72	0.50
1	827	7400.00	56.69	220.00	64.96	62.02	65.88	0.001240	7.89	962.15	132.84	0.50
1	820	7400.00	56.47	940.00	64.68	61.80	65.60	0.001284	7.78	950.72	132.18	0.51
1	810	7400.00	55.50	100.00	62.58	60.96	63.98	0.002277	9.44	780.47	124.34	0.67
1	805	7400.00	51.50	180.00	63.18	56.91	63.56	0.000676	4.84	1623.50	159.73	0.28
1	800	7400.00	51.50	76.51	63.18	56.90	63.42	0.000589	3.95	1875.08	234.87	0.25
1	790	7400.00	51.50	82.72	63.16	57.02	63.37	0.000515	3.64	2035.87	272.77	0.23
1	780	7400.00	51.50	556.70	63.15	57.07	63.33	0.000492	3.45	2143.10	301.05	0.23
1	770	7400.00	51.50	567.69	63.06	54.76	63.14	0.000176	2.05	3608.73	513.80	0.14
1	760	7400.00	51.50	255.70	63.01	54.12	63.07	0.000083	2.02	3660.26	639.92	0.11
1	755	7400.00	51.50	10.00	62.71	58.03	63.00	0.000518	4.33	1709.18	174.86	0.24
1	750	7400.00	54.50	10.00	59.70	59.70	62.30	0.005836	12.94	571.88	110.00	1.00
1	740	7400.00	50.85	20.83	54.58	58.52	61.03	0.022871	20.38	363.04	104.90	1.93
1	730	7400.00	50.85	41.04	58.56	58.53	59.85	0.001923	9.10	812.79	120.85	0.62
1	720	7400.00	60.85	40.00	57.95	56.73	58.66	0.001024	10.51	704.34	113.40	0.74
1	710	7400.00	50.50	350.00	56.60	56.60	59.31	0.001848	13.21	560.00	103.80	1.00
1	700	7400.00	48.50	140.00	53.92	54.99	57.22	0.030632	15.07	570.87	278.09	1.56
1	690	7400.00	47.00	150.00	64.06	51.88	54.38	0.001468	4.87	1887.34	447.13	0.37
1	680	7550.00	45.00	150.00	54.01	48.77	54.13	0.000284	2.85	3272.96	620.35	0.18
1	670	7550.00	40.00	125.00	54.00	46.06	54.04	0.000073	1.70	5198.26	655.04	0.09
1	660	7550.00	40.00	90.00	54.00	44.55	54.03	0.000043	1.37	6048.57	654.96	0.07
1	650	7550.00	44.00	38.00	53.21	51.95	53.72	0.001025	7.30	2031.45	770.58	0.47
1	645	Culvert										
1	640	7550.00	43.80	60.00	53.22	51.81	53.72	0.000961	7.21	2054.71	771.04	0.46
1	630	7800.00	38.00	170.00	53.25	47.93	53.41	0.000418	3.89	3144.12	654.18	0.22
1	620	7800.00	38.00	100.00	53.28	43.21	53.29	0.000035	1.28	6312.64	666.51	0.07
1	610	7800.00	38.00	110.00	53.23	43.75	53.27	0.000060	1.60	4952.81	550.71	0.09
1	600	7800.00	39.00	280.00	53.20	44.85	53.25	0.000102	2.04	4480.87	548.98	0.11
1	590	7800.00	39.00	80.00	53.19	46.24	53.21	0.000052	1.28	8505.90	838.87	0.08
1	580	7800.00	43.00	38.00	52.73	50.84	53.03	0.000802	5.85	2375.80	841.89	0.36
1	575	Culvert										
1	570	7800.00	42.80	150.00	52.73	50.81	53.03	0.000575	5.82	2383.37	841.83	0.36
1	560	7800.00	39.00	160.00	51.69	47.27	52.81	0.001351	8.13	1328.31	181.91	0.41
1	550	7700.00	37.00	110.00	48.82	47.68	51.12	0.005025	13.27	707.52	117.69	0.76
1	540	7700.00	36.50	40.00	48.02	48.02	50.45	0.008112	14.20	840.44	180.44	0.83
1	530	7700.00	38.00	180.00	42.44	44.21	48.01	0.048483	18.94	408.53	135.49	1.93
1	520	7700.00	36.00	170.00	43.97	40.91	44.58	0.001748	6.18	1290.78	189.75	0.43
1	510	7700.00	34.00	210.00	43.89	38.57	44.14	0.000523	4.04	1851.44	249.14	0.24
1	500	7700.00	32.00	110.00	43.73	37.42	44.01	0.000474	4.33	1808.20	212.84	0.24
1	490	7700.00	31.00	120.00	43.23	37.74	43.78	0.000908	6.02	1360.85	159.25	0.33
1	480	7700.00	30.00	200.00	43.31	33.20	43.37	0.000081	2.11	3026.53	358.53	0.10
1	470	8000.00	27.00	120.00	43.31	29.78	43.33	0.000017	1.03	8729.34	719.83	0.05
1	460	8350.00	27.00	130.00	43.30	29.83	43.32	0.000019	1.14	8335.63	640.47	0.05
1	450	8350.00	27.00	70.00	43.17	32.27	43.27	0.000114	2.72	2954.64	417.38	0.12
1	440	8350.00	32.00	38.00	42.01	39.96	42.82	0.001249	9.10	1527.41	328.30	0.53
1	435	Culvert										
1	430	8350.00	31.80	80.00	42.02	39.81	42.82	0.001175	8.00	1548.24	328.83	0.52
1	420	8350.00	27.00	100.00	41.99	35.87	42.48	0.000884	6.97	1690.52	199.83	0.32
1	410	8350.00	27.00	120.00	42.04	31.48	42.15	0.000128	2.79	3504.66	365.00	0.13
1	400	8350.00	27.00	245.00	42.04	30.52	42.11	0.000074	2.19	4205.80	357.61	0.10
1	390	8350.00	27.00	25.00	41.91	31.78	42.04	0.000152	3.08	3105.27	291.84	0.14
1	380	8350.00	31.50	38.00	40.20	39.38	41.40	0.002182	10.87	1195.47	281.43	0.68
1	375	Culvert										
1	370	8350.00	31.10	20.00	39.79	39.32	41.23	0.002811	11.73	1108.15	254.01	0.74
1	360	8350.00	30.50	40.00	39.87	35.01	40.32	0.000750	4.75	1780.97	239.58	0.29
1	350	8350.00	30.00	30.00	39.33	35.75	40.14	0.001843	7.20	1159.78	150.34	0.46
1	340	8350.00	29.77	20.00	39.18	35.74	40.07	0.001089	7.54	1107.84	143.28	0.48
1	330	8350.00	28.70	0.00	37.32	36.12	39.62	0.001484	12.17	686.12	80.00	0.78
1	327.5	Bridge										
1	320	8350.00	28.46	80.00	37.25	35.88	39.45	0.001390	11.90	701.41	90.00	0.75
1	310	8500.00	29.27	82.21	37.19	35.70	39.33	0.001100	11.73	724.47	81.50	0.73
1	300	8500.00	29.08	20.00	37.14	35.51	39.20	0.001042	11.83	737.12	81.50	0.72
1	290	8500.00	29.03	0.00	35.54	35.54	38.81	0.002474	14.50	684.02	80.00	1.00

HEC-RAS Plan: Kaloi River: 1 Reach: 1

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	Length Chnl (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	287.5	Bridge										
1	280	8500.00	28.74	80.00	35.26	35.26	38.52	0.002465	14.49	646.77	80.00	1.00
1	270	8500.00	28.85	154.56	33.42	34.70	38.07	0.006186	17.30	491.30	110.43	1.45
1	260	8500.00	28.18	180.91	35.68	33.68	36.95	0.000990	9.07	936.89	139.86	0.62
1	250	8500.00	27.75	109.03	35.56	33.25	36.73	0.000862	8.68	978.72	140.55	0.58
1	240	8500.00	27.49	93.87	34.60	33.18	36.43	0.001036	10.87	781.83	110.00	0.72
1	230	8500.00	27.27	111.91	34.55	32.96	36.30	0.000962	10.62	800.35	110.00	0.69
1	220	8500.00	27.01	180.40	34.49	32.71	36.15	0.000841	10.33	822.78	110.00	0.67
1	210	8500.00	26.58	32.77	34.42	32.28	35.93	0.000761	9.86	861.90	110.00	0.62
1	200	8500.00	26.50	121.02	34.41	32.22	35.84	0.000717	8.72	874.07	112.95	0.62
1	190	8800.00	26.22	28.66	34.43	32.04	35.67	0.000665	8.81	967.78	136.67	0.58
1	180	8800.00	26.15	20.00	34.43	31.94	35.62	0.000623	8.74	1007.04	138.14	0.57
1	170	8800.00	26.10	0.00	33.82	32.28	35.41	0.003230	10.73	820.00	123.09	0.73
1	167.5	Bridge										
1	160	8800.00	26.10	80.00	33.25	32.29	35.25	0.003744	11.37	774.29	121.60	0.78
1	150	8800.00	26.06	50.00	33.03	31.84	34.78	0.004989	10.61	829.56	132.90	0.75
1	140	8800.00	26.00		33.80	28.55	33.83	0.000323	2.93	3002.83	437.42	0.18



KALOI CHANNEL IMPROVEMENTS - PLATE 6 FLOOD PROFILE
(SECTIONS 140 TO 730 FROM EWA VILLAGES DRAINAGE MASTER PLAN, Rev. 3/97)
SUMMARY OF CROSS SECTIONS – NO RR BRIDGE

C	114	
C	140	GENTRY SUBDIVISION (Q=8800)
C	150	DOWNSTR. ~~FACE OF BRIDGE AT~~ OR&L ROW OR&L RAILROAD CENTER LINE
C	160	~~DOWNSTR. EDGE OF BRIDGE AT OR&L ROW~~
~~C~~	~~170~~	~~UPSTR. EDGE OF BRIDGE AT OR&L ROW~~ OMIT
~~C~~	~~180~~	~~UPSTR. FACE OF BRIDGE AT OR&L ROW (CHANNEL)~~ OMIT
C	190	CHANNEL SECTION
C	200	SECTION LEFT TRANSITION FROM CONC TO CRM RIGHT CRM (Q=8500)
C	210	SECTION LEFT CONC RIGHT TRAN FROM CONC TO CRM
C	220	SECTION LEFT TRAN FROM CONC TO CRM RIGHT CONC
C	230	SECTION LEFT CRM RIGHT CONC
C	240	SECTION LEFT CRM RIGHT TRAN CONC TO CRM
C	250	SECTION CRM LEFT AND RIGHT
C	260	SECTION CHANNEL WIDEST POINT CRM LEFT AND RIGHT
C	270	DOWNSTR. FACE OF BRIDGE AT N-S ROAD (CHANNEL)
C	280	DOWNSTR. EDGE OF BRIDGE AT N-S ROAD
C	290	UPSTR. EDGE OF BRIDGE AT N-S ROAD
C	300	UPSTR. FACE OF BRIDGE AT N-S ROAD (CHANNEL)
C	310	DOWNSTR. FACE OF BRIDGE AT RENTON ROAD (CHANNEL)
C	320	DOWNSTR. EDGE OF BRIDGE AT RENTON ROAD (Q=8350)
C	330	UPSTR. EDGE OF BRIDGE AT RENTON ROAD
C	340	UPSTR. FACE OF BRIDGE AT RENTON ROAD (GOLF COURSE)
C	350	GOLF COURSE CHANNEL
C	360	GOLF COURSE CHANNEL
C	370	BASIN #4 CULVERT OUTLET
C	380	BASIN #4 CULVERT INLET
C	390	GOLF COURSE CHANNEL
C	400	GOLF COURSE CHANNEL
C	410	#4 TA
C	420	GOLF COURSE CHANNEL
C	430	BASIN #3 CULVERT OUTLET
C	440	BASIN #3 CULVERT INLET
C	450	GOLF COURSE CHANNEL
C	460	GOLF COURSE CHANNEL
C	470	GOLF COURSE CHANNEL (Q=8000)
C	480	GOLF COURSE CHANNEL (Q=7700)
C	490	GOLF COURSE CHANNEL
C	500	GOLF COURSE CHANNEL
C	510	GOLF COURSE CHANNEL
C	520	GOLF COURSE CHANNEL
C	530	GOLF COURSE CHANNEL
C	540	GOLF COURSE CHANNEL
C	550	#4 GREEN
C	560	GOLF COURSE CHANNEL (Q=7600)
C	570	BASIN #2 CULVERT OUTLET
C	580	BASIN #2 CULVERT INLET
C	590	#5 TA
C	600	#6 GREEN
C	610	GOLF COURSE CHANNEL
C	620	GOLF COURSE CHANNEL
C	630	#6 TB
C	640	BASIN #1 CULVERT OUTLET (Q=7550)
C	650	BASIN #1 CULVERT INLET
C	660	#5 GREEN
C	670	GOLF COURSE CHANNEL
C	680	DRIVING RANGE TB
C	690	GOLF COURSE CHANNEL (Q=7400)
C	700	GOLF COURSE CHANNEL
C	710	DOWNSTREAM OF BRIDGE AT CURVE "A"
C	720	UPSTREAM OF BRIDGE AT CURVE "A"
C	730	CRM CHANNEL SECTION
C	740	SECTION AT BOTTOM OF BERM
C	750	SECTION TOP OF BERM
C	760	SECTION AT FULL WIDTH CHANNEL W/ 2.5% PARK
C	770	SECTION AT FULL WIDTH CHANNEL W/ 2.5% PARK
C	780	TRANSITION CHANNEL SECTION
C	790	TRANSITION CHANNEL SECTION
C	800	TRANSITION CHANNEL SECTION
C	810	CHANNEL SECTION TO POND
C	820	END CRM CHANNEL SECTION
C	830	CRM CHANNEL SECTION
C	840	DOWNSTREAM FACE OF BRIDGE
C	850	UPSTREAM FACE OF BRIDGE
C	855	SECTION THROUGH CRM
C	860	SECTION AT BOTTOM OF BERM, CRM
C	870	SECTION AT TOP OF BERM, CRM
C	880	SECTION THROUGH WIDEST POND SECTION W/ 2.5% PARK (Q=6150)
C	890	SECTION THROUGH TYPICAL CHANNEL SECTION W/ 2.5% PARK
C	900	SECTION THROUGH CHANNEL SECTION W/ 2.5% PARK
C	910	CHANNEL SECTION,THROUGH 2.5% PARK
C	920	TYPICAL CHANNEL SECTION, END CRM & BEGIN PARK
C	925	TYPICAL CHANNEL SECTION, CRM
C	930	BEGIN TYP CHANNEL SECTION, CRM
C	940	END NARROW CRM SECTION
C	945	SECTION, NARROW CRM CHANNEL
C	950	BEGIN NARROW CRM SECTION (BOTTOM OF BERM) (Q=6000)
C	955	TOP OF BERM (RESERVOIR 3)
C	960	SECTION, TRANSITION FROM PARK SECTION TO NARROW CRM SECTION
C	970	TYPICAL PARK SECTION
C	975	TYPICAL PARK SECTION, END CRM
C	977	TYPICAL PARK SECTION AT BOTTOM OF BERM
C	980	TYPICAL PARK SECTION AT TOP OF BERM, BEGIN CRM
C	984	BEGIN TYPICAL PARK SECTION
C	985	SECTION THROUGH POND AND PARK
C	990	SECTION THROUGH POND AND PARK
C	1000	SECTION THROUGH WIDEST PART OF POND AND PARK
C	1010	SECTION END CRM
C	1020	TYPICAL CHANNEL SECTION, CRM
C	1030	DOWNSTREAM FACE OF BRIDGE (Q=5900)
C	1040	UPSTREAM FACE OF BRIDGE
C	1045	SECTION AT BOTTOM OF BERM
C	1050	SECTION AT TOP OF BERM
C	1060	SECTION THROUGH POND
C	1070	SECTION AT BEGINNING OF CRM
C	1080	SECTION THROUGH CRM SECTION
C	1090	SECTION THROUGH TYPICAL CRM SECTION
C	1100	SECTION THROUGH TYPICAL CRM SECTION
C	1105	SECTION THROUGH BOTTOM OF BERM
C	1110	SECTION THROUGH PARK SECTION, TOP OF BERM
C	1120	SECTION THROUGH PARK SECTION
C	1130	SECTION THROUGH CRM CHANNEL
C	1135	SECTION THROUGH CRM CHANNEL AT HEADWALL
C	1140	SECTION AT DOWSTREAM FACE OF DBL 12X12 BOX (Q=5300)
C	1150	SECTION AT UPSTREAM FACE OF DBL 12X12 BOX
C	1160	SECTION ABOVE HWY

PLATE 6 FLOWS - NO RR BRIDGE   6-18-98

HEC-RAS Plan: Kalor River: 1 Reach: 1

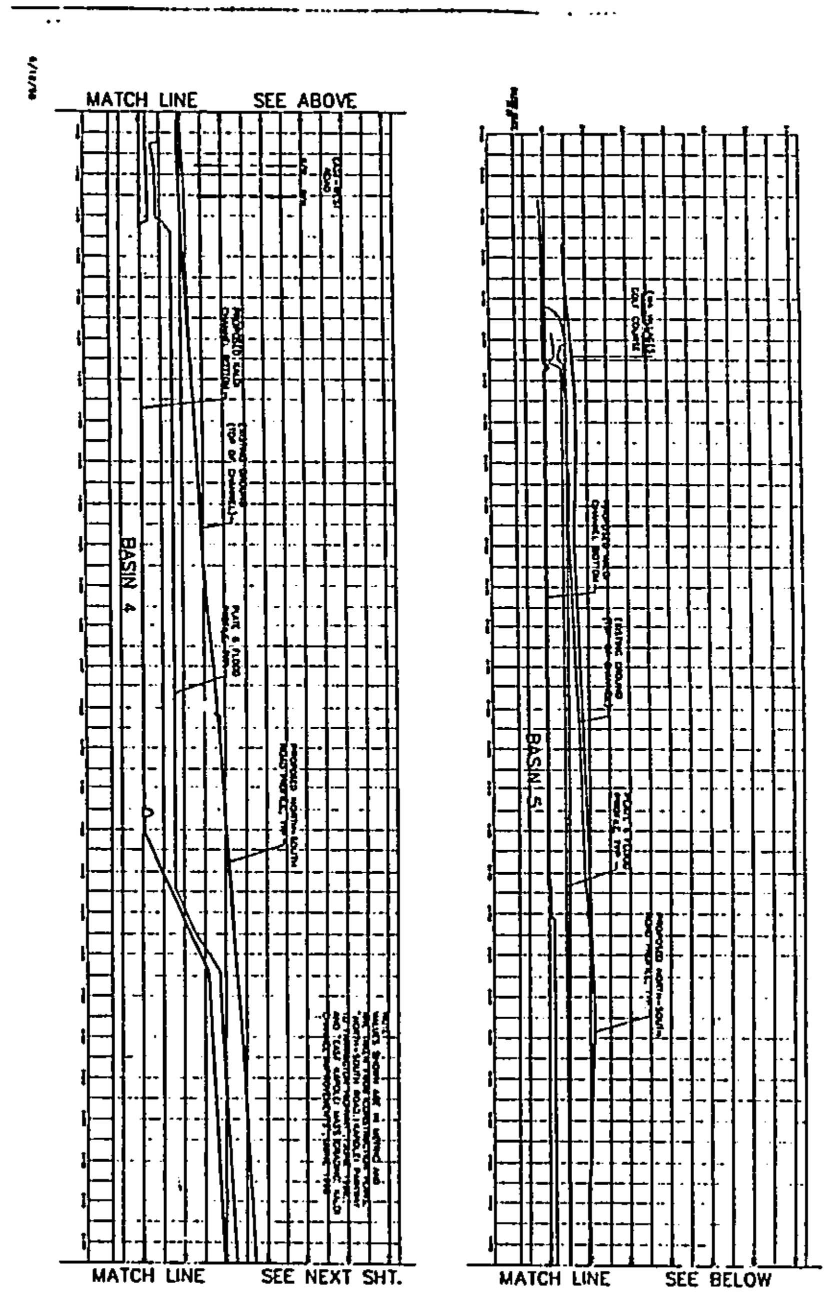
Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	Length Chnl (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	1160	5300.00	200.79	185.00	206.37	206.37	207.57	0.013374	8.79	603.29	254.60	1.01
1	1150	5300.00	189.50	0.00	206.45	198.08	206.84	0.000111	5.07	1234.51	360.01	0.26
1	1145	Bridge										
1	1140	5300.00	189.00	25.40	198.61	199.82	205.08	0.004244	20.40	259.78	27.02	1.18
1	1135	5900.00	187.00	25.40	193.83	198.82	203.75	0.024810	25.53	231.08	40.82	1.89
1	1134	5900.00	183.72	50.80	189.71	193.65	202.48	0.033812	28.60	205.88	38.24	2.18
1	1132	5900.00	177.18	56.75	182.14	186.83	198.77	0.057441	33.69	175.12	40.77	2.86
1	1130	5900.00	170.00	20.00	173.80	178.23	195.47	0.087482	37.38	157.83	48.19	3.67
1	1125	5900.00	170.00	108.00	184.92	175.65	185.19	0.000407	4.17	1414.54	124.66	0.22
1	1120	5900.00	170.00	240.00	185.05	173.40	185.11	0.000068	2.01	3119.83	313.03	0.08
1	1119	5900.00	170.00	118.00	185.03	173.38	185.09	0.000072	2.00	3114.56	312.68	0.10
1	1117	5900.00	169.62	85.00	184.42	179.65	185.01	0.001150	6.78	1187.34	312.44	0.36
1	1115	5900.00	168.53	10.00	184.04	178.56	184.90	0.000850	7.46	793.03	93.37	0.42
1	1110	5900.00	175.00	10.00	181.86	181.86	184.69	0.005431	13.51	436.79	77.42	1.00
1	1105	5900.00	168.00	45.75	175.20	178.00	184.01	0.020149	23.82	247.66	48.80	1.86
1	1100	5900.00	167.42	355.00	174.81	177.42	182.94	0.018078	22.88	257.88	49.78	1.77
1	1095	5900.00	162.65	350.00	170.73	172.65	177.05	0.012778	20.18	292.41	52.37	1.50
1	1090	5900.00	158.00	40.00	166.02	168.00	172.48	0.013185	20.42	288.93	62.07	1.53
1	1088	5900.00	155.84	30.00	161.98	164.93	171.47	0.023884	24.72	238.68	61.17	2.02
1	1087	5900.00	154.20	60.00	159.32	162.57	170.47	0.032526	26.80	220.14	53.27	2.32
1	1085	5900.00	150.92	60.00	154.77	158.15	167.68	0.048350	29.05	203.08	60.40	2.79
1	1084	5900.00	147.64	60.00	150.74	153.97	164.41	0.083967	29.67	198.88	70.27	3.11
1	1082	5900.00	144.35	44.00	158.58	150.04	158.86	0.000219	4.21	1401.13	126.81	0.22
1	1080	5900.00	142.00	20.00	158.67	147.26	158.81	0.000084	3.03	2107.48	183.59	0.14
1	1079	5900.00	142.00	70.00	158.66	147.26	158.80	0.000079	2.97	2210.65	194.41	0.14
1	1077	5900.00	142.00	10.00	158.67	147.25	158.80	0.000074	2.92	2191.77	339.20	0.14
1	1075	5900.00	147.00	10.00	158.63	150.83	158.78	0.000148	3.42	1659.83	525.10	0.19
1	1070	5900.00	142.00	235.00	158.68	147.32	158.78	0.000064	2.71	2425.82	564.92	0.13
1	1060	5900.00	142.00	128.00	158.68	145.29	158.73	0.000053	1.88	3148.22	820.66	0.08
1	1055	5900.00	142.00	10.00	158.52	147.82	158.71	0.000113	3.48	1745.48	170.00	0.16
1	1050	5900.00	147.00	10.00	154.55	154.55	158.34	0.006640	15.63	377.45	50.00	1.00
1	1046	5900.00	142.00	25.00	146.72	149.55	158.42	0.028128	25.00	236.03	50.00	2.03
1	1040	5900.00	141.08	94.50	145.28	148.22	155.71	0.015093	25.94	227.43	62.74	2.40
1	1035	5900.00	138.44	94.50	143.59	146.58	154.22	0.015458	28.16	225.57	62.62	2.43
1	1030	5900.00	137.80	76.00	142.11	145.02	151.98	0.031881	25.21	234.07	58.82	2.22
1	1025	5900.00	132.87	58.00	136.27	139.39	148.26	0.049815	27.79	212.30	65.81	2.73
1	1020	6000.00	129.25	48.00	132.22	135.34	144.68	0.081517	28.87	208.31	73.53	2.98
1	1015	6000.00	129.31	50.00	129.04	132.05	141.91	0.068267	28.80	208.35	78.14	3.13
1	1012	6000.00	123.00	62.33	132.77	127.92	133.24	0.000529	5.63	1142.87	151.49	0.33
1	1010	6000.00	118.90	85.00	133.03	122.79	133.12	0.000070	2.30	2607.00	250.66	0.13
1	1005	6000.00	115.47	50.00	133.06	118.74	133.10	0.000020	1.61	3736.65	339.18	0.07
1	1000	6000.00	115.47	165.00	133.08	118.26	133.09	0.000011	1.09	8507.00	425.35	0.05
1	990	6000.00	115.47	284.00	133.08	118.25	133.09	0.000020	1.02	5900.92	461.07	0.05
1	985	6000.00	115.47	300.00	133.07	118.58	133.09	0.000025	1.13	5310.11	429.34	0.06
1	980	6000.00	115.47	300.00	133.05	118.64	133.08	0.000034	1.27	4738.83	398.80	0.06
1	975	6000.00	115.47	392.00	133.03	119.41	133.06	0.000044	1.42	4232.12	367.84	0.07
1	970	6000.00	115.47	106.00	132.98	119.80	133.04	0.000058	1.84	3269.34	349.24	0.09
1	960	6000.00	115.47	65.00	132.92	119.95	133.03	0.000059	2.71	2214.72	335.90	0.12
1	958	6000.00	115.47	10.00	132.70	122.40	133.00	0.000180	4.44	1351.24	108.38	0.20
1	957	6000.00	120.47	10.00	128.11	128.11	131.84	0.006827	15.71	381.91	50.00	1.00
1	955	6000.00	115.47	54.60	121.50	124.10	130.33	0.020905	23.85	251.59	50.00	1.87
1	950	6000.00	114.83	526.70	121.11	123.49	129.82	0.018043	21.99	272.88	68.87	1.77
1	945	6150.00	109.20	1168.00	117.08	118.04	121.48	0.008398	16.80	364.78	83.48	1.24
1	940	6150.00	95.96	180.00	102.79	104.69	108.98	0.013647	19.96	308.07	60.22	1.54
1	930	6150.00	94.00	80.00	101.61	102.68	106.57	0.009613	17.88	343.85	60.40	1.32
1	929	6150.00	88.58	70.75	93.19	96.48	104.89	0.038772	27.44	224.10	57.80	2.48
1	928	6150.00	82.02	70.75	85.54	89.20	101.15	0.084549	31.71	193.97	82.09	3.16
1	927	6150.00	75.50	70.75	78.37	81.87	95.81	0.088778	33.33	184.54	70.14	3.82
1	926	6150.00	68.90	61.43	71.39	74.81	88.68	0.103825	33.36	184.34	78.88	3.85
1	925	6150.00	58.51	50.00	72.78	63.83	73.01	0.000190	4.01	1534.61	134.58	0.21
1	923	6150.00	53.51	154.00	72.88	60.07	72.95	0.000048	2.09	2945.63	253.28	0.11
1	920	6150.00	53.31	300.00	72.89	60.48	72.93	0.000036	1.66	3705.98	359.18	0.09
1	910	6150.00	53.31	593.00	72.88	60.48	72.92	0.000078	1.52	4042.85	488.33	0.09
1	900	6150.00	53.31	381.00	72.78	60.49	72.85	0.000159	2.12	2903.28	382.24	0.13
1	890	6150.00	53.31	426.11	72.80	56.45	72.82	0.000018	0.90	6853.12	648.78	0.05
1	880	6150.00	53.31	189.27	72.77	56.45	72.80	0.000027	1.48	4147.84	823.82	0.06
1	875	6150.00	53.31	10.00	72.64	58.48	72.70	0.000083	3.01	2045.86	838.50	0.13
1	870	7400.00	58.31	10.00	67.09	67.09	71.50	0.006625	16.85	439.18	50.00	1.00
1	860	7400.00	58.20	38.00	63.20	65.48	70.55	0.007052	21.78	340.10	78.04	1.84

HEC-RAS Plan: Kaloi River: 1 Reach: 1

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	Length Chnl (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	860	7400.00	58.20	38.00	63.20	65.48	70.56	0.007052	21.78	340.10	78.04	1.84
1	850	7400.00	57.80	100.00	63.36	65.38	68.87	0.006875	20.48	361.38	78.04	1.86
1	840	7400.00	56.80	71.00	62.43	64.61	69.14	0.006983	20.78	356.07	74.42	1.87
1	835	7400.00	56.73	0.50	58.76	62.06	68.00	0.013600	23.04	321.20	111.87	2.40
1	830	7400.00	56.73	20.00	58.76	62.06	68.01	0.037803	23.08	320.93	111.87	2.40
1	829	7400.00	56.70	20.00	64.98	62.03	66.80	0.001231	7.87	984.87	132.72	0.50
1	827	7400.00	56.68	220.00	64.96	62.02	65.88	0.001240	7.89	982.15	132.84	0.50
1	820	7400.00	56.47	840.00	64.64	61.90	65.60	0.001284	7.78	950.72	132.18	0.51
1	810	7400.00	55.50	100.00	62.58	60.98	63.96	0.002277	9.48	780.47	124.34	0.67
1	805	7400.00	51.50	180.00	63.19	58.91	63.54	0.000876	4.86	1523.90	158.73	0.28
1	800	7400.00	51.50	78.51	63.18	58.96	63.42	0.000569	3.95	1875.08	236.87	0.25
1	790	7400.00	51.50	82.72	63.18	57.02	63.37	0.000515	3.84	2035.67	272.77	0.23
1	780	7400.00	51.50	556.70	63.15	57.07	63.33	0.000482	3.45	2143.10	301.05	0.73
1	770	7400.00	51.50	557.60	63.08	54.76	63.14	0.000175	2.05	3606.73	513.80	0.14
1	760	7400.00	51.50	255.70	63.01	54.12	63.07	0.000083	2.02	3660.28	638.82	0.11
1	755	7400.00	51.80	10.00	62.71	58.03	63.00	0.000518	4.33	1708.18	174.96	0.24
1	750	7400.00	54.60	10.00	58.70	58.70	62.30	0.005836	12.94	571.88	110.00	1.00
1	740	7400.00	50.85	20.63	54.58	56.52	61.03	0.022971	20.38	363.04	104.90	1.93
1	730	7400.00	50.85	41.04	58.58	56.53	59.85	0.001923	9.10	812.79	120.85	0.62
1	720	7400.00	50.85	40.00	57.95	58.73	59.66	0.001024	10.51	704.34	113.40	0.74
1	710	7400.00	50.50	350.00	56.60	56.60	58.31	0.001848	13.21	560.00	103.80	1.00
1	700	7400.00	48.50	140.00	53.92	54.99	57.22	0.030832	15.07	570.87	278.09	1.56
1	690	7400.00	47.00	180.00	54.05	51.68	54.38	0.001448	4.87	1887.34	447.13	0.37
1	680	7550.00	45.00	150.00	54.01	48.77	54.13	0.000284	2.85	3272.98	820.35	0.18
1	670	7550.00	40.00	125.00	54.00	46.08	54.04	0.000073	1.70	5186.28	653.04	0.09
1	660	7550.00	40.00	80.00	54.00	44.55	54.03	0.000043	1.37	6068.87	654.96	0.07
1	650	7550.00	44.00	38.00	63.21	51.95	53.72	0.001025	7.30	2031.45	770.58	0.47
1	645	Culvert										
1	640	7550.00	43.80	60.00	53.22	51.81	53.72	0.000961	7.21	2054.71	771.04	0.46
1	630	7800.00	39.00	170.00	53.25	47.93	53.41	0.000418	3.69	3144.12	658.18	0.22
1	620	7800.00	39.00	100.00	53.28	43.21	53.29	0.000035	1.28	6312.64	666.51	0.07
1	610	7800.00	38.00	110.00	53.23	43.75	53.27	0.000060	1.88	4952.61	850.71	0.09
1	600	7800.00	38.00	280.00	53.20	44.85	53.25	0.000102	2.04	4480.87	546.86	0.11
1	590	7800.00	38.00	60.00	53.18	46.24	53.21	0.000052	1.26	6505.90	836.87	0.06
1	580	7800.00	43.00	38.00	52.73	50.84	53.03	0.000602	5.65	2375.90	641.69	0.38
1	575	Culvert										
1	570	7800.00	42.80	150.00	52.73	50.81	53.03	0.000576	6.82	2383.37	641.63	0.36
1	560	7800.00	38.00	180.00	51.88	47.27	52.51	0.001351	8.13	1328.31	181.81	0.41
1	550	7700.00	37.00	110.00	49.82	47.68	51.12	0.005025	13.27	707.52	117.88	0.78
1	540	7700.00	38.50	40.00	48.02	48.02	50.45	0.008112	14.20	840.44	190.44	0.83
1	530	7700.00	36.00	180.00	47.73	44.21	48.18	0.001203	5.47	1506.65	252.31	0.38
1	520	7700.00	35.00	170.00	47.65	40.81	47.89	0.000385	3.91	2040.53	227.41	0.22
1	510	7700.00	34.00	210.00	47.84	38.57	47.78	0.000151	2.77	2938.18	273.20	0.14
1	500	7700.00	32.00	110.00	47.67	37.42	47.71	0.000157	3.08	2728.62	238.74	0.14
1	490	7700.00	31.00	120.00	47.38	37.74	47.62	0.000278	4.17	2081.61	190.20	0.19
1	480	7700.00	30.00	200.00	47.40	33.20	47.43	0.000031	1.57	5493.44	419.43	0.07
1	470	8000.00	27.00	120.00	47.40	29.78	47.41	0.000007	0.78	11755.12	754.80	0.03
1	460	8350.00	27.00	130.00	47.38	29.63	47.41	0.000008	0.88	11056.77	680.00	0.03
1	450	8350.00	27.00	70.00	47.34	32.27	47.38	0.000041	1.94	6113.27	545.00	0.06
1	440	8350.00	32.00	38.00	47.22	39.96	47.34	0.000125	3.01	3028.91	652.89	0.18
1	435	Culvert										
1	430	8350.00	31.60	80.00	47.22	39.91	47.34	0.000121	3.87	3873.71	555.65	0.18
1	420	8350.00	27.00	100.00	47.13	35.87	47.28	0.000253	3.52	2930.14	303.37	0.19
1	410	8350.00	27.00	120.00	47.15	31.48	47.20	0.000039	1.90	5536.80	415.00	0.06
1	400	8350.00	27.00	245.00	47.19	30.52	47.18	0.000025	1.57	8298.40	440.00	0.06
1	390	8350.00	27.00	25.00	47.10	31.78	47.18	0.000048	2.12	4715.53	315.00	0.08
1	380	8350.00	31.50	38.00	46.87	39.38	47.11	0.000131	4.03	3178.05	304.00	0.19
1	375	Culvert										
1	370	8350.00	31.10	20.00	46.87	39.32	47.11	0.000128	4.02	3185.28	304.00	0.18
1	360	8350.00	30.50	40.00	46.87	35.01	47.08	0.000090	2.47	3708.91	295.00	0.11
1	350	8350.00	30.00	30.00	46.88	33.75	47.03	0.000200	3.38	2825.30	228.00	0.16
1	340	8350.00	29.77	20.00	46.82	35.74	47.02	0.000118	3.80	2322.18	162.87	0.17
1	330	8350.00	29.70	0.00	46.47	36.12	46.94	0.000141	5.51	1515.87	81.50	0.24
1	327.5	Bridge										
1	320	8350.00	29.48	80.00	46.06	35.60	46.54	0.000146	5.56	1500.52	81.50	0.24
1	310	8500.00	29.27	82.21	46.08	35.70	46.53	0.000110	5.53	1535.90	81.50	0.24
1	300	8500.00	29.08	20.00	46.05	35.61	46.52	0.000107	5.47	1552.95	81.50	0.23
1	290	8500.00	29.03	0.00	46.04	35.64	46.51	0.000139	5.52	1538.51	81.50	0.24
1	287.5	Bridge										

HEC-RAS Plan: Kaloi River 1 Reach: 1

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	Length Chnl (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	280	8500.00	28.74	80.00	45.84	33.28	48.31	0.000137	5.50	1548.88	91.50	0.24
1	270	8500.00	28.55	156.58	46.05	34.70	46.28	0.000070	3.87	2187.82	158.29	0.18
	260	8500.00	28.18	180.91	46.07	33.88	46.24	0.000048	3.27	2801.22	174.00	0.15
	250	8500.00	27.75	109.03	46.07	33.25	46.23	0.000043	3.18	2863.30	174.00	0.14
1	240	8500.00	27.48	93.67	45.81	33.18	46.18	0.000054	4.18	2026.54	110.00	0.17
1	230	8500.00	27.27	111.81	45.91	32.98	46.18	0.000052	4.15	2050.54	110.00	0.17
1	220	8500.00	27.01	180.40	45.91	32.71	46.17	0.000050	4.09	2078.91	110.00	0.17
	210	8500.00	26.68	32.77	45.81	32.28	46.15	0.000047	4.00	2125.87	110.00	0.18
	200	8500.00	26.50	121.02	45.81	32.22	46.14	0.000041	3.84	2210.85	118.00	0.16
	190	8400.00	28.22	75.00	45.95	32.04	46.10	0.000038	3.14	2798.83	187.92	0.14
1	180	8400.00	42.60	20.00	44.83	44.83	45.84	0.007380	8.05	1093.88	550.00	1.01
1	150	8400.00	26.08	50.00	28.80	31.84	41.93	0.117824	29.08	302.00	115.96	3.17
	140	8400.00	28.00		33.80	28.55	33.93	0.000323	2.83	3002.63	437.42	0.18

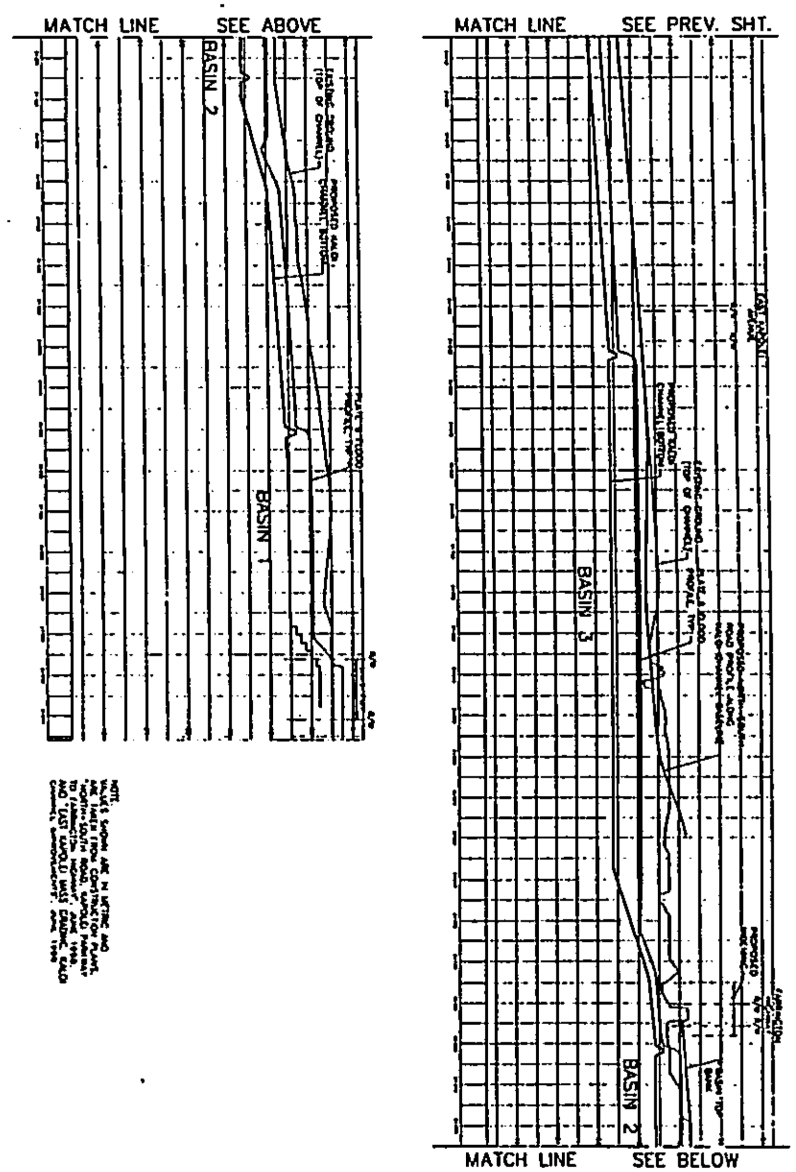


KALOI CHANNEL -- PLATE 6 HYDRAULIC GRADES

6/17/98
FILE: brdgsum.wk3
EAST KAPOLEI DRAINAGE MASTER PLAN
BRIDGE SUMMARY (HEC-2 RESULTS)

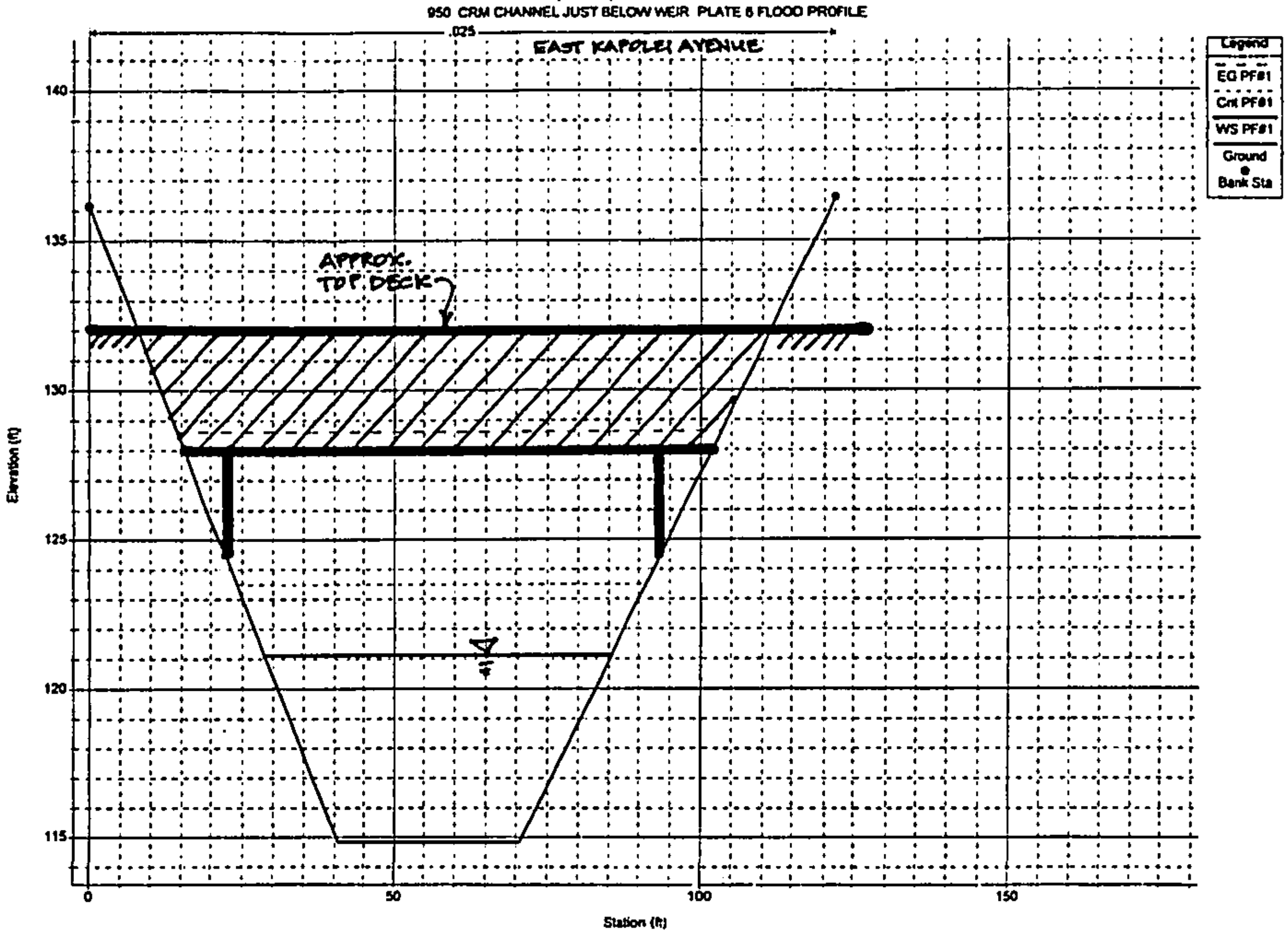
HEC-2 BRIDGE SUMMARY

	TOP ROAD	BOT. DECK	CHAN. INVERT	CWSEL	F.B.
BRIDGE AT RESERVOIR 2 (FARRINGTON HIGHWAY)	164.2	159.2	141	145.26	13.94
BRIDGE AT RESERVOIR 3 (EAST KAPOLEI AVENUE)	132	128	114.8	121.11	6.89
BRIDGE AT RESERVOIR 4 (EAST-WEST ROAD)	81	77	57.0	63.36	13.64

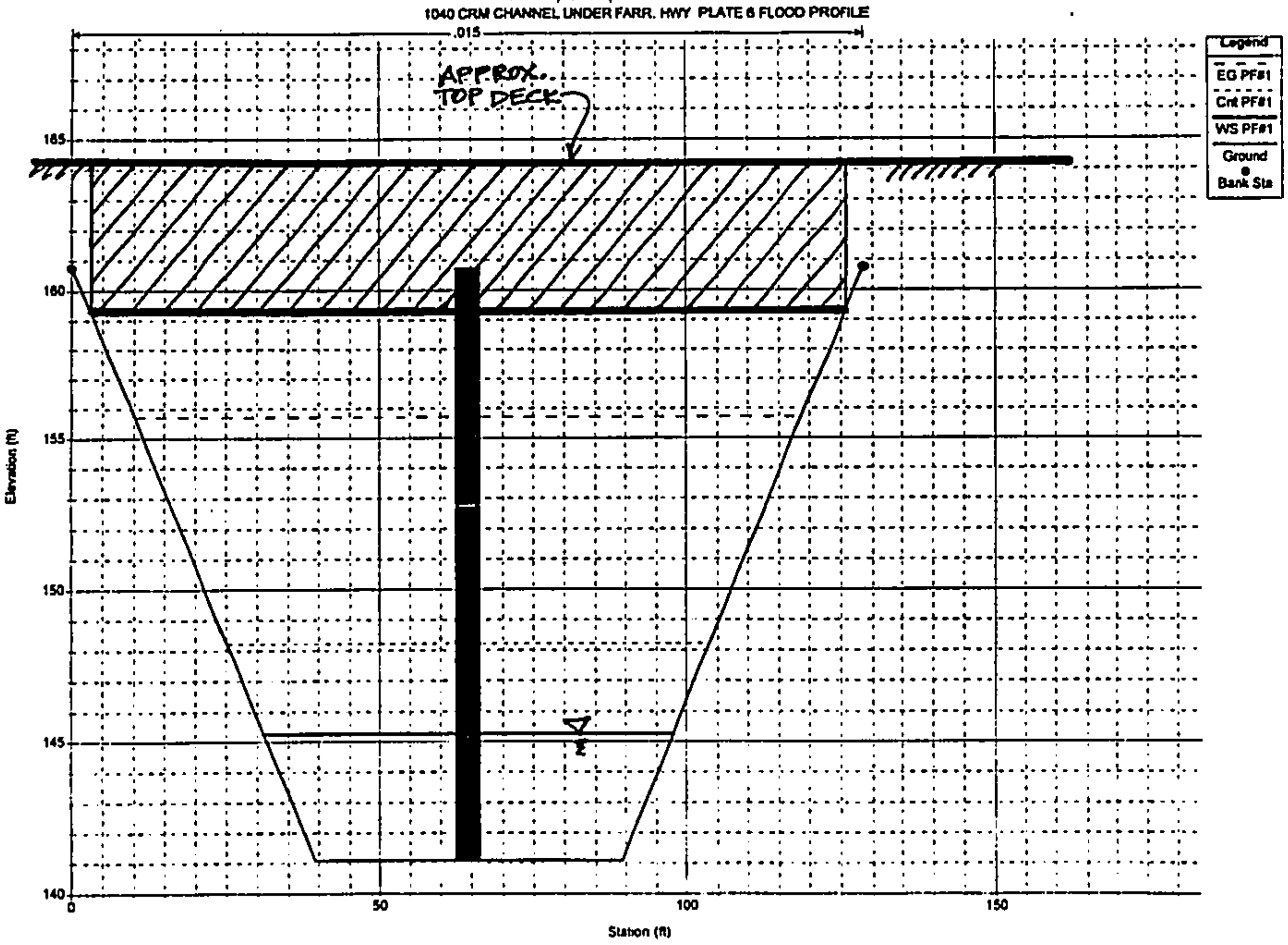


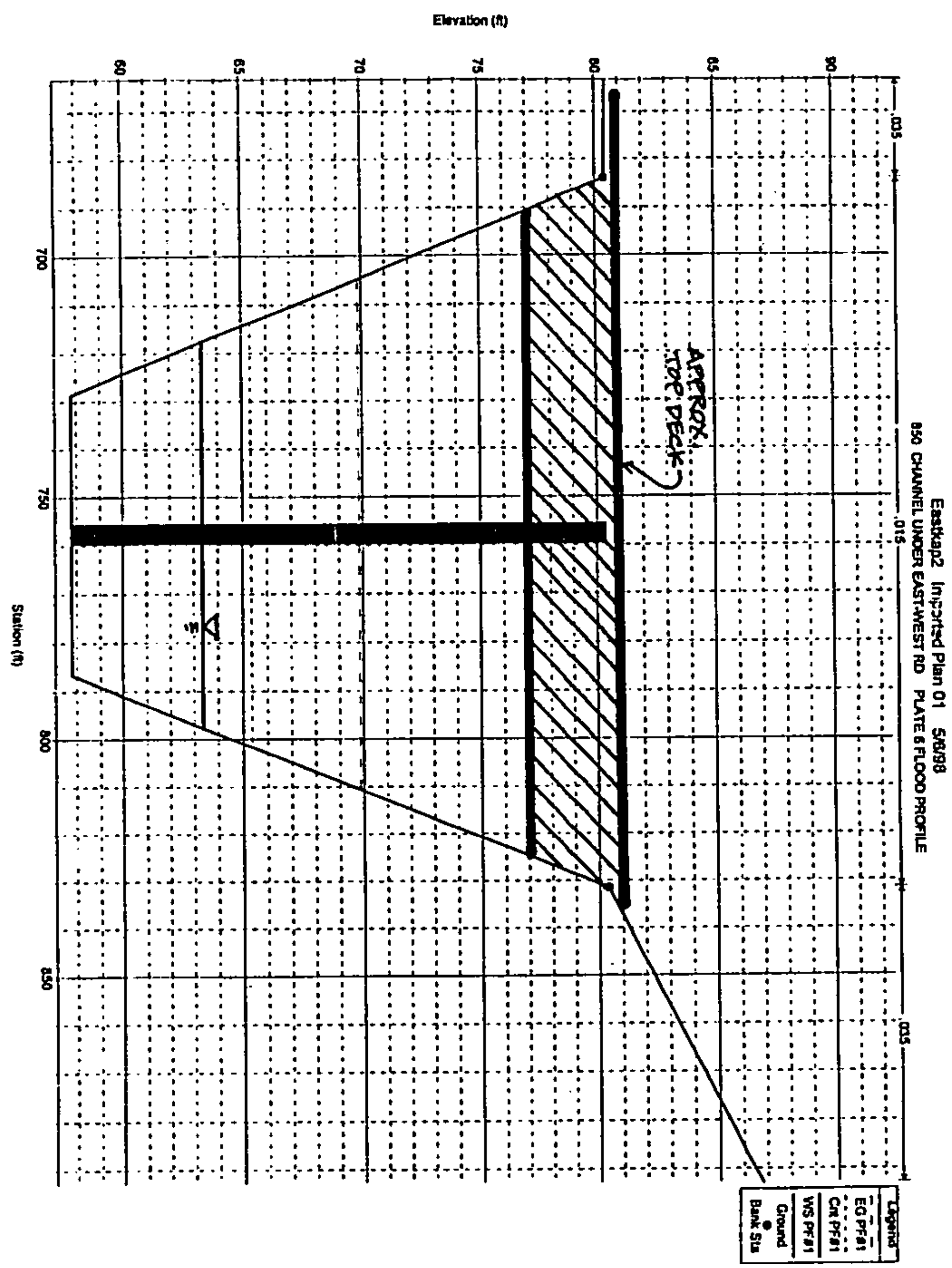
KALOI CHANNEL -- PLATE 6 HYDRAULIC GRADES

950 CRM CHANNEL JUST BELOW WEIR PLATE 6 FLOOD PROFILE



Eastkap2 Imported Plan 01 5/6/98
1040 CRM CHANNEL UNDER FARR. HWY PLATE 6 FLOOD PROFILE





Basin2.xls Chan between 4 and 5 at elev. 56
5/5/98 Use with eastkap2.dat
East Kapolei - Kaloi Channel Detention Basin Storage

Basin 5

Depth	Elev	Area (ac)	Vol (ac-ft)	Cumulative Vol (ac-ft)
0	51.5	8.01		
1	52.5	8.17	8.09	8.09
1	53.5	8.61	8.39	16.48
2	55.5	8.97	17.58	34.06
1	56.5	11.12	10.045	44.11
0.9	57.4	13.53	11.0925	55.20
1.6	59	16.04	23.656	78.85
1.7	60.7	18.26	29.155	108.01
1.6	62.3	20.42	30.944	138.95

Basin 4

Depth	Elev	Area (ac)	Vol (ac-ft)	Cumulative Vol (ac-ft)
0	53.31	6.46		
5	58.31	7.52	35	35.00
3	61.31	8.29	23.715	58.72
1.02	62.33	10.49	9.5778	68.29
1.65	63.98	13.99	20.196	88.49
2.33	66.31	19.43	38.9343	127.42
2.59	68.90	25.11	57.6793	185.10
1.64	70.54	28.33	43.8208	228.92
1.64	72.18	29.54	47.4534	276.38
3.28	75.46	30.43	98.3508	374.73

Basin 3

Depth	Elev	Area (ac)	Vol (ac-ft)	Cumulative Vol (ac-ft)
0	115.47	6.32		
5	120.47	7.48	34.50	34.50
10	125.47	11.69	48.43	82.93
12	127.47	13.77	25.66	108.59
14	129.47	15.61	29.38	137.97

Basin 2

Depth	Elev	Area (ac)	Vol (ac-ft)	Cumulative Vol (ac-ft)
0	142.00	3.51		
5	147.00	4.14	19.13	19.13
8	150.00	5.16	13.95	33.08
11	153.00	6.21	17.06	50.13
14	156.00	6.59	19.20	69.33

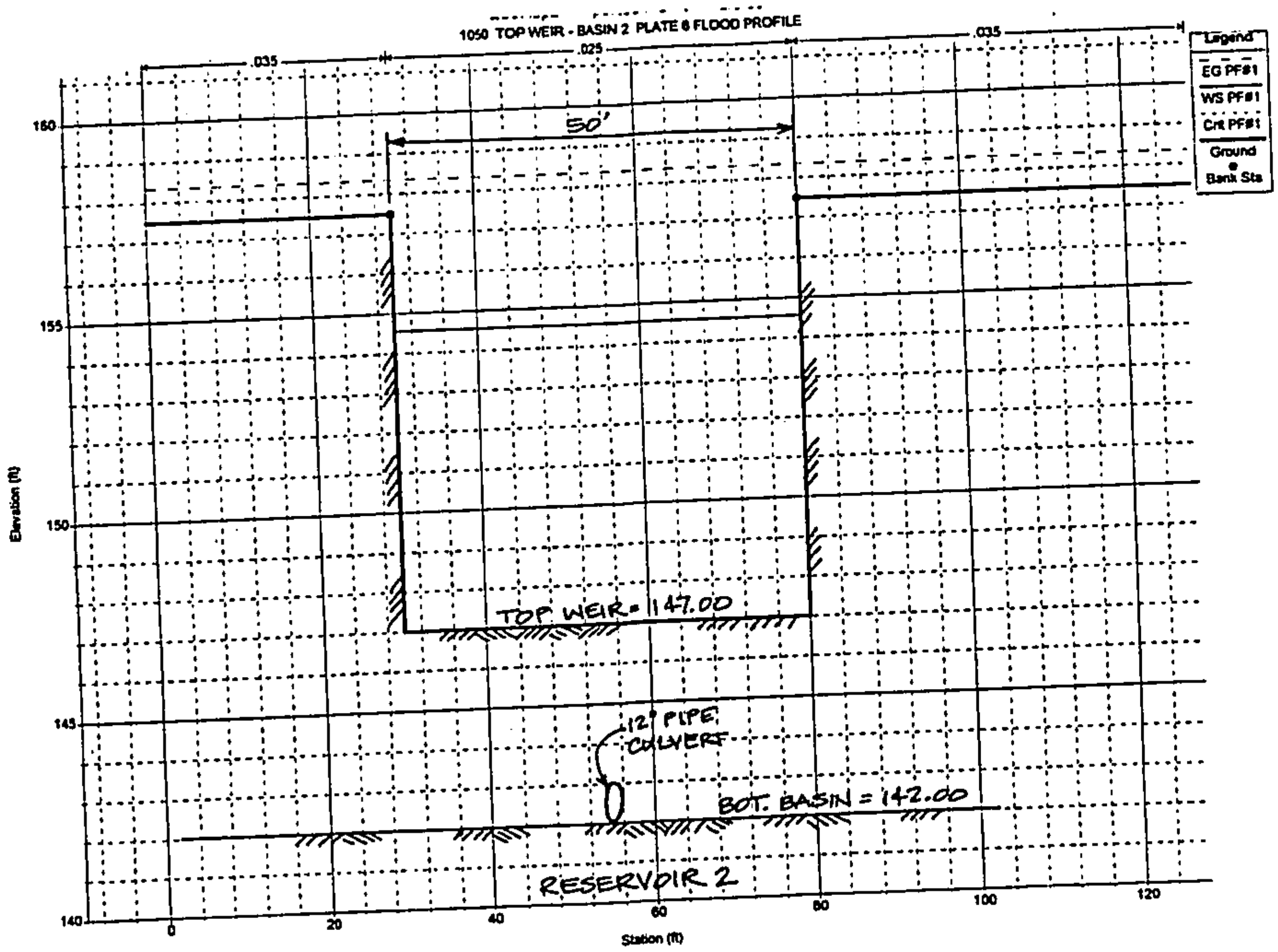
Basin 1

Depth	Elev	Area (ac)	Vol (ac-ft)	Cumulative Vol (ac-ft)
0	170	5.37		
5	175.00	6.22	28.975	28.98
5	180.00	7.04	33.15	62.13
3.73	183.73	10.22	32.1899	94.31
4.92	188.65	13.41	58.1298	152.44

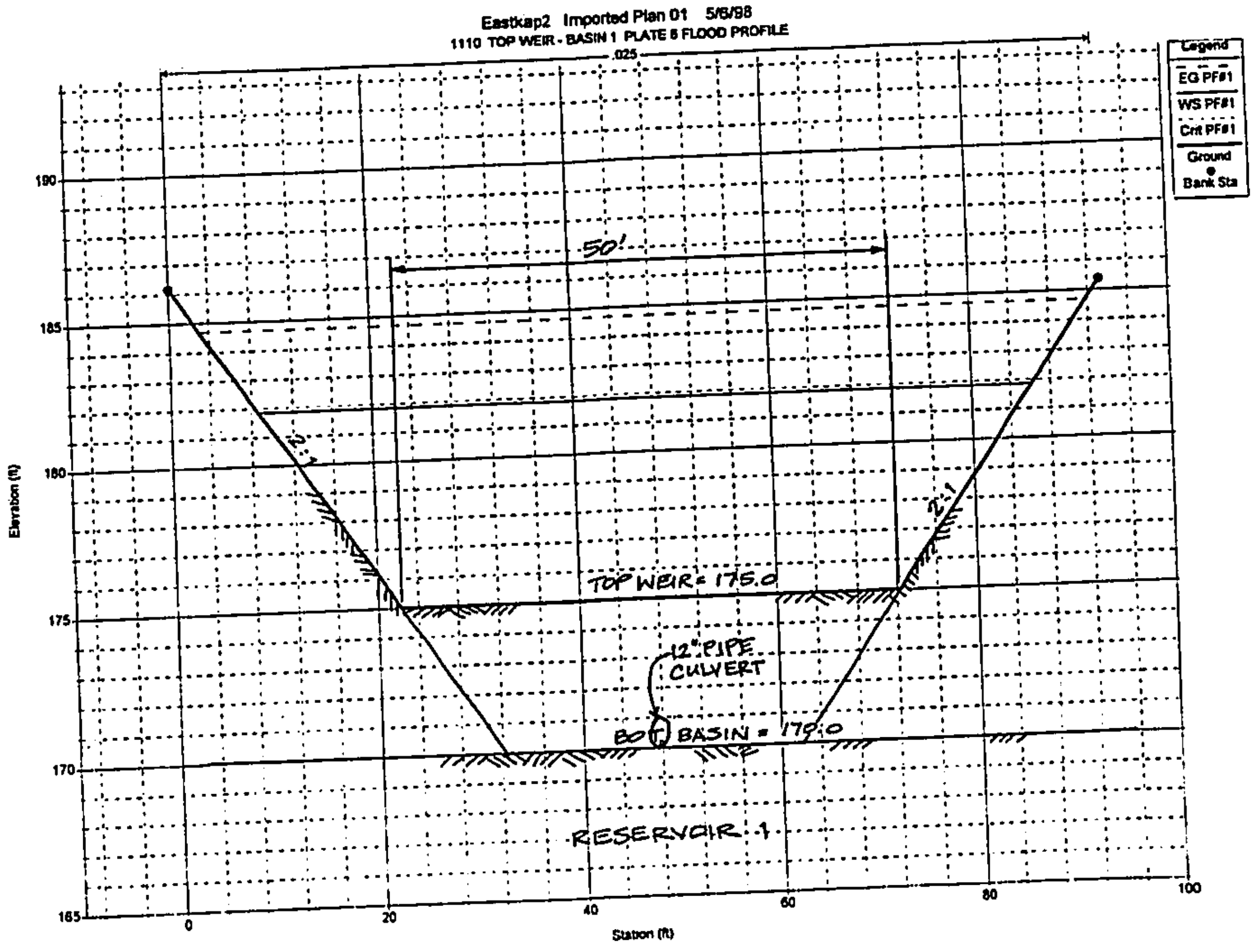
5/14/98 Use with New1c2.dat

SPORTS COMPLEX

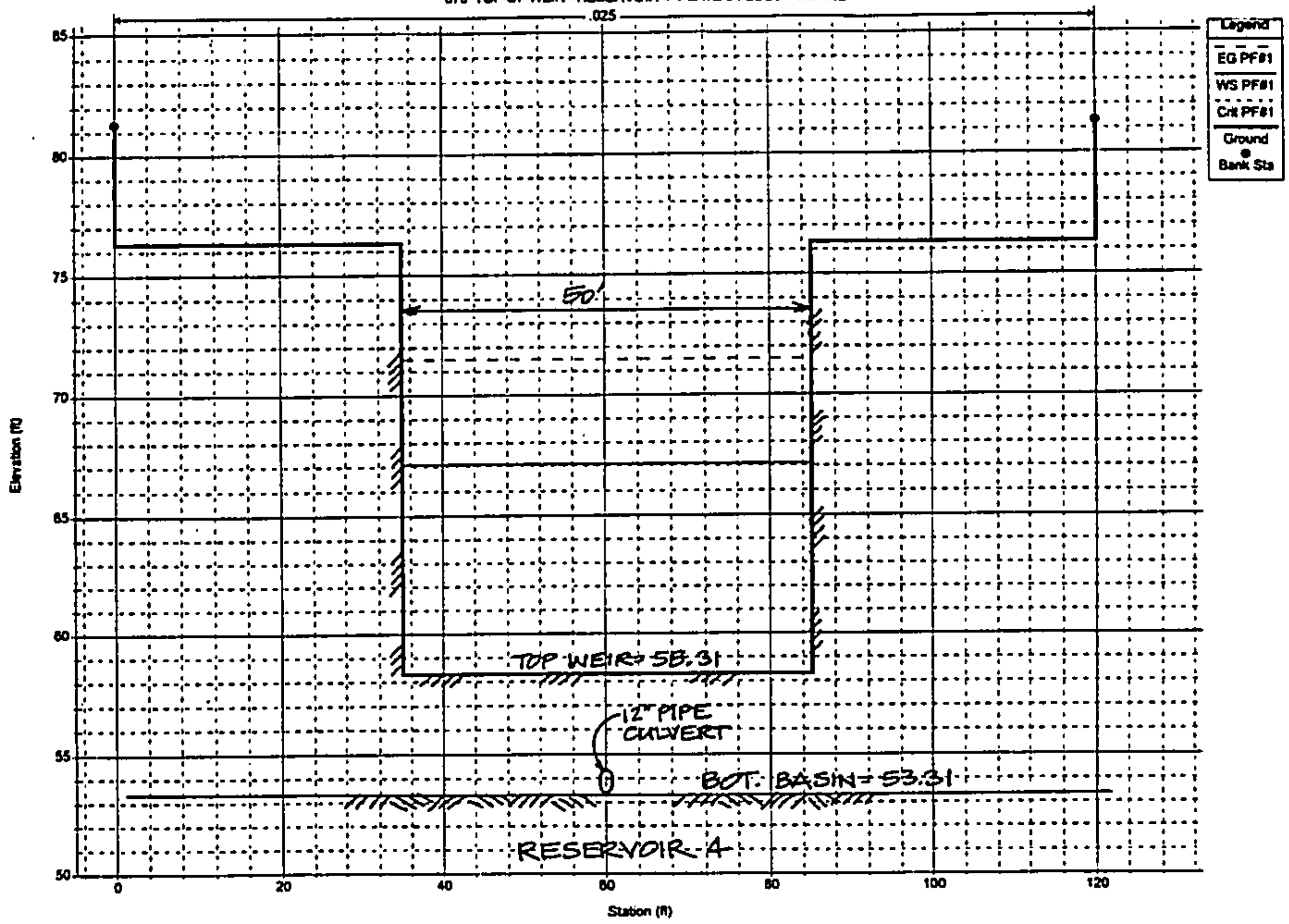
Depth	Elev	Area (ac)	Vol (ac-ft)	Cumulative Vol (ac-ft)
0	43	0.67		
1	44	1.27	0.97	0.97
1	45	2.38	1.825	2.80
1	46	4.26	3.32	6.12
1	47.0	5.64	4.95	11.07
1	48.0	7.17	6.405	17.47
1	49	8.47	7.82	25.29
1	50	12.43	10.45	35.74



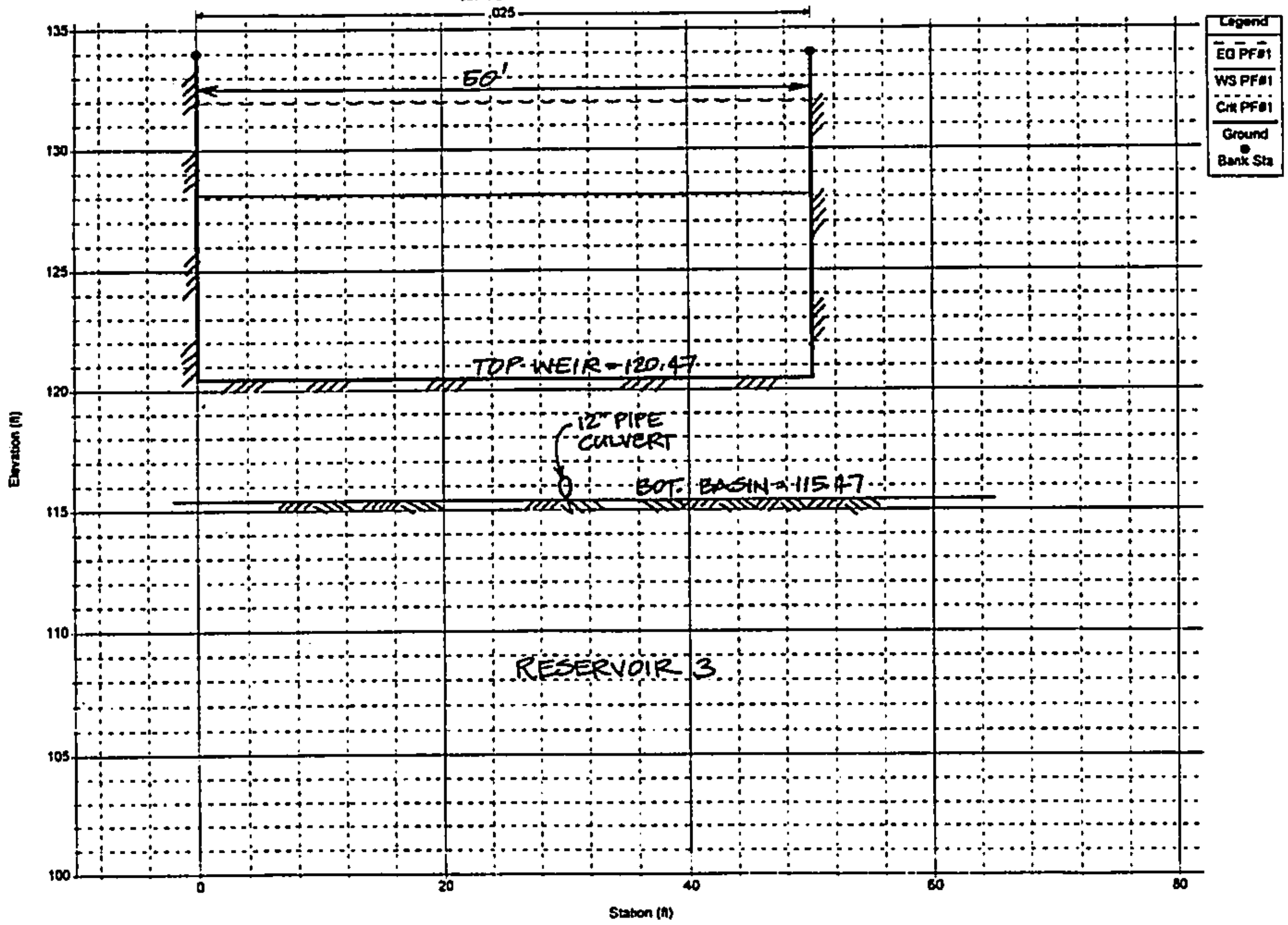
Eastkap2 Imported Plan 01 5/6/98



870 TOP OF WEIR - RESERVOIR 4 PLATE 6 FLOOD PROFILE



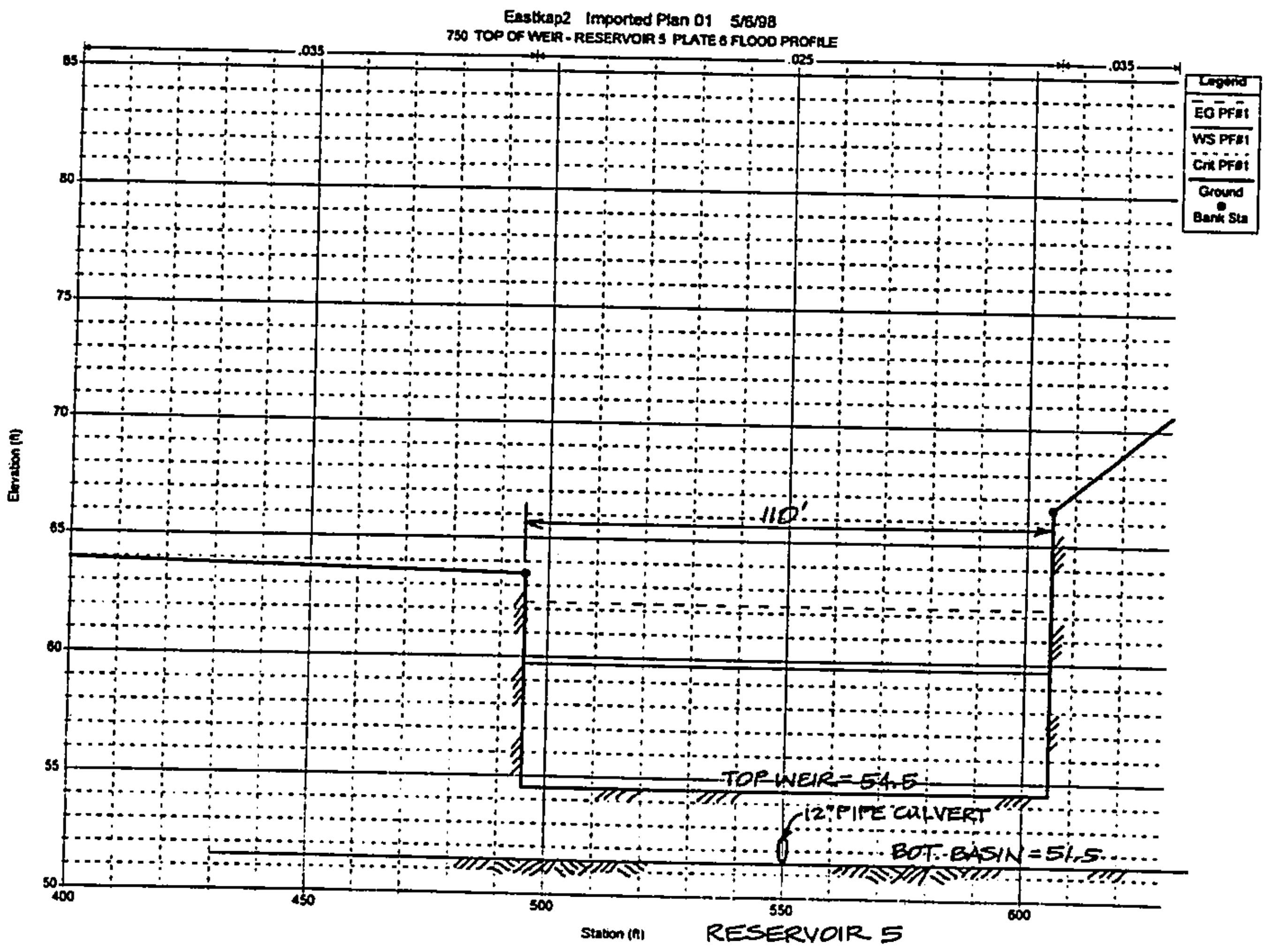
Eastkap2 Imported Plan 01 5/6/98
957 TOP WEIR - RESERVOIR 3 PLATE 6 FLOOD PROFILE

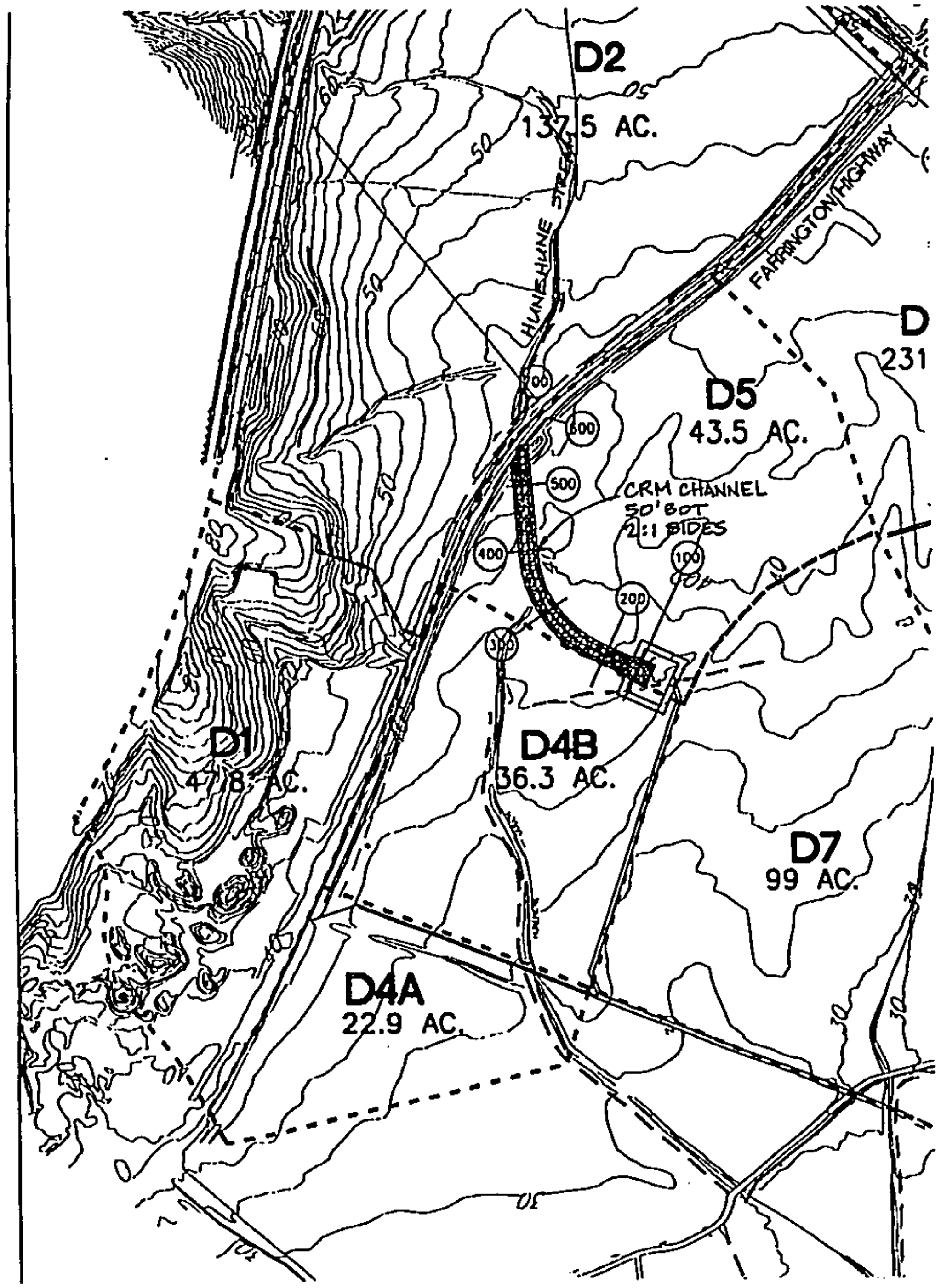


APPENDIX D

BACKBONE DRAINAGE SYSTEM HYDRAULIC SIZING

- HEC-2 Computations for CRM Channel
- Hunehune Stream Channel Improvements
- Box Drain Sizing and Hydraulic Data





HEC-RAS Version 2.0 April 1997
U.S. Army Corp of Engineers
Hydrologic Engineering Center
609 Second Street, Suite D
Davis, California 95616-4687
(916) 756-1104

```
X     X XXXXXX   XXXX        XXXX     XX     XXXX
X     X X       X    X       X   X   X  X   X
X     X X       X            X   X  X    X  X
XXXXXXX XXXX    X      XXX   XXXX   XXXXXX   XXXX
X     X X       X            X  X   X    X       X
X     X X       X    X       X   X  X    X       X
X     X XXXXXX   XXXX        X    X X    X  XXXXX
```

PROJECT DATA
Project Title: HUNEHUNE
Project File : hunehune.prj
Run Date and Time: 6/18/98 10:34:06 AM

Project in English units

Project Description:
HUNEHUNE STREAM-CRM CHANNEL CONNECTING FARRINGTON HWY AND BOX DRAIN
PLATE 6 FLOOD PROFILE - (STARTING WSEL = 105.13, PER BOX DRAIN 1 HYDR. CALC'S: *EX-BOXD.XLS*)

PLAN DATA

Plan Title: Imported Plan 01
Plan File : c:\hecras2\hunehune.p01

Geometry Title: Imported Geom 01
Geometry File : c:\hecras2\hunehune.g01

Flow Title : Imported Flow 01
Flow File : c:\hecras2\hunehune.f01

Plan Summary Information:

Number of:	Cross Sections = 7		Mulitple Openings =	0
	Culverts = 0		Inline Weirs =	0
	Bridges = 1			

Computational Information
Water surface calculation tolerance = 0.01
Critical depth calculaton tolerance = 0.01
Maximum number of interations = 20
Maximum difference tolerance = 0.3
Flow tolerance factor = 0.001

Computational Flow Regime: Mixed Flow

FLOW DATA

Flow Title: Imported Flow 01
Flow File : c:\hecras2\hunehune.f01

Flow Data (cfs)

River	Reach	RS	PF#1
RIVER-1	Reach-1	700	1250
RIVER-1	Reach-1	100	1390

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
RIVER-1	Reach-1	PF#1	Critical	Known WS = 105.13

```
GEOMETRY DATA

Geometry Title: Imported Geom 01
Geometry File : c:\hecras2\hunehune.g01

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1             RS: 700

INPUT
Description: 700
Station Elevation Data     num=      6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   143.7       0  139.44      16  131.44      66  131.44      82  139.44
      82   143.7

Manning's n Values         num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .025       0    .025      82    .025

Bank Sta: Left   Right     Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0      82                40      40      40               .1       .3

BRIDGE                 RIVER: RIVER-1
REACH: Reach-1             RS: 650

INPUT
Description: Bridge #1
Distance from Upstream XS  =      0
Deck/Roadway Width         =     40
Weir Coefficient           =    2.6
Bridge Deck/Roadway Skew   =
Upstream  Deck/Roadway Coordinates
    num=       6
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
       0   143.7  139.44      16   143.7  131.44      16   143.7  139.44
      66   143.7  139.44      66   143.7  131.44      82   143.7  139.44

Upstream Bridge Cross Section Data
Station Elevation Data     num=      6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   143.7       0  139.44      16  131.44      66  131.44      82  139.44
      82   143.7

Manning's n Values         num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .025       0    .025      82    .025

Bank Sta: Left   Right     Coeff Contr.   Expan.
             0      82               .1       .3

Downstream  Deck/Roadway Coordinates
    num=       6
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
       0   143.7   139.3      16   143.7   131.3      16   143.7   139.3
      66   143.7   139.3      66   143.7   131.3      82   143.7   139.3

Downstream Bridge Cross Section Data
Station Elevation Data     num=      6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   143.7       0   139.3      16   131.3      66   131.3      82   139.3
      82   143.7

Manning's n Values         num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .025       0    .025      82    .025

Bank Sta: Left   Right     Coeff Contr.   Expan.
             0      82               .1       .3

Upstream Embankment side slope                  =     0 horiz. to 1.0 vertical
Downstream Embankment side slope                =     0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow     =   .95
Elevation at which weir flow begins             =
Energy head used in spillway design             =
Spillway height used in design                  =
Weir crest shape                                = Broad Crested

Number of Bridge Coefficient Sets =  1

Low Flow Methods and Data
      Energy
Selected Low Flow Methods = Energy

High Flow Method
      Energy Only

Additional Bridge Parameters
      Add Friction component to Momentum
      Do not add Weight component to Momentum
      Class B flow critical depth computations use critical depth
          inside the bridge at the downstream end
      Criteria to check for pressure flow = Upstream water surface

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1             RS: 600

INPUT
Description: 600
Station Elevation Data     num=      6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   143.7       0   139.3      16   131.3      66   131.3      82   139.3
      82   143.7

Manning's n Values         num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .025       0    .025      82    .025

Bank Sta: Left   Right     Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0      82               180     140     100               .1       .3

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1             RS: 500

INPUT
Description: 500
Station Elevation Data     num=      4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  137.18      16  129.18      66  129.18      82  137.18

Manning's n Values         num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .025       0    .025      82    .025

Bank Sta: Left   Right     Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0      82               275     275     275               .1       .3

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1             RS: 400

INPUT
Description: 400
Station Elevation Data     num=      4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  133.02      16  125.02      66  125.02      82  133.02

Manning's n Values         num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .025       0    .025      82    .025

Bank Sta: Left   Right     Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0      82               220     240     260               .1       .3

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1             RS: 300

INPUT
Description: 300
Station Elevation Data     num=      4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  129.39      16  121.39      66  121.39      82  129.39

Manning's n Values         num=      3
```

Sta	n Val	Sta	n Val	Sta	n Val
0	.025	0	.025	82	.025

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	82	280	290	300	.1	.3

CROSS SECTION RIVER: RIVER-1
REACH: Reach-1 RS: 200

INPUT
Description: 200
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	125	16	117	66	117	82	125

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.025	0	.025	82	.025

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	82	150	150	150	.1	.3

CROSS SECTION RIVER: RIVER-1
REACH: Reach-1 RS: 100

INPUT
Description: 100
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	114	0	89.58	195	89.58	195	114

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.025	0	.025	195	.025

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	195	0	0	0	.1	.3

SUMMARY OF MANNING'S N VALUES

River:RIVER-1

Reach	River Sta.	n1	n2	n3
Reach-1	700	.025	.025	.025
Reach-1	650	Bridge		
Reach-1	600	.025	.025	.025
Reach-1	500	.025	.025	.025
Reach-1	400	.025	.025	.025
Reach-1	300	.025	.025	.025
Reach-1	200	.025	.025	.025
Reach-1	100	.025	.025	.025

SUMMARY OF REACH LENGTHS

River: RIVER-1

Reach	River Sta.	Left	Channel	Right
Reach-1	700	40	40	40
Reach-1	650	Bridge		
Reach-1	600	180	140	100
Reach-1	500	275	275	275
Reach-1	400	220	240	260
Reach-1	300	280	290	300
Reach-1	200	150	150	150
Reach-1	100	0	0	0

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: RIVER-1

Reach	River Sta.	Contr.	Expan.
Reach-1	700	.1	.3
Reach-1	650	Bridge	
Reach-1	600	.1	.3
Reach-1	500	.1	.3
Reach-1	400	.1	.3
Reach-1	300	.1	.3
Reach-1	200	.1	.3
Reach-1	100	.1	.3

6/17/98
EAST KAPOLEI DRAINAGE MASTER PLAN
BACKBONE DRAINAGE – BOX DRAIN TRIBUTARY AREAS

DRAINAGE SUBAREA	SURFACE AREA	SUBTL
BOX DRAIN #1		
A6A	39.68	
A6B	17.28	
A6C	93.44	
A12	76.80	
D2	137.60	
D5	43.56	408.36
FROM BOX DRAIN #2	193.05	
D7	98.91	
TOTAL	700.32	
BOX DRAIN #2		
A8	99.84	
A7	8.96	
D1	48.00	
D4B	36.25	
TOTAL	193.05	
BOX DRAIN #3		
D4A	22.89	
D8 (NO ROAD, CHANNEL)	152.30	
TOTAL	175.19	
BOX DRAIN #4		
D9 (NO ROAD, CHANNEL)	34.00	
BOX DRAIN #5		
D9 (NO ROAD, CHANNEL)	26.00	
BOX DRAIN #6		
D6 (ABOVE COLL. RD. A)	50.00	

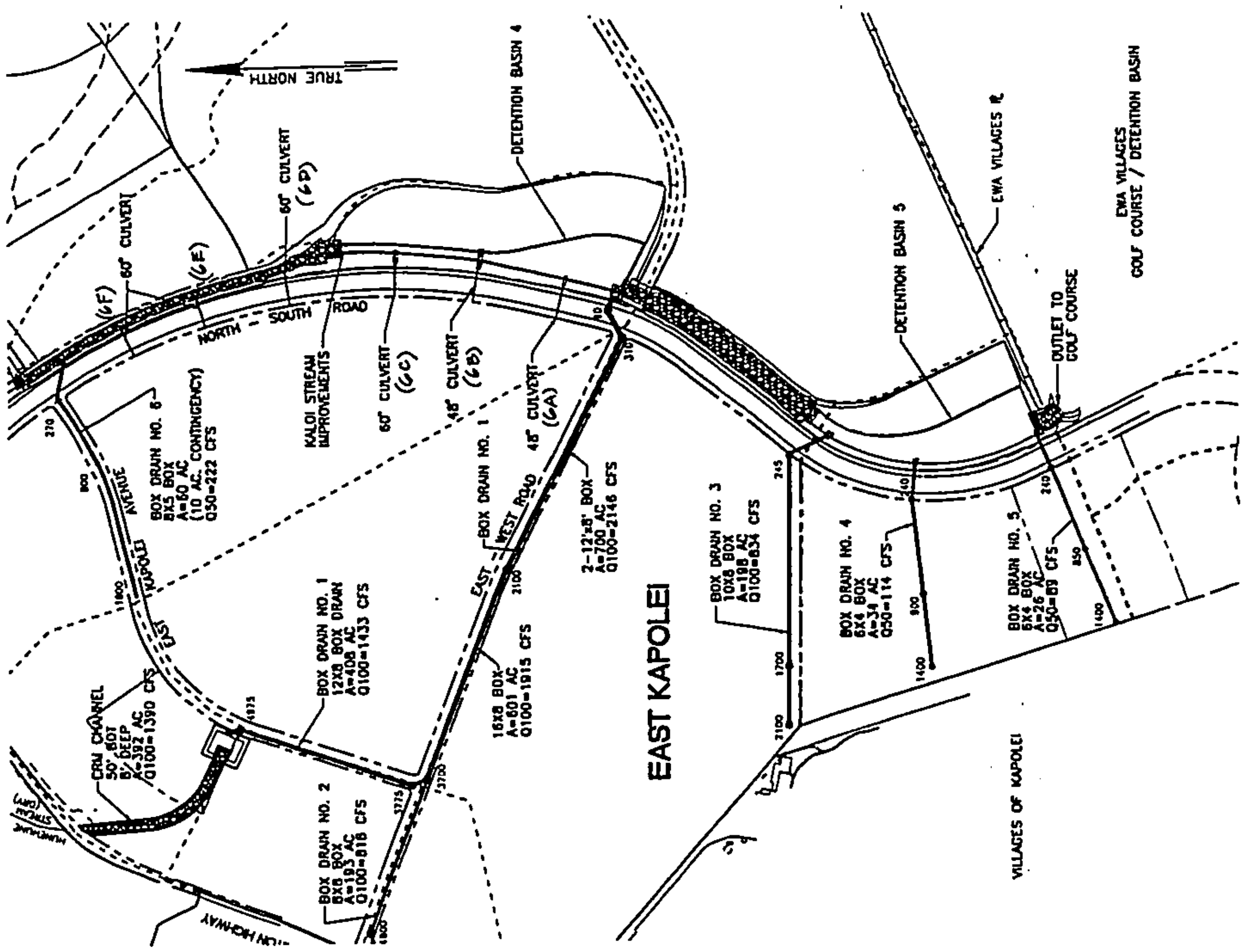
6-18-98

HUNEHUNE CRM CHANNEL PLATE 6 FLOOD PROFILE

HEC-RAS Plan: Imported Pla River: RIVER-1 Reach: Reach-1

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	Length Chnl (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach-1	700	1250.00	131.44	0.00	134.85	134.02	135.50	0.002752	6.44	193.96	63.65	0.65
Reach-1	650	Bridge										
Reach-1	600	1250.00	131.30	140.00	133.36	133.90	135.31	0.015329	11.22	111.43	58.24	1.43
Reach-1	500	1250.00	129.18	275.00	131.24	131.77	133.19	0.015303	11.21	111.49	58.24	1.43
Reach-1	400	1250.00	125.02	240.00	127.08	127.61	129.03	0.015290	11.21	111.52	58.24	1.43
Reach-1	300	1250.00	121.39	290.00	123.45	123.97	125.40	0.015272	11.20	111.56	58.25	1.43
Reach-1	200	1250.00	117.00	150.00	119.06	119.59	121.01	0.015257	11.20	111.60	58.25	1.43
Reach-1	100	1390.00	89.58		105.13	90.75	105.13	0.000002	0.46	3032.25	195.00	0.02

FILE: EX-ROAD.XLS DATE: 6/15/98 INLET	AREA NAME	Total Area (ac)	Offsite Flow Name	Tc	C	(50-YR) i (in/hr)	F	A (ac)	Runoff Q=CiFA (cfs)	Other Flows (cfs)	Total Inflow (cfs)	Cumul Q=CiFA (cfs)	Plate 6 Group C (cfs)	Pipe Q (cfs)	Dn (ft)	Vf (fps)
BOX DRAIN #1	(East-West Road)															
0									0.0		0.0	0.0	2146.4	2146.4	5.3	11.2
		700.36														
90									0.0		0.0	0.0	2146.4	2146.4	5.3	11.7
		700.36														
310								99.0	0.0		0.0	0.0	2146.4	2146.4	8.4	13.4
		700.36	D7													
2100									0.0	0.0	0.0	0.0	1915.0	1915.0	3.9	15.0
		601.36	FROM BOX DRAIN # 2													
2700									0.0		0.0	0.0	1433.4	1433.4	6.8	14.9
		408.36														
3775	(Collector Road "A")								0.0		0.0	0.0	1433.4	1433.4	6.7	14.9
		408.36														
4975								408.4	0.0		0.0	0.0	1433.4	1433.4	6.7	14.9
		408.36														
5075			INLET AT CHANNEL													
																15.0
BOX DRAIN #2	(East-West Road)															
3700			ADD TO BOX DRAIN # 1					36.3	0.0		0.0	0.0	818.0	818.0	4.3	12.8
		193.00	D46													
4800								156.9	0.0		0.0	0.0	700.1	700.1	4.8	14.8
		156.73														
5020			DROP STRU. INLET													
BOX DRAIN #3																
0			OUTLET INTO KALOI CHANNEL						0.0		0.0	0.0	833.8	833.8	5.3	10.7
		198.00														
245								175.0	0.0		0.0	0.0	833.8	833.8	7.2	10.4
		198.00	D46, D8 (NO ROAD. CHANNEL)													
1700	(Kalo Watershed)			15.0	0.70	2.3	2.0	23.0	74.1		74.1	74.1	0.0	74.1	1.5	2.1
		23.00														
2100	(Kapolei Watershed)		BEGIN CULVERT													



FILE: EX-BOXD.XLS DATE: 6/15/98 INLET	AREA NAME	Total Area (ac)	Other Flow Name	TC	C	(50-YR) i (in/hr)	F	A (ac)	Runoff Q=CiFA (cfs)	Other Flows (cfs)	Total Inflow (cfs)	Cumul Q=CiFA (cfs)	Phase & Group C (cfs)	Pipe Q (cfs)	Dn (ft)	Vf (fps)
BOX DRAIN #4																
0			OUTLET INTO KALDI CHANNEL													
		34.00							0.0		0.0	112.4	0.0	112.4	2.7	4.7
240																
		34.00	POR. D8 (NO ROAD, CHANNEL)	15.0	0.70	2.3	2.0	25.0	80.5		80.5	112.4	0.0	112.4	2.8	4.7
900	(Kalei Watershed)															
		9.00	POR. D8	10.0	0.70	2.3	2.2	9.0	31.9		31.9	31.9	0.0	31.9	1.6	2.0
1400	(Kapolei Watershed)		BEGIN CULVERT													
BOX DRAIN #5																
0			OUTLET INTO KALDI CHANNEL													
		26.00							0.0		0.0	84.6	0.0	84.6	1.7	3.7
240	(Kalei Watershed)															
		26.00	POR. D8 (NO ROAD, CHANNEL)	15.0	0.70	2.3	2.0	11.0	35.4		35.4	84.6	0.0	84.6	2.6	3.7
350																
		15.00	POR. D8	10.0	0.70	2.3	2.2	15.0	53.1		53.1	53.1	0.0	53.1	2.2	2.7
1400	(Kapolei Watershed)		BEGIN CULVERT													
BOX DRAIN #6	(Collector Road "A")															
0			OUTLET INTO KALDI CHANNEL													
		60.00	(10 AC. ADDED FOR CONTINGENCY)	10.0	0.70	2.3	2.3	18.7	61.7		61.7	222.2	0.0	222.2	2.8	5.6
270	(Kalei Watershed)															
		43.33		10.0	0.70	2.3	2.3	21.7	80.2		80.2	160.5	0.0	160.5	3.3	3.3
900																
		21.67		10.0	0.70	2.3	2.3	21.7	80.2		80.2	80.2	0.0	80.2	2.5	3.3
1500	(Kalei Watershed)		BEGIN CULVERT													

FILE: EX-BOXD.XLS DATE: 6/15/98 INLET	Pipe Diam. or Box Dim (in) X (ft)	L (ft)	n	Sf	S	INV. ELEV DOWN	INV ELEV UP	Hf (ft)	MANHOLE LOSSES A	B	C	D	EXT. CONT.	HGL DOWN	HGL UP	FIN GR.	FB (ft)
BOX DRAIN #1																	
0							62.00								72.80	80.3	
	2 - 12 X 8	90	0.013	0.002	0.005			0.27						73.07			
90						62.44	62.44				0.796				73.86	80.3	Full 6.47 FB
	2 - 12 X 8	220	0.013	0.003	0.005			0.65						74.52			
310						63.50	63.50				1.222				75.74	77.3	Full 1.56 FB
	2 - 10 X 8	1790	0.013	0.005	0.005			8.50						84.24			
2100						73.00	73.00		0.068	Expan					84.31	92.0	Full 7.69 FB
	1 - 16 X 8	1600	0.013	0.005	0.006			7.41						91.72			
3700						82.71	82.71		0.001	Expan	1.572	1.40			94.70	105.0	Full 10.30 FB
	1 - 12 X 8	75	0.013	0.005	0.005			0.40						95.10			
3775						83.08	83.08				1.563				96.66	105.0	Full 8.34 FB
	1 - 12 X 8	1200	0.013	0.005	0.005			6.37						103.03			
4975						89.08	89.08				1.563				104.60	114.5	Full 9.94 FB
	1 - 12 X 8	100	0.013	0.005	0.005			0.53						105.13			
5075						89.58	89.58						13.60		105.13	116.6	Full 11.48 FB
BOX DRAIN #2														94.70			
3700							82.71		0.084	Expan					94.78	105.0	Full 10.21 FB
	1 - 8 X 8	1100	0.013	0.005	0.016			5.46						104.32			
4800						100.00	102.00		0.077	Expan	0.487				106.58	121.7	Open 15.14 FB
	1 - 8 X 8	220	0.013	0.008	0.010			1.75						106.76			
5020						104.20	104.20						13.80		118.00	126.8	Full 8.81 FB
BOX DRAIN #3																	
0							58.50								63.18	74.9	
	1 - 15 X 8	245	0.013	0.003	0.005			0.70						63.88			
245						57.65	57.65				0.672				64.95	74.8	Open 9.85 FB
	1 - 10 X 8	1455	0.013	0.003	0.002			4.17						69.12			
1700						61.00	63.00		0.162	Expan					69.28	76.0	Full 6.72 FB
	1 - 8 X 8	400	0.013	0.000	0.005			0.08						69.36			
2100						65.00	65.00								69.36	77.0	Full 7.64 FB

FILE: EX-CULV.XLS		Total				(50-YR)			Runoff	Other	Total	Cumul.	Plate 8	Pipe		
DATE: 8/15/98	AREA	Area	Other Flow	Tc	C	i	F	A	q=CiFA	Flows	Inflow	Q=CiFA	Group C	Q	Dn	Vf
INLET	NAME	(ac)	Name			(in/hr)		(ac)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(ft)	(fps)
DRAINAGE AREA DE - CULVERT [illegible]																
OUTLET																
		8.70		10	0.80	2.3	2.3	2.9	12.3		12.3	36.8		36.8	1.8	2.9
DMH1	(HYPOTHETICAL															
	LENGTH OF PIPE	5.80		10	0.80	2.3	2.3	2.9	12.3		12.3	24.5		24.5	2.0	2.0
DMH2	AND MANHOLES															
	FOR ESTIMATING	2.90		10	0.80	2.3	2.3	2.9	12.3		12.3	12.3		12.3	1.3	1.7
DMH3	PURPOSES ONLY)															
DRAINAGE AREA DE - CULVERT [illegible]																
OUTLET																
		8.70		10	0.80	2.3	2.3	2.9	12.3		12.3	36.8		36.8	1.8	2.9
DMH1	(HYPOTHETICAL															
	LENGTH OF PIPE	5.80		10	0.80	2.3	2.3	2.9	12.3		12.3	24.5		24.5	2.0	2.0
DMH2	AND MANHOLES															
	FOR ESTIMATING	2.90		10	0.80	2.3	2.3	2.9	12.3		12.3	12.3		12.3	1.3	1.7
DMH3	PURPOSES ONLY)															
DRAINAGE AREA DE - CULVERT [illegible]																
OUTLET																
		17.40		10	0.80	2.3	2.3	5.8	24.5		24.5	73.6		73.6	2.4	3.6
DMH1	(HYPOTHETICAL															
	LENGTH OF PIPE	11.60		10	0.80	2.3	2.3	5.8	24.5		24.5	48.1		48.1	2.9	3.6
DMH4	AND MANHOLES															
	FOR ESTIMATING	5.80		10	0.80	2.3	2.3	5.8	24.5		24.5	24.5		24.5	2.3	3.5
DMH6	PURPOSES ONLY)															

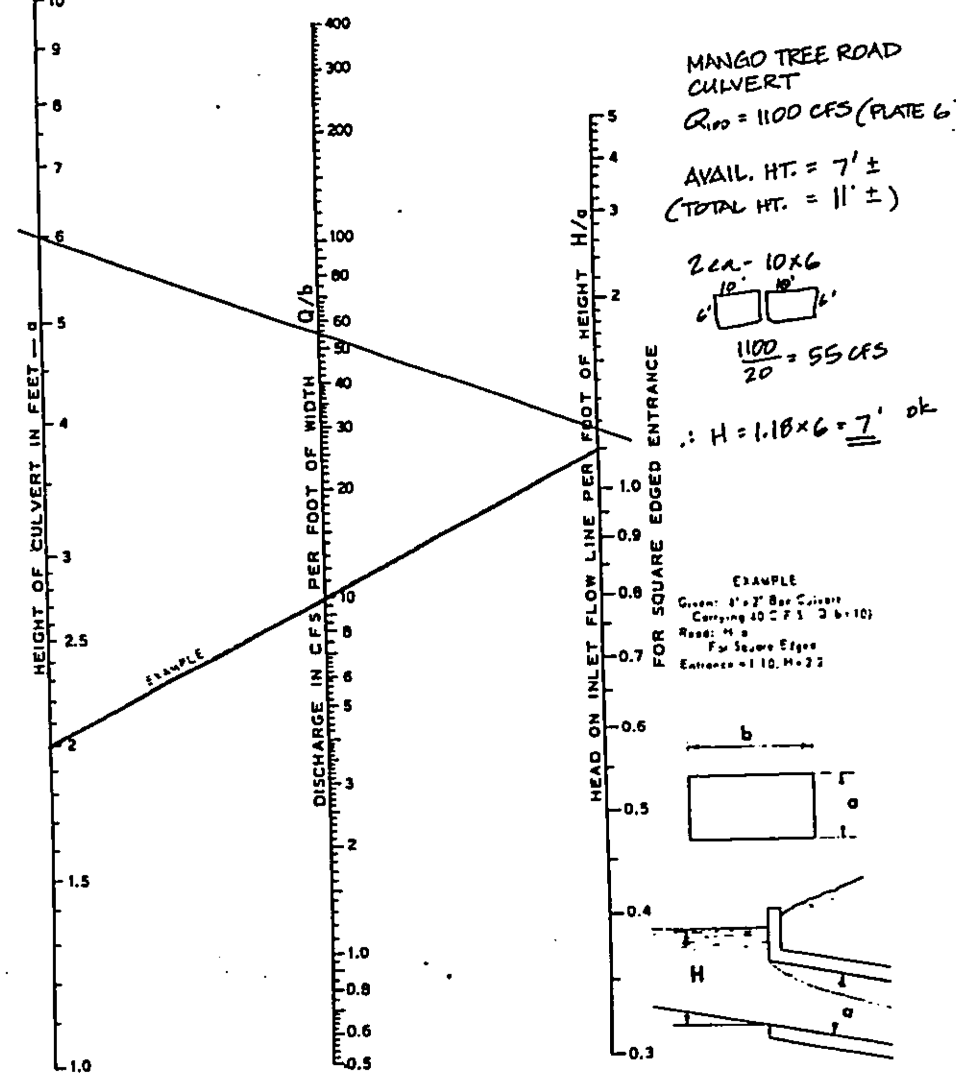
FILE: EX-BOXD.XLS	Pipe Diam. or								INV.	INV.										
DATE: 8/15/98	Box Dim.				L	n	Sf	S	ELEV.	ELEV	Hf	MANHOLE LOSSES				ENT.	H.G.L.		FIN.	FB
INLET		(ft)		(ft)	(ft)				DOWN	UP	(ft)	A	B	C	D	CONT.	DOWN	UP	GR.	(ft)
BOX DRAIN #4																				
0										53.30								63.08	69.9	
	1 -	8	X	4	240	0.013	0.007	0.005			0.32						63.40			
240									54.80	54.80				0.076				63.47	69.5	Full 6.07 FB
	1 -	6	X	4	660	0.013	0.007	0.002			0.87						64.34			
900									56.00	56.00		0.078	Expan					64.37	71.6	Full 7.22 FB
	1 -	4	X	4	500	0.013	0.000	0.002			0.15						64.52			
1400									59.00	59.00								64.52	68.5	Full 4.00 FB
BOX DRAIN #5																				
0										51.50								62.71	68.2	
	1 -	8	X	4	240	0.013	0.001	0.005			0.20						62.91			
240									52.80	52.80		0.000	Expan					62.91	65.6	Full 2.69 FB
	1 -	6	X	4	610	0.013	0.007	0.001			0.50						63.40			
850									53.00	53.00				0.035				63.44	66.6	Full 2.76 FB
	1 -	6	X	4	550	0.013	0.000	0.001			0.16						63.60			
1400									53.50	53.50								63.60	64.7	Full 1.14 FB
BOX DRAIN #6																				
0										112.00								118.70	131.9	
	1 -	8	X	5	270	0.013	0.007	0.005			0.36						119.06			
270									113.30	113.30		0.003	Expan	0.128				119.19	131.4	Full 12.23 FB
	1 -	8	X	5	530	0.013	0.007	0.002			0.77						119.96			
800									114.50	115.50		0.027	Expan					119.98	131.4	Full 11.44 FB
	1 -	8	X	4	1000	0.013	0.007	0.002			0.87						120.86			
1800									117.00	117.00								123.84	131.4	Full 10.79 FB

FILE: EX-CULV.XLS DATE: 8/15/98 INLET	AREA NAME	Total Area (ac)	Other Flow Name	Tc	C	(10-YR) I (in/hr)	T	A (ac)	Runoff q=CIA (cfs)	Other Flows (cfs)	Total Inflow (cfs)	Cumul. Q=CIA (cfs)	Plate & Group C (cfs)	Pipe Q (cfs)	Dn (ft)	W (fps)
DRAINAGE AREA DE - CULVERT [illegible]																
OUTLET																
		17.40		10	0.70	2.3	2.3	5.8	21.5		21.5	64.4		64.4	2.2	3.3
DMH1	(HYPOTHETICAL															
	LENGTH OF PIPE	11.80		10	0.70	2.3	2.3	5.8	21.5		21.5	43.0		43.0	2.9	3.4
DMH4	AND MANHOLES															
	FOR ESTIMATING	5.80		10	0.70	2.3	2.3	5.8	21.5		21.5	21.5		21.5	2.1	3.8
DMH5	PURPOSES ONLY)															
DRAINAGE AREA DE - CULVERT [illegible]																
OUTLET																
		17.40		10	0.70	2.3	2.3	5.8	21.5		21.5	64.4		64.4	2.2	3.3
DMH1	(HYPOTHETICAL															
	LENGTH OF PIPE	11.80		10	0.70	2.3	2.3	5.8	21.5		21.5	43.0		43.0	2.9	3.4
DMH4	AND MANHOLES															
	FOR ESTIMATING	5.80		10	0.70	2.3	2.3	5.8	21.5		21.5	21.5		21.5	2.1	3.0
DMH5	PURPOSES ONLY)															
DRAINAGE AREA DE - CULVERT [illegible]																
OUTLET																
		17.40		10	0.70	2.3	2.3	5.8	21.5		21.5	64.4		64.4	2.2	3.3
DMH1	(HYPOTHETICAL															
	LENGTH OF PIPE	11.80		10	0.70	2.3	2.3	5.8	21.5		21.5	43.0		43.0	2.8	3.4
DMH4	AND MANHOLES															
	FOR ESTIMATING	5.80		10	0.70	2.3	2.3	5.8	21.5		21.5	21.5		21.5	1.8	3.0
DMH5	PURPOSES ONLY)															

FILE: EX-CULV.XLS DATE: 8/15/98 INLET	Pipe Diam. or Box Dim #	(in)	(ft)	L (ft)	n	Sf	S	INV. ELEV DOWN	INV. ELEV UP	Hf (ft)	MANHOLE LOSSES A	B	C	D	ENT. CONT.	HGL DOWN	UP	FIN GR.	FB (ft)
DRAINAGE AREA DE -																72.80			
OUTLET									71.00								72.80	83.7	
	1	48		300	0.013	0.001	0.003			0.26						74.30			
DMH1								72.50	72.50		0.008	0.073	0.015	0.33	3.182		76.05	82.1	Open 6.05 FB
	1	48		1000	0.013	0.000	0.007			0.39						76.44			
DMH2								74.00	75.00		0.003	0.017	0.006	0.50	3.058		77.54	91.0	Open 13.46 FB
	1	36		700	0.013	0.000	0.003			0.32						78.29			
DMH3								77.00							2.298		79.30	91.0	Full 11.70 FB
DRAINAGE AREA DE -																72.80			
OUTLET									79.00								80.80	91.0	
	1	48		300	0.013	0.001	0.003			0.26						82.30			
DMH1								80.50	80.50		0.008	0.073	0.015	0.33	3.182		84.05	88.7	Open 4.65 FB
	1	48		1000	0.013	0.000	0.007			0.39						84.44			
DMH2								82.00	83.00		0.003	0.017	0.006	0.50	3.058		85.56	98.4	Open 12.84 FB
	1	36		700	0.013	0.000	0.003			0.32						86.29			
DMH3								85.00							2.298		87.30	98.7	Full 11.38 FB
DRAINAGE AREA DE -																72.84			
OUTLET									77.00								78.33	100.0	
	1	60		300	0.013	0.001	0.003			0.32						80.85			
DMH1								78.50	88.50		0.021	0.000	0.047	0.35	4.064		91.38	99.0	Open 7.62 FB
	1	48		1000	0.013	0.002	0.002			1.54						93.38			
DMH4								90.50	91.50		0.021	0.049	0.047	0.50	3.354		94.40	100.0	Open 5.60 FB
	1	36		1000	0.013	0.002	0.003			1.80						96.20			
DMH5								93.50							2.532		96.20	100.0	Full 3.80 FB

NOMOGRAPH FOR BOX CULVERTS WITH ENTRANCE CONTROL

PLATE 20



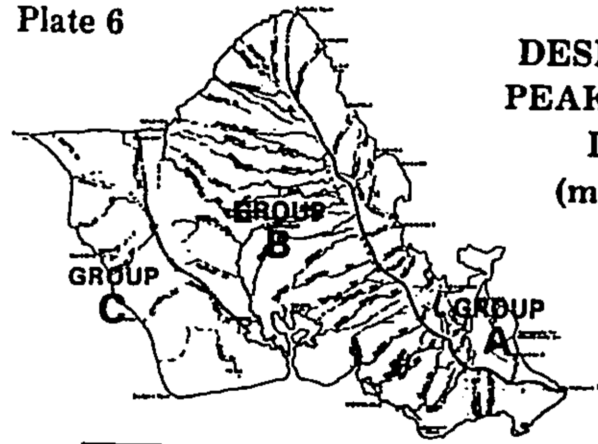
FILE: EX-CULV.XLS DATE: 6/15/98 INLET	Pipe Diam. or Box Dim.	(in)	L (ft)	n	Sf	S	INV. ELEV. DOWN	INV. ELEV. UP	Hf (ft)	MANHOLE LOSSES A	B	C	D	ENT. CONT.	HGL DOWN	HGL UP	FIN GR	FB (ft)
DRAINAGE AREA 1A:															83.20			
																97.20	112.4	EX Cont 15.17 FB
								95.00										
OUTLET									0.24						98.70			
	1	60	300	0.015	0.001	0.005				0.013	0.000	0.027	0.33	3.978		100.86	113.0	Open 8.14 FB
							96.50	97.50										
DMH1									1.15						102.05			
	1	48	1000	0.015	0.001	0.002				0.013	0.037	0.027	0.50	3.262		102.79	111.5	Open 8.64 FB
							99.00	100.00										
DMH4									1.36						104.17			
	1	36	1000	0.015	0.001	0.002								2.459		104.46	114.0	Full 9.54 FB
							102.00											
DMH5																		
DRAINAGE AREA 1B:															108.00			
																108.00	119.8	Full 11.75 FB
								103.00										
OUTLET									0.24						108.24			
	1	62	300	0.015	0.001	0.005				0.013	0.000	0.027	0.33	3.978		108.86	117.9	Open 8.04 FB
							104.50	105.50										
DMH1									1.15						110.05			
	1	48	1000	0.015	0.001	0.002				0.013	0.037	0.027	0.50	3.262		110.79	118.0	Open 7.21 FB
							107.00	108.00										
DMH4									1.36						112.17			
	1	36	1000	0.015	0.001	0.002								2.459		112.46	120.0	Full 7.54 FB
							110.00											
DMH5																		
DRAINAGE AREA 1C:															114.30			
																115.30	127.1	Full 12.83 FB
								107.50										
OUTLET									0.24						114.74			
	1	60	300	0.015	0.001	0.003				0.013	0.000	0.027	0.33	3.978		115.13	125.8	EX Cont 10.33 FB
							108.00	110.00										
DMH1									1.19						116.33			
	1	48	1000	0.015	0.001	0.002				0.013	0.037	0.027	0.50	3.262		116.90	124.7	Open 7.77 FB
							112.00	113.00										
DMH4									0.87						117.87			
	1	36	700	0.015	0.001	0.002								2.459		117.67	127.8	Full 9.87 FB
							115.00											
DMH5																		

APPENDIX E

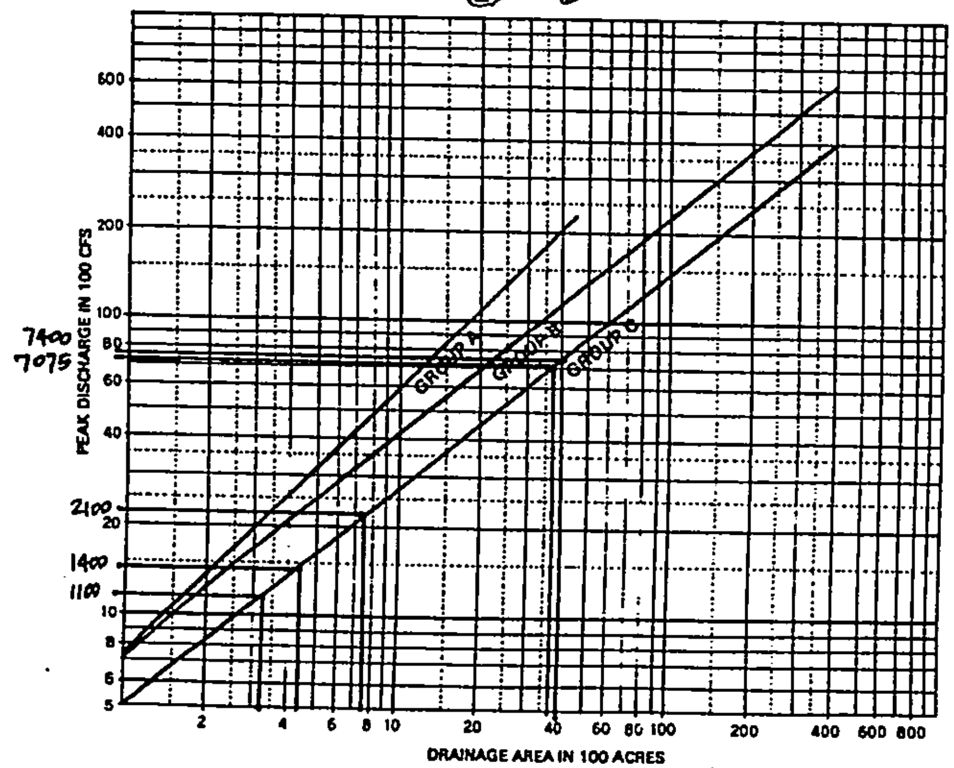
CITY & COUNTY PLATE 6 DISCHARGES

Plate 6

DESIGN CURVES FOR PEAK DISCHARGE VS. DRAINAGE AREA (more than 100 acres)



● CURVES ARE FOR STREAM CHANNELS AND DRAINAGE STRUCTURES.



SOURCE DATA FROM U.S. GEOLOGICAL SURVEY

APPENDIX F

RELATED DRAINAGE MASTER PLANS

- Ewa Villages Drainage Master Plan
- Kapolei Village Drainage Master Plan

EWA VILLAGES

DRAINAGE MASTER PLAN

Ewa, Oahu, Hawaii

KENNETH T. YAMADA
LICENSED PROFESSIONAL ENGINEER
No. 4153-C
HAWAII, U.S.A.

Kenneth T. Yamada

Kenneth T. Yamada
Project Manager

Prepared for:

Department of Housing and Community Development
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

APRIL 1996
(REV. 3/97)

Prepared by:

R. M. Towill Corporation
420 Waiakamilo Road, Suite 411
Honolulu, Hawaii 96817

SECTION 4
PROPOSED DRAINAGE PLAN

4.1 Drainage Plan Concept

The intent of the drainage plan is to control riverine flooding and provide adequate drainage for on-site and off-site generated runoff.

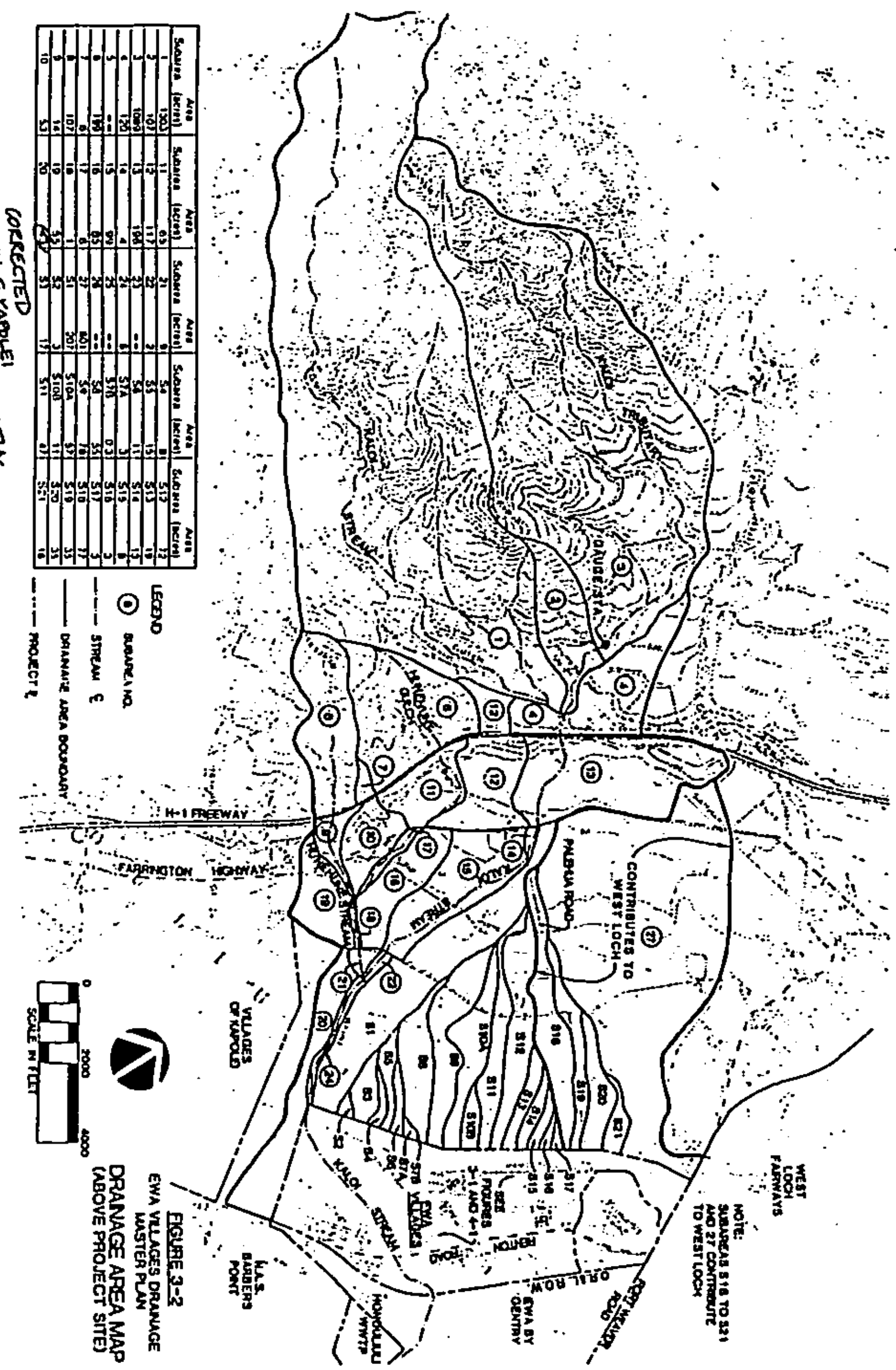
To carry out the plan, "regional" facilities are proposed to address off-site runoff and mitigate flooding from Kaloi Stream. "Backbone" facilities are proposed to address on-site generated runoff and feeds into the regional facilities. The street drainage systems within each of the development parcels which feed the backbone system are referred to as the subdivision systems. Due to the preliminary status of street layouts within these subdivisions, sizing and alignment of these smaller systems are left as design items.

4.2 Regional Drainage System

Flood control along Kaloi Stream and conveyance of major runoff are handled by the regional drainage system. The primary facilities of the regional system include the golf course, Kaloi Stream channel improvements, and roadway bridges and box culverts. Figure 4-1 shows the regional drainage system.

The regional facilities were sized using the criteria in Section 2. HEC-1 analyses were conducted to determine the 2-year, 10-year and 100-year peak flow rates under Interim and Ultimate conditions. Interim conditions refer to the watershed with the areas above Ewa Villages as undeveloped (remain as sugarcane/agriculture). Ultimate conditions assume that the areas above Ewa Villages are reasonably built-out.

The golf course is the main regional facility. It stretches the entire length of the project site and intercepts all incoming mauka flows. The golf course will be excavated in order to convey the City standard Plate 6 peak discharge. Detention basins will be incorporated to help attenuate peak flows and address water quality.



Subarea	Area (acres)	Subarea	Area (acres)	Subarea	Area (acres)	Subarea	Area (acres)	Subarea	Area (acres)
1	1303	11	65	21	9	S4	8	S12	72
2	107	12	117	22	3	S5	15	S13	19
3	1089	13	198	23	--	S6	11	S14	13
4	120	14	4	24	6	S7A	3	S15	6
5	--	15	99	25	--	S7B	0.3	S16	3
6	199	16	85	26	--	S8	55	S17	3
7	6	17	6	27	801	S9	78	S18	77
8	107	18	1	S1	207	S10A	57	S19	35
9	14	19	52	S2	3	S10B	11	S20	35
10	53	20	[illegible]	S3	17	S11	47	S21	16

CORRECTED IN E. KAPOLEI DRN. M.P. A= 107Ac.

FIGURE 3-2
EWA VILLAGES DRAINAGE MASTER PLAN
DRAINAGE AREA MAP
(ABOVE PROJECT SITE)

Kaloi Stream will be realigned slightly as part of the golf course and downstream channel improvements. The connection point to the Gentry development is about 350 feet southwest of the present Kaloi channel crossing at the OR&L Railroad Right-of-Way. The invert tie-in to the Gentry development is 26 feet msl.

A 105-foot wide bridge is proposed at the Kaloi Stream/OR&L Railroad crossing. Ninety-foot wide bridges are also proposed at North-South Road and at Renton Road. Each of these bridges are designed to pass the Plate 6 discharge. Interim use basins will be constructed between each of these bridges. Ultimately, an open channel will replace the basins. The channel will consist of rectangular and trapezoidal sections, varying in width between 90 and 110 feet. The channel will be lined with concrete and riprap and is proposed to be maintained by the City.

Overflows from Kaloi Stream above Ewa Villages is expected to flow on the east overbank and enter Ewa Villages from subwatershed S1.

A 20' x 8' box culvert is planned at the top of Kaloi Stream Branch "A" at the northwest corner of the golf course. This culvert is sized to the capacity of the Kaloi Stream channel (approximately 1,000 feet). It is anticipated that this culvert will be expanded in the future to carry the Plate 6 discharge.

A 20' x 8' box culvert/golf cart underpass along Branch "B" at the subdivision "A" Access Road will also be used. It is anticipated that when the mauka lands are developed, a large drainage culvert will be installed at the golf course boundary at subwatershed S7B to carry runoff into Basin 5.

A set of pipe culverts are proposed to pass the 10-year flow beneath relocated Mango Tree Road. These culverts will be temporary until the mauka drainage systems are implemented. A 10-year protection was used as required by the Oahu Sugar Company.

The State Department of Land and Natural Resources (DLNR) required that relocated Mango Tree Road be placed at existing grade. Flows exceeding the 10-year storm will overtop the roadway and enter the golf course. Contouring within the golf course will direct these flows either to Kaloi Stream (Branches "A" or "B") or to West Loch (Fort Weaver Road).

The golf course detention basins and outlets are used to control discharge and provide on-site storage. The storage and outflow requirements are based on the goals of the Kaloi Stream Technical Committee. For the interim period until the Ewa Marina opens the flow capacity, the Committee recommended minimal release of flows from the basins until on-site storage of approximately 60 acre-feet is obtained. Subsequently, the basin outflows are to be limited to the 2-year, 6-hour rate until on-site detention of approximately 300 acre-feet is obtained.

Runoff contributing to West Loch are routed to two basins before entering the two existing 54-inch culverts at Fort Weaver Road. Based on the Fernandez Village HGL of 39 feet, the inlet capacity of these culverts is about 500 cfs. The culverts are not planned to be upgraded at this time since the routed 100-year flow does not exceed the 500 cfs limit.

The golf course is sized with sufficient capacity to pass the Plate 6 flow to Fort Weaver Road, however, improvements will be needed should the mauka areas develop and add runoff to the golf course. The two culverts at Fort Weaver Road may need upgrading. An existing 42-inch water main crossing between Basins 8 and 9 limit the amount of runoff that may leave Basin 8.

Multiple HEC-1 computations were made to size the basins and outlets to allow passage of the 100-year flow while meeting the Technical Committee's recommended storage volumes and controlled outflow rates. The resulting discharges for interim and ultimate conditions are shown on Table 5-1. Flooding from Kaloi Stream will be controlled ultimately by increasing capacity at the OR&L Railroad right-of-way and excavating drainageways through the golf course.

The FEMA flood map revision that reflects the interim conditions described herein became effective on March 21, 1995 (Reference 16). A request for flood map revision to show the ultimate conditions is planned to be submitted to FEMA in the near future.

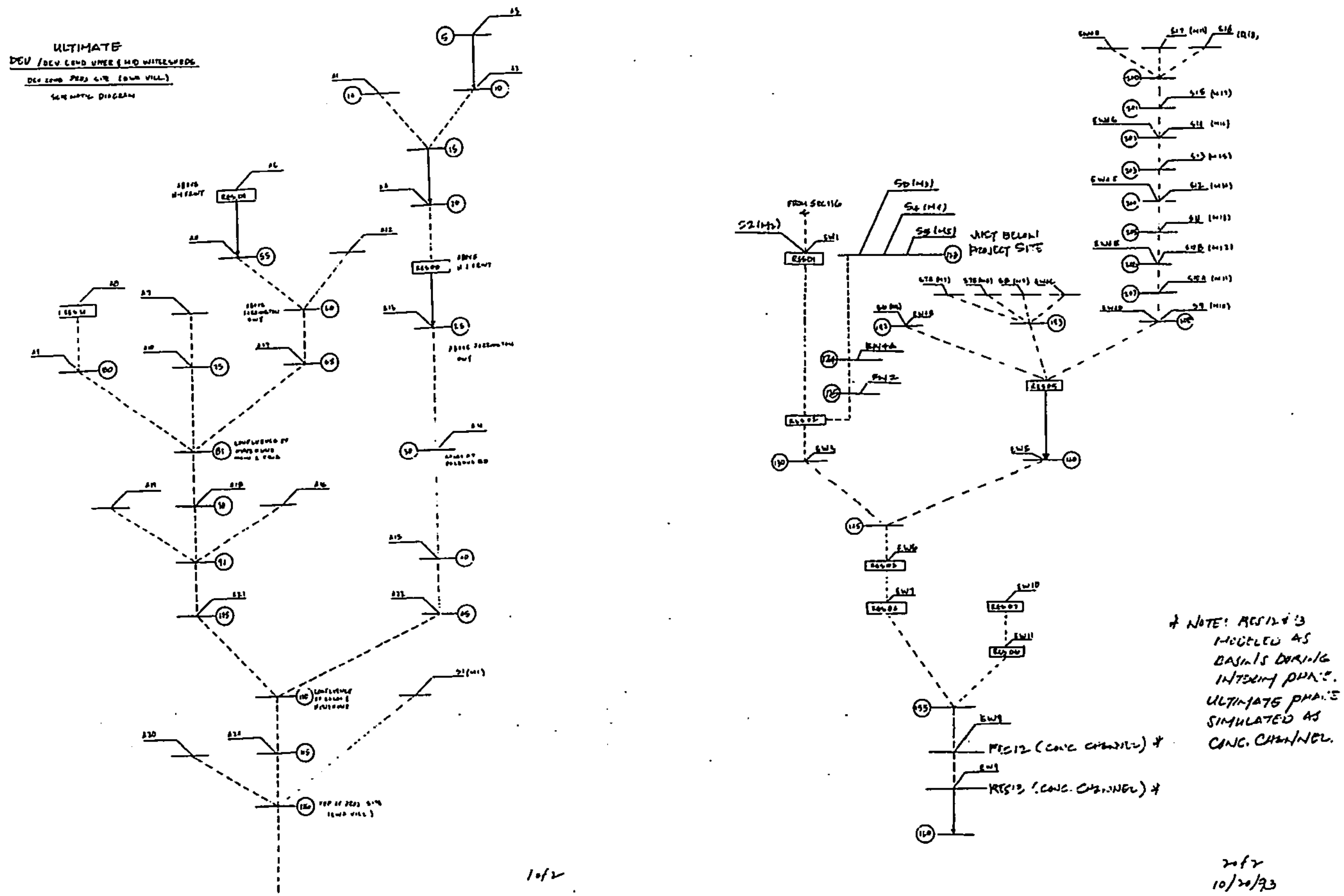
4.3 Backbone Drainage System

The backbone system consists of major pipe and box culverts which convey on-site generated runoff from the subdivision systems, as well as a portion of the golf course, to the OR&L Railroad bridge. The middle portion of the golf course below Subdivision "B" does not accept any off-site runoff and is considered a part of the backbone system (rather than part of the regional system). Figure 4-2 illustrates the layout of the backbone drainage system. Drain line and node labels are indicated for cross-referencing with the discharge, invert and HGL data in the appendices.

The backbone system includes facilities sized to convey runoff from the off-site area west of the project site.

APPENDIX D

REGIONAL HYDROLOGY FOR ULTIMATE CONDITIONS


ULTIMATE
S2 (M3)
FROM SEC.116
S0 (M3)
S4 (M4)
S5 (M5)
JUST BELOW PROJECT SITE
RES12 (CONC. CHANNEL) *
RES13 (CONC. CHANNEL) *
* NOTE: RES12 & 13
MODELED AS
BASINS DURING
INTERIM PHASE.
ULTIMATE PHASE
SIMULATED AS
CONC. CHANNEL.
1 of 2
2 of 2
10/20/93

```
                                        ****
            FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985
   U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616
                                        ****
```

HEC-1 ANALYSIS - KALOI
100-YR, 24-HR STORM (ULTIMATE)

```
THIS HEC-1 VERSION CONTAINS ALL OPTIONS EXCEPT ECONOMICS, AND THE NUMBER OF PLANS ARE REDUCED TO 3

                                 HEC-1 INPUT                                              PAGE 1

LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1        ID   EWA VILLAGES PROJECT FLOOD (100-YEAR STORM)
  2        ID   FN: Y100.HEC (BRIDGE AT ORAL ROW)
  3        ID   PROJECT CONDITIONS: UPPER WATERSHED - DEVELOPED CONDITIONS
  4        ID   (ULTIMATE)          EWA VILLAGES    - DEVELOPED CONDITIONS
  5        ID   KALOI - MAKAKILO NETWORK MODE   (10/17/93)
           *DIAGRAM
  6        IT      5 01JAN93    1200     300
  7        IO      5

  8        KK     A3
  9        KM          GENERATE HYDROGRAPH FROM SUBBASIN A3 TO SEC05
 10        KM          UPPERMOST WATERSHED PRECIPITATION DATA
 11        BA   1.701
 12        PH          1.701     .69    1.40    2.60    3.70    4.75    6.85    9.30   12.70
 13        LS      0      68
 14        UD   1.206

 15        KK   SEC10
 16        KM          ROUTE KALOI TRIBUTARY FLOW FROM SEC05 TO SEC10
 17        KM          KALOI STREAM ABOVE CONFLUENCE OF MAIN AND TRIBUTARY
 18        RS      1    FLOW       0
 19        RC   0.035   .035   0.035    2250   0.024     220
 20        RX      0     150     155     165     180     190     195     520
 21        RY    220     218     215     208     208     218     218     220

 22        KK     A2
 23        KM          GENERATE HYDROGRAPH FROM SUBBASIN A2 TO SEC10
 24        KM          UPPERMOST WATERSHED PRECIPITATION DATA
 25        BA   0.167
 26        PH          0.167     .69    1.40    2.60    3.70    4.75    6.85    9.30   12.70
 27        LS      0      66
 28        UD   0.390

 29        KK   SEC10
 30        KM          COMBINE HYDROGRAPHS AT SEC10
 31        HC      2

 32        KK     A1
 33        KM          GENERATE HYDROGRAPH FROM SUBBASIN A1 TO SEC14
 34        KM          UPPERMOST WATERSHED PRECIPITATION DATA
 35        BA   2.036
 36        PH          2.036     .69    1.40    2.60    3.70    4.75    6.85    9.30   12.70
 37        LS      0      70
 38        UD   1.434

 39        KK   SEC15
 40        KM          COMBINE HYDROGRAPHS AT SEC15
 41        HC      2

 42        KK   SEC20
 43        KM          ROUTE KALOI TRIBUTARY FLOW FROM SEC15 TO SEC20
 44        RS      2    FLOW       0
 45        RC   .035    .035    .035     200   0.025     207
 46        RX      0     160     180     190     205     240     400     550
 47        RY    215     215     215     194     194     207     210     215
                                 HEC-1 INPUT                                              PAGE 2

LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10
```

1

```
 48        KK     A4
 49        KM          GENERATE HYDROGRAPH FROM SUBBASIN A4 TO SEC20
 50        KM          UPPER WATERSHED PRECIPITATION DATA
 51        BA   0.188
 52        PH          0.188     .66    1.35    2.50    3.60    4.65    6.80    9.25   12.50
 53        LS      0      66
 54        UD   0.450

 55        KK   SEC20
 56        KM          COMBINE HYDROGRAPHS AT SEC20
 57        HC      2

 58        KK . RESO8
 59        KM          ROUTE FLOW FROM SEC20 THROUGH RESO8
 60        RS      1    ELEV   193.5
 61        SV      0     0.1     0.8     3.1     6.9    12.1    18.8    28.5    54.1
 62        SE   193.5    200     202     204     206     208     210     212     215
 63        SQ      0     500     725     964    1285    2099    3121    3541    3904
 64        SE   193.5    200     202     204     206     208     210     212     215

 65        KK   SEC25
 66        KM          ROUTE KALOI TRIBUTARY FLOW FROM RESO8 TO SEC25
 67        RS      2    FLOW       0
 68        RC   .035    .035    .035    2350   0.013     165
 69        RX      0     270     330     340     355     640     700     900
 70        RY    170     165     165     158     158     165     167     170

 71        KK    A13
 72        KM          GENERATE HYDROGRAPH FROM SUBBASIN A13 TO SEC25
 73        KM          MID-WATERSHED PRECIPITATION DATA
 74        BA   0.307
 75        PH          0.307     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 76        LS      0      79
 77        UD   0.290

 78        KK   SEC25
 79        KM          COMBINE HYDROGRAPHS AT SEC25
 80        HC      2

 81        KK    A14
 82        KM          GENERATE HYDROGRAPH FROM SUBBASIN A14 TO SEC30
 83        KM          MID-WATERSHED PRECIPITATION DATA
 84        BA   0.007
 85        PH          0.007     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 86        LS      0      78
 87        UD   0.050

 88        KK   SEC30
 89        KM          COMBINE HYDROGRAPHS AT SEC30
 90        HC      2
                                 HEC-1 INPUT                                              PAGE 3

LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 91        KK    A15
 92        KM          GENERATE HYDROGRAPH FROM SUBBASIN A15 TO SEC40
 93        KM          MID-WATERSHED PRECIPITATION DATA
 94        BA   0.155
 95        PH          0.155     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
 96        LS      0      88
 97        UD   0.270

 98        KK . SEC40
 99        KM          COMBINE HYDROGRAPHS AT SEC40
100        HC      2

101        KK    A22
102        KM          GENERATE HYDROGRAPH FROM SUBBASIN A15 TO SEC45
103        KM          MID-WATERSHED PRECIPITATION DATA
104        BA   0.003
105        PH          0.003     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
106        LS      0      85
107        UD   0.050
```

2

```
KK   SEC45
KM        COMBINE HYDROGRAPHS AT SEC45
HC      2

KK     A6
KM        GENERATE HYDROGRAPH FROM SUBBASIN A6 TO RES09
KM        UPPER WATERSHED PRECIPITATION DATA
BA   0.312
PH          0.312     .66    1.35    2.50    3.60    4.65    6.80    9.25   12.50
LS       0     66
UD   0.230

KK   RES09
KM        ROUTE NUMENUME FLOW FROM SUBBASIN A6 THROUGH RES09
RS   .   1   ELEV   206.5
SV       0     0.1     0.3     0.5     0.9     1.1     1.1
SE   206.5     218     220     222     224   225.5     226
SQ       0     692     755     817     888     923     907
SE   206.5     218     220     222     224   225.5     226

KK   SEC55
KM        ROUTE NUMENUME FLOW FROM RES09 TO SEC55
RS       2    FLOW       0
RC    .035    .035    .035    2950     .01     150
RX       0     430     510     517     527     534     545     670
RY     150     150     150     143     143     150     155     160

KK    A11
KM        GENERATE HYDROGRAPH FROM SUBBASIN A11 TO SEC55
KM        MID-WATERSHED PRECIPITATION DATA
BA   0.101
PH          0.101     .65    1.32    2.45    3.35    4.60    6.75    9.20   12.30
LS       0     77
UD   0.180
                             HEC-1 INPUT                                         PAGE 4

     ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

KK   SEC55
KM        COMBINE HYDROGRAPHS AT SEC55
HC      2

KK    A12
KM        GENERATE HYDROGRAPH FROM SUBBASIN A12 TO SEC50
KM        MID-WATERSHED PRECIPITATION DATA
BA   0.183
PH          0.183     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
LS       0     83
UD   0.300

KK   SEC60
KM        COMBINE HYDROGRAPHS AT SEC60
HC      2

KK    A17
KM        GENERATE HYDROGRAPH FROM SUBBASIN A17 TO SEC65
KM        MID-WATERSHED PRECIPITATION DATA
BA   0.009
PH          0.009     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
LS       0     78
UD   0.130

KK   SEC65
KM        COMBINE HYDROGRAPHS AT SEC65
HC      2

KK     A7
KM        GENERATE HYDROGRAPH FROM SUBBASIN A7 TO SEC70
KM        UPPER WATERSHED PRECIPITATION DATA
BA   0.009
PH          0.009     .66    1.35    2.50    3.60    4.65    6.80    9.25   12.50
LS       0     70
UD   0.060

KK    A10
KM        GENERATE HYDROGRAPH FROM SUBBASIN A10 TO SEC75
```



```
KM        MID-WATERSHED PRECIPITATION DATA
BA   0.082
PH          0.082     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
LS       0     76
UD   0.130

KK   SEC75
KM        COMBINE HYDROGRAPHS AT SEC75
HC      2

KK     A8
KM        GENERATE HYDROGRAPH FROM SUBBASIN A8 TO RES09
KM        UPPER WATERSHED PRECIPITATION DATA
BA   0.168
PH          0.168     .66    1.35    2.50    3.60    4.65    6.80    9.25   12.50
LS       0     73
                             HEC-1 INPUT                                         PAGE 5

     ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

UD   0.270

KK   RES14
KM        ROUTE NUMENUME FLOW FROM SUBBASIN A8 THROUGH RES14
RS       1    ELEV     220
SV       0    0.05     0.3     0.4     0.5     0.6     0.7     0.8
SE     220     230     232     234     236     238     240     242
SQ       0     100     175     225     350     425     525     625
SE     220     230     232     234     236     238     240    ,242

KK     A9
KM        GENERATE HYDROGRAPH FROM SUBBASIN A9 TO SEC80
KM        MID-WATERSHED PRECIPITATION DATA
BA   0.021
PH          0.021     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
LS       0     77
UD   0.160

KK   SEC80
KM        COMBINE HYDROGRAPHS AT SEC80
HC      2

KK   SEC81
KM        COMBINE HYDROGRAPHS AT SEC81
HC      3

KK    A18
KM        GENERATE HYDROGRAPH FROM SUBBASIN A18 TO SEC90
KM        MID-WATERSHED PRECIPITATION DATA
BA   0.002
PH          0.002     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
LS       0     78
UD   0.070

KK   SEC90
KM        COMBINE HYDROGRAPHS AT SEC90
HC      2

KK    A19
KM        GENERATE HYDROGRAPH FROM SUBBASIN A19 TO SEC100
KM        MID-WATERSHED PRECIPITATION DATA
BA   0.087
PH          0.087     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
LS       0     84
UD   0.210

KK    A16
KM        GENERATE HYDROGRAPH FROM SUBBASIN A18 TO SEC95
KM        MID-WATERSHED PRECIPITATION DATA
BA   0.133
PH          0.133     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
LS       0     84
UD   0.220
                             HEC-1 INPUT                                         PAGE 6

     ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10
```

```
229          KK  SEC91
230          KM       COMBINE HYDROGRAPHS AT SEC91
231          NC      3

232          KK     A21
233          KM       GENERATE HYDROGRAPH FROM SUBBASIN A21 TO SEC105
234          KM       MID-WATERSHED PRECIPITATION DATA
235          BA   0.014
236          PH          0.014     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
237          LS       0     78
238          UD   0.060

239          KK  SEC105
240          KM       COMBINE HYDROGRAPHS AT SEC105
241          NC      2

242          KK  SEC110
243          KM       COMBINE HYDROGRAPHS AT SEC110
244          KM       CONFLUENCE OF KALOI AND HUNEHUNE STREAMS
245          NC      2

246          KK     A24
247          KM       GENERATE HYDROGRAPH FROM SUBBASIN A24 TO SEC115
248          KM       MID-WATERSHED PRECIPITATION DATA
249          BA   0.010
250          PH          0.010     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
251          LS       0     88
252          UD   0.180

253          KK  SEC115
254          KM       COMBINE HYDROGRAPHS AT SEC115
255          NC      2

256          KK·    A20
257          KM       GENERATE HYDROGRAPH FROM SUBBASIN A20 TO SEC125
258          KM       MID-WATERSHED PRECIPITATION DATA
259          BA   0.067
260          PH          0.067     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
261          LS       0     88
262          UD   0.220

263          KK      S1
264          KM       GENERATE HYDROGRAPH FROM SUBBASIN S1 TO SEC118
265          KM       MID-WATERSHED PRECIPITATION DATA
266          BA   0.324
267          PH          0.324     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
268          LS       0     86
269          UD   0.520
1                                     HEC-1 INPUT                                          PAGE 7

LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

270          KK  SEC116
271          KM       COMBINE HYDROGRAPHS AT SEC116 (TOP OF PROJECT SITE - KALOI GULCH)
272          NC      3

273          KK      S2
274          KM       GENERATE HYDROGRAPH FROM SUBBASIN S2 TO RES01
275          KM       MID-WATERSHED PRECIPITATION DATA
276          BA   0.004
277          PH          0.004     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
278          LS       0     88
279          UD   0.030

280          KK     EW1
281          KM       GENERATE HYDROGRAPH FROM SUBBASIN EW1 TO RES01
282          KM       EWA VILLAGES PRECIPITATION DATA
283          BA   0.029
284          PH          0.029     .64    1.30    2.41    3.50    4.55    6.70    9.10   12.20
285          LS       0     80
286          UD   0.070

287          KK   RES01
288          KM       COMBINE HYDROGRAPHS AT RES01
289          NC      3

                                        5

290          KK   RES01
291          KM       ROUTE FLOW FROM SEC116 THROUGH RES01
292          RS       1    ELEV      40
293          SV       0     6.0     8.3    11.8    16.4    22.2    29.1    37.2    46.2    60.9
294          SE      40      44      45      46      47      48      49      50      51      52
295          SQ       0      10      45      60      72      82     391     948    2761    7309
296          SE      40      44      45      46      47      48      49      50      51      52

297          KK      S3
298          KM       GENERATE HYDROGRAPH FROM SUBBASIN S3 TO SEC123
299          KM       MID-WATERSHED PRECIPITATION DATA
300          BA   0.027
301          PH          0.027     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
302          LS     · 0     88
303          UD   0.090

304          KK      S4
305          KM       GENERATE HYDROGRAPH FROM SUBBASIN S4 TO SEC123
306          KM       MID-WATERSHED PRECIPITATION DATA
307          BA   0.012
308          PH          0.012     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
309          LS       0     88
310          UD   0.090

311          KK      S5
312          KM       GENERATE HYDROGRAPH FROM SUBBASIN S5 TO SEC123
313          KM       MID-WATERSHED PRECIPITATION DATA
314          BA   0.023
315          PH          0.023     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
316          LS       0     88
1                                     HEC-1 INPUT                                          PAGE 8

LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

317          UD   0.140

318          KK  SEC123
319          KM       COMBINE HYDROGRAPHS AT SEC123
320          NC      3

321          KK    EW4A
322          KM       GENERATE HYDROGRAPH FROM SUBBASIN EW4A TO SEC124
323          KM       EWA VILLAGES PRECIPITATION DATA
324          BA   0.006
325          PH          0.006     .64    1.30    2.41    3.50    4.55    6.70    9.10   12.20
326          LS       0     80
327          UD   0.071

328          KK  SEC124
329          KM       COMBINE HYDROGRAPHS AT SEC124
330          NC      2

331          KK     EV2
332          KM       GENERATE HYDROGRAPH FROM SUBBASIN EV2 TO SEC125
333          KM       EWA VILLAGES PRECIPITATION DATA
334          BA   0.030
335          PH          0.030     .64    1.30    2.41    3.50    4.55    6.70    9.10   12.20
336          LS       0     80
337          UD   0.134

338          KK  SEC125
339          KM       COMBINE HYDROGRAPHS AT SEC125
340          NC      2

341          KK   RES02
342          KM       COMBINE HYDROGRAPHS AT RES02
343          NC      2

344          KK   RES02
345          KM       ROUTE FLOW FROM RES01 THROUGH RES02
346          RS       1    ELEV      39
347          SV       0    10.2    13.5    17.6    22.6    28.4    35.0    42.7    51.6    67.1
348          SE      39      43      44      45      46      47      48      49      50    51.5
349          SQ       0      10      45      60      72      82     391     948    2806    7487
350          SE      39      43      44      45      46      47      48      49      50    51.5

                                        6
```

```
351          KK     EW3
352          KM          GENERATE HYDROGRAPH FROM SUBBASIN EW3 TO SEC130
353          KM          EWA VILLAGES PRECIPITATION DATA
354          BA   0.021
355          PH           0.021     .64    1.30    2.41    3.50    4.55    6.70    9.10   12.20
356          LS       0      80
357          UD   0.204
                                        HEC-1 INPUT                                         PAGE  9

LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

358          KK  SEC130
359          KM          COMBINE HYDROGRAPHS AT SEC130
360          HC       2

361          KK      S6
362          KM          GENERATE HYDROGRAPH FROM SUBBASIN S6
363          KM          MID-WATERSHED PRECIPITATION DATA
364          BA   0.017
365          PH           0.017     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
366          LS       0      88
367          UD   0.110

368          KK     EW4B
369          KM          GENERATE HYDROGRAPH FROM SUBBASIN EW4B
370          KM          EWA VILLAGES PRECIPITATION DATA
371          BA   0.008
372          PH           0.008     .64    1.30    2.41    3.50    4.55    6.70    9.10   12.20
373          LS       0      80
374          UD   0.049

375          KK  SEC192
376          KM          COMBINE HYDROGRAPHS AT SEC192
377          HC       2

378          KK     S7A
379          KM          GENERATE HYDROGRAPH FROM SUBBASIN S7A
380          KM          MID-WATERSHED PRECIPITATION DATA
381          BA   0.005
382          PH           0.005     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
383          LS       0      88
384          UD   0.040

385          KK     S7B
386          KM          GENERATE HYDROGRAPH FROM SUBBASIN S7B
387          KM          MID-WATERSHED PRECIPITATION DATA
388          BA   0.001
389          PH           0.001     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
390          LS       0      88
391          UD   0.010

392          KK      S8
393          KM          GENERATE HYDROGRAPH FROM SUBBASIN S8
394          KM          MID-WATERSHED PRECIPITATION DATA
395          BA   0.086
396          PH           0.086     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
397          LS       0      88
398          UD   0.270

399          KK     EW4C
400          KM          GENERATE HYDROGRAPH FROM SUBBASIN EW4C
401          KM          EWA VILLAGES PRECIPITATION DATA
402          BA   0.015
403          PH           0.015     .64    1.30    2.41    3.50    4.55    6.70    9.10   12.20
404          LS       0      80
                                        HEC-1 INPUT                                         PAGE 10

LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

405          UD   0.043

406          KK  SEC193
407          KM          COMBINE HYDROGRAPHS AT SEC193
408          HC       4

409          KK     S17
```



```
410          KM          GENERATE HYDROGRAPH FROM SUBBASIN S17
411          KM          MID-WATERSHED PRECIPITATION DATA
412          BA   0.004
413          PH           0.004     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
414          LS       0      88
415          UD   0.040

416          KK     S16
417          KM          GENERATE HYDROGRAPH FROM SUBBASIN S16
418          KM          MID-WATERSHED PRECIPITATION DATA
419          BA   0.004
420          PH           0.004     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
421          LS       0      88
422          UD   0.040

423          KK     EW4H
424          KM          GENERATE HYDROGRAPH FROM SUBBASIN EW4H
425          KM          EWA VILLAGES PRECIPITATION DATA
426          BA   0.004
427          PH           0.004     .64    1.30    2.41    3.50    4.55    6.70    9.10   12.20
428          LS       0      80
429          UD   0.115

430          KK  SEC200
431          KM          COMBINE HYDROGRAPHS AT SEC200
432          HC       3

433          KK     S15
434          KM          GENERATE HYDROGRAPH FROM SUBBASIN S15
435          KM          MID-WATERSHED PRECIPITATION DATA
436          BA   0.012
437          PH           0.012     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
438          LS       0      88
439          UD   0.100

440          KK  SEC201
441          KM          COMBINE HYDROGRAPHS AT SEC201
442          HC       2

443          KK     S14
444          KM          GENERATE HYDROGRAPH FROM SUBBASIN S14
445          KM          MID-WATERSHED PRECIPITATION DATA
446          BA   0.020
447          PH           0.020     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
448          LS       0      88
449          UD   0.130
                                        HEC-1 INPUT                                         PAGE 11

LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

450          KK     EW4G
451          KM          GENERATE HYDROGRAPH FROM SUBBASIN EW4G
452          KM          EWA VILLAGES PRECIPITATION DATA
453          BA   0.006
454          PH           0.006     .64    1.30    2.41    3.50    4.55    6.70    9.10   12.20
455          LS       0      80
456          UD   0.095

457          KK  SEC202
458          KM          COMBINE HYDROGRAPHS AT SEC202
459          HC       3

460          KK     S13
461          KM          GENERATE HYDROGRAPH FROM SUBBASIN S13
462          KM          MID-WATERSHED PRECIPITATION DATA
463          BA   0.030
464          PH           0.030     .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
465          LS       0      88
466          UD   0.160

467          KK  SEC203
468          KM          COMBINE HYDROGRAPHS AT SEC203
469          HC       2

470          KK     S12
471          KM          GENERATE HYDROGRAPH FROM SUBBASIN S12
```

```
472           KM       MID-WATERSHED PRECIPITATION DATA
473           BA  0.113
474           PH          0.113    .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
475           LS      0      88
476           UD  0.340

477           KK    EW4F
478           KM       GENERATE HYDROGRAPH FROM SUBBASIN EW4F
479           KM       EWA VILLAGES PRECIPITATION DATA
480           BA  0.010
481           PH          0.010    .64    1.30    2.41    3.50    4.55    6.70    9.10   12.20
482           LS      0      80
483           UD  0.103

484           KK  SEC204
485           KM       COMBINE HYDROGRAPHS AT SEC204
486           NC      3

487           KK    S11
488           KM       GENERATE HYDROGRAPH FROM SUBBASIN S11
489           KM       MID-WATERSHED PRECIPITATION DATA
490           BA  0.073
491           PH          0.073    .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
492           LS      0      88
493           UD  0.350
                                         HEC-1 INPUT                                     PAGE 12

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

494           KK  SEC205
495           KM       COMBINE HYDROGRAPHS AT SEC205
496           NC      2

497           KK    S10B
498           KM       GENERATE HYDROGRAPH FROM SUBBASIN S10B
499           KM       MID-WATERSHED PRECIPITATION DATA
500           BA  0.018
501           PH          0.018    .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
502           LS      0      88
503           UD  0.090

504           KK    EW4E
505           KM       GENERATE HYDROGRAPH FROM SUBBASIN EW4E
506           KM       EWA VILLAGES PRECIPITATION DATA
507           BA  0.015
508           PH          0.015    .64    1.30    2.41    3.50    4.55    6.70    9.10   12.20
509           LS      0      81
510           UD  0.112

511           KK  SEC206
512           KM       COMBINE HYDROGRAPHS AT SEC206
513           NC      3

514           KK    S10A
515           KM       GENERATE HYDROGRAPH FROM SUBBASIN S10A
516           KM       MID-WATERSHED PRECIPITATION DATA
517           BA  0.089
518           PH          0.089    .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
519           LS      0      88
520           UD  0.290

521           KK  SEC207
522           KM       COMBINE HYDROGRAPHS AT SEC207
523           NC      2

524           KK    S9
525           KM       GENERATE HYDROGRAPH FROM SUBBASIN S9
526           KM       MID-WATERSHED PRECIPITATION DATA
527           BA  0.122
528           PH          0.122    .65    1.32    2.45    3.55    4.60    6.75    9.20   12.30
529           LS      0      88
530           UD  0.320

531           KK    EW4D
532           KM       GENERATE HYDROGRAPH FROM SUBBASIN EW4D
533           KM       EWA VILLAGES PRECIPITATION DATA
```



```
534           BA  0.022
535           PH          0.022    .64    1.30    2.41    3.50    4.55    6.70    9.10   12.20
536           LS      0      80
537           UD  0.147
                                         HEC-1 INPUT                                     PAGE 13

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

538           KK  SEC208
539           KM       COMBINE HYDROGRAPHS AT SEC208
540           NC      3

541           KK  RES05
542           KM       COMBINE HYDROGRAPHS AT RES05 FROM SECs 192,193 &208
543           NC      3

544           KK  RES05
545           KM       ROUTE FLOW THROUGH RES05
546           RS      1    ELEV      39
547           SV      0     6.3     8.4    13.6    17.6    22.8    29.6    37.4    46.5    57.0
548           SE     39      43      45      46      47      48      49      50      51      52
549           SQ      0       7      32      38      44      48     172     726    1617    2738
550           SE     39      43      45      46      47      48      49      50      51      52

551           KK  SEC140
552           KM       ROUTE FLOW FROM RES05 TO SEC140
553           RS     10    FLOW       0
554           RC   .035    .035    .035     950   0.012      50
555           RX      0      90     160     205     255     265     300     330
556           RY     50      36      34      32      32      40      50      60

557           KK    EW5
558           KM       GENERATE HYDROGRAPH FROM SUBBASIN EW5 TO SEC140
559           KM       EWA VILLAGES PRECIPITATION DATA
560           BA  0.015
561           PH          0.015    .64    1.30    2.41    3.50    4.55    6.70    9.10   12.20
562           LS      0      81
563           UD  0.096

564           KK  SEC140
565           KM       COMBINE HYDROGRAPHS AT SEC140
566           NC      2

567           KK  SEC145
568           KM       COMBINE HYDROGRAPHS AT SEC145
569           NC      2

570           KK    EW6
571           KM       GENERATE HYDROGRAPH FROM SUBBASIN EW6 TO RES03
572           KM       EWA VILLAGES PRECIPITATION DATA
573           BA  0.265
574           PH          0.265    .64    1.30    2.41    3.50    4.55    6.70    9.10   12.20
575           LS      0      88
576           UD  0.133

577           KK  RES03
578           KM       COMBINE HYDROGRAPHS AT RES03
579           NC      2
                                         HEC-1 INPUT                                     PAGE 14

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

580           KK  RES03
581           KM       ROUTE FLOW THROUGH RES03
582           RS      1    ELEV      23
583           SV      0    21.1    47.3    58.8    71.5    78.3    92.5   115.9   126.1   133.1
584           SE     23      32    35.5    36.5    37.5      38      39    40.5    41.1    41.5
585           SQ      0       0     127     354    1204    1824    3334    6146    7428    8327
586           SE     23      32    35.5    36.5    37.5      38      39    40.5    41.1    41.5

587           KK    EW7
588           KM       GENERATE HYDROGRAPH FROM SUBBASIN EW7 TO RES04
589           KM       EWA VILLAGES PRECIPITATION DATA
590           BA  0.050
591           PH          0.050    .64    1.30    2.41    3.50    4.55    6.70    9.10   12.20
```

```
592          LS      0      86
593          UD  0.081

594          KK  RES04
595          KM       COMBINE HYDROGRAPHS AT RES04
596          NC      2

597          KK  RES04
598          KM       ROUTE FLOW THROUGH RES04
599          RS      1    ELEV     23
600          SV      0    20.5   33.8   38.1   42.6   47.3   52.2   57.4   60.0   62.8
601          SE     23    31.5     35     36     37     38     39     40   40.5     41
602          SQ      0       0    127    324   1164   2509   4199   6171   7251   8390
603          SE     23    31.5     35     36     37     38     39     40   40.5     41

604          KK   EW10
605          KM       GENERATE HYDROGRAPH FROM SUBBASIN EW10 TO RES07
606          KM       EWA VILLAGES PRECIPITATION DATA
607          BA  0.018
608          PH          0.018    .64   1.30   2.41   3.50   4.55   6.70   9.10  12.20
609          LS      0      80
610          UD  0.033

611          KK  RES07
612          KM       ROUTE FLOW FROM SUBBASIN EW10 THROUGH RES07
613          RS      1    ELEV     43
614          SV      0    26.7   31.0   35.8   46.5   52.5
615          SE     30      43     44     45     47     48
616          SQ      0       0      0      0      0     75
617          SE     30      43     44     45     47     48

618          KK   EW11
619          KM       GENERATE HYDROGRAPH FROM SUBBASIN EW11 TO RES06
620          KM       EWA VILLAGES PRECIPITATION DATA
621          BA  0.123
622          PH          0.123    .64   1.30   2.41   3.50   4.55   6.70   9.10  12.20
623          LS      0      86
624          UD  0.219
                                  HEC-1 INPUT                                        PAGE 15

LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

625          KK  RES06
626          KM       COMBINE HYDROGRAPHS AT RES06
627          NC      2

628          KK  RES06
629          KM       ROUTE FLOW THROUGH RES06
630          RS      1    ELEV     30
631          SV      0     2.6    7.6    9.9   12.6   15.4   16.9   18.5   20.3   22.2
632          SE     30      34     37     38     39     40   40.5     41   41.5     42
633          SQ      0       0     13     15     17     46     69     96    288    615
634          SE     30      34     37     38     39     40   40.5     41   41.5     42

635          KK SEC155
636          KM       COMBINE HYDROGRAPHS AT SEC155
637          NC      2

638          KK    EW8
639          KM       GENERATE HYDROGRAPH FROM SUBBASIN EW8 TO RES12
640          KM       EWA VILLAGES PRECIPITATION DATA
641          BA  0.118
642          PH          0.118    .64   1.30   2.41   3.50   4.55   6.70   9.10  12.20
643          LS      0      90
644          UD  0.319

645          KK  RES12
646          KM       COMBINE HYDROGRAPHS AT RES12 (CONCRETE CHANNEL)
647          NC      2

648          KK    EW9
649          KM       GENERATE HYDROGRAPH FROM SUBBASIN EW9 TO RES13
650          KM       EWA VILLAGES PRECIPITATION DATA
651          BA  0.242
652          PH          0.242    .64   1.30   2.41   3.50   4.55   6.70   9.10  12.20
653          LS      0      86
```



```
654          UD  0.244

655          KK  RES13
656          KM       COMBINE HYDROGRAPHS AT RES13 (CONCRETE CHANNEL)
657          NC      2

658          KK SEC160
659          KM       ROUTE FLOW FROM RES13 TO SEC160 (OR&L RR ROW)
660          RS     10    FLOW      0
661          RC   .013    .013   .013    110  0.003     40
662          RX      0     100    105    105    195    195    200    297
663          RY     40      40     40     26     26     40     40     40
664          ZZ

          SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE     (V) ROUTING         (--->) DIVERSION OR PUMP FLOW

  NO.     (.) CONNECTOR       (<---) RETURN OF DIVERTED OR PUMPED FLOW

   8        A3
            V
            V
  15      SEC10
            .
            .
  22        .         A2
            .          .
            .          .
  29      SEC10.........
            .
            .
  32        .         A1
            .          .
            .          .
  39      SEC15.........
            V
            V
  42      SEC20
            .
            .
  48        .         A4
            .          .
            .          .
  55      SEC20.........
            V
            V
  58      RES08
            V
            V
  65      SEC25
            .
            .
  71        .        A13
            .          .
            .          .
  78      SEC25.........
            .
            .
  81        .        A14
            .          .
            .          .
  88      SEC30.........
            .
            .
  91        .        A15
            .          .
            .          .
  98      SEC40.........
            .
            .
 101        .        A22
            .          .
            .          .
 108      SEC45.........
            .
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	A3	1633.	13.33	935.	376.	362.	1.70		
ROUTED TO	SEC10	1632.	13.33	935.	375.	361.	1.70	213.09	13.33
HYDROGRAPH AT	A2	275.	12.42	91.	36.	35.	.17		
2 COMBINED AT	SEC10	1738.	13.33	1024.	411.	396.	1.87		
HYDROGRAPH AT	A1	1857.	13.58	1144.	462.	445.	2.04		
2 COMBINED AT	SEC15	3568.	13.42	2167.	873.	841.	3.90		
ROUTED TO	SEC20	3568.	13.42	2167.	873.	841.	3.90	201.36	13.42
HYDROGRAPH AT	A4	277.	12.50	100.	40.	38.	.19		
2 COMBINED AT	SEC20	3688.	13.42	2264.	913.	879.	4.09		
ROUTED TO	RES08	3581.	13.75	2263.	913.	879.	4.09	212.18	13.75
ROUTED TO	SEC25	3580.	13.75	2263.	910.	877.	4.09	162.18	13.75
HYDROGRAPH AT	A13	653.	12.33	195.	79.	76.	.31		
2 COMBINED AT	SEC25	3765.	13.67	2442.	989.	953.	4.40		
HYDROGRAPH AT	A14	26.	12.08	4.	2.	2.	.01		
2 COMBINED AT	SEC30	3769.	13.67	2446.	991.	955.	4.41		
HYDROGRAPH AT	A15	365.	12.33	107.	45.	43.	.16		

2 COMBINED AT	SEC40	3868.	13.67	2543.	1036.	998.	4.56		
HYDROGRAPH AT	A22	12.	12.08	2.	1.	1.	.00		
2 COMBINED AT	SEC45	3869.	13.67	2544.	1037.	999.	4.56		
HYDROGRAPH AT	A6	623.	12.25	167.	66.	64.	.31		
ROUTED TO	RES09	622.	12.25	167.	66.	64.	.31	216.84	12.25
ROUTED TO	SEC55	607.	12.33	167.	66.	64.	.31	147.70	12.33
HYDROGRAPH AT	A11	254.	12.25	43.	25.	24.	.10		
2 COMBINED AT	SEC55	821.	12.33	229.	92.	88.	.41		
HYDROGRAPH AT	A12	398.	12.33	121.	50.	48.	.18		
2 COMBINED AT	SEC60	1219.	12.33	350.	142.	136.	.60		
HYDROGRAPH AT	A17	26.	12.17	6.	2.	2.	.01		
2 COMBINED AT	SEC65	1235.	12.33	356.	144.	139.	.61		
HYDROGRAPH AT	A7	30.	12.08	5.	2.	2.	.01		
HYDROGRAPH AT	A10	232.	12.17	50.	20.	20.	.08		
2 COMBINED AT	SEC75	255.	12.17	55.	22.	21.	.09		
HYDROGRAPH AT	A8	351.	12.33	100.	40.	39.	.17		
ROUTED TO	RES14	349.	12.33	100.	40.	39.	.17	235.99	12.33
HYDROGRAPH AT	A9	55.	12.17	13.	5.	5.	.02		
2 COMBINED AT	SEC80	391.	12.33	113.	46.	44.	.19		
3 COMBINED AT	SEC81	1781.	12.33	524.	212.	204.	.88		
HYDROGRAPH AT	A18	7.	12.08	1.	1.	0.	.00		
2 COMBINED AT	SEC90	1783.	12.33	525.	212.	204.	.89		
HYDROGRAPH AT	A19	223.	12.25	58.	24.	23.	.09		
HYDROGRAPH AT	A16	334.	12.25	89.	37.	35.	.13		
3 COMBINED AT									

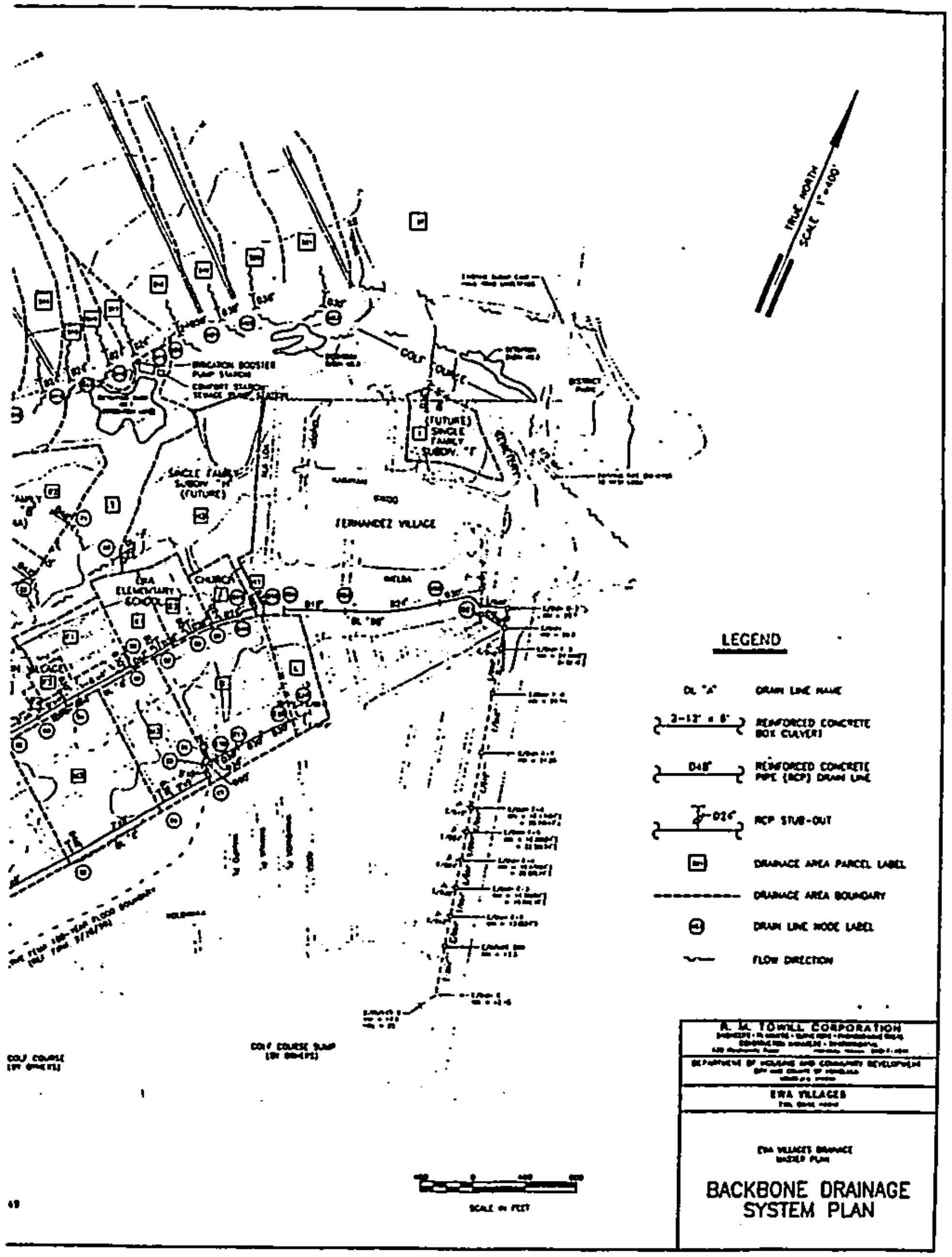
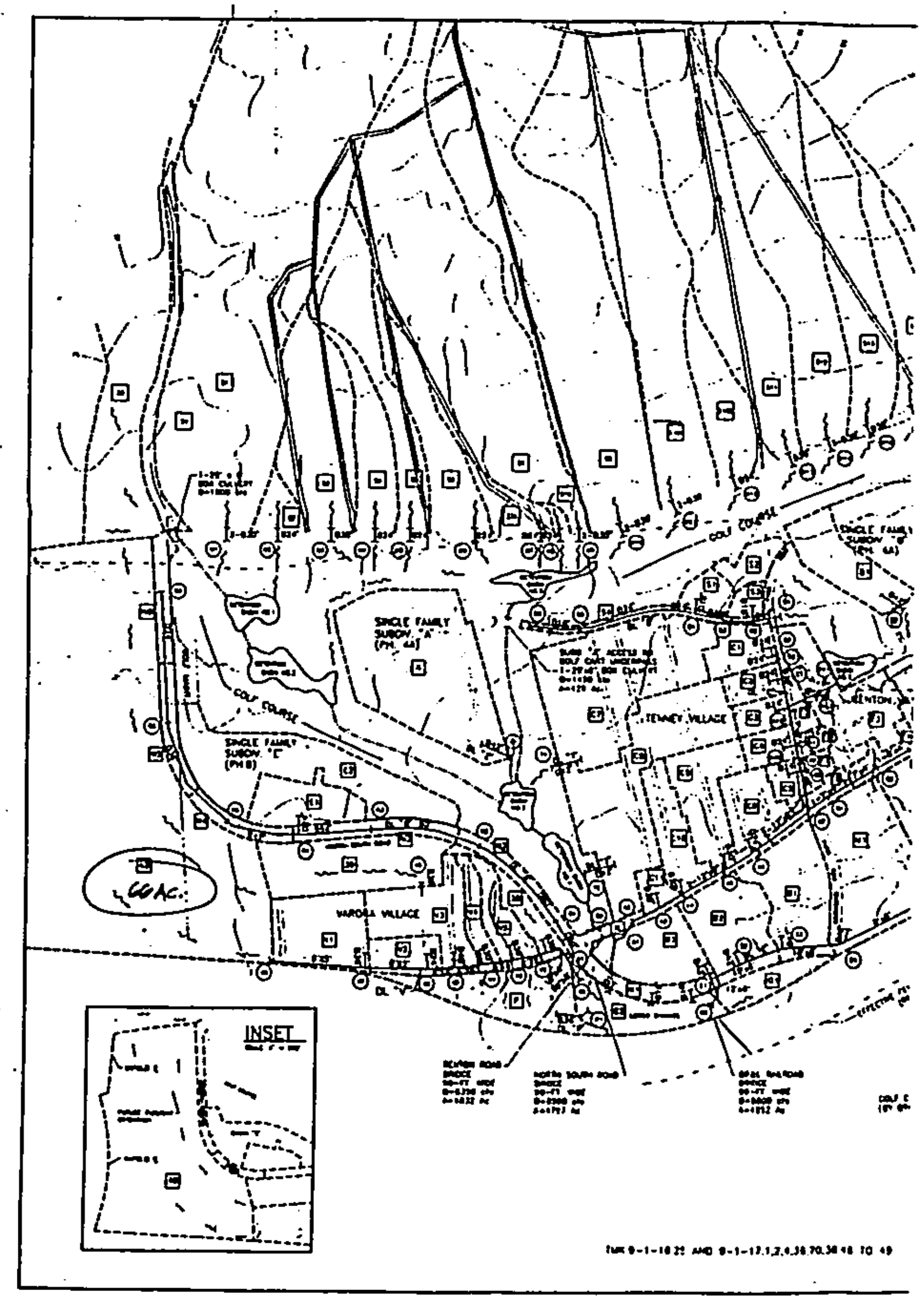
	SEC91	2339.	12.25	672.	273.	263.	1.11		
HYDROGRAPH AT	A21	50.	12.08	9.	4.	3.	.01		
2 COMBINED AT	SEC105	2364.	12.25	681.	277.	266.	1.12		
2 COMBINED AT	SEC110	5224.	12.33	3192.	1314.	1265.	5.69		
HYDROGRAPH AT	A24	28.	12.25	7.	3.	3.	.01		
2 COMBINED AT	SEC115	5247.	12.33	3198.	1316.	1268.	5.70		
HYDROGRAPH AT	A20	173.	12.25	46.	19.	19.	.07		
HYDROGRAPH AT	S1	553.	12.58	219.	92.	88.	.32		
3 COMBINED AT	SEC116	5863.	12.33	3455.	1428.	1375.	6.09		
HYDROGRAPH AT	S2	17.	12.08	3.	1.	1.	.00		
HYDROGRAPH AT	EW1	97.	12.08	18.	8.	7.	.03		
3 COMBINED AT	RES01	5903.	12.33	3475.	1436.	1383.	6.12		
ROUTED TO	RES01	5826.	12.42	3474.	1420.	1368.	6.12	51.67	12.42
HYDROGRAPH AT	S3	89.	12.17	19.	8.	8.	.03		
HYDROGRAPH AT	S4	40.	12.17	8.	3.	3.	.01		
HYDROGRAPH AT	S5	71.	12.17	16.	7.	6.	.02		
3 COMBINED AT	SEC123	200.	12.17	43.	18.	17.	.06		
HYDROGRAPH AT	EW4A	20.	12.08	4.	2.	1.	.01		
2 COMBINED AT	SEC124	217.	12.17	47.	20.	19.	.07		
HYDROGRAPH AT	EW2	86.	12.17	19.	8.	7.	.03		
2 COMBINED AT	SEC125	304.	12.17	66.	27.	26.	.10		
2 COMBINED AT	RES02	5985.	12.33	3536.	1448.	1394.	6.22		
ROUTED TO	RES02	5968.	12.42	3535.	1428.	1376.	6.22	51.01	12.42
HYDROGRAPH AT	EW3	52.	12.25	13.	5.	5.	.02		
2 COMBINED AT	SEC130	6005.	12.42	3548.	1434.	1381.	6.24		
HYDROGRAPH AT									

	S6	56.	12.17	12.	5.	5.	.02
HYDROGRAPH AT	EW4B	31.	12.08	5.	2.	2.	.01
2 COMBINED AT	SEC192	78.	12.08	17.	7.	7.	.03
HYDROGRAPH AT	S7A	21.	12.08	3.	1.	1.	.00
HYDROGRAPH AT	S7B	4.	12.08	1.	0.	0.	.00
HYDROGRAPH AT	S8	203.	12.33	59.	25.	24.	.09
HYDROGRAPH AT	EW4C	59.	12.08	10.	4.	4.	.01
4 COMBINED AT	SEC193	230.	12.25	73.	31.	29.	.11
HYDROGRAPH AT	S17	17.	12.08	3.	1.	1.	.00
HYDROGRAPH AT	S16	17.	12.08	3.	1.	1.	.00
HYDROGRAPH AT	EW4H	12.	12.17	3.	1.	1.	.00
3 COMBINED AT	SEC200	44.	12.08	8.	3.	3.	.01
HYDROGRAPH AT	S15	40.	12.17	8.	3.	3.	.01
2 COMBINED AT	SEC201	80.	12.08	16.	7.	7.	.02
HYDROGRAPH AT	S14	63.	12.17	14.	6.	6.	.02
HYDROGRAPH AT	EW4G	18.	12.17	4.	2.	1.	.01
3 COMBINED AT	SEC202	155.	12.17	34.	14.	14.	.05
HYDROGRAPH AT	S13	86.	12.17	21.	9.	8.	.03
2 COMBINED AT	SEC203	241.	12.17	55.	23.	22.	.08
HYDROGRAPH AT	S12	239.	12.42	78.	33.	32.	.11
HYDROGRAPH AT	EW4F	31.	12.17	6.	3.	2.	.01
3 COMBINED AT	SEC204	437.	12.17	139.	58.	56.	.20
HYDROGRAPH AT	S11	153.	12.42	50.	21.	20.	.07
2 COMBINED AT	SEC205	569.	12.25	189.	80.	77.	.28
HYDROGRAPH AT	S10B	60.	12.17	12.	5.	5.	.02
HYDROGRAPH AT	EW4E	46.	12.17	10.	4.	4.	.01

+	3 COMBINED AT	SEC206	646.	12.17	211.	89.	85.	.31		
+	HYDROGRAPH AT	S10A	204.	12.33	61.	26.	25.	.09		
+	2 COMBINED AT	SEC207	838.	12.25	273.	115.	110.	.40		
+	HYDROGRAPH AT	S9	266.	12.33	84.	35.	34.	.12		
+	HYDROGRAPH AT	EW40	61.	12.17	14.	6.	5.	.02		
+	3 COMBINED AT	SEC208	1135.	12.25	371.	156.	150.	.54		
+	3 COMBINED AT	RES05	1421.	12.25	461.	193.	186.	.67		
+ +	ROUTED TO	RES05	1303.	12.42	460.	182.	175.	.67	50.65	12.42
+ +	ROUTED TO	SEC140	1309.	12.42	460.	182.	175.	.67	34.32	12.42
+	HYDROGRAPH AT	EW5	46.	12.17	10.	4.	4.	.01		
+	2 COMBINED AT	SEC140	1324.	12.42	470.	186.	179.	.69		
+	2 COMBINED AT	SEC145	7329.	12.42	4000.	1619.	1560.	6.93		
+	HYDROGRAPH AT	EW6	815.	12.17	182.	76.	73.	.26		
+	2 COMBINED AT	RES03	7693.	12.42	4171.	1695.	1633.	7.19		
+ +	ROUTED TO	RES03	7459.	12.50	4169.	1663.	1601.	7.19	41.11	12.50
+	HYDROGRAPH AT	EW7	164.	12.08	34.	14.	14.	.05		
+	2 COMBINED AT	RES04	7497.	12.50	4200.	1677.	1615.	7.24		
+ +	ROUTED TO	RES04	7476.	12.50	4200.	1656.	1595.	7.24	40.60	12.50
+	HYDROGRAPH AT	EW10	71.	12.08	11.	5.	4.	.02		
+ +	ROUTED TO	RES07	0.	.08	0.	0.	0.	.02	45.03	24.33
+	HYDROGRAPH AT	EW11	309.	12.25	83.	35.	33.	.12		
+	2 COMBINED AT	RES06	309.	12.25	83.	35.	33.	.14		
+ +	ROUTED TO	RES06	251.	12.42	75.	29.	28.	.14	41.40	12.42
+	2 COMBINED AT	SEC155	7704.	12.50	4274.	1685.	1623.	7.38		

+	HYDROGRAPH AT	EW8	257.	12.33	82.	35.	33.	.12		
+	2 COMBINED AT	RES12	7929.	12.50	4351.	1719.	1656.	7.50		
+	HYDROGRAPH AT	EW9	573.	12.25	163.	68.	65.	.24		
+	2 COMBINED AT	RES13	8317.	12.50	4506.	1787.	1722.	7.74		
+ +	ROUTED TO	SEC160	8319.	12.50	4506.	1787.	1721.	7.74	31.24	12.50

*** NORMAL END OF HEC-1 ***


TRUE NORTH
SCALE 1"=400'
LEGEND
DL "A" DRAIN LINE NAME
2-12' x 6' REINFORCED CONCRETE BOX CULVERT
D48" REINFORCED CONCRETE PIPE (RCP) DRAIN LINE
RCP STUB-OUT
DRAINAGE AREA PARCEL LABEL
DRAINAGE AREA BOUNDARY
DRAIN LINE NODE LABEL
FLOW DIRECTION
R. M. TOWILL CORPORATION
DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
EWA VILLAGES
BACKBONE DRAINAGE SYSTEM PLAN
SCALE IN FEET
FERNANDEZ VILLAGE
EWA ELEMENTARY SCHOOL
CHURCH
SINGLE FAMILY SUBDV. "H" (FUTURE)
(FUTURE) SINGLE FAMILY SUBDV. "F"
IRRIGATION BOOSTER PUMP STATION
GOLF COURSE
GOLF COURSE SUMP

SINGLE FAMILY SUBDV. "A" (PH. 4A)
SINGLE FAMILY SUBDV. "C" (PH II)
TENNEY VILLAGE
VARONA VILLAGE
GOLF COURSE
INSET
66 AC.
TMK 9-1-10:22 AND 9-1-17:1,2,4,38,70,38 48 TO 49

KAPOLEI VILLAGE

DRAINAGE MASTER PLAN

Prepared for:

Housing Finance and Development Corporation
State of Hawaii

Prepared by:

R. M. Towill Corporation
420 Waiakamilo Road, Suite 411
Honolulu, Hawaii 96817-4941

DECEMBER 1991

FILE: NEWDRAIN DATE: 4-18-95 INLET	AREA NAME	Total Area (ac)	Other Flow Name	Tc	C	i (in/hr)	F	A (ac)	Runoff Q=CIFA (cfs)	Other Flows (cfs)	Total Inflow (cfs)	Cumul. Q=CIFA (cfs)	Plate 4 Group C (cfs)	Pipe Q (cfs)	Dn (ft)
DRAIN LINE "V"	(Varona Village/Renton Road)														
V0															
V1	DL-R	145.90	FROM DRAIN LINE "R"						0.0	152.8	152.8	464.9	663.5	663.5	8.3
V2	J8	108.80		20.0	0.55	2.3	1.6	3.2	5.7		5.7	312.1	522.7	522.7	7.1
V3	V5	105.60		11.7	0.70	2.3	2.2	4.2	14.9		14.9	306.4	520.9	520.9	9.0
V4	V4	101.40		12.5	0.70	2.3	2.2	2.6	9.2		9.2	291.5	505.3	505.3	8.2
V5	V3	98.80	FROM AREA 29	13.7	0.70	2.3	2.0	8.5	27.4	41.2	68.6	282.3		282.3	7.7
V6	V2	78.10		11.7	0.70	2.3	2.4	3.2	12.4		12.4	213.7		213.7	7.6
V7	V1	74.90		12.8	0.70	2.3	2.2	8.7	30.8		30.8	201.3		201.3	6.6
V8	40	66.20		22.8	0.70	2.3	1.6	66.2	170.5		170.5	170.5		170.5	7.7
DRAIN LINE "R"	(North-South Road)														
V1			ADD TO DRAIN LINE "A"								663.5				
R1	TRANS	37.10							0.0		0.0	152.8		152.8	7.3
R2	R2	37.10		5.0	0.85	2.3	2.8	3.0	16.4		16.4	152.8		152.8	7.5
R3	R3	34.10		5.0	0.85	2.3	2.8	3.2	17.5		17.5	136.4		136.4	7.2
R4	R1	30.90	FROM R2	10.7	0.70	2.3	2.3	6.0	22.2	56.7	78.9	118.9		118.9	7.9
R5	R4	7.30		5.0	0.85	2.3	2.8	2.3	12.6		12.6	40.0		40.0	2.1
R6	R5	5.00		5.0	0.85	2.3	2.8	2.7	14.8		14.8	27.4		27.4	1.4
R7	R6	2.30		5.0	0.85	2.3	2.8	2.3	12.6		12.6	12.6		12.6	1.7

FILE: NEWDRAIN DATE: 4-18-95 INLET	Vf (fps)	Pipe Diam. or Box Dim. (No) (in) (ft)	L (ft)	n	Sf	S	INV. ELEV. DOWN	INV. ELEV. UP	Hf (ft)	MANHOLE LOSSES A	B	C	D	ENT. CONT.	H.G.L. DOWN	H.G.L. UP	FIN. GR.	FB (ft)
DRAIN LINE "V"																		
V0								29.00								35.45	42.0	
V1	8.2	1 - 10 X 8	300	0.013	0.002	0.001	29.30	29.30	0.54	0.016	Expan.	0.452	0.20		37.80	38.47	44.5	Full 6.03 FB
V2	8.9	1 - 10 X 6	150	0.013	0.002	0.001	29.45	29.45	0.39	0.060	Expan.		0.05		38.86	38.97	44.0	Full 5.03 FB
V3	10.9	1 - 8 X 6	250	0.013	0.002	0.001	29.70	29.70	1.10				0.05		40.07	40.12	44.0	Full 3.88 FB
V4	10.3	1 - 8 X 6	250	0.013	0.002	0.001	30.00	30.00	1.03	0.077	Expan.		0.05		41.15	41.28	44.0	Full 2.72 FB
V5	7.8	1 - 6 X 6	200	0.013	0.002	0.001	30.20	32.20	0.85				0.20		41.83	42.03	44.5	Full 2.47 FB
V6	7.9	1 - 6 X 6	200	0.013	0.002	0.002	32.60	32.60	0.31	0.015	Expan.		0.05		42.34	42.41	46.0	Full 3.59 FB
V7	6.7	1 - 6 X 5	500	0.013	0.002	0.002	33.50	33.50	1.14	0.002	Expan.		0.20		43.55	43.75	45.5	Full 1.75 FB
V8	6.8	1 - 5 X 5	700	0.013	0.002	0.005	37.00	37.00	1.85					6.00	45.60	45.60	47.0	Full 1.40 FB
DRAIN LINE "A"	8.3																	
V1															38.47			
R1	7.8	1 - 60	200	0.013	0.002	0.014	29.30	29.30	0.69	0.363	0.126	0.380	0.50		40.53	39.84	44.5	Full 4.66 FB
R2	7.8	1 - 60	860	0.013	0.003	0.005	33.00	33.00	2.75	0.161	0.000	0.108	0.05	5.265	42.60	40.85	46.0	Full 5.15 FB
R3	6.9	1 - 60	800	0.013	0.003	0.005	37.00	37.00	2.19	0.161	0.189	0.108	0.05	5.265	46.30	44.11	48.0	Full 3.89 FB
R4	7.5	1 - 54	600	0.013	0.004	0.003	41.00	41.00	2.19	0.145	0.000	0.097	0.05	4.947	48.78	46.59	50.0	Full 3.41 FB
R5	4.2	1 - 42	600	0.013	0.003	0.003	43.00	43.00	0.95	0.145	0.589	0.097	0.50	4.777	51.06	50.12	52.0	Full 1.88 FB
R6	3.9	1 - 36	900	0.013	0.002	0.008	45.00	45.00	1.52	0.026	0.034	0.017	0.35	3.036	53.41	51.49	54.0	Full 2.51 FB
R7	4.0	1 - 24	1000	0.013	0.003	0.003	52.00	52.00	3.10	0.087	0.000	0.016	0.50	2.606	56.22	55.12	58.0	Ent. Cont. 2.88 FB
							55.00	55.00						1.885		58.22	61.0	Full 3.78 FB

SECTION 3
EXISTING DRAINAGE CONDITIONS

3.1 GROUND COVER

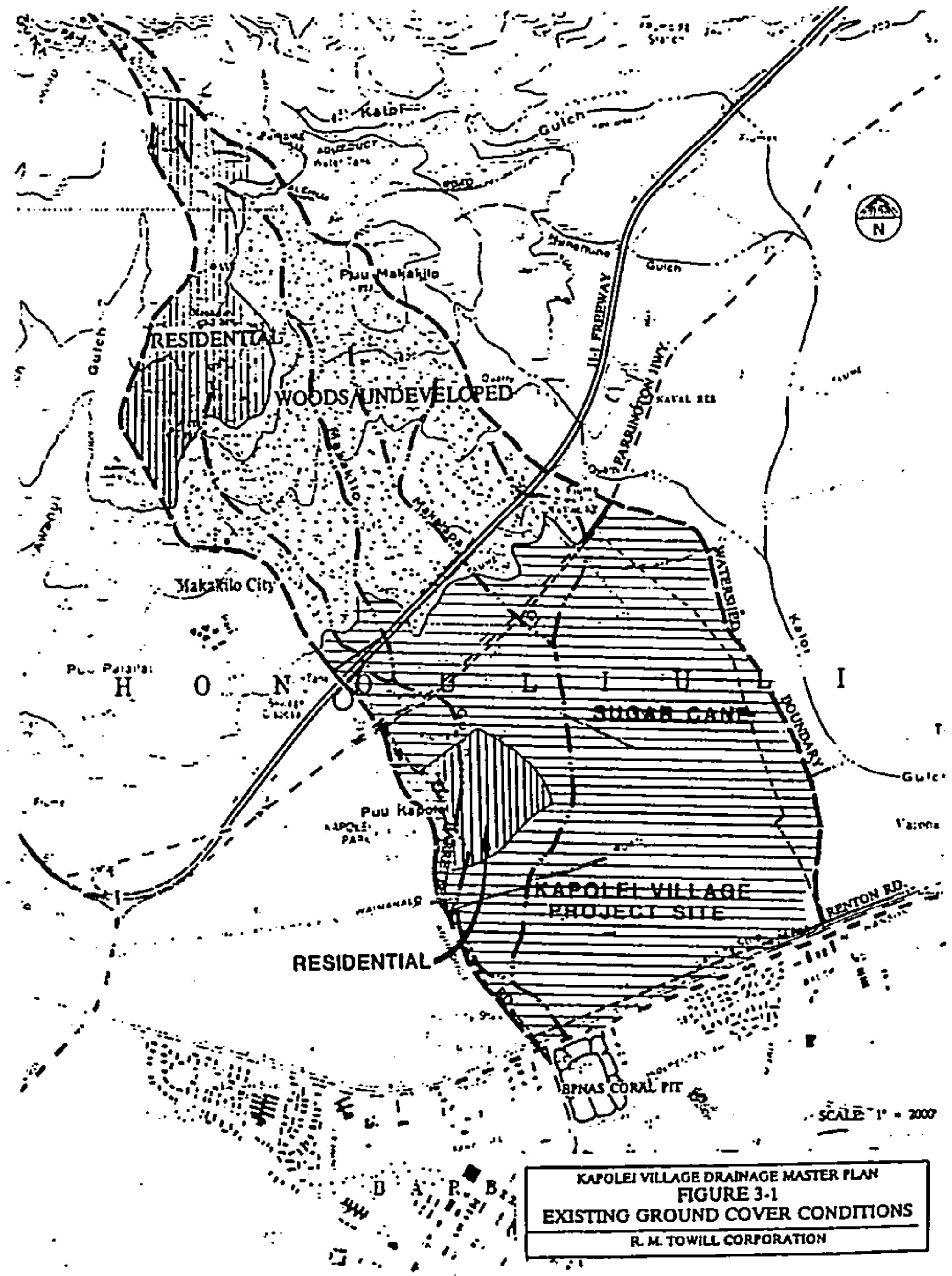
Between the NASBP and the H-1 Freeway, the ground cover consists mostly of sugarcane fallow. Near Farrington Highway, the early increments of the Kapolei Village residential development is under construction. Above the H-1 Freeway, the cover conditions vary from sparse vegetation on steep rocky slopes to moderately dense growth of small trees and brush along the trough of the gulches. The only developed area above the freeway is the Makakilo residential subdivision, located in the upper reaches of watersheds. Figure 3-1 shows the existing ground cover conditions.

3.2 DRAINAGE PATTERNS

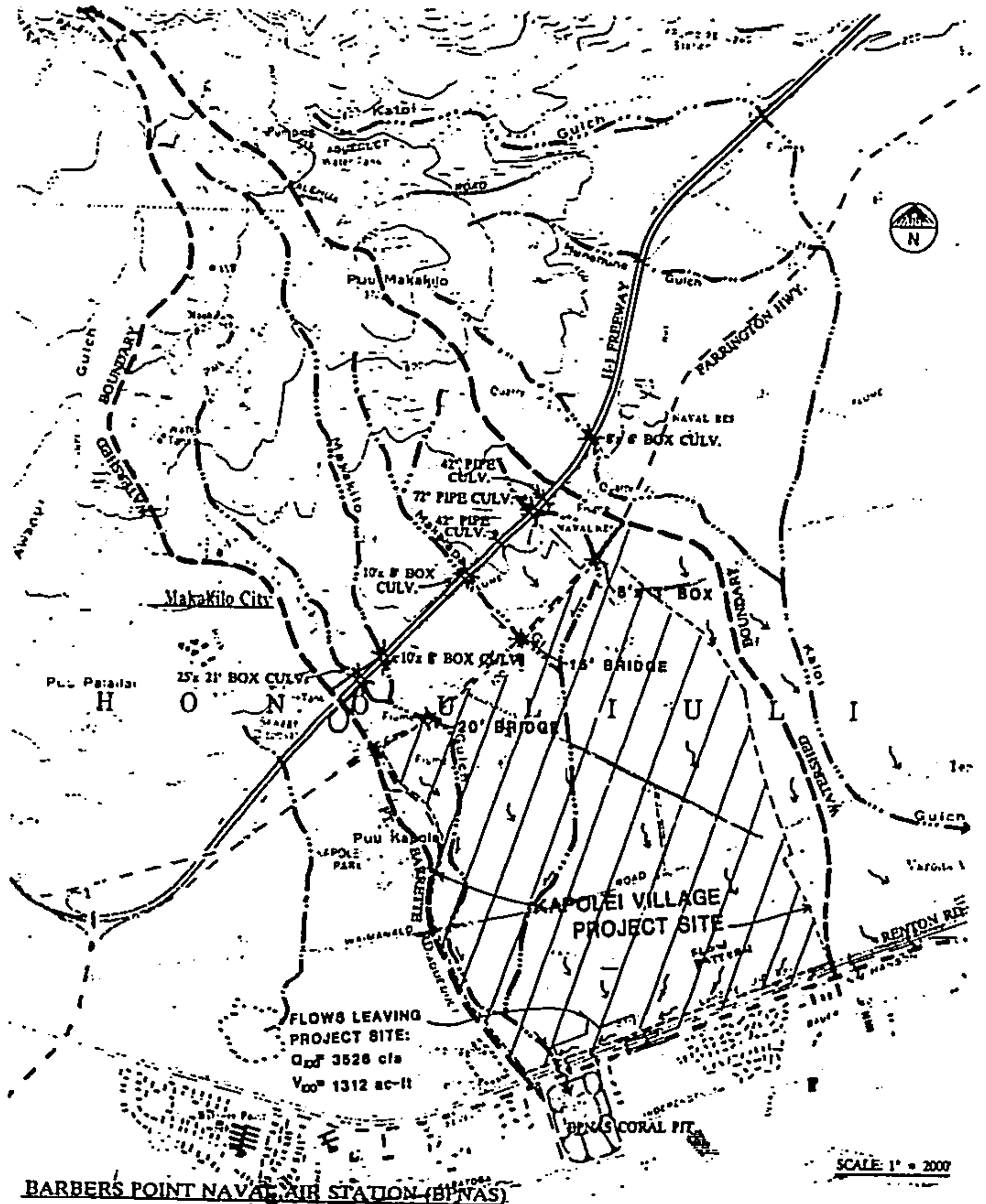
Kapolei Village will be developed on the lower portions of the Makakilo/Makalapa Gulch watershed, as illustrated in Figure 3-2. The existing drainage pattern is described below:

The Makakilo/Makalapa watershed covers about 2,038 acres. Makalapa Gulch, Makakilo Gulch and their tributaries make up the drainageways through the watershed. In addition, scattered small swales, dirt road embankments, and sugarcane furrows create some seasonal variations in the runoff patterns of the lower watershed. Makalapa and Makakilo gulches originate in the Waianae Mountains. The slopes of these gulches are relatively steep (greater than 10 percent) upstream of the H-1 Freeway. Below Farrington Highway, these gulches flatten to less than 2 percent and become ditches perched above the adjacent plain, with built-up banks. The perched condition allows streamwater to be diverted for irrigation use and the built-up banks help prevent flooding of the sugarcane fields during small storms. The capacities of these ditches are very limited due to small channel size, flat slope, and heavy vegetative growth. These two ditches converge in the lower region of the watershed at a location about 1,000 feet north of the NASBP.

The Makalapa and Makakilo Gulches are not able to receive runoff in the lower reaches (below Farrington Highway) due to the built-up channel banks. Runoff not contained in the gulches overflow flows over fallow cane land and through the initial roadway developments



KAPOLEI VILLAGE DRAINAGE MASTER PLAN
FIGURE 3-1
EXISTING GROUND COVER CONDITIONS
R. M. TOWILL CORPORATION



KAPOLEI VILLAGE DRAINAGE MASTER PLAN
FIGURE 3-2
WATERSHED FLOW PATTERNS
R. M. TOWILL CORPORATION

of Kapolei Village, eventually ending up in the NASBP coral pit or in low areas just north of the NASBP.

A wide undeveloped strip and the OR&L railroad track combine to divert runoff along the NASBP boundary, west towards the vicinity of the Makakilo Gulch and the NASBP coral pit. Subsequently, the flows pass through a 6' diameter culvert beneath a cane haul road and a set of four 6' x 4' box culverts beneath Franklin D. Roosevelt Road before entering the NASBP coral pit. Bars are placed in front of the box culverts for base security. The capacity of the boxes was estimated at 1,600 cfs by the SCS in an earlier study (Reference 8). The NASBP coral pit is approximately 45 feet deep and consists of a very porous interior, densely vegetated with kiawe and baole koa trees.

The H-1 Freeway and the Farrington Highway both cut across the middle of the watershed and are significant flow obstructions. The H-1 culverts have adequate capacity to pass the SCS 100-year, 24-hour flood and the freeway is an effective barrier which concentrates upper watershed runoff at the culverts.

Under existing conditions, the total runoff leaving the Kapolei Village site into the NASBP was computed to be approximately 1,312 acre-feet with a peak rate of 3,526 cfs (100-year, 24-hour storm), refer to Table 4-1 in Section 4.

SECTION 4

PROPOSED DRAINAGE PLAN

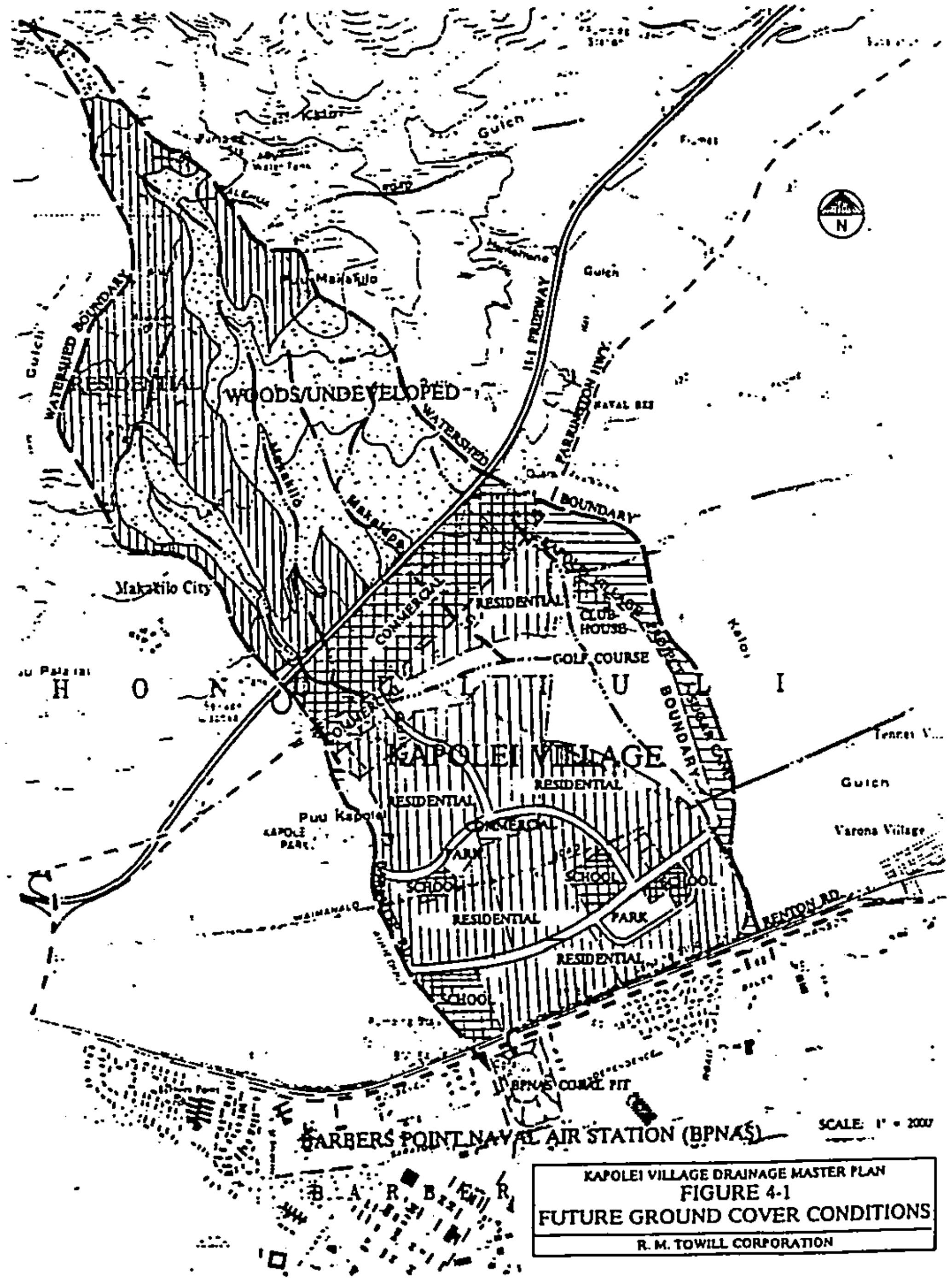
4.1 DRAINAGE PLAN CONCEPT

The concept of this drainage plan is to maintain a scheme of infiltration for disposal of runoff, similar to what is presently occurring. Under ideal conditions, an ocean outlet (channel or culvert) is utilized for drainage of a watershed. Unfortunately, the project site is bounded downstream by the NASBP and defined drainageways to the ocean do not exist. Runoff presently collects at the NASBP coral pit and is disposed by infiltration and percolation.

Construction of a channel or culvert to the ocean through the NASBP is considered unfeasible at the present time by the State due to extremely high costs and probable lengthy process of coordination with the navy in regards to easement location, construction and maintenance matters. It is recommended that a drainage channel or culvert to the ocean be considered in a separate study as a long range facility to eventually replace or supplement the onsite detention/disposal facilities.

A primary goal of this drainage plan is to limit runoff rates and sediment loads entering the NASBP to existing amounts for varying storm magnitudes. Recurrence intervals of 2-, 10-, 50-, and 100-years were analyzed. The plan considers the increases in runoff due to urbanization of the entire watershed above the NASBP, including developments such as Lusk Hawaii (commercial/residential development between Farrington Highway and the H-1 Freeway) and Makakilo (residential development above the H-1 Freeway). Figure 4-1 illustrates the future ground cover conditions. The increase in runoff due to urbanization of the watershed is summarized in Table 4-1.

The increase in runoff due to the development of Kapolei Village will be appropriately 126 acre-feet for a 100-year, 24-hour storm. Whereas, urbanization of the entire watershed above the NASBP will produce an increase of 247 acre-feet. The minimum amount for onsite disposal was set at 247 acre-feet to not increase runoff into the NASBP for the design 100-year, 24-hour storm.



KAPOLEI VILLAGE DRAINAGE MASTER PLAN
FIGURE 4-1
FUTURE GROUND COVER CONDITIONS
R. M. TOWILL CORPORATION

TABLE 4-1

RUNOFF INCREASE DUE TO KAPOLEI VILLAGE

(FOR COMPARISON PURPOSES -- NO FLOOD CONTROL PROJECTS IMPLEMENTED)

RUNOFF VOLUMES (AT LOWER BOUNDARY OF PROJECT SITE)

RECURRENCE	EXISTING	ONLY KAPOLEI VILLAGE DEVELOPED	INCREASE	ENTIRE WATERSHED DEVELOPED	INCREASE
Tm = 2 yrs	275 ac-ft	338 ac-ft	+63 ac-ft	402 ac-ft	+127 ac-ft
10 yrs	656 ac-ft	746 ac-ft	+90 ac-ft	841 ac-ft	+185 ac-ft
50 yrs	1,087 ac-ft	1,201 ac-ft	+114 ac-ft	1,315 ac-ft	+228 ac-ft
100 yrs	1,312 ac-ft	1,438 ac-ft	+126 ac-ft	1,559 ac-ft	+247 ac-ft

PEAK FLOW RATES (AT LOWER BOUNDARY OF PROJECT SITE)

RECURRENCE	EXISTING	ONLY KAPOLEI VILLAGE DEVELOPED	INCREASE	ENTIRE WATERSHED DEVELOPED	INCREASE
Tm = 2 yrs	622 cfs	887 cfs	+265 cfs	1,246 cfs	+624 cfs
10 yrs	1,665 cfs	2,071 cfs	+406 cfs	2,892 cfs	+1,227 cfs
50 yrs	2,882 cfs	3,394 cfs	+512 cfs	4,662 cfs	+1,780 cfs
100 yrs	3,526 cfs	4,077 cfs	+551 cfs	5,570 cfs	+2,044 cfs

Note: Flow rates and volumes obtained by Soil Conservation Service Method using TR-20 program.

The peak flow rates will also increase significantly with urbanization of the watershed (if no flood control projects are implemented). For the 100-year, 24-hour storm, the peak rate entering the NASBP will increase from 3,526 cfs to 4,077 cfs if only Kapolei Village is developed, and to 5,570 cfs if the entire watershed is developed. Detention within the onsite basins will route stormwater to offset these increases.

4.2 DRAINAGE PLAN DESCRIPTION

Two types of drainage systems are discussed in this plan: regional and subdivision. The regional system includes those facilities which will be used to limit runoff entering the NASBP. Three primary regional facilities are identified as: 1) the Kapolei Village Golf Course/detention basin, located along the eastern boundary of the project site; 2) a drainage channel/basin located along the Kapolei Village-NASBP boundary (referred to as the "Lower Channel"); and 3) the NASBP coral pit. The proposed regional drainage plan is illustrated in Figure 4-2.

4.2.1 Golf Course/Detention Basin

Disposal of runoff will occur through infiltration and percolation in the golf course, lower channel and the NASBP coral pit. A soils exploration conducted by Geolabs-Hawaii produced infiltration/percolation estimates for these facilities and are summarized below:

Location	Percolation Rate
Golf Course	50 gpd/sf
Lower Channel	360 gpd/sf
NASBP Coral Pit	1,000 gpd/sf

Runoff from the watershed will enter the regional drainage system at the golf course. Makakilo and Makalapa Gulches and their tributaries will be diverted into the Kapolei Village Golf Course just below Farrington Highway via several box culverts. The flows entering the golf course are summarized in Table 4-2.

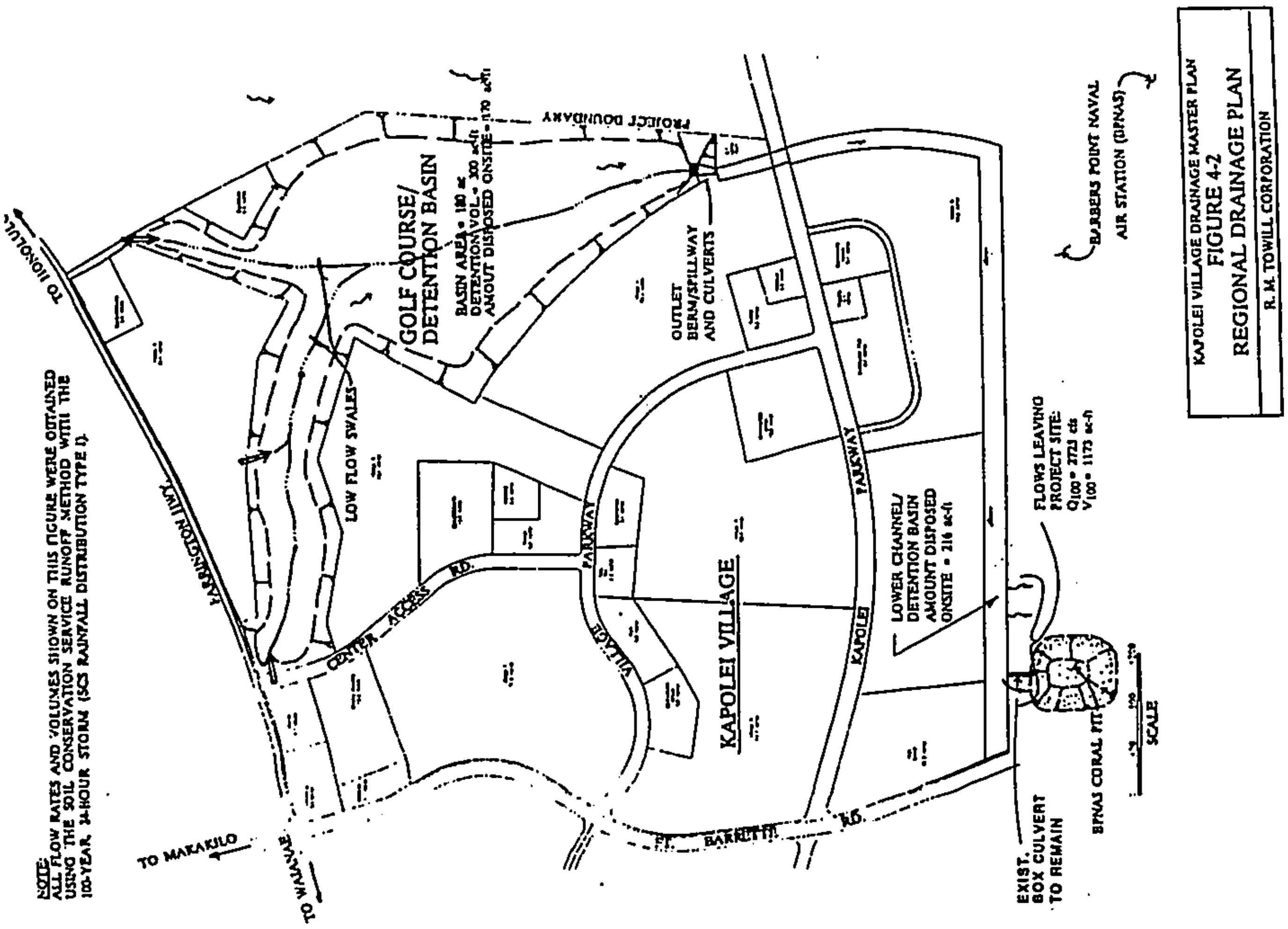


TABLE 4-2
RUNOFF VALUES FOR THE REGIONAL DRAINAGE SYSTEM
(ENTIRE WATERSHED DEVELOPED -- FLOOD CONTROL PROJECTS IMPLEMENTED)

RUNOFF VOLUMES

RECURRENCE	GOLF COURSE/ DETENTION BASIN INFLOW	OUTFLOW	LOWER CHANNEL/BASIN INFLOW	OUTFLOW	NASBP CORAL PIT INFLOW	OUTFLOW	EXISTING RUNOFF ENTERING NASBP	CHANGE IN RUNOFF ENTERING NASBP
Tm = 2 yrs.	184 ac-ft	62 ac-ft	281 ac-ft	181 ac-ft	195 ac-ft	0	275 ac-ft	-94 ac-ft
10 yrs.	430 ac-ft	280 ac-ft	691 ac-ft	517 ac-ft	550 ac-ft	0	656 ac-ft	-139 ac-ft
50 yrs.	707 ac-ft	543 ac-ft	1,150 ac-ft	942 ac-ft	997 ac-ft	0	1,087 ac-ft	-145 ac-ft
100 yrs.	853 ac-ft	683 ac-ft	1,389 ac-ft	1,173 ac-ft	1,239 ac-ft	0	1,312 ac-ft	-139 ac-ft

RUNOFF PEAK FLOWS

RECURRENCE	GOLF COURSE/ DETENTION BASIN INFLOW	OUTFLOW	LOWER CHANNEL/BASIN INFLOW	OUTFLOW	NASBP CORAL PIT INFLOW	OUTFLOW	EXISTING RUNOFF ENTERING NASBP	CHANGE IN RUNOFF ENTERING NASBP
Tm = 2 yrs.	677 cfs	73 cfs	816 cfs	233 cfs	246 cfs	0	622 cfs	-389 cfs
10 yrs.	1,726 cfs	149 cfs	1,597 cfs	1,546 cfs	1,720 cfs	0	1,665 cfs	-119 cfs
50 yrs.	2,940 cfs	523 cfs	2,338 cfs	2,250 cfs	2,521 cfs	0	2,882 cfs	-632 cfs
100 yrs.	3,576 cfs	875 cfs	2,759 cfs	2,725 cfs	2,856 cfs	0	3,526 cfs	-801 cfs

Notes:
1. Flows rates and volumes obtained by Soil Conservation Service Method using TR-20 program.
2. Lower Basin Outflow = Runoff Entering NASBP

The golf course will be designed such that at least 126 acre-feet of runoff is disposed onsite (during the 100-year design storm). This criteria will ensure that Kapolei Village will not increase runoff to the NASBP. As a contingency factor, onsite disposal of an arbitrary amount of at least 200 acre-feet will be used for design of the golf course.

The golf course will cover a total area of 180 acres. For purposes of this study, only 20% of the total area, or 36 acres was considered as effective for infiltration. At 36 acres, the golf course will have capacity to dispose nearly 200 acre-feet of runoff during the 100-year, 24-hour storm based on percolation estimates by Golabs-Hawaii. The actual area used for infiltration will most likely be greater than 36 acres and disposal of the required runoff within the golf course should not be a problem. Seepage pits will be constructed as required, to meet the disposal criteria if surface infiltration is inadequate.

The outlet of the golf course/detention basin will consist of a berm and spillway for releasing storm flows at a controlled rate. The spillway will be designed to pass up to the 250-year flood without failure to conform with the liability stipulations of the Hawaii Dam Safety Act of 1987, administered by the State Department of Land and Natural Resources.

The design and construction of the golf course/detention basin, spillway and berm structure will be done by HFDC. When this report was prepared, a preliminary mass grading plan was available (attached as Exhibit A). This plan, dated October 4, 1990, was prepared by Park Engineering. It was used to develop the elevation-storage-discharge relationship of the golf course for the hydrologic routing calculations.

The culverts will be placed through the berm to allow irrigation excess and low flows to escape without creating a situation of frequent ponding. Without such an outlet, daily ponding would lead to soggy ground conditions and insect/health hazards. Maintenance of these culverts will be necessary due to high possibility of clogging by debris. However, since the primary outlet for storm flow will be over the spillway, temporary blockage of these culverts will not affect the capacity of the system to pass storm flows. The design of the berm should have provisions to clear debris from the culverts during ponded conditions.

4.2.2 Lower Channel/Detention Basin

Runoff from the golf course will enter the lower channel/detention basin, located within a 125-foot wide drainage easement along the eastern and lower boundaries of Kapolei Village. Dimensions will include an average bottom width of approximately 30 feet and a depth of roughly 15 feet. High infiltration rates are expected to be obtained due to excavation into a permeable substratum of coral. Seepage pits will be constructed, as required, to ensure adequate disposal capacity is obtained.

The amount of runoff disposed in the lower channel/basin was computed to be approximately 216 acre-feet during the 100-year, 24-hour storm. This was obtained by taking the difference between the basin inflows and outflows. The infiltration rates provided by Geolabs-Hawaii were applied over a portion of the channel bottom. As a conservative measure, only 60% of the channel bottom paralleling the NASBP was considered as effective for infiltration. The leg of the channel extending north to the golf course as well and the channel sides and remaining 40% of the channel bottom were not included in the computations. This approach was used as an attempt to account for reduced infiltration due to inevitable residual sedimentation after maintenance operations.

The lower channel/basin will end at a point several hundred feet east of Fort Barrette Road, where the Makakilo Gulch enters the NASBP coral pit. An existing buffer strip will remain between the lower channel/basin and the NASBP. If the channel overflows, runoff should proceed on its natural course over existing drainage patterns.

A portion of the overflow from lower channel/basin will drain into the existing Makakilo Gulch before the NASBP. However, due to the relatively high invert of the gulch, it is anticipated that a large part of the runoff will overflow the lower channel/basin in an area just east of the gulch. Existing grades within the buffer strip will direct these flows back towards the Makakilo Gulch. A multi-cell box culvert is located at the entrance to the NASBP beneath Franklin D. Roosevelt Road. Runoff from the buffer strip will flow through this culvert and subsequently into the NASBP coral pit.

4.2.3 NASBP Coral Pit

The NASBP coral pit is the downstream-most facility of the regional drainage system. The coral pit has a volume of approximately 680 acre-feet as computed from a topographic survey conducted in August 1990 (Reference 13, attached as Exhibit B). A high percolation rate was reported in a soils exploration by Geolabs-Hawaii (Reference 14). When analyzed in conjunction with the golf course and lower channel/basin, it was determined that the NASBP coral pit would not overflow during the 100-year, 24-hour storm.

Only a portion of the coral pit's bottom was considered as effective for infiltration. The bottom area covers approximately 545,600 sf. Of this area, 15% was excluded to account for rubble, concrete spills and other non-porous areas. Of the remaining 463,760 sf, another 15% was excluded to account for inevitable residual sedimentation after maintenance operations. Therefore, an effective bottom area of 394,200 sf or approximately 72% of the total area was used in the computations.

Table 4-2 summarizes the inflows to the NASBP coral pit. Note that the inflows to the NASBP coral pit are greater than outflows from the lower channel/basin because of contributions from within the coral pit and surrounding areas.

4.2.4 Sedimentation

An analysis was conducted to determine the amount of sediment expected to be deposited in the basins (golf course, lower channel and NASBP coral pit). The analysis utilized the Universal Soil Loss Equation (Reference 15) for determining sediment production from the watershed. Sediment estimates were also prepared for existing conditions in order to compare with developed conditions. Table 4-3 summarizes the results of the analysis.

The following describes the general procedure used in determining sedimentation: 1) sediment production was computed by using the Universal Soil Loss Equation, 2) a sediment-delivery ratio was estimated and multiplied to the sediment production to determine transported to a basin, 3) any sediment from upstream basins is added to the

PART 3

CALCULATIONS FOR

DEVELOPED CONDITIONS

(SCS ANALYSIS)

FN:KVDMF1.WK1   R. M. TOWILL CORPORATION   P.1

KAPOLEI VILLAGE DRAINAGE MASTER PLAN

KAPOLEI VILLAGE
EWA, OAHU, HAWAII
PREPARED BY: GHH

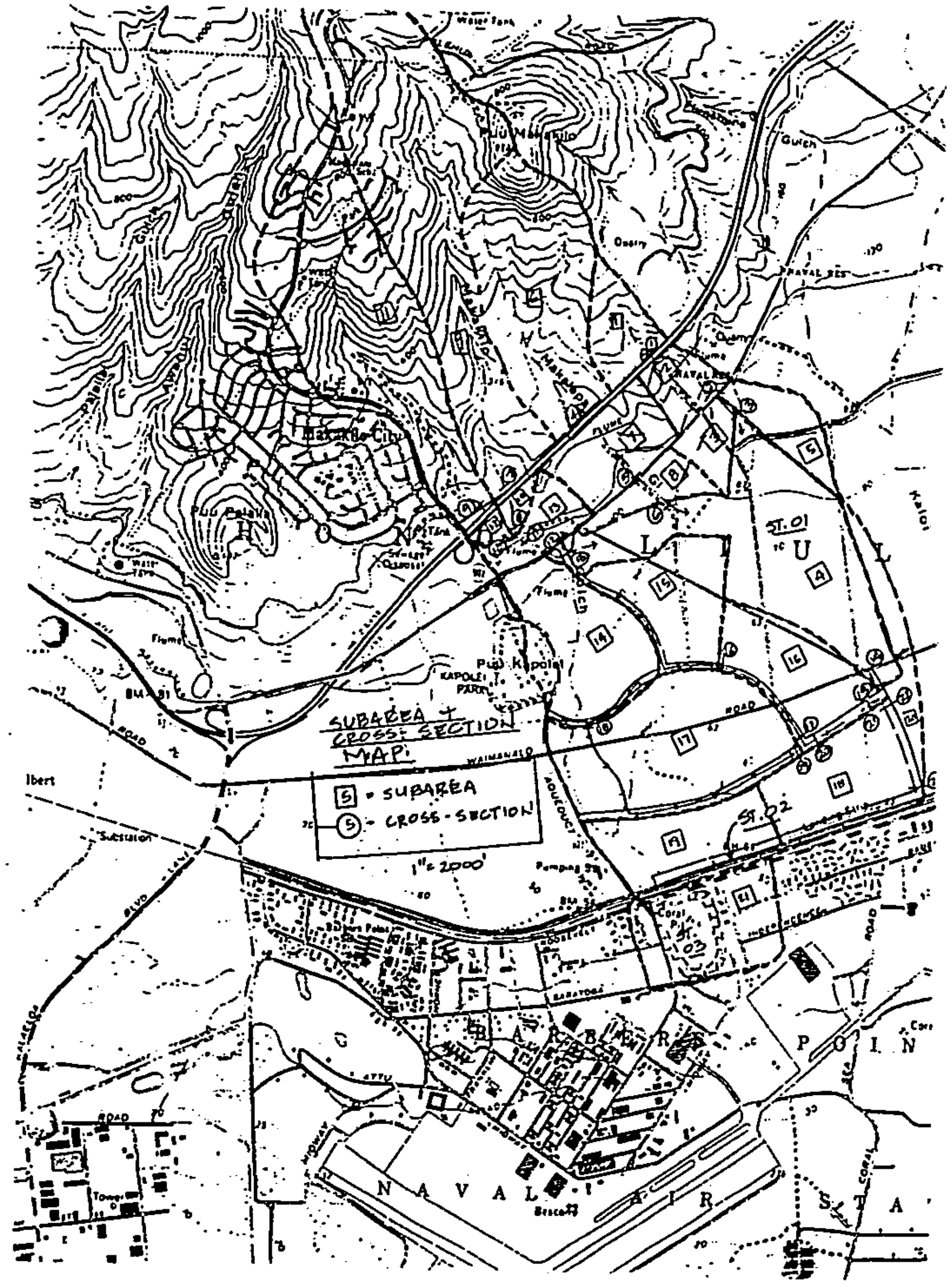
JOB REF: 1-15713-0E
DATE: 8/28/89
CHECKED BY:

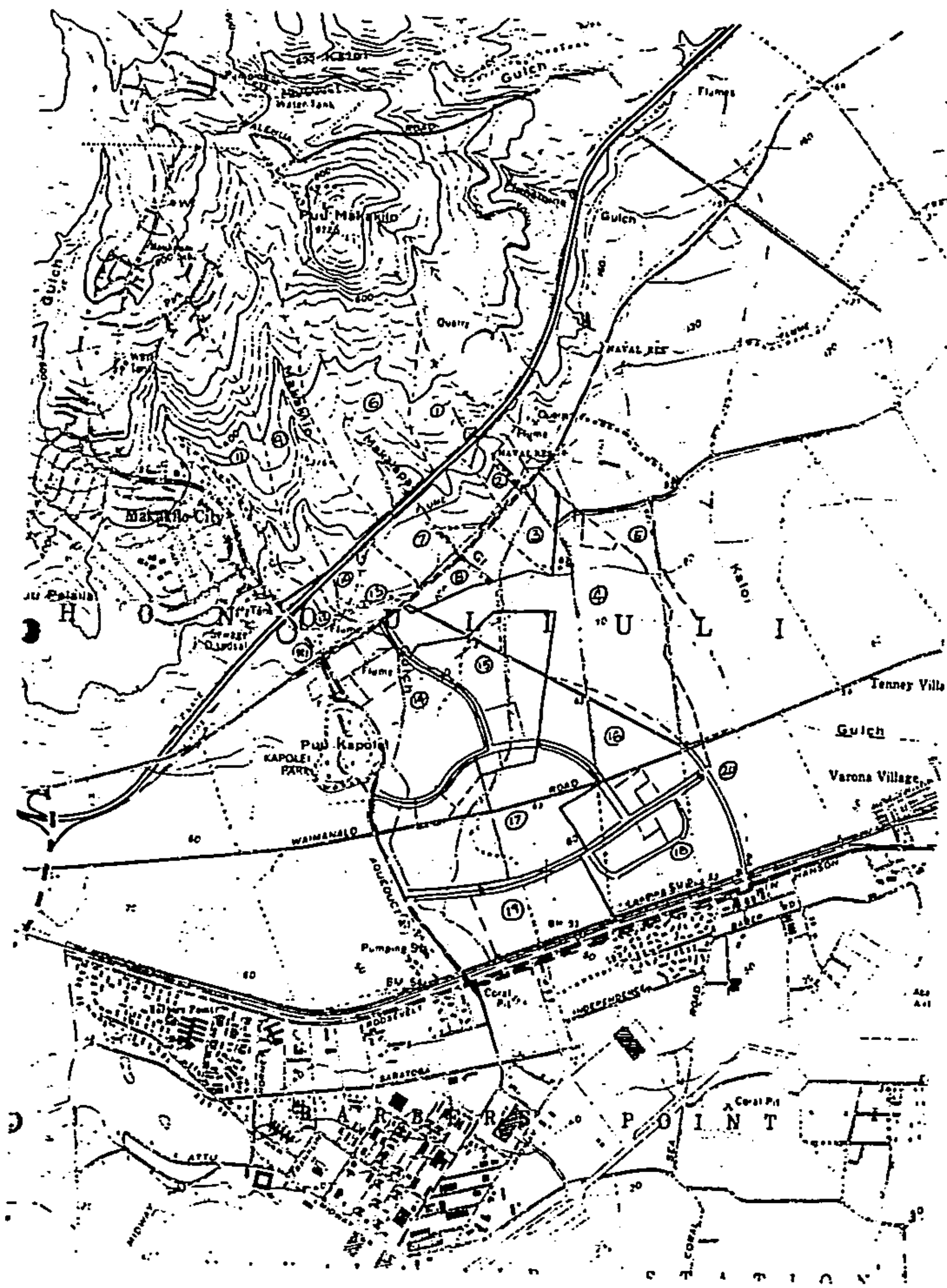
PURPOSE:

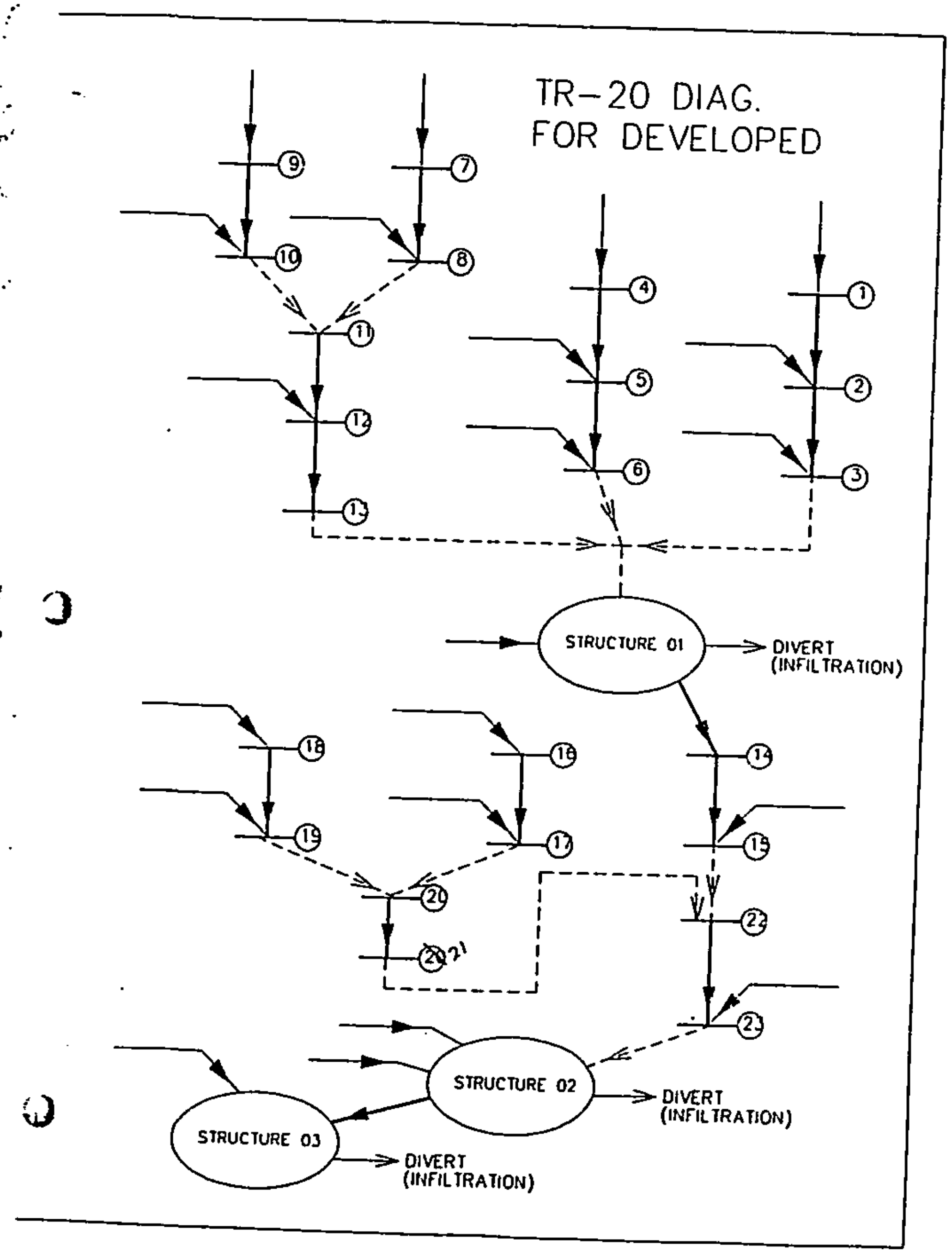
Divide the study watershed into subareas to reflect differing stream reaches with respective contributing areas. The subareas should be divided according to homogeneity of hydrologic characteristics and according to the location of the system's design points.

WATERSHED DATA:

SUBAREA	AREA (acres)	AREA (sq.mi)
1	42	0.066
2	35	0.055
3	26	0.041
4	200	0.313
5	126	0.197
6	198	0.309
7	66	0.103
8	35	0.055
9	363	0.567
10	8	0.013
11	292	0.456
12	9	0.014
13	38	0.059
14	126	0.197
15	95	0.148
16	107	0.167
17	154	0.241
18	88	0.138
19	83	0.130
20	19	0.030
TOTALS =	2110	3.297
21	96	0.15
	2206	3.447




Puu Makakilo
Makakilo City
Gulch
Kaloi
H O N O U L I U L I
Tenney Villa
Varona Village
Puu Kapolei
WAIMANALO
BARBERS POINT


TR-20 DIAG.
FOR DEVELOPED
STRUCTURE 01
DIVERT
(INFILTRATION)
STRUCTURE 02
DIVERT
(INFILTRATION)
STRUCTURE 03
DIVERT
(INFILTRATION)

KAPOLEI VILLAGE DRAINAGE MASTER PLAN

SCS RUNOFF CURVE NUMBERS - FULLY DEVELOPED WATERSHED

KAPOLEI VILLAGE
EWA, OAHU, HAWAII
PREPARED BY: GHH

JOB REF: 1-15713-1E
DATE: 3/5/91
CHECKED BY:

PURPOSE:

Determine the composite SCS RUNOFF CURVE NUMBERS for the contributing watersheds assuming FULLY DEVELOPED WATERSHED conditions.

REFERENCES:

1. McCuen, Richard H., A Guide to Hydrologic Analysis Using SCS Methods, Prentice-Hall, Inc., Englewood Cliffs, NJ c.1982

2. U.S. Department of Agriculture Soil Conservation Service, Urban Hydrology for Small Watersheds, Technical Release No. 55, Washington DC, Jan.1975

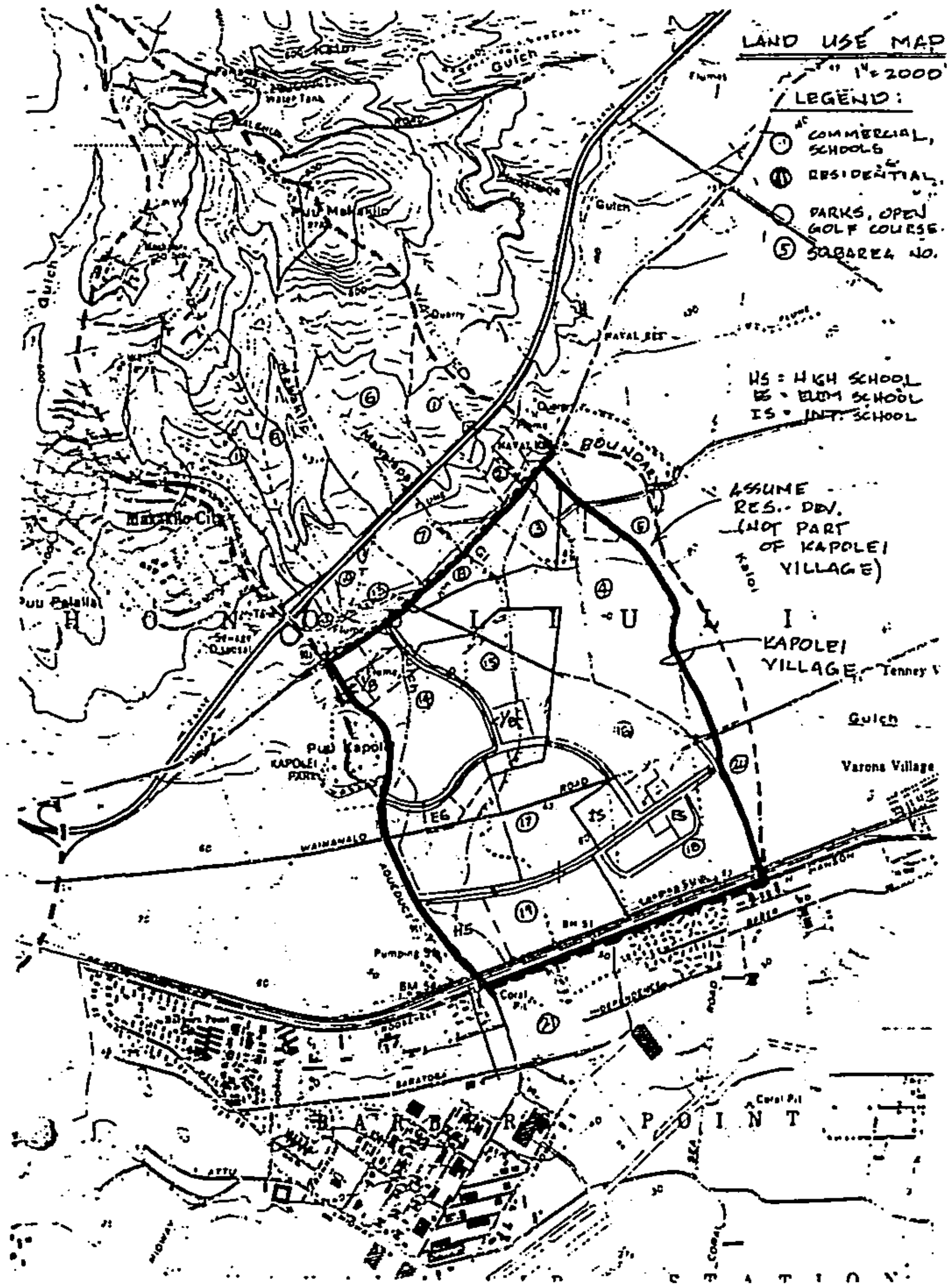
CALCULATIONS:

Subarea	Soil Group	Acres	Land Use	CN	Acres*CN
1	A	28	Woods	45	1260
	B	14	Woods	66	924
		42		total =	2184
				Composite CN =	52
2	A	16	Commercial	89	1388
	B	19	Commercial	92	1776
		35		total =	3164
				Composite CN =	91
3	B	11	Residential	85	935
	D	15	Residential	92	1380
		26		total =	2315
				Composite CN =	89
4	B	140	Open/Golf Course	61	8540
	C	50	Open/Golf Course	74	3700
	D	10	Open/Golf Course	80	800
		200		total =	13040
				Composite CN =	65

Subarea	Soil Group	Acres	Land Use	CN	Acres*CN
5	B	6	Residential	85	536
	D	120	Residential	92	11012
		126		total =	11548
				Composite CN =	92
6	A	160	Woods	45	7200
	B	38	Woods	66	2508
		198		total =	9708
				Composite CN =	49
7	A	18	Commercial	89	1602
	B	38	Commercial	92	3496
	C	10	Commercial	94	940
		66		total =	6038
				Composite CN =	91
8	B	35	Residential	85	2975
		35		total =	2975
				Composite CN =	85
9	A	90	Open/Parks/Woods	45	4050
	B	11	Open/Parks/Woods	66	726
	C	26	Open/Parks/Woods	77	2002
	A	105	Residential	77	8085
	B	110	Residential	85	9350
	C	21	Residential	90	1890
		363		total =	26103
				Composite CN =	72
10	B	8	Commercial	92	764
		8		total =	764
				Composite CN =	92
11	A	160	Residential	77	12320
	B	30	Residential	85	2550
	A	102	Open/Parks/Woods	45	4590
		292		total =	19460
				Composite CN =	67
12	B	9	Commercial	92	846
		9		total =	846
				Composite CN =	92

FN:1VIMFC.WK1   F. M. TOKILL CORPORATION   P.3

Subarea	Soil Group	Acres	Land Use	CN	Acres*CN
13	A	3	Commercial	89	267
	B	33	Commercial	92	3036
	C	2	Commercial	94	188
		38		total =	3501
				Composite CN =	92
14	B	8	Comm./Church	92	736
	B	76	Residential	85	6426
	C	1	Comm./Church	94	118
	C	4	Residential	86	344
	D	13	Comm./Church	95	1197
	D	25	Residential	92	2318
		126		total =	11096
				Composite CN =	88
15	B	87	Residential	85	7395
	D	5	Residential	92	437
	D	3	GC	92	276
		95		total =	8108
				Composite CN =	86
16	B	76	Residential	85	6460
	D	16	Residential	92	1472
	D	15	School	92	1380
		107		total =	9312
				Composite CN =	87
17	B	6	Park	61	366
	B	6	School	85	510
	B	37	Residential	85	3145
	D	105	Residential	92	9660
		154		total =	13681
				Composite CN =	89
18	B	1	Rec. Center	85	85
	D	2	Rec. Center	92	184
	D	6	School	92	552
	D	65	Residential	92	5980
	D	14	Commerical	95	1330
		88		total =	8131
				Composite CN =	92
19	B	12	School	85	1020
	B	9	Residential	85	765
	D	13	School	85	1105
	D	49	Residential	92	4508
		83		total =	7398
				Composite CN =	89
20	D	19	Residential	92	1748
		19		total =	1748
					92



DEVELOPED CONDITIONS

(File: KVDES.DAT)

```
END OF  1 JOBS IN THIS RUN

1

******************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY******************

JOB TR-20                         FULLPRINT          SUMMARY
TITLE 001 KVDES.DAT - ENTIRE WATERSHED DEV. - W/PROJECTS - REFINED
 2 XSECTN   002         1.0        97.0
 8                      93.5       0.0        0.0
 8                      94.0       76.0       20.0
 8                      94.5       172.0      48.0
 8                      95.0       242.0      70.0
 8                      96.0       865.0      159.0
 8                      97.0       1673.0     248.0
 9 ENDTBL
 2 XSECTN   003         1.0        108.0
 8                      100.0      0.0        0.0
 8                      100.3      101.0      2.0
 8                      100.5      154.0      4.0
 8                      101.0      307.0      8.0
 8                      102.0      615.0      16.0
 8                      105.0      1890.0     40.0
 8                      108.0      3222.0     64.0
 9 ENDTBL
 2 XSECTN   005         1.0        112.0
 8                      107.0      0.0        0.0
 8                      107.3      47.0       7.0
 8                      107.5      94.0       14.0
 8                      108.0      153.0      26.0
 8                      109.0      332.0      54.0
 8                      110.0      473.0      80.0
 8                      111.0      1834.0     280.0
 8                      112.0      3204.0     480.0
 9 ENDTBL
 2 XSECTN   006         1.0        113.0
 8                      105.0      0.0        0.0
 8                      105.5      120.0      4.0
 8                      106.0      240.0      8.0
 8                      107.0      480.0      16.0
 8                      110.0      1477.0     40.0
 8                      113.0      2518.0     64.0
 9 ENDTBL
 2 XSECTN   008         1.0        118.0
 8                      111.0      0.0        0.0
 8                      112.0      98.0       17.0
 8                      113.0      199.0      35.0
 8                      115.5      988.0      120.5
 8                      118.0      1840.0     206.0
 9 ENDTBL
 2 XSECTN   010         1.0        118.0
 8                      111.0      0.0        0.0
1

**********************80-80 LIST OF INPUT DATA (CONTINUED)**********************

 8                      112.0      106.0      19.0
 8                      113.0      222.0      40.0
 8                      115.5      956.0      135.0
 8                      118.0      1720.0     230.0
 9 ENDTBL
 2 XSECTN   012         1.0        93.0
 8                      84.0       0.0        0.0
 8                      84.5       67.0       8.0
 8                      85.0       179.0      19.0
 8                      86.0       373.0      39.0
 8                      87.0       517.0      57.0
 8                      88.0       726.0      78.0
 8                      90.5       1741.0     155.0
 8                      93.0       2814.0     232.0
 9 ENDTBL
 2 XSECTN   013         1.0        98.0
 8                      90.0       0.0        0.0
 8                      90.3       139.0      5.0
 8                      90.5       278.0      10.0
```

```
8                   91.0      557.0     20.0
8                   92.0      1113.0    40.0
8                   95.0      3647.0    100.0
8                   98.0      6378.0    160.0
8
9 ENDTBL
2 XSECTN   014      1.0       52.0
8                   42.0      0.0       0.0
8                   43.0      163.0     50.0
8                   44.0      358.0     108.0
8                   48.0      2702.0    404.0
8                   52.0      5872.0    700.0
8
9 ENDTBL
2 XSECTN   015      1.0       52.0
8                   42.0      0.0       0.0
8                   43.0      163.0     50.0
8                   44.0      358.0     108.0
8                   48.0      2702.0    404.0
8                   52.0      5872.0    700.0
8
9 ENDTBL
2 XSECTN   017      1.0       51.0
8                   45.0      0.0       0.0
8                   46.0      65.0      10.0
8                   47.0      130.0     20.0
8                   49.0      296.0     40.0
8                   51.0      466.0     60.0
8
9 ENDTBL
2 XSECTN   019      1.0       50.0
```

```
**********************80-80 LIST OF INPUT DATA (CONTINUED)***********************

8                   42.0      0.0       0.0
8                   43.0      52.0      14.0
8                   44.0      104.0     30.0
8                   47.0      335.0     75.0
8                   50.0      581.0     120.0
8
9 ENDTBL
2 XSECTN   021      1.0       48.0
8                   40.0      0.0       0.0
8                   41.0      152.0     30.0
8                   42.0      294.0     60.0
8                   45.0      947.0     150.0
8                   48.0      1644.0    240.0
8
9 ENDTBL
2 XSECTN   023      1.0       50.0
8                   40.0      0.0       0.0
8                   41.0      163.0     50.0
8                   42.0      358.0     108.0
8                   46.0      2702.0    404.0
8                   50.0      5872.0    700.0
8
9 ENDTBL
3 STRUCT       01
8                   47.0      0.0       0.0
8                   48.0      30.0      8.0
8                   49.0      42.0      24.0
8                   50.0      75.0      40.0
8                   51.0      90.0      56.0
8                   52.0      108.0     72.0
8                   53.0      123.0     102.0
8                   54.0      135.0     132.0
8                   55.0      150.0     162.0
8                   56.0      162.0     192.0
8                   57.0      276.0     233.0
8                   58.0      788.0     279.0
8                   59.0      1776.0    300.0
8
9 ENDTBL
3 STRUCT       02
8                   44.0      0.0       0.0
8                   46.0      5.0       24.0
8                   48.0      85.0      51.0
8                   50.0      140.0     82.0
8                   50.5      551.0     93.0
8                   51.0      2720.0    103.0
8                   51.5      5699.0    107.0
8                   52.0      9825.0    110.0
8
9 ENDTBL
3 STRUCT       03
```

```
**********************80-80 LIST OF INPUT DATA (CONTINUED)***********************

8                   4.0       0.0       0.0
8                   49.0      0.10      655.0
8                   50.0      140.0     682.0
8                   51.0      4010.0    709.0
8                   52.0      11820.0   738.0
8
9 ENDTBL
6 RUNOFF 1 001        1 0.066      52.0      0.08        1     1  1
6 REACH  3 002    1   2 1200.0                           1     1  1
6 RUNOFF 1 002        1 0.055      91.0      0.09        1     1  1
6 ADDHYD 4 002    1 2 3                                  1     1  1
6 REACH  3 003    3   2 600.0                            1     1  1
6 RUNOFF 1 003        1 0.041      89.0      0.09        1     1  1
6 ADDHYD 4 003    1 2 3                                  1     1  1
6 RUNOFF 1 004        4 0.309      49.0      0.30        1     1  1
6 REACH  3 005    4   5 1200.0                           1     1  1
6 RUNOFF 1 005        6 0.103      91.0      0.11        1     1  1
6 ADDHYD 4 005    5 6 4                                  1     1  1
6 REACH  3 006    4   5 700.0                            1     1  1
6 RUNOFF 1 006        6 0.055      85.0      0.14        1     1  1
6 ADDHYD 4 006    5 6 4                                  1     1  1
6 ADDHYD 4     01 3 4 1                                  1     1  1
6 RUNOFF 1 007        2 0.587      72.0      0.57        1     1  1
6 REACH  3 008    2   3 800.0                            1     1  1
6 RUNOFF 1 008        4 0.013      92.0      0.07        1     1  1
6 ADDHYD 4 008    3 4 2                                  1     1  1
6 RUNOFF 1 009        3 0.456      67.0      0.38        1     1  1
6 REACH  3 010    3   4 700.0                            1     1  1
6 RUNOFF 1 010        5 0.014      92.0      0.06        1     1  1
6 ADDHYD 4 010    4 5 6                                  1     1  1
6 ADDHYD 4 011    2 6 7                                  1     1  1
6 REACH  3 012    7   4 300.0                            1     1  1
6 RUNOFF 1 012        5 0.059      92.0      0.11        1     1  1
6 ADDHYD 4 012    4 5 3                                  1     1  1
6 REACH  3 013    3   4 500.0                            1     1  1
6 ADDHYD 4     01 1 4 2                                  1     1  1
6 RUNOFF 1     01     4 0.313      65.0      2.13        1     1  1
6 ADDHYD 4     01 2 4 6                                  1     1  1
6 DIVERT 6     01 6 7 1 100.0                25.         1 1 1 1  1
6 RESVOR 2     01 1   2 47.0                             1     1  1
6 REACH  3 014    2   3 50.0                             1     1  1
6 REACH  3 015    3   4 400.0                            1     1  1
6 RUNOFF 1 015        3 0.197      92.0      1.15        1     1  1
6 ADDHYD 4 015    3 4 1                                  1     1  1
6 RUNOFF 1 016        2 0.148      86.0      0.57        1     1  1
6 REACH  3 017    2   3 2500.0                           1     1  1
6 RUNOFF 1 017        2 0.167      87.0      0.89        1     1  1
```

```
**********************80-80 LIST OF INPUT DATA (CONTINUED)***********************

6 ADDHYD 4 017  . 2 3 4                                  1     1  1
6 RUNOFF 1 018        5 0.197      88.0      0.53        1     1  1
6 REACH  3 019    5   6 5200.0                           1     1  1
6 RUNOFF 1 019        5 0.241      89.0      0.77        1     1  1
6 ADDHYD 4 019    6 5 7                                  1     1  1
6 ADDHYD 4 020    4 7 2                                  1     1  1
6 REACH  3 021    2   3 1400.0                           1     1  1
6 ADDHYD 4 022    1 3 2                                  1     1  1
6 REACH  3 023    2   1 1900.0                           1     1  1
6 RUNOFF 1 023        2 0.030      84.0      0.69        1     1  1
6 ADDHYD 4 023    1 2 3                                  1     1  1
6 RUNOFF 1     02     5 0.138      92.0      1.04        1     1  1
6 ADDHYD 4     02 3 5 6                                  1     1  1
6 RUNOFF 1     02     5 0.130      89.0      0.73        1     1  1
6 ADDHYD 4     02 6 5 2                                  1     1  1
6 DIVERT 6     02 2 3 4 50.0                 26.         1 1 1 1  1
6 RESVOR 2     02 4   1 44.0                             1     1  1
6 RUNOFF 1     03     2 0.15       72.0      0.23        1     1  1
6 ADDHYD 4     03 1 2 3                                  1     1  1
6 DIVERT 6     03 3 4 5 610.0                27.         1     1  1
6 RESVOR 2     03 5   2 4.0                              1 1 1 1  1
  ENDATA
7 INCREM 6              0.200
```

```
7 COMPUT 7 001      03 0.0      12.0      1.0      1 2  01  01
  ENDCMP 1
7 COMPUT 7 001      03 0.0      10.5      1.0      1 2  01  02
  ENDCMP 1
7 COMPUT 7 001      03 0.0      7.5       1.0      1 2  01  03
  ENDCMP 1
7 COMPUT 7 001      03 0.0      4.5       1.0      1 2  01  04
  ENDCMP 1
  ENDJOB 2
******************************END OF 80-80 LIST******************************
```


ILE NO. 1

COMPUTER PROGRAM FOR PROJECT FORMULATION - HYDROLOGY USER NOTES

THE USERS MANUAL FOR THIS PROGRAM IS THE MAY 1982 DRAFT OF TR-20. CHANGES FROM THE 2/14/74 VERSION INCLUDE:

REACH ROUTING - THE MODIFIED ATT-KIN ROUTING PROCEDURE REPLACES THE CONVEX METHOD. INPUT DATA PREPARED FOR PREVIOUS PROGRAM VERSIONS USING CONVEX ROUTING COEFFICIENTS WILL NOT RUN ON THIS VERSION.

THE PREFERRED TYPE OF DATA ENTRY IS CROSS SECTION DATA REPRESENTATIVE OF A REACH. IT IS RECOMMENDED THAT THE OPTIONAL CROSS SECTION DISCHARGE-AREA PLOTS BE OBTAINED WHENEVER NEW CROSS SECTION DATA IS ENTERED. THE PLOTS SHOULD BE CHECKED FOR REASONABLENESS AND ADEQUACY OF INPUT DATA FOR THE COMPUTATION OF "M" VALUES USED IN THE ROUTING PROCEDURE.

GUIDELINES FOR DETERMINING OR ANALYZING REACH LENGTHS AND COEFFICIENTS (X,M) ARE AVAILABLE IN THE USERS MANUAL. SUMMARY TABLE 2 DISPLAYS REACH ROUTING RESULTS AND ROUTING PARAMETERS FOR COMPARISON AND CHECKING.

HYDROGRAPH GENERATION - THE PROCEDURE TO CALCULATE THE INTERNAL TIME INCREMENT AND PEAK TIME OF THE UNIT HYDROGRAPH HAVE BEEN IMPROVED. PEAK DISCHARGES AND TIMES MAY DIFFER FROM THE PREVIOUS VERSION. OUTPUT HYDROGRAPHS ARE STILL INTERPOLATED, PRINTED, AND ROUTED AT THE USER SELECTED MAIN TIME INCREMENT.

INTERMEDIATE PEAKS - METHOD ADDED TO PROVIDE DISCHARGES AT INTERMEDIATE POINTS WITHIN REACHES WITHOUT ROUTING.

OTHER - THIS VERSION CONTAINS SOME ADDITIONS TO THE INPUT AND NUMEROUS MODIFICATIONS TO THE OUTPUT. USER OPTIONS HAVE BEEN MODIFIED AND AUGMENTED ON THE JOB RECORD, RAINTABLES ADDED, ERROR AND WARNING MESSAGES EXPANDED, AND THE SUMMARY TABLES COMPLETELY REVISED. THE HOLDOUT OPTION IS NOT OPERATIONAL AT THIS TIME.

PROGRAM QUESTIONS OR PROBLEMS SHOULD BE DIRECTED TO HYDRAULIC ENGINEERS AT THE SCS NATIONAL TECHNICAL CENTERS:
CHESTER, PA (NORTHEAST) -- 215-499-3933, FORT WORTH, TX (SOUTH) -- 334-5242 (FTS)
LINCOLN, NB (MIDWEST) -- 541-5318 (FTS), PORTLAND, OR (WEST) -- 423-4099 (FTS)

PROGRAM CHANGES SINCE MAY 1982:

```
12/17/82 - CORRECT PEAK RATE FACTOR FOR USER ENTERED DIMHYD
           CORRECT REACH ROUTING PEAK TRAVEL TIME PRINTED WITH FULLPRINT OPTION
 5/02/83 - CORRECT COMPUTATIONS FOR ---
                 1. DIVISION OF BASEFLOW IN DIVERT OPERATION
                 2. HYDROGRAPH VOLUME SPLIT BETWEEN BASEFLOW AND ABOVE BASEFLOW
                 3. CROSS SECTION DATA PLOTTING POSITION
                 4. INTERMEDIATE PEAK WHEN "FROM" AREA IS LARGER THAN "THRU" AREA
                 5. STORAGE ROUTED REACH TRAVEL TIME FOR MULTIPEAK HYDROGRAPH
                 6. ORDERING "FLOW-FREQ" FILE FROM SUMMARY TABLE #3 DATA
                 7. BASEFLOW ENTERED WITH READHYD
                 8. LOW FLOW SPLIT DURING DIVERT PROCEDURE #2 WHEN SECTION RATINGS START AT DIFFERENT ELEVATIONS
           ENHANCEMENTS ---
                 1. REPLACE USER MANUAL ERROR CODES (PAGE 4-9 TO 4-11) WITH MESSAGES
                 2. LABEL OUTPUT HYDROGRAPH FILES WITH CROSS SECTION/STRUCTURE, ALTERNATE AND STORM NO'S
09/01/83 - CORRECT INPUT AND OUTPUT ERRORS FOR INTERMEDIATE PEAKS
           CORRECT COMBINATION OF RATING TABLES FOR DIVERT
           CHECK REACH ROUTING PARAMETERS FOR ACCEPTABLE LIMITS
           ELIMINATE MINIMUM REACH TRAVEL TIME WHEN ATT-KIN COEFFICIENT EQUALS ONE
```



```
10000+----------------------------------+----------------------------------+
     :                                                                      :
```

EXECUTIVE CONTROL OPERATION ENDJOB RECORD ID
1

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

SECTION/ STRUCTURE ID		STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)
ALTERNATE 1 STORM 1														
XSECTION	1	RUNOFF	.07	1	2	.20	.0	12.00	24.00	5.33	---	9.94	115.03	1742.9
XSECTION	2	REACH	.07	1	2	.20	.0	12.00	24.00	5.33	94.20	9.94	115.03	1742.9
XSECTION	2	RUNOFF	.05	1	2	.20	.0	12.00	24.00	10.90	---	9.90	190.26	3459.3
XSECTION	2	ADDHYD	.12	1	2	.20	.0	12.00	24.00	7.86	95.10	9.92	304.37	2515.5
XSECTION	3	REACH	.12	1	2	.20	.0	12.00	24.00	7.86	100.99	9.92	304.37	2515.5
XSECTION	3	RUNOFF	.04	1	2	.20	.0	12.00	24.00	10.64	---	9.90	140.10	3417.0
XSECTION	3	ADDHYD	.16	1	2	.20	.0	12.00	24.00	8.56	101.45	9.91	444.29	2742.5
XSECTION	4	RUNOFF	.31	1	2	.20	.0	12.00	24.00	4.84	---	10.03	384.02	1242.8
XSECTION	5	REACH	.31	1	2	.20	.0	12.00	24.00	4.84	109.37	10.03	384.02	1242.9
XSECTION	5	RUNOFF	.10	1	2	.20	.0	12.00	24.00	10.86	---	9.90	355.44	3450.9
XSECTION	5	ADDHYD	.41	1	2	.20	.0	12.00	24.00	6.35	110.18	9.96	718.23	1743.3
XSECTION	6	REACH	.41	1	2	.20	.0	12.00	24.00	6.35	107.72	9.96	718.23	1743.3
XSECTION	6	RUNOFF	.05	1	2	.20	.0	12.00	24.00	10.05	---	9.91	179.63	3266.1
XSECTION	6	ADDHYD	.47	1	2	.20	.0	12.00	24.00	6.78	108.25	9.95	894.77	1916.0
STRUCTURE	1	ADDHYD	.63	1	2	.20	.0	12.00	24.00	7.24	58.55	9.94	1335.48	2123.2
XSECTION	7	RUNOFF	.57	1	2	.20	.0	12.00	24.00	8.33	---	10.18	1148.42	2025.4
XSECTION	8	REACH	.57	1	2	.20	.0	12.00	24.00	8.33	115.98	10.18	1148.42	2025.4
XSECTION	8	RUNOFF	.01	1	2	.20	.0	12.00	24.00	11.06	---	9.90	45.26	3481.7
XSECTION	8	ADDHYD	.58	1	2	.20	.0	12.00	24.00	8.39	116.02	10.17	1163.68	2006.7
XSECTION	9	RUNOFF	.46	1	2	.20	.0	12.00	24.00	7.62	---	10.06	938.65	2058.4
XSECTION	10	REACH	.46	1	2	.20	.0	12.00	24.00	7.62	115.44	10.06	938.65	2058.4
XSECTION	10	RUNOFF	.01	1	2	.20	.0	12.00	24.00	11.06	---	9.90	48.84	3488.5
XSECTION	10	ADDHYD	.47	1	2	.20	.0	12.00	24.00	7.73	115.58	10.04	978.95	2082.9
XSECTION	11	ADDHYD	1.05	1	2	.20	.0	12.00	24.00	8.09	---	10.10	2078.73	1979.7
XSECTION	12	REACH	1.05	1	2	.20	.0	12.00	24.00	8.09	91.29	10.10	2078.73	1979.7
XSECTION	12	RUNOFF	.06	1	2	.20	.0	12.00	24.00	10.99	---	9.90	204.71	3469.7
XSECTION	12	ADDHYD	1.11	1	2	.20	.0	12.00	24.00	8.25	91.69	10.07	2249.61	2028.5
XSECTION	13	REACH	1.11	1	2	.20	.0	12.00	24.00	8.25	93.35	10.07	2249.61	2028.5
STRUCTURE	1	ADDHYD	1.74	1	2	.20	.0	12.00	24.00	7.88	60.74	10.01	3491.68	2009.0
STRUCTURE	1	RUNOFF	.31	1	2	.20	.0	12.00	24.00	7.31	---	11.31	275.65	880.7
STRUCTURE	1	ADDHYD	2.05	1	2	.20	.0	12.00	24.00	7.60	60.82	10.01	3576.37	1743.7
STRUCTURE	1	DIVERT	.00	1	2	.20	.0	12.00	24.00	7.60	51.56	6.00*	100.00**********	

1

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)

ALTERNATE 1 STORM 1

ECTION 25	DIVERT	2.05	1	2	.20	.0	12.00	24.00	6.22	---	10.01	3476.37	1695.0
RUCTURE 1	RESVOR	2.05	1	2	.20	.0	12.00	24.00	6.24	58.09	11.58	874.61	426.4
ECTION 14	REACH	2.05	1	2	.20	.0	12.00	24.00	6.24	44.88	11.58	874.61	426.4
ECTION 15	REACH	2.05	1	2	.20	.0	12.00	24.00	6.24	44.88	11.58	874.61	426.4
ECTION 15	RUNOFF	.20	1	2	.20	.0	12.00	24.00	11.00	---	10.52	367.02	1867.1
ECTION 15	ADDHYD	2.25	1	2	.20	.0	12.00	24.00	8.66	45.18	11.46	1049.29	466.8
ECTION 16	RUNOFF	.15	1	2	.20	.0	12.00	24.00	10.24	---	10.16	364.90	2465.5
ECTION 17	REACH	.15	1	2	.20	.0	12.00	24.00	10.24	49.81	10.16	364.90	2465.5
ECTION 17	RUNOFF	.17	1	2	.20	.0	12.00	24.00	10.37	---	10.38	340.12	2038.8
ECTION 17	ADDHYD	.31	1	2	.20	.0	12.00	24.00	10.31	53.61	10.23	687.83	2183.6
ECTION 18	RUNOFF	.20	1	2	.20	.0	12.00	24.00	10.50	---	10.17	488.98	2482.1
ECTION 19	REACH	.20	1	2	.20	.0	12.00	24.00	10.49	48.06	10.47	422.11	2142.7
ECTION 19	RUNOFF	.24	1	2	.20	.0	12.00	24.00	10.63	---	10.27	536.43	2225.9
ECTION 19	ADDHYD	.44	1	2	.20	.0	12.00	24.00	10.57	54.20	10.38	925.81	2113.7
ECTION 20	ADDHYD	.75	1	2	.20	.0	12.00	24.00	10.46	---	10.31	1573.25	2089.3
ECTION 21	REACH	.75	1	2	.20	.0	12.00	24.00	10.46	47.70	10.31	1573.25	2089.3
ECTION 22	ADDHYD	3.00	1	2	.20	.0	12.00	24.00	7.61	---	10.46	2158.43	719.2
ECTION 23	REACH	3.00	1	2	.20	.0	12.00	24.00	7.61	45.07	10.46	2158.43	719.2
ECTION 23	RUNOFF	.03	1	2	.20	.0	12.00	24.00	9.98	---	10.23	67.46	2248.7
ECTION 23	ADDHYD	3.03	1	2	.20	.0	12.00	24.00	7.63	45.17	10.44	2218.04	731.1
RUCTURE 2	RUNOFF	.14	1	2	.20	.0	12.00	24.00	11.01	---	10.44	273.47	1981.7
RUCTURE 2	ADDHYD	3.17	1	2	.20	.0	12.00	24.00	7.78	50.95	10.44	2489.51	785.6
RUCTURE 2	RUNOFF	.13	1	2	.20	.0	12.00	24.00	10.83	---	10.25	298.37	2295.2
RUCTURE 2	ADDHYD	3.30	1	2	.20	.0	12.00	24.00	7.89	51.01	10.41	2758.87	836.3
RUCTURE 2	DIVERT	.00	1	2	.20	.0	12.00	24.00	7.89	47.13	3.00*	50.00***********	
ECTION 26	DIVERT	3.30	1	2	.20	.0	12.00	24.00	6.79	---	10.41	2708.87	821.1
RUCTURE 2	RESVOR	3.30	1	2	.20	.0	12.00	24.00	6.66	51.00	10.46	2724.60	825.9
RUCTURE 3	RUNOFF	.15	1	2	.20	.0	12.00	24.00	8.31	---	9.95	386.82	2578.8
RUCTURE 3	ADDHYD	3.45	1	2	.20	.0	12.00	24.00	6.74	50.70	10.45	2856.11	828.1
RUCTURE 3	DIVERT	.00	1	2	.20	.0	12.00	24.00	6.74	50.12	9.80*	610.00***********	
ECTION 27	DIVERT	3.45	1	2	.20	.0	12.00	24.00	2.21	---	10.45	2246.11	651.2
RUCTURE 3	RESVOR	3.45	1	2	.20	.0	12.00	24.00	.00	32.00	16.80?	.06?	.0

ALTERNATE 1 STORM 2

ECTION 1	RUNOFF	.07	1	2	.20	.0	10.50	24.00	4.19	---	9.95	88.72	1344.3
ECTION 2	REACH	.07	1	2	.20	.0	10.50	24.00	4.19	94.07	9.95	88.72	1344.3
ECTION 2	RUNOFF	.05	1	2	.20	.0	10.50	24.00	9.41	---	9.90	165.35	3006.3

MMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

CTION/ TRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	AMOUNT (IN)	DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)
ALTERNATE 1 STORM 2													
ECTION 2	ADDHYD	.12	1	2	.20	.0	10.50	24.00	6.56	95.02	9.92	253.11	2091.8
ECTION 3	REACH	.12	1	2	.20	.0	10.50	24.00	6.56	100.82	9.92	253.11	2091.8
ECTION 3	RUNOFF	.04	1	2	.20	.0	10.50	24.00	9.15	---	9.90	121.39	2960.8
ECTION 3	ADDHYD	.16	1	2	.20	.0	10.50	24.00	7.22	101.22	9.92	374.34	2310.7
ECTION 4	RUNOFF	.31	1	2	.20	.0	10.50	24.00	3.77	---	10.04	284.74	921.5
ECTION 5	REACH	.31	1	2	.20	.0	10.50	24.00	3.77	108.74	10.04	284.74	921.5
ECTION 5	RUNOFF	.10	1	2	.20	.0	10.50	24.00	9.38	---	9.90	308.84	2998.4
ECTION 5	ADDHYD	.41	1	2	.20	.0	10.50	24.00	5.17	110.07	9.96	573.95	1393.1
ECTION 6	REACH	.41	1	2	.20	.0	10.50	24.00	5.17	107.28	9.96	573.95	1393.1
ECTION 6	RUNOFF	.05	1	2	.20	.0	10.50	24.00	8.59	---	9.91	154.43	2807.9
ECTION 6	ADDHYD	.47	1	2	.20	.0	10.50	24.00	5.57	107.74	9.95	725.87	1554.3
RUCTURE 1	ADDHYD	.63	1	2	.20	.0	10.50	24.00	5.59	58.31	9.94	1097.43	1744.7
XSECTION 7	RUNOFF	.57	1	2	.20	.0	10.50	24.00	6.94	---	10.18	952.24	1679.4
XSECTION 8	REACH	.57	1	2	.20	.0	10.50	24.00	6.94	115.39	10.18	952.24	1679.4
XSECTION 8	RUNOFF	.01	1	2	.20	.0	10.50	24.00	9.58	---	9.90	39.39	3030.2
XSECTION 8	ADDHYD	.58	1	2	.20	.0	10.50	24.00	7.00	115.43	10.17	965.43	1664.5
XSECTION 9	RUNOFF	.46	1	2	.20	.0	10.50	24.00	6.28	---	10.06	764.99	1677.6
XSECTION 10	REACH	.46	1	2	.20	.0	10.50	24.00	6.28	114.85	10.06	764.99	1677.6
XSECTION 10	RUNOFF	.01	1	2	.20	.0	10.50	24.00	9.56	---	9.90	42.51	3036.3
XSECTION 10	ADDHYD	.47	1	2	.20	.0	10.50	24.00	6.38	114.97	10.05	799.69	1701.5
XSECTION 11	ADDHYD	1.05	1	2	.20	.0	10.50	24.00	6.72	---	10.11	1712.96	1631.4
XSECTION 12	REACH	1.05	1	2	.20	.0	10.50	24.00	6.72	90.43	10.11	1712.96	1631.4
XSECTION 12	RUNOFF	.06	1	2	.20	.0	10.50	24.00	9.50	---	9.90	178.11	3018.8
XSECTION 12	ADDHYD	1.11	1	2	.20	.0	10.50	24.00	6.87	90.77	10.07	1857.79	1675.2
XSECTION 13	REACH	1.11	1	2	.20	.0	10.50	24.00	6.87	92.88	10.07	1857.79	1675.2
STRUCTURE 1	ADDHYD	1.74	1	2	.20	.0	10.50	24.00	6.55	60.11	10.01	2875.27	1654.4
STRUCTURE 1	RUNOFF	.31	1	2	.20	.0	10.50	24.00	5.99	---	11.33	222.86	712.0
STRUCTURE 1	ADDHYD	2.05	1	2	.20	.0	10.50	24.00	6.47	60.18	10.01	2940.08	1433.5
STRUCTURE 1	DIVERT	.00	1	2	.20	.0	10.50	24.00	6.47	51.56	6.60*	100.00***********	
XSECTION 25	DIVERT	2.05	1	2	.20	.0	10.50	24.00	4.84	---	10.01	2840.08	1384.7
STRUCTURE 1	RESVOR	2.05	1	2	.20	.0	10.50	24.00	4.96	57.48	12.43	523.20	255.1
XSECTION 14	REACH	2.05	1	2	.20	.0	10.50	24.00	4.96	44.28	12.43	523.20	255.1
XSECTION 15	REACH	2.05	1	2	.20	.0	10.50	24.00	4.96	44.28	12.43	523.20	255.1
XSECTION 15	RUNOFF	.20	1	2	.20	.0	10.50	24.00	9.51	---	10.53	319.59	1622.3
XSECTION 15	ADDHYD	2.25	1	2	.20	.0	10.50	24.00	5.36	44.44	12.14	614.50	273.4
XSECTION 16	RUNOFF	.15	1	2	.20	.0	10.50	24.00	8.77	---	10.17	313.78	2120.1

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	AMOUNT (IN)	DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)
ALTERNATE 1 STORM 2													
XSECTION 17	REACH	.15	1	2	.20	.0	10.50	24.00	8.77	49.21	10.17	313.78	2120.1
XSECTION 17	RUNOFF	.17	1	2	.20	.0	10.50	24.00	8.89	---	10.36	292.91	1753.9
XSECTION 17	ADDHYD	.31	1	2	.20	.0	10.50	24.00	8.83	52.48	10.24	591.76	1878.6
XSECTION 18	RUNOFF	.20	1	2	.20	.0	10.50	24.00	9.02	---	10.18	422.13	2142.8
XSECTION 19	REACH	.20	1	2	.20	.0	10.50	24.00	9.01	47.33	10.48	362.26	1838.9
XSECTION 19	RUNOFF	.24	1	2	.20	.0	10.50	24.00	9.14	---	10.28	463.78	1924.4
XSECTION 19	ADDHYD	.44	1	2	.20	.0	10.50	24.00	9.08	52.64	10.38	797.40	1820.6
XSECTION 20	ADDHYD	.75	1	2	.20	.0	10.50	24.00	8.98	---	10.31	1354.30	1798.5
XSECTION 21	REACH	.75	1	2	.20	.0	10.50	24.00	8.98	46.75	10.31	1354.30	1798.5
XSECTION 22	ADDHYD	3.00	1	2	.20	.0	10.50	24.00	6.27	---	10.36	1805.87	601.8
SECTION 23	REACH	3.00	1	2	.20	.0	10.50	24.00	6.27	44.47	10.36	1805.87	601.8
SECTION 23	RUNOFF	.03	1	2	.20	.0	10.50	24.00	8.52	---	10.23	57.73	1924.4
SECTION 23	ADDHYD	3.03	1	2	.20	.0	10.50	24.00	6.29	44.56	10.36	1859.35	613.4
TRUCTURE 2	RUNOFF	.14	1	2	.20	.0	10.50	24.00	9.52	---	10.44	237.62	1721.9
TRUCTURE 2	ADDHYD	3.17	1	2	.20	.0	10.50	24.00	6.43	50.86	10.37	2093.35	660.6
TRUCTURE 2	RUNOFF	.13	1	2	.20	.0	10.50	24.00	9.14	---	10.25	257.98	1984.4
TRUCTURE 2	ADDHYD	3.30	1	2	.20	.0	10.50	24.00	6.54	50.91	10.35	2337.57	708.6
TRUCTURE 2	DIVERT	.00	1	2	.20	.0	10.50	24.00	6.54	47.13	3.40*	50.00***********	
SECTION 26	DIVERT	3.30	1	2	.20	.0	10.50	24.00	5.46	---	10.35	2287.57	693.4
TRUCTURE 2	RESVOR	3.30	1	2	.20	.0	10.50	24.00	5.35	50.89	10.35	2250.00	682.0
TRUCTURE 3	RUNOFF	.15	1	2	.20	.0	10.50	24.00	6.92	---	9.96	321.25	2141.7
TRUCTURE 3	ADDHYD	3.45	1	2	.20	.0	10.50	24.00	5.42	50.62	10.30	2520.52	730.8
TRUCTURE 3	DIVERT	.00	1	2	.20	.0	10.50	24.00	5.42	50.12	10.00*	610.00***********	
SECTION 27	DIVERT	3.45	1	2	.20	.0	10.50	24.00	1.29	---	10.30	1910.52	553.9
TRUCTURE 3	RESVOR	3.45	1	2	.20	.0	10.50	24.00	.00	20.14	15.20?	.04?	.0

ALTERNATE 1 STORM 3

SECTION 1	RUNOFF	.07	1	2	.20	.0	7.50	24.00	2.15	---	9.96	41.31	625.9
SECTION 2	REACH	.07	1	2	.20	.0	7.50	24.00	2.15	93.77	9.96	41.31	625.9
SECTION 2	RUNOFF	.05	1	2	.20	.0	7.50	24.00	6.43	---	9.90	115.15	2093.7
SECTION 2	ADDHYD	.12	1	2	.20	.0	7.50	24.00	4.10	94.41	9.92	155.42	1284.4
SECTION 3	REACH	.12	1	2	.20	.0	7.50	24.00	4.10	100.50	9.92	155.42	1284.4
SECTION 3	RUNOFF	.04	1	2	.20	.0	7.50	24.00	6.20	---	9.91	83.68	2041.1
SECTION 3	ADDHYD	.16	1	2	.20	.0	7.50	24.00	4.63	100.78	9.92	238.96	1475.1
SECTION 4	RUNOFF	.31	1	2	.20	.0	7.50	24.00	1.85	---	10.08	112.71	364.8
SECTION 5	REACH	.31	1	2	.20	.0	7.50	24.00	1.85	107.66	10.08	112.71	364.8
SECTION 5	RUNOFF	.10	1	2	.20	.0	7.50	24.00	6.41	---	9.91	214.96	2087.0

UMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

ECTION/ TRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)
ALTERNATE 1 STORM 3													
SECTION 5	ADDHYD	.41	1	2	.20	.0	7.50	24.00	2.99	108.88	9.96	310.78	754.3
SECTION 6	REACH	.41	1	2	.20	.0	7.50	24.00	2.99	106.29	9.96	310.78	754.3
SECTION 6	RUNOFF	.05	1	2	.20	.0	7.50	24.00	5.69	---	9.92	103.67	1884.9
SECTION 6	ADDHYD	.47	1	2	.20	.0	7.50	24.00	3.31	106.72	9.95	413.14	884.7
TRUCTURE 1	ADDHYD	.63	1	2	.20	.0	7.50	24.00	3.65	57.73	9.94	650.77	1034.6
SECTION 7	RUNOFF	.57	1	2	.20	.0	7.50	24.00	4.26	---	10.20	569.15	1003.8
SECTION 8	REACH	.57	1	2	.20	.0	7.50	24.00	4.26	114.18	10.20	569.15	1003.8
SECTION 8	RUNOFF	.01	1	2	.20	.0	7.50	24.00	6.57	---	9.90	27.58	2121.3
SECTION 8	ADDHYD	.58	1	2	.20	.0	7.50	24.00	4.31	114.20	10.18	577.88	996.3
SECTION 9	RUNOFF	.46	1	2	.20	.0	7.50	24.00	3.72	---	10.08	432.59	948.7
SECTION 10	REACH	.46	1	2	.20	.0	7.50	24.00	3.72	113.72	10.08	432.59	948.7
SECTION 10	RUNOFF	.01	1	2	.20	.0	7.50	24.00	6.57	---	9.90	29.77	2126.2
SECTION 10	ADDHYD	.47	1	2	.20	.0	7.50	24.00	3.80	113.80	10.06	455.98	970.2
SECTION 11	ADDHYD	1.05	1	2	.20	.0	7.50	24.00	4.08	---	10.13	1004.82	957.0
SECTION 12	REACH	1.05	1	2	.20	.0	7.50	24.00	4.08	68.69	10.13	1004.82	957.0
SECTION 12	RUNOFF	.06	1	2	.20	.0	7.50	24.00	6.53	---	9.91	124.56	2111.2
SECTION 12	ADDHYD	1.11	1	2	.20	.0	7.50	24.00	4.21	88.92	10.08	1098.53	990.6
SECTION 13	REACH	1.11	1	2	.20	.0	7.50	24.00	4.21	91.97	10.08	1098.53	990.6
TRUCTURE 1	ADDHYD	1.74	1	2	.20	.0	7.50	24.00	4.01	58.92	10.01	1696.44	976.1
TRUCTURE 1	RUNOFF	.31	1	2	.20	.0	7.50	24.00	3.49	---	11.40	123.03	393.1
TRUCTURE 1	ADDHYD	2.05	1	2	.20	.0	7.50	24.00	3.93	58.95	10.01	1725.61	841.4
TRUCTURE 1	DIVERT	.00	1	2	.20	.0	7.50	24.00	3.93	51.56	8.20*	100.00**********	
SECTION 25	DIVERT	2.05	1	2	.20	.0	7.50	24.00	2.54	---	10.01	1625.61	792.6
TRUCTURE 1	RESVOR	2.05	1	2	.20	.0	7.50	24.00	2.55	54.91	15.09	148.69	72.5
SECTION 14	REACH	2.05	1	2	.20	.0	7.50	24.00	2.55	42.91	15.09	148.69	72.5
SECTION 15	REACH	2.05	1	2	.20	.0	7.50	24.00	2.55	42.91	15.09	148.69	72.5
SECTION 15	RUNOFF	.20	1	2	.20	.0	7.50	24.00	6.54	---	10.53	222.48	1129.2
SECTION 15	ADDHYD	2.25	1	2	.20	.0	7.50	24.00	2.90	43.93	10.57	343.80	152.9
SECTION 16	RUNOFF	.15	1	2	.20	.0	7.50	24.00	5.85	---	10.17	210.81	1424.4
SECTION 17	REACH	.15	1	2	.20	.0	7.50	24.00	5.85	47.97	10.17	210.81	1424.4
SECTION 17	RUNOFF	.17	1	2	.20	.0	7.50	24.00	5.98	---	10.37	197.80	1184.4
SECTION 17	ADDHYD	.31	1	2	.20	.0	7.50	24.00	5.91	50.20	10.24	398.24	1264.3
SECTION 18	RUNOFF	.20	1	2	.20	.0	7.50	24.00	6.08	---	10.18	287.37	1458.7
SECTION 19	REACH	.20	1	2	.20	.0	7.50	24.00	6.07	45.68	10.51	233.60	1185.8
SECTION 19	RUNOFF	.24	1	2	.20	.0	7.50	24.00	6.19	---	10.28	317.29	1316.6
SECTION 19	ADDHYD	.44	1	2	.20	.0	7.50	24.00	6.14	49.40	10.39	532.06	1214.7

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)
ALTERNATE 1 STORM 3													
XSECTION 20	ADDHYD	.75	1	2	.20	.0	7.50	24.00	6.04	---	10.32	906.41	1203.7
XSECTION 21	REACH	.75	1	2	.20	.0	7.50	24.00	6.04	44.81	10.32	906.41	1203.7
XSECTION 22	ADDHYD	3.00	1	2	.20	.0	7.50	24.00	3.69	---	10.37	1231.32	410.3
XSECTION 23	REACH	3.00	1	2	.20	.0	7.50	24.00	3.69	43.49	10.37	1231.32	410.3
XSECTION 23	RUNOFF	.03	1	2	.20	.0	7.50	24.00	5.62	---	10.24	38.18	1272.6
XSECTION 23	ADDHYD	3.03	1	2	.20	.0	7.50	24.00	3.71	43.55	10.36	1266.73	417.9
STRUCTURE 2	RUNOFF	.14	1	2	.20	.0	7.50	24.00	6.54	---	10.45	165.40	1198.6
STRUCTURE 2	ADDHYD	3.17	1	2	.20	.0	7.50	24.00	3.83	50.70	10.37	1429.83	451.2
STRUCTURE 2	RUNOFF	.13	1	2	.20	.0	7.50	24.00	6.19	---	10.25	176.53	1357.9
STRUCTURE 2	ADDHYD	3.30	1	2	.20	.0	7.50	24.00	3.93	50.74	10.36	1596.85	484.0
STRUCTURE 2	DIVERT	.00	1	2	.20	.0	7.50	24.00	3.93	47.13	4.80*	50.00***********	
XSECTION 26	DIVERT	3.30	1	2	.20	.0	7.50	24.00	3.03	---	10.36	1546.85	468.9
STRUCTURE 2	RESVOR	3.30	1	2	.20	.0	7.50	24.00	2.93	50.75	10.63	1655.44	501.8
STRUCTURE 3	RUNOFF	.15	1	2	.20	.0	7.50	24.00	4.24	---	9.97	192.97	1286.5
STRUCTURE 3	ADDHYD	3.45	1	2	.20	.0	7.50	24.00	2.99	50.41	10.62	1719.67	498.6
STRUCTURE 3	DIVERT	.00	1	2	.20	.0	7.50	24.00	2.99	50.12	10.40*	610.00***********	
XSECTION 27	DIVERT	3.45	1	2	.20	.0	7.50	24.00	.28	---	10.62	1109.67	321.7
STRUCTURE 3	RESVOR	3.45	1	2	.20	.0	7.50	24.00	.00	7.29	11.80?	.01?	.0
ALTERNATE 1 STORM 4													
XSECTION 1	RUNOFF	.07	1	2	.20	.0	4.50	24.00	.59	---	10.03	5.90	83.4
XSECTION 2	REACH	.07	1	2	.20	.0	4.50	24.00	.59	93.54	10.03	5.90	83.4
XSECTION 2	RUNOFF	.05	1	2	.20	.0	4.50	24.00	3.50	---	9.91	64.23	1167.8
XSECTION 2	ADDHYD	.12	1	2	.20	.0	4.50	24.00	1.91	93.95	9.93	68.83	568.9
XSECTION 3	REACH	.12	1	2	.20	.0	4.50	24.00	1.91	100.20	9.93	68.83	568.9
XSECTION 3	RUNOFF	.04	1	2	.20	.0	4.50	24.00	3.30	---	9.91	45.47	1108.9
XSECTION 3	ADDHYD	.16	1	2	.20	.0	4.50	24.00	2.26	100.35	9.92	114.23	705.1
XSECTION 4	RUNOFF	.31	1	2	.20	.0	4.50	24.00	.46	---	10.62	9.55	30.9
XSECTION 5	REACH	.31	1	2	.20	.0	4.50	24.00	.46	107.06	10.62	9.55	30.9
XSECTION 5	RUNOFF	.10	1	2	.20	.0	4.50	24.00	3.49	---	9.91	119.71	1162.2
XSECTION 5	ADDHYD	.41	1	2	.20	.0	4.50	24.00	1.21	107.72	9.92	119.73	290.6
XSECTION 6	REACH	.41	1	2	.20	.0	4.50	24.00	1.21	105.50	9.92	119.73	290.6
XSECTION 6	RUNOFF	.05	1	2	.20	.0	4.50	24.00	2.89	---	9.93	52.81	960.1
XSECTION 6	ADDHYD	.47	1	2	.20	.0	4.50	24.00	1.41	105.72	9.92	172.50	369.4
STRUCTURE 1	ADDHYD	.63	1	2	.20	.0	4.50	24.00	1.63	57.02	9.92	286.71	455.8
XSECTION 7	RUNOFF	.57	1	2	.20	.0	4.50	24.00	1.82	---	10.22	220.15	388.3
XSECTION 8	REACH	.57	1	2	.20	.0	4.50	24.00	1.82	113.07	10.22	220.15	388.3

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)

ALTERNATE 1 STORM 4

SECTION 8	RUNOFF	.01	1	2	.20	.0	4.50	24.00	3.62	---	9.91	15.59	1199.5
SECTION 8	ADDHYD	.58	1	2	.20	.0	4.50	24.00	1.86	113.08	10.21	224.53	387.1
SECTION 9	RUNOFF	.46	1	2	.20	.0	4.50	24.00	1.47	---	10.13	144.41	316.7
SECTION 10	REACH	.46	1	2	.20	.0	4.50	24.00	1.47	112.33	10.13	144.41	316.7
SECTION 10	RUNOFF	.01	1	2	.20	.0	4.50	24.00	3.62	---	9.91	16.84	1203.1
SECTION 10	ADDHYD	.47	1	2	.20	.0	4.50	24.00	1.53	112.43	10.09	156.40	332.8
SECTION 11	ADDHYD	1.05	1	2	.20	.0	4.50	24.00	1.71	---	10.16	372.29	354.6
SECTION 12	REACH	1.05	1	2	.20	.0	4.50	24.00	1.71	86.00	10.16	372.29	354.6
SECTION 12	RUNOFF	.06	1	2	.20	.0	4.50	24.00	3.59	---	9.91	70.24	1190.6
SECTION 12	ADDHYD	1.11	1	2	.20	.0	4.50	24.00	1.81	86.31	10.09	417.44	376.4
SECTION 13	REACH	1.11	1	2	.20	.0	4.50	24.00	1.81	90.75	10.09	417.44	376.4
TRUCTURE 1	ADDHYD	1.74	1	2	.20	.0	4.50	24.00	1.75	57.78	10.00	673.15	387.3
TRUCTURE 1	RUNOFF	.31	1	2	.20	.0	4.50	24.00	1.33	---	11.58	39.00	124.6
TRUCTURE 1	ADDHYD	2.05	1	2	.20	.0	4.50	24.00	1.68	57.78	10.00	677.25	330.2
TRUCTURE 1	DIVERT	.00	1	2	.20	.0	4.50	24.00	1.68	51.56	9.40*	100.00*	**********
SECTION 25	DIVERT	2.05	1	2	.20	.0	4.50	24.00	.56	---	10.00	577.25	281.5
TRUCTURE 1	RESVOR	2.05	1	2	.20	.0	4.50	24.00	.57	49.94	12.30	73.11	35.6
SECTION 14	REACH	2.05	1	2	.20	.0	4.50	24.00	.57	42.45	12.30	73.11	35.6
SECTION 15	REACH	2.05	1	2	.20	.0	4.50	24.00	.57	42.45	12.30	73.11	35.6
SECTION 15	RUNOFF	.20	1	2	.20	.0	4.50	24.00	3.60	---	10.54	123.98	629.4
SECTION 15	ADDHYD	2.25	1	2	.20	.0	4.50	24.00	.83	43.08	10.63	179.54	79.9
SECTION 16	RUNOFF	.15	1	2	.20	.0	4.50	24.00	3.00	---	10.18	107.60	727.1
SECTION 17	REACH	.15	1	2	.20	.0	4.50	24.00	3.00	46.65	10.39	107.00	722.9
SECTION 17	RUNOFF	.17	1	2	.20	.0	4.50	24.00	3.10	---	10.38	102.26	612.3
SECTION 17	ADDHYD	.31	1	2	.20	.0	4.50	24.00	3.05	47.95	10.39	209.25	664.3
SECTION 18	RUNOFF	.20	1	2	.20	.0	4.50	24.00	3.19	---	10.19	151.40	768.5
SECTION 19	REACH	.20	1	2	.20	.0	4.50	24.00	3.19	44.15	10.58	115.17	584.6
SECTION 19	RUNOFF	.24	1	2	.20	.0	4.50	24.00	3.29	---	10.29	169.23	702.2
SECTION 19	ADDHYD	.44	1	2	.20	.0	4.50	24.00	3.25	46.18	10.41	271.91	620.8
SECTION 20	ADDHYD	.75	1	2	.20	.0	4.50	24.00	3.17	---	10.40	481.02	638.8
SECTION 21	REACH	.75	1	2	.20	.0	4.50	24.00	3.17	42.86	10.40	481.02	638.8
SECTION 22	ADDHYD	3.00	1	2	.20	.0	4.50	24.00	1.42	---	10.43	650.75	216.8
SECTION 23	REACH	3.00	1	2	.20	.0	4.50	24.00	1.42	42.49	10.64	646.24	215.3
SECTION 23	RUNOFF	.03	1	2	.20	.0	4.50	24.00	2.82	---	10.25	18.78	825.9
SECTION 23	ADDHYD	3.03	1	2	.20	.0	4.50	24.00	1.43	42.51	10.64	659.25	217.5
TRUCTURE 2	RUNOFF	.14	1	2	.20	.0	4.50	24.00	3.60	---	10.46	92.17	667.9

UMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

ECTION/ TRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)
ALTERNATE 1 STORM 4													
TRUCTURE 2	ADDHYD	3.17	1	2	.20	.0	4.50	24.00	1.53	50.54	10.62	745.81	235.3
TRUCTURE 2	RUNOFF	.13	1	2	.20	.0	4.50	24.00	3.29	---	10.26	94.20	724.6
TRUCTURE 2	ADDHYD	3.30	1	2	.20	.0	4.50	24.00	1.60	50.56	10.60	815.63	247.2
TRUCTURE 2	DIVERT	.00	1	2	.20	.0	4.50	24.00	1.60	47.13	7.60*	50.00*	**********
SECTION 26	DIVERT	3.30	1	2	.20	.0	4.50	24.00	1.12	---	10.60	765.63	232.1
TRUCTURE 2	RESVOR	3.30	1	2	.20	.0	4.50	24.00	1.03	50.11	12.38	233.00	70.6
TRUCTURE 3	RUNOFF	.15	1	2	.20	.0	4.50	24.00	1.81	---	9.99	75.58	503.8
TRUCTURE 3	ADDHYD	3.45	1	2	.20	.0	4.50	24.00	1.06	50.03	12.38	245.83	71.3
TRUCTURE 3	DIVERT	.00	1	2	.20	.0	4.50	24.00	1.06	50.03	12.38	245.83	**********
SECTION 27	DIVERT	3.45	1	2	.20	.0	4.50	24.00	.00	---	.00	.00	.0
TRUCTURE 3	RESVOR	3.45	1	2	.20	.0	4.50	24.00	.00	---	.00	.00	.0

SUMMARY TABLE 2 - SELECTED MODIFIED ATT-KIN REACH ROUTINGS IN ORDER OF STANDARD EXECUTIVE CONTROL INSTRUCTIONS
(A STAR(*) AFTER VOLUME ABOVE BASE(IN) INDICATES A HYDROGRAPH TRUNCATED AT A VALUE EXCEEDING BASE + 10% OF PEAK
A QUESTION MARK(?) AFTER COEFF.(C) INDICATES PARAMETERS OUTSIDE ACCEPTABLE LIMITS, SEE PREVIOUS WARNINGS)

XSEC ID	REACH LENGTH (FT)	INFLOW PEAK (CFS)	INFLOW TIME (HR)	OUTFLOW PEAK (CFS)	OUTFLOW TIME (HR)	OUTFLOW+ INTERV.AREA PEAK (CFS)	OUTFLOW+ INTERV.AREA TIME (HR)	BASE-FLOW (CFS)	VOLUME ABOVE BASE (IN)	MAIN TIME INCR (HR)	ITER-ATION #	Q AND A EQUATION COEFF (X)	Q AND A EQUATION POWER (M)	LENGTH FACTOR (K*)	PEAK RATIO O/I (Q*)	S/Q @PEAK (K) (SEC)	ATT-KIN COEFF (C)	PEAK TRAVEL TIME STOR-AGE (HR)	PEAK TRAVEL TIME KINE-MATIC (HR)
ALTERNATE 1 STORM 1																			
+ 2	1200	111	10.0	111	10.0	287	10.0	0	5.33	.20	0	3.70	1.00	.044	1.000	324	1.007	.00	.00
+ 3	600	287	10.0	287	10.0	417	10.0	0	7.88	.20	0	38.4	1.00	.002	1.000	16	1.007	.00	.00
+ 5	1200	382	10.0	382	10.0	711	10.0	0	4.84	.20	0	6.05	1.00	.022	1.000	198	1.007	.00	.00
+ 6	700	711	10.0	711	10.0	880	10.0	0	6.35	.20	0	27.5	1.05	.002	1.000	21	1.007	.00	.00
+ 8	800	1147	10.2	1147	10.2	1160	10.2	0	8.33	.20	0	2.78	1.22	.004	1.000	78	1.007	.00	.00
+ 10	700	923	10.0	923	10.0	968	10.0	0	7.62	.20	0	3.42	1.15	.006	1.000	87	1.007	.00	.00
+ 12	300	2014	10.2	2014	10.2	2194	10.0	0	8.09	.20	0	4.63	1.18	.001	1.000	22	1.007	.00	.00
+ 13	500	2194	10.0	2194	10.0	---	---	0	8.25	.20	0	20.2	1.11	.001	1.000	14	1.007	.00	.00
+ 14	50	874	11.6	874	11.6	---	---	0	6.24	.20	0	1.60	1.20	.000	1.000	9	1.007	.00	.00
+ 15	400	874	11.6	874	11.6	1047	11.4	0	6.24	.20	0	1.60	1.20	.001	1.000	74	1.007	.00	.00
+ 17	2500	363	10.2	363	10.2	685	10.2	0	10.24	.20	0	4.99	1.11	.024	1.000	299	1.007	.00	.00
+ 19	5200	488	10.2	415	10.4	925	10.4	0	10.50	.20	1	2.19	1.17	.078	.851	946	.55	.20	.27
+ 21	1400	1549	10.4	1549	10.4	---	---	0	10.46	.20	0	2.63	1.17	.009	1.000	175	1.007	.00	.00
+ 23	1900	2151	10.4	2151	10.4	2211	10.4	0	7.61	.20	0	.574	1.41	.002	1.000	219	1.007	.00	.00
ALTERNATE 1 STORM 2																			
+ 2	1200	86	10.0	86	10.0	239	10.0	0	4.19	.20	0	3.77	1.00	.043	1.000	319	1.007	.00	.00
+ 3	600	239	10.0	239	10.0	352	10.0	0	6.56	.20	0	38.4	1.00	.002	1.000	16	1.007	.00	.00
+ 5	1200	282	10.0	282	10.0			0	3.77	.20	0	5.09	1.00	.021	1.000	197	1.007	.00	.00

						568	10.0												
6	700	568	10.0	568	10.0	714	10.0	0	5.17	.20	0	29.1	1.02	.002	1.000	22	1.007	.00	.00
8	800	951	10.2	951	10.2	963	10.2	0	6.94	.20	0	2.78	1.22	.004	1.000	80	1.007	.00	.00
0	700	750	10.0	750	10.0	790	10.0	0	6.28	.20	0	3.79	1.12	.007	1.000	92	1.007	.00	.00
2	300	1665	10.2	1665	10.2	1809	10.0	0	6.72	.20	0	4.83	1.17	.001	1.000	23	1.007	.00	.00
3	500	1809	10.0	1809	10.0	---	---	0	6.87	.20	0	22.5	1.08	.001	1.000	15	1.007	.00	.00
4	50	523	12.4	523	12.4	---	---	0	4.96	.20	0	2.39	1.09	.000	1.000	12	1.007	.00	.00
5	400	523	12.4	523	12.4	614	12.2	0	4.96	.20	0	2.39	1.09	.001	1.000	97	1.007	.00	.00
7	2500	312	10.2	312	10.2	589	10.2	0	8.77	.20	0	5.02	1.11	.024	1.000	304	1.007	.00	.00
9	5200	421	10.2	356	10.4	797	10.4	0	9.02	.20	1-	2.20	1.16	.081	.844	967	.54	.20	.27
1	1400	1334	10.4	1334	10.4	---	---	0	8.98	.20	0	2.62	1.18	.009	1.000	179	1.007	.00	.00
3	1900	1801	10.4	1801	10.4	1853	10.4	0	6.27	.20	0	.727	1.36	.003	1.000	240	1.007	.00	.00
ALTERNATE 1 STORM 3																			
2	1200	41	10.0	41	10.0	148	10.0	0	2.15	.20	0	3.97	1.00	.037	1.000	302	1.007	.00	.00
3	600	148	10.0	148	10.0	225	10.0	0	4.10	.20	0	39.8	1.00	.002	1.000	15	1.007	.00	.00

MMARY TABLE 2 - SELECTED MODIFIED ATT-KIN REACH ROUTINGS IN ORDER OF STANDARD EXECUTIVE CONTROL INSTRUCTIONS
(A STAR(*) AFTER VOLUME ABOVE BASE(IN) INDICATES A HYDROGRAPH TRUNCATED AT A VALUE EXCEEDING BASE + 10% OF PEAK
A QUESTION MARK(?) AFTER COEFF.(C) INDICATES PARAMETERS OUTSIDE ACCEPTABLE LIMITS, SEE PREVIOUS WARNINGS)

EC REACH D	LENGTH (FT)	HYDROGRAPH INFORMATION: INFLOW PEAK (CFS)	INFLOW TIME (HR)	OUTFLOW PEAK (CFS)	OUTFLOW TIME (HR)	OUTFLOW+ INTERV.AREA PEAK (CFS)	OUTFLOW+ INTERV.AREA TIME (HR)	BASE-FLOW (CFS)	ROUTING PARAMETERS: VOLUME ABOVE BASE (IN)	MAIN TIME INCR (HR)	ITER-ATION #	Q AND A EQUATION COEFF (X)	Q AND A EQUATION POWER (M)	LENGTH FACTOR (K*)	PEAK RATIO O/I (Q*)	S/Q @PEAK (K) (SEC)	ATT-KIN COEFF (C)	PEAK TRAVEL TIME STOR-AGE (HR)	PEAK TRAVEL TIME KINE-MATIC (HR)
ALTERNATE 1 STORM 3																			
5	1200	107	10.0	107	10.0	307	10.0	0	1.85	.20	0	6.48	1.00	.015	1.000	185	1.007	.00	.00
5	700	307	10.0	307	10.0	405	10.0	0	2.99	.20	0	30.0	1.00	.003	1.000	23	1.007	.00	.00
5	800	569	10.2	569	10.2	577	10.2	0	4.26	.20	0	3.94	1.14	.006	1.000	97	1.007	.00	.00
												4.80							
+ 10	700	420	10.0	420	10.0	447	10.0	0	3.72	.20	0		1.06	.009	1.000	107	1.007	.00	.00
+ 12	300	985	10.2	985	10.2	1065	10.0	0	4.08	.20	0	6.83	1.08	.002	1.000	28	1.007	.00	.00
+ 13	500	1065	10.0	1065	10.0	---	---	0	4.21	.20	0	27.8	1.00	.002	1.000	18	1.007	.00	.00
+ 14	50	149	15.0	149	15.0	---	---	0	2.55	.20	0	3.00	1.02	.000	1.000	15	1.007	.00	.00
+ 15	400	149	15.0	149	15.0	344	10.6	0	2.55	.20	0	3.00	1.02	.001	1.000	120	1.007	.00	.00
+ 17	2500	210	10.2	210	10.2	396	10.2	0	5.85	.20	0	5.72	1.06	.031	1.000	336	1.007	.00	.00
+ 19	5200	287	10.2	230	10.6	532	10.4	0	6.08	.20	3	2.90	1.09	.106	.803	1132	.48	.40	.32
+ 21	1400	896	10.4	896	10.4	---	---	0	6.04	.20	0	2.76	1.16	.010	1.000	193	1.007	.00	.00
+ 23	1900	1229	10.4	1229	10.4	1264	10.4	0	3.69	.20	0	1.14	1.27	.006	1.000	293	1.007	.00	.00
ALTERNATE 1 STORM 4																			
+ 2	1200	6	10.0	6	10.0	66	10.0	0	.59	.20	0	4.57	1.00	.017	1.000	262	1.007	.00	.00
+ 3	600	66	10.0	66	10.0	108	10.0	0	1.81	.20	0	66.5	1.00	.001	1.000	9	1.007	.00	.00
+ 5	1200	10	10.6	10	10.6	113	10.0	0	.46	.20	0	6.71	1.00	.005	1.000	179	1.007	.00	.00
+ 6	700	113	10.0	113	10.0	164	10.0	0	1.21	.20	0	30.0	1.00	.002	1.000	23	1.007	.00	.00
+ 8	800	220	10.2	220	10.2	224	10.2	0	1.82	.20	0	5.82	1.00	.013	1.000	138	1.007	.00	.00
+ 10	700	141	10.2	141	10.2	150	10.0	0	1.47	.20	0	5.57	1.00	.011	1.000	126	1.007	.00	.00
+ 12	300	370	10.2	370	10.2	401	10.0	0	1.71	.20	0	7.22	1.08	.002	1.000	29	1.007	.00	.00
+ 13	500	401	10.0	401	10.0	---	---	0	1.61	.20	0	27.8	1.00	.002	1.000	18	1.007	.00	.00
+ 14	50	73	12.2	73	12.2	---	---	0	.57	.20	0	3.00	1.02	.000	1.000	15	1.007	.00	.00
+ 15	400	73	12.2	73	12.2	179	10.6	0	.57	.20	0	3.00	1.02	.003	1.000	122	1.007	.00	.00
+ 17	2500	107	10.2	107	10.4	209	10.4	0	3.00	.20	1	8.50	1.00	.040	.995	385	.977	.20	.11
+ 19	5200	151	10.2	115	10.6	272	10.4	0	3.19	.20	2	3.65	1.00	.147	.760	1424	.40	.40	.40
+ 21	1400	481	10.4	481	10.4	---	---	0	3.17	.20	0	4.55	1.04	.019	1.000	247	1.007	.00	.00
+ 23	1900	649	10.4	643	10.6	657	10.6	0	1.42	.20	1	2.05	1.14	.019	.991	410	.937	.20	.11

REV PC 09/83(.1)

UMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

SECTION/ TRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS.......... 1	2	3	4
STRUCTURE 3	3.45				
ALTERNATE 1		.06	.04	.01	.00
STRUCTURE 2	3.30				
ALTERNATE 1		2724.60	2250.00	1655.44	233.00
STRUCTURE 1	2.05				
ALTERNATE 1		874.61	523.20	148.69	73.11
XSECTION 1	.07				
ALTERNATE 1		115.03	88.72	41.31	5.90
XSECTION 2	.12				
ALTERNATE 1		304.37	253.11	155.42	68.83
XSECTION 3	.16				
ALTERNATE 1		444.29	374.34	238.96	114.23
XSECTION 4	.31				
ALTERNATE 1		384.02	284.74	112.71	9.55
XSECTION 5	.41				
ALTERNATE 1		718.23	573.95	310.78	119.73
XSECTION 6	.47				
ALTERNATE 1		894.77	725.87	413.14	172.50
XSECTION 7	.57				
ALTERNATE 1		1148.42	952.24	569.15	220.15
XSECTION 8	.58				
ALTERNATE 1		1163.88	965.43	577.88	224.53
XSECTION 9	.46				
ALTERNATE 1		938.65	764.93	432.59	144.41
XSECTION 10	.47				
ALTERNATE 1		978.95	799.69	455.98	156.40
XSECTION 11	1.05				
ALTERNATE 1		2078.73	1712.96	1004.82	372.29

T20 XEQ 03-07-91 09:38 KVDES.DAT - ENTIRE WATERSHED DEV. - W/PROJECTS - REFINED JOB 1 SUMMARY
REV PC 09/83(.1)

UMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

SECTION/ TRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS.......... 1	2	3	4
XSECTION 12	1.11				
ALTERNATE 1		2249.61	1657.79	1098.53	417.44
XSECTION 13	1.11				
ALTERNATE 1		2249.61	1857.79	1098.53	417.44
XSECTION 14	2.05				
ALTERNATE 1		874.61	523.20	148.69	73.11
XSECTION 15	2.25				
ALTERNATE 1		1049.29	614.50	343.80	179.54
XSECTION 16	.15				
ALTERNATE 1		364.90	313.78	210.81	107.60
0 XSECTION 17	.31				
ALTERNATE 1		687.83	591.76	398.24	209.25
0 XSECTION 18	.20				
ALTERNATE 1		488.98	422.13	287.37	151.40
0 XSECTION 19	.44				
ALTERNATE 1		925.81	787.40	532.06	271.91
0 XSECTION 20	.75				
ALTERNATE 1		1573.25	1354.30	906.41	481.02
0 XSECTION 21	.75				
ALTERNATE 1		1573.25	1354.30	906.41	481.02
0 XSECTION 22	3.00				
ALTERNATE 1		2158.43	1805.87	1231.32	650.75
0 XSECTION 23	3.03				
ALTERNATE 1		2216.04	1859.35	1266.73	659.25
0 XSECTION 25	2.05				
ALTERNATE 1		3476.37	2840.08	1625.61	577.25
0 XSECTION 26	3.30				
ALTERNATE 1		2708.87	2287.57	1548.65	765.63

1

TR20 XEQ 03-07-91 09:38 KVDES.DAT - ENTIRE WATERSHED DEV. - W/PROJECTS - REFINED JOB 1 SUMMARY
REV PC 09/83(.1)

SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS.......... 1	2	3	4
0 XSECTION 27	3.45				
ALTERNATE 1		2246.11	1910.52	1109.67	.00

1END OF 1 JOBS IN THIS RUN

DRAFT REPORT for the

EAST KAPOLEI SEWER MASTER PLAN
Ewa, Oahu, Hawaii

FEBRUARY 1998

PREPARED FOR:

Housing Finance and Development Corporation
State of Hawaii

RMTC
R. M. Towill Corporation
420 Waiakamilo Rd., Suite 411
Honolulu, Hawaii 96817-4941
(808) 842-1133 • Fax: (808) 842-1937

EAST KAPOLEI

SEWERAGE MASTER PLAN

Ewa, Oahu, Hawaii

February 23, 1998

Prepared for:

Housing Finance and Development Corporation
Department of Budget and Finance
State of Hawaii

Prepared by:

R.M. Towill Corporation
420 Waiakamilo Road, Suite 411
Honolulu, Hawaii 96817-4941

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SECTION 1
INTRODUCTION

1.1 General

The East Kapolei Project is a master planned residential community and is sponsored by the State of Hawaii's Housing Finance and Development Corporation (HFDC). The project is located in the Ewa Plains area, covering portions of TMK: 9-1-16: 8, 108, 109, 9-1-17: 4 (POR.), 71 and 9-1-18: 3 and 5. The site is situated above Ewa Villages and is bound by the Villages of Kapolei, Campbell Estate lands and the H-1 Freeway. The development includes approximately 8,300 residential units on 1,300 acres of State owned land, and consists of residential homes, schools, parks and commercial and civic facilities.

1.2 Purpose and Scope

This report describes the proposed sewer system for the East Kapolei project. The scope of this master plan includes:

- Projection of ultimate wastewater contributions.
- Schematic layout and description of the proposed onsite sewerage system.
- Sewage system analysis based upon design standards of the City and County of Honolulu (CCH), Department of Wastewater Management (DWWM)

1.3 Related Studies

1.3.1 Wastewater Collection System Master Plan for the East Kapolei Area

In December 1995, a Draft EIS for the Schuler Homes' East Kapolei Project was prepared. The project was to be located on Campbell Estate lands between Fort Weaver Road and the proposed North-South Road. The EIS includes a wastewater collection system master plan prepared by Gray, Hong, Bills & Associates. The Schuler Homes' East Kapolei Project is no longer active.

1.3.2 Other Sewer Master Plans

The *Villages of Kapolei Sewerage Master Plan* and the *Ewa Villages Sewerage Master Plan*, prepared by R.M. Towill Corporation, discuss the existing and planned sewer facilities in the Ewa plains. These master plans have been updated on several occasions to reflect the actual sewer system layout as construction in the areas have of progressed.

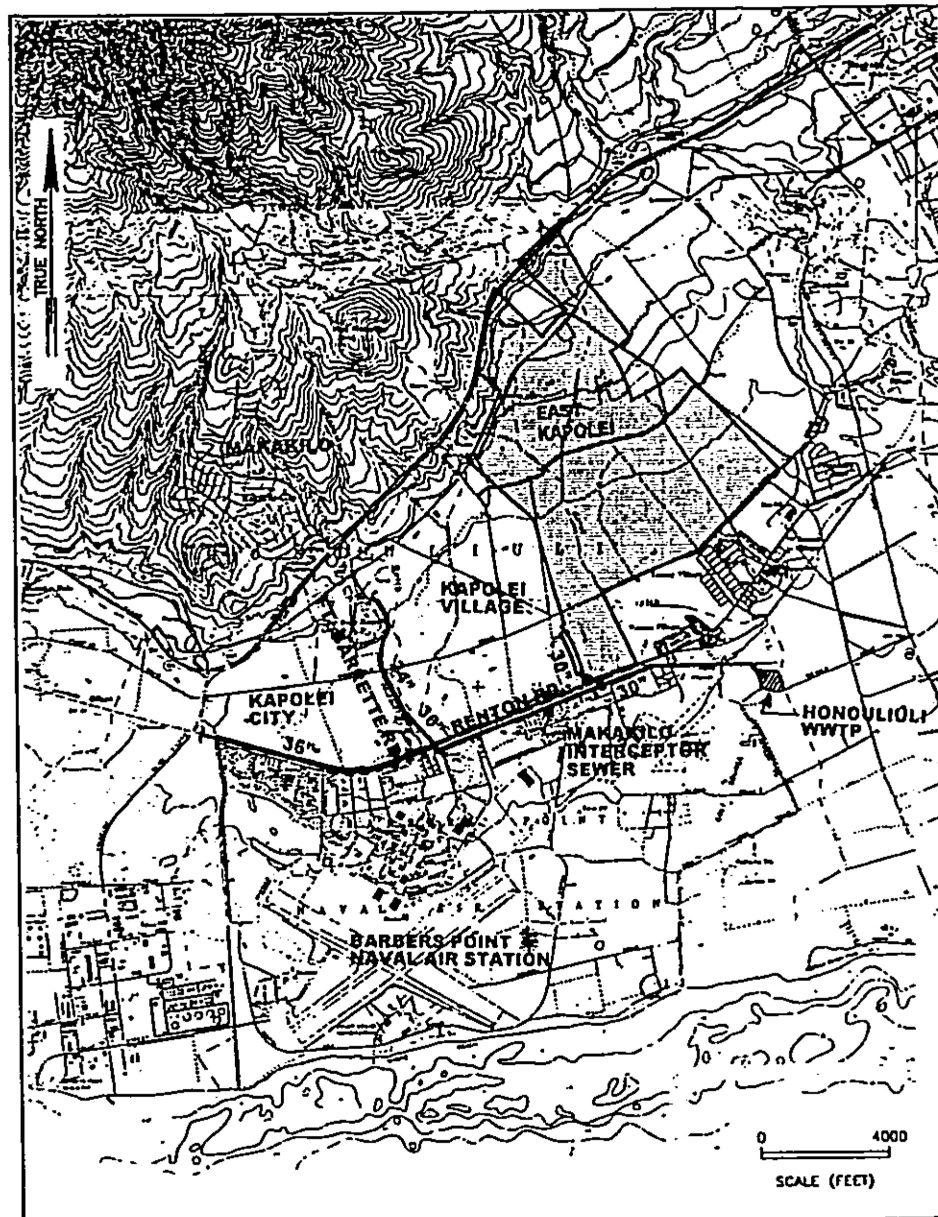
1.4 Existing Conditions

East Kapolei is located within the service area of the Honouliuli Wastewater Treatment Plant (WWTP). Figure 1-1 illustrates the existing sewer system in the area. Currently, the only major trunk sewer near this development site is the 30-inch Makakilo Interceptor, which runs from Makakilo, along Ft. Barrette Road and Renton Road (parallel to the OR&L Railroad right-of-way) to the Honouliuli WWTP. This interceptor presently serves the Makakilo community and a portion of The Villages of Kapolei.

The Honouliuli WWTP has a primary treatment capacity of 38 mgd and a deep ocean outfall with a design capacity of 112 mgd. This WWTP presently treats approximately 25 mgd to a primary level and has secondary treatment facilities which process 13 mgd. The planned ultimate capacity of the Honouliuli WWTP is 51 mgd, with a planned 13 mgd of tertiary treatment for re-use purposes. WWTP capacity is based on average daily flows.

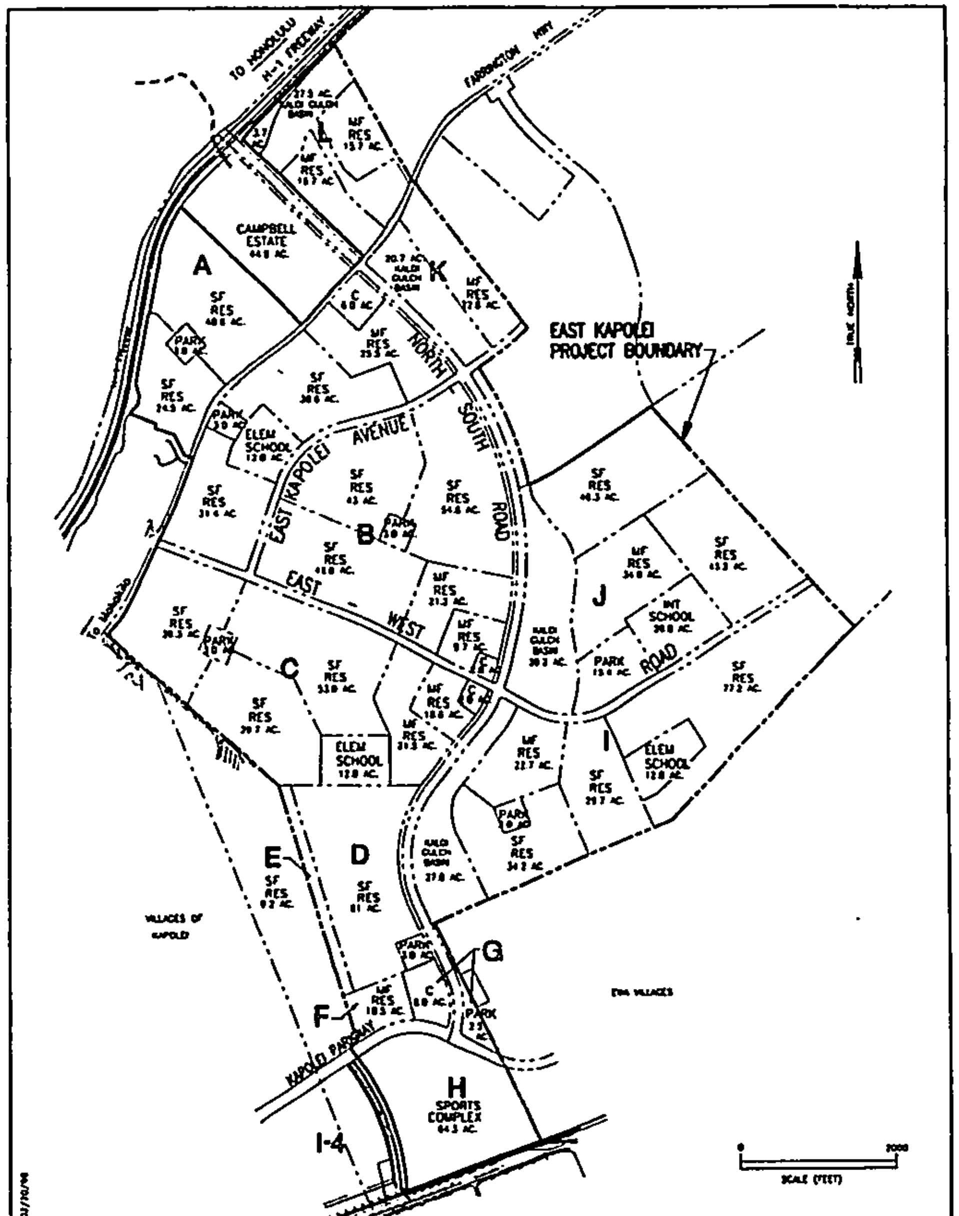
1.5 Developed Conditions

The proposed East Kapolei Development Plan is shown on Figure 1-2. East Kapolei is planned for final build-out by around year 2020. Each parcel, or clusters of parcels will be improved by individual developers under the overall coordination of the HFDC. The major streets and utilities (backbone infrastructure) that serve these parcels will be developed by the HFDC. The proposed North-South Road provides a major arterial street connecting Ewa Villages, Villages of Kapolei and East Kapolei to the H-1 Freeway. Secondary or collector roads include the proposed East-West Road and East Kapolei Avenue. The "backbone" sewer system discussed in this master plan are generally limited to these roads. Discussion of sewer systems internal to the individual parcels are to be included in the actual design phases of the project.



EXISTING SITE CONDITIONS

FIGURE 1-1
EAST KAPOLEI SEWER MASTER PLAN
R.M. TOWILL CORPORATION



EAST KAPOLEI DEVELOPMENT PLAN

FIGURE 1-2
EAST KAPOLEI SEWER MASTER PLAN
R.M. TOWILL CORPORATION

SECTION 2
CRITERIA AND METHODOLOGY

2.1 Design Criteria

The criteria used in this sewerage master plan follows the design standards of the City and County of Honolulu, Department of Wastewater Management (DWWM). Table 2-1 summarizes the sewer demand rates as well as system design criteria

Currently there are no boring logs for this project area. Boring logs from A'eloa at The Villages of Kapolei show no presence of groundwater. Calculations for this project were based on the assumption that all pipes should be installed above the groundwater table.

The East Kapolei project sewer demands are derived from the most recent development plan received from HFDC. See the appendix for the development schedule. The development plan, along with a preliminary topographic survey, was used to layout the proposed backbone sewer system. Construction plans were used to obtain design information for the Makakilo and Kapolei Interceptor Sewers (References 7 and 8).

2.2 Methodology

The first step in this study was to identify the location and adequacy of any off-site sewers which are able to serve the project. Sewer demands for the proposed project were then computed, and a backbone sewer system was designed in coordination with the drainage plan. Finally, a hydraulic analysis was performed to evaluate the proposed sewer system.

Table 3-1
EAST KAPOLEI
PROJECTED SEWER DEMANDS

Parcel	Unit Type	Acreage	Number of Units	Average Flow (MGD)	Maximum Flow Factor	Maximum Flow (MGD)	Dry Weather I/I (gal/day)	Design Ave. Flow (MGD)	Design Max. Flow (MGD)	Wet Weather I/I (gal/day)	Design Peak Flow (MGD)
A	Park	3.0		0.001	5.00	0.006	75	0.001	0.006	3,750	0.010
	Comm(Campbell Est	44.9		0.503	5.00	2.514	8,980	0.512	2.523	56,125	2.580
	Single Family	73.1	585	0.187	4.35	0.814	11,696	0.199	0.826	91,375	0.917
	SUBTOTAL	121.0	585	0.691		3.334	20,751	0.712	3.355	151,250	3.506
B	Park	6.0		0.002	5.00	0.012	150	0.003	0.012	7,500	0.020
	Commercial	8.0		0.026	5.00	0.128	1,600	0.027	0.130	10,000	0.140
	Elementary School	12.0		0.030	5.00	0.150	6,000	0.036	0.156	15,000	0.171
	Single Family	211.6	1693	0.542	4.40	2.383	33,856	0.576	2.417	264,500	2.682
	Multi Family	56.4	677	0.152	5.00	0.758	9,475	0.161	0.767	70,500	0.838
	SUBTOTAL	294.0	2,370	0.751		3.431	51,081	0.802	3.483	367,500	3.850
C	Park	3.0		0.001	5.00	0.006	75	0.001	0.006	3,750	0.010
	Commercial	2.0		0.006	5.00	0.032	400	0.007	0.032	2,500	0.035
	Elementary School	12.0		0.030	5.00	0.150	6,000	0.036	0.156	15,000	0.171
	Single Family	132.0	1056	0.338	4.00	1.352	21,120	0.359	1.373	165,000	1.538
	Multi Family	32.1	385	0.086	4.90	0.423	5,393	0.092	0.428	40,125	0.468
	SUBTOTAL	181.1	1,441	0.462	3.75	1.962	32,988	0.496	1.995	226,375	2.222
D	Park	3.0		0.001	5.00	0.006	75	0.001	0.006	3,750	0.010
	Single Family	61.0	488	0.156	4.40	0.687	9,760	0.166	0.697	76,250	0.773
	SUBTOTAL	64.0	488	0.157		0.693	9,835	0.167	0.703	80,000	0.783
E	Single Family	9.2	74	0.024	4.40	0.104	1,472	0.025	0.105	11,500	0.117
F	Multi Family	10.5	126	0.028	5.00	0.141	1,764	0.030	0.143	13,125	0.156
G	Park	2.5		0.001	5.00	0.005	63	0.001	0.005	3,125	0.008
	Commercial	8.0		0.026	5.00	0.128	1,600	0.027	0.130	10,000	0.140
	SUBTOTAL	10.5	0	0.027		0.133	1,663	0.028	0.135	13,125	0.148
H	Sports Complex	64.3		0.026	5.00	0.129	1,608	0.027	0.130	80,375	0.211
I	Park	3.0		0.001	5.00	0.006	75	0.001	0.006	3,750	0.010
	Elemenetry School	12.0		0.030	5.00	0.150	6,000	0.036	0.156	15,000	0.171
	Single Family	141.1	1129	0.361	4.50	1.625	22,576	0.384	1.648	176,375	1.824
	Multi Family	22.7	272	0.061	4.85	0.296	3,814	0.065	0.300	28,375	0.328
	SUBTOTAL	178.8	1,401	0.452		2.071	32,390	0.485	2.104	219,750	2.324

Table 3-1
EAST KAPOLEI
PROJECTED SEWER DEMANDS

Parcel	Unit Type	Acreage	Number of Units	Average Flow (MGD)	Maximum Flow Factor	Maximum Flow (MGD)	Dry Weather I/I (gal/day)	Design Ave. Flow (MGD)	Design Max. Flow (MGD)	Wet Weather I/I (gal/day)	Design Peak Flow (MGD)
(CONTINUED)											
J	Park	15.4		0.006	5.00	0.031	385	0.007	0.031	19,250	0.050
	Intermediate School	20.0		0.040	5.00	0.200	8,000	0.048	0.208	25,000	0.233
	Single Family	94.5	756	0.242	4.20	1.016	15,120	0.257	1.031	118,125	1.149
	Multi Family	34.0	408	0.091	4.90	0.448	5,712	0.097	0.454	42,500	0.496
	SUBTOTAL	163.9	1,164	0.379		1.695	29,217	0.409	1.724	204,875	1.929
K	Multi Family	22.8	274	0.061	5.00	0.306	3,830	0.065	0.310	28,500	0.339
L	Multi Family	32.4	389	0.087	5.00	0.435	5,443	0.093	0.441	40,500	0.481
	TOTALS (W/O UHWOC)	1,152.5	8,311	3.146		14.436	192,041	3.338	14.628	1,436,875	16.065
UH *	University	991.0		1.600	2.87	4.592	320,000	1.920	4.912	1,238,750	6.151
	GRAND TOTAL	2,144	8,311	4.746		19.028	512,041	5.258	19.540	2,675,625	22.215

TABLE 2-1

SEWER SYSTEM DESIGN CRITERIA

SEWER DEMAND RATES
Average daily per capita flow = 80 gpd

Single-Family Residential	4 persons/unit
Multi-Family Residential	2.8 persons/unit
Community Business	140 persons/acre
Neighborhood Business	40 persons/acre
Parks	5 persons/acre
Churches	40 persons/acre
Public Facility	40 persons/acre
Schools	25 gals/person/day

Assumed Enrollment:
- Elementary 1,200 students
- Intermediate 1,600 students
- High School 2,000 students

Maximum Flow = average daily flow x flow factor
Dry Weather Infiltration/Inflow (I/I) = 5 gal/person/day
Wet Weather Infiltration/Inflow (I/I) = 1250 gal/acre/day
Design Average Flow = average daily flow + dry weather I/I
Design Maximum Flow = maximum flow + dry weather I/I
Design Peak Flow = design maximum flow + wet weather I/I

HYDRAULIC CRITERIA

Design based on Manning's Formula:

$$\text{Velocity} = \frac{1.486\, r^{2/3} s^{1/2}}{n}$$

Manning's "n" value:

0.013 for all pipes larger than 18 inches in diameter
0.015 for all pipes 18 inches and smaller in diameter

Pipe Capacity:

Based on 90% actual pipe capacity

SOURCE: *Design Standards of the Department of Wastewater Management, Volume I*, City and County of Honolulu, July 1993 (Reference 1)

SECTION 3

PROJECTED SEWER DEMANDS

3.1 Design Flows

The sewer system for East Kapolei is analyzed under two conditions. The first analysis considers only the sewer generated by the on-site parcels of East Kapolei. The second analysis includes the projected off-site sewer demands generated from UHWOC, which will ultimately contribute to the East Kapolei sewer system.

Based on the criteria in Section 2, the calculated sewer demands are given in Table 3-1 and are summarized below:

	On-site Contributions Only	Inclusive of UHWOC
Average Design Flow =	3.338 mgd	5.258 mgd
Maximum Design Flow =	14.628 mgd	19.540 mgd
Peak Design Flow =	16.065 mgd	22.215 mgd

The projected sewer demands for UHWOC is based on the assumption of 8,000 students and 100 acres designated for use mauka of the H-1 Freeway.

3.2 Honouliuli WWTP Capacity

Since the present capacity of the Honouliuli WWTP primary treatment is 38 mgd and presently treats 25 mgd, there is a probable 13 mgd available capacity. It needs to be determined if the allowable nutrient concentrations discharged by the deep ocean outfall are affected by additional flows. The design average flow based on the sewer generated on-site is 3.338 mgd, and design average flow including the UHWOC is 5.258 mgd. The Honouliuli WWTP is determined to be able to accept projected flows from East Kapolei in its current capacity.

SECTION 4
SEWER SYSTEM DESCRIPTION

4.1 Proposed Sewer System

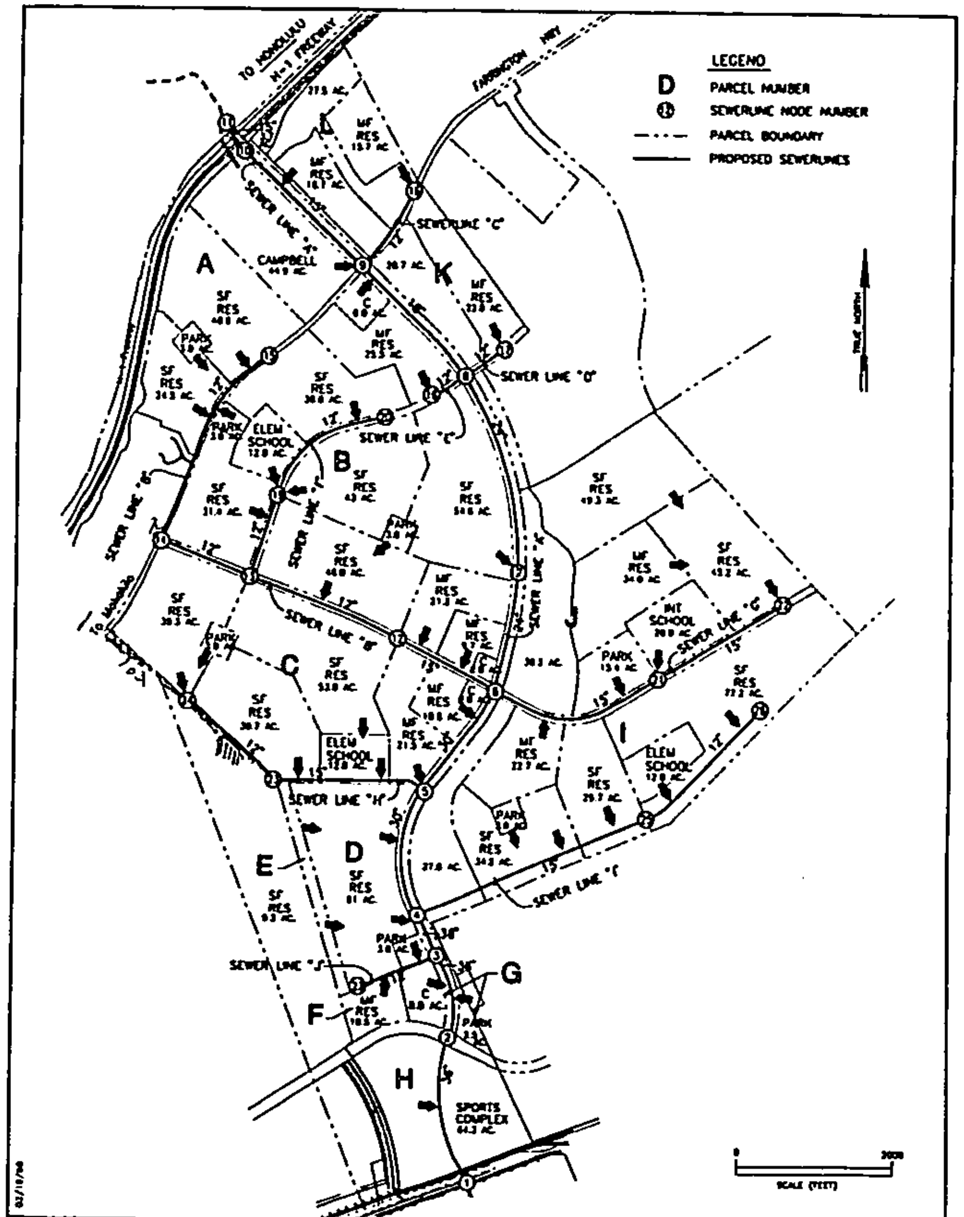
The proposed East Kapolei Sewer System Plan is illustrated in Figure 4-1. This backbone system serves all of the East Kapolei Project as well as a portion of Campbell Estate land and the UHWOC. The figure shows the contribution points to the proposed system for correlation to the hydraulic analysis.

The "backbone" sewer system of East Kapolei is comprised of a major trunk line along North-South Road with size varying from 18-inches to 36-inches, and 12-inch and 15-inch branch lines along connecting collector roads. All pipe sizes range from a minimum diameter of 12-inches to a maximum of 36-inches. Pipe slopes vary between 0.09% and 5.0% and depths are up to 31.5 feet. The wide range of slopes and depths are due to East Kapolei's flat topography at the lower regions and steep grades in the higher areas. The great depths of certain pipes are due to the inevitable crossings of the realigned Kaloi Stream channel as well as the crossings of the proposed backbone drainage system. The proposed backbone drainage system is described in the *East Kapolei Drainage Master Plan*, prepared concurrently for this project.

4.2 Off-site Sewers

Two off-site trunk sewers are planned to be utilized by East Kapolei; the existing 30-inch Makakilo Interceptor and the proposed 54-inch Kapolei Interceptor Sewer along Renton Road, from Ft. Barrette Road to the Honouliuli WWTP. It is anticipated that the Makakilo 30-inch Interceptor Sewer will be utilized to near its capacity before the Kapolei 54-inch Interceptor Sewer becomes operational. If this occurs, either East Kapolei may force the construction of the 54-inch sewer or there may be a moratorium imposed until this interceptor sewer is complete.

The existing 30-inch Makakilo Interceptor has a pipe capacity of 10.587 mgd. Based on the *Force Majeure Study* conducted by Fukunaga & Associates, Inc. the existing peak flow in this



EAST KAPOLEI SEWER SYSTEM PLAN

FIGURE 4-1
EAST KAPOLEI SEWER MASTER PLAN
R.M. TOWILL CORPORATION

pipe is 6.838 mgd, which is approximately 65% of the pipe's capacity.

The proposed 54-inch Kapolei Interceptor Sewer is estimated to have a capacity of 42.0 mgd. Its required capacity is 41.9 mgd (Reference 8) and was sized to accommodate ultimate flows from developments including the Villages of Kapolei, the Kapolei Town Center, and Ko'Olina. Contingent upon results from the *West Mamala Bay Facilities Plan*, which is currently being prepared, the size of the interceptor sewer may have to be revised.

Complete construction schedules of these developments to the west are unknown at this time due to the present economic status. Slow unit sales have caused these developers to postpone new construction. Construction of the proposed Kapolei Interceptor Sewer by Campbell Estate is dependent upon the time frame of future developments in the tributary area.

4.3 Sewer System Analysis

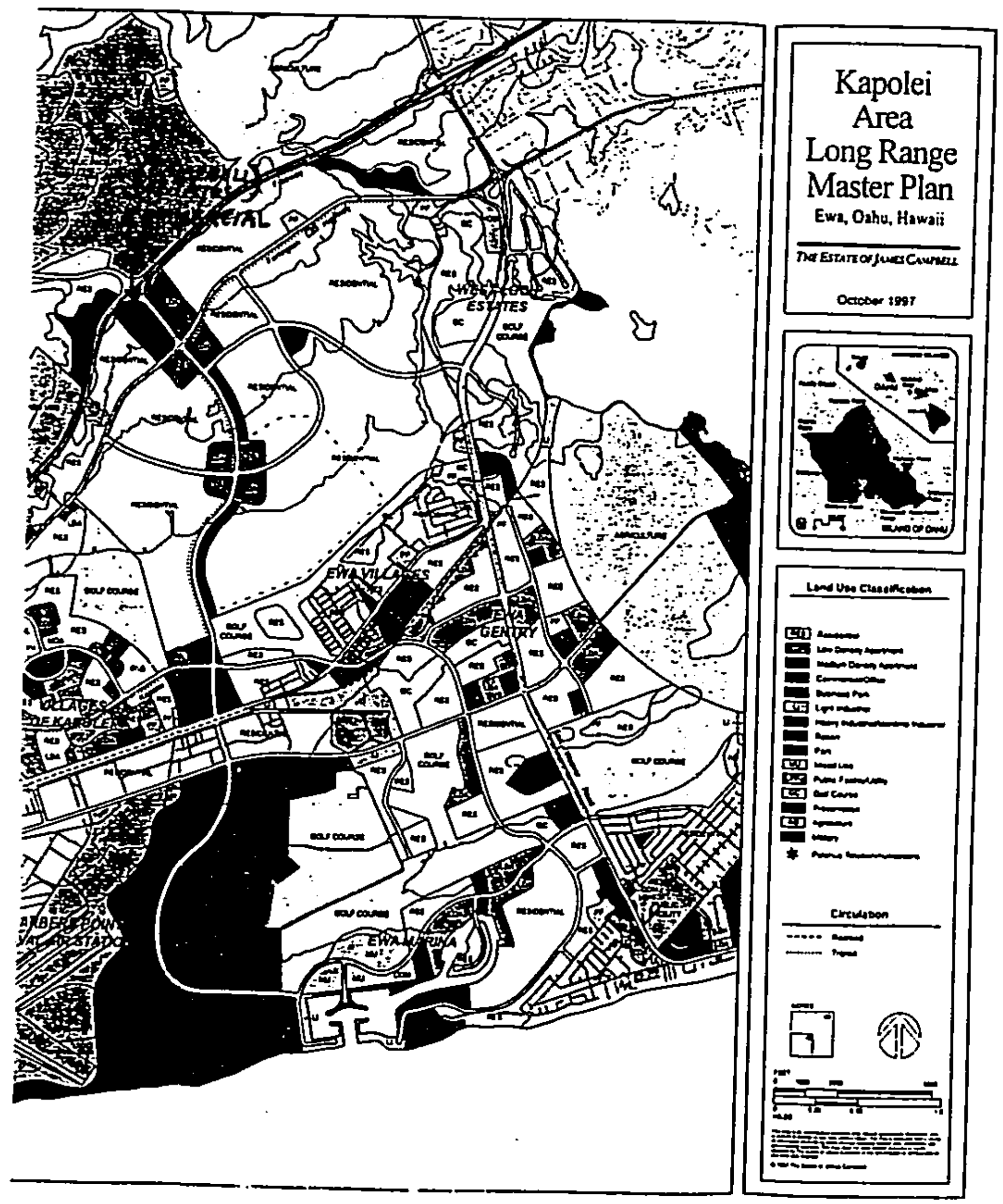
The analyses for the proposed sewer system are shown in the Appendix. On-site contributions are analyzed separately from the ultimate conditions (with UHWOC) in order to determine minimum pipe slopes and velocities. Analysis of the ultimate condition is done to determine minimum pipe sizes.

In determining minimum pipe sizes, pipe segments have been checked to ensure open (channel) pipe flow and an excess capacity of 10-percent. Pipe velocities meet the minimum 2-feet per second requirement at average flow with the exception of a few pipe segments. In these segments, contributing flows are small and the pipe slopes are constrained due to drainage system conflicts.

REFERENCES

1. *Design Standards of the Department of Wastewater Management, Volume I*, City and County of Honolulu, July 1993.
2. *East Kapolei Master Plan Development Project, Environmental Impact Statement, Notice of Preparation*, prepared by PBR Hawaii for the Housing Finance and Development Corporation, State of Hawaii, March 1997.
3. *Villages of Kapolei Sewerage Master Plan*, prepared by R.M. Towill Corporation for the Housing Finance and Development Corporation, Department of Budget and Finance, State of Hawaii, March 1997.
4. *Ewa Water Master Plan*, prepared by Belt Collins and Associates for the Ewa Water Development Corporation, August 1987.
5. *Ewa Development Plan Report*, City and County of Honolulu, Planning Department, Draft-April 1995.
6. Brater, Ernest F. and King, Horace W. Handbook of Hydraulics, 6th Edition. McGraw-Hill Book Company, New York, N.Y. c. 1976.
7. Construction Plans for the "Makakilo Interceptor Sewer," Division of Wastewater Management, Department of Public Works, City and County of Honolulu, February 1981.
8. Construction Plans for the "Kapolei Interceptor Sewer Preliminary Plan," prepared by Community Planning, Inc., June 5, 1990.

APPENDIX



Kapolei
Area
Long Range
Master Plan
Ewa, Oahu, Hawaii
THE ESTATE OF JAMES CAMPBELL
October 1997
ISLAND OF OAHU
Land Use Classification
Circulation
EWA VILLAGES
EWA GENTRY
EWA MARINA
ESTATES
GOLF COURSE
RESIDENTIAL
AGRICULTURE

R.M. TOWILL CORPORATION
PREPARED BY [illegible]

TABLE 4-1
EAST KAPOLEI - SANITARY SEWER HYDRAULICS
(EXCLUSIVE OF [illegible])

SEWER LOCATION | TRIBUTARY AREA (acres) | TRIBUTARY EQUIVALENT POPULATION (RESIDENTIAL, OTHER, TOTAL) | WASTEWATER FLOW COMPUTATION | SEWER STUDY | (1) ULTIMATE AVERAGE FLOW | PEAK FLOW | FULL FLOW

SEWER LINE "A"

SEWER LINE "B"

SEWER LINE "C"

SEWER LINE "D"

SEWER LINE "E"

SEWER LINE "F"

SEWER LINE "G"

R.M. TOWILL CORPORATION
PREPARED BY AM. [illegible]

TABLE 4-[illegible]
EAST KAPOLEI - SANITARY SEWER HYDRAULICS
(INCLUSIVE OF U H W O C.)

SEW-HYDL.XLS
SEWER
LOCATION

TRIBUTARY AREA (acres)

TRIBUTARY EQUIVALENT POPULATION

RESIDENTIAL

OTHER

TOTAL

WASTEWATER FLOW COMPUTATION

SEWER STUDY

(A) ULTIMATE AVERAGE FLOW

PEAK FLOW

FULL FLOW

SEWER LINE "A"

11		University
10	L	Flow Carry Over
		Multi-family
9		Flow Carry Over
		Sewerline "C" Carry Over
		Commercial
		Commercial (Comp. Ed.)
8		Flow Carry Over
		Sewerline "D" Carry Over
		Sewerline "E" Carry Over
7		Flow Carry Over
		Single Family
6		Flow Carry Over
		Sewerline "B" Carry Over
		Sewerline "G" Carry Over
		Multi-family
		Commercial
5		Flow Carry Over
		Sewerline "H" Carry Over
		Multi-family
		Single Family
		Single Family
4		Flow Carry Over
		Sewerline "I" Carry Over
		Single Family
		Single Family
3		Flow Carry Over
		Sewerline "J" Carry Over
		Commercial
		Park
2		Flow Carry Over
		Sports Complex
1		

Zone	Parcel	Land Use	Area	Total	Remaining columns
SEWER LINE "B"					
15	B	Park	[illegible]		[illegible]
	A	Park	[illegible]		[illegible]
	A	Single Family	73.10	79.1	[illegible]
14		Flow Carry Over	79.1	79.1	[illegible]
13		Flow Carry Over	79.1		[illegible]
		Sewerline "F" Carry Over	123.00		[illegible]
	B	Park	3.00		[illegible]
	B	Single Family	45.00	251.1	[illegible]
12		Flow Carry Over	251.10		[illegible]
	B	Multi-family	[illegible]		[illegible]
	B	Commercial	2.00	304.0	[illegible]
8					
SEWER LINE "E"					
16	L	Multi-family	15.70	15.7	[illegible]
8					
SEWER LINE "D"					
17	L	Multi-family	22.40	22.4	[illegible]
8					
SEWER LINE "E"					
18	G	Multi-family	[illegible]	[illegible]	[illegible]
8					
SEWER LINE "F"					
20	G	Single Family	[illegible]	[illegible]	[illegible]
19		Flow Carry Over	[illegible]		[illegible]
	G	Single Family	[illegible]		[illegible]
	G	Single Family	[illegible]		[illegible]
	G	Elementary School	12.0	123.0	[illegible]
13					
SEWER LINE "G"					
22	J	Single Family	[illegible]		[illegible]
	J	Single Family	[illegible]		[illegible]

Zone	Parcel	Land Use	Area	Total	Remaining columns
	J	Multi-family	[illegible]	[illegible]	[illegible]
21		Flow Carry Over	[illegible]		[illegible]
	J	Intermediate School	[illegible]		[illegible]
	J	Park	15.4		[illegible]
	I	Multi-family	[illegible]	[illegible]	[illegible]
8					
SEWER LINE "H"					
24	C	Park	3.0		[illegible]
	C	Single Family	[illegible]	42.3	[illegible]
23		Flow Carry Over	[illegible]		[illegible]
	C	Single Family	[illegible]		[illegible]
	C	Elementary School	12.0	[illegible]	[illegible]
5					
SEWER LINE "I"					
26	I	Single Family	77.30		[illegible]
	I	Elementary School	12.0	[illegible]	[illegible]
25		Flow Carry Over	[illegible]		[illegible]
	I	Park	3.00		[illegible]
	I	Single Family	[illegible]	[illegible]	[illegible]
4					
SEWER LINE "J"					
27	D	Park	3.00		[illegible]
	F	Multi-family	10.0	13.0	[illegible]
3					

DRAFT REPORT for the

EAST KAPOLEI WATER MASTER PLAN
Ewa, Oahu, Hawaii

FEBRUARY 1998

PREPARED FOR:

Housing Finance and Development Corporation
State of Hawaii

RMTC
R. M. Towill Corporation
420 Waiakamilo Rd., Suite 411
Honolulu, Hawaii 96817-4941
(808) 842-1133 • Fax: (808) 842-1937

EAST KAPOLEI

WATER MASTER PLAN

Ewa, Oahu, Hawaii

February 23, 1998

Prepared for:

Housing Finance and Development Corporation
Department of Budget and Finance
State of Hawaii

Prepared by:

R.M. Towill Corporation
420 Waiakamilo Road, Suite 411
Honolulu, Hawaii 96817-4941

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SECTION 1
INTRODUCTION

1.1 General

The East Kapolei Project is a master planned residential community and is sponsored by the State of Hawaii's Housing Finance and Development Corporation (HFDC). The project is located in the Ewa Plains area, covering portions of TMK: 9-1-16: 8, 108, 109, 9-1-17: 4 (POR.), 71 and 9-1-18: 3 and 5. The site is situated above Ewa Villages and is bound by the Villages of Kapolei, Campbell Estate lands and the H-1 Freeway. The development includes approximately 8,300 residential units on 1,300 acres of State owned land, and consists of residential homes, schools, parks and commercial and civic facilities.

1.2 Purpose and Scope

This report describes the proposed water system for the East Kapolei project. The scope of this master plan includes:

- Assessment of proposed potable water demands.
- Assessment of proposed non-potable water demands
- Sizing of backbone potable water facilities.

1.3 Related Studies

1.3.1 Potable Water Master Plan for the East Kapolei Area

In January 1996, a Draft EIS for the Schuler Homes' East Kapolei Project was prepared. The project was to be located on Campbell Estate lands between Fort Weaver Road and the proposed North-South Road. The EIS includes a water master plan prepared by Tom Nance Water Resource Engineering. The Schuler Homes' East Kapolei Project is no longer active.

1.3.2 Other Water Master Plans

The *Villages of Kapolei Water Master Plan* and the *Ewa Villages Water Master Plan*, each prepared by R. M. Towill Corporation, discuss the existing and planned water facilities in the Ewa plains. These master plans have been updated on several occasions to reflect the actual water system layout as construction in the areas have progressed.

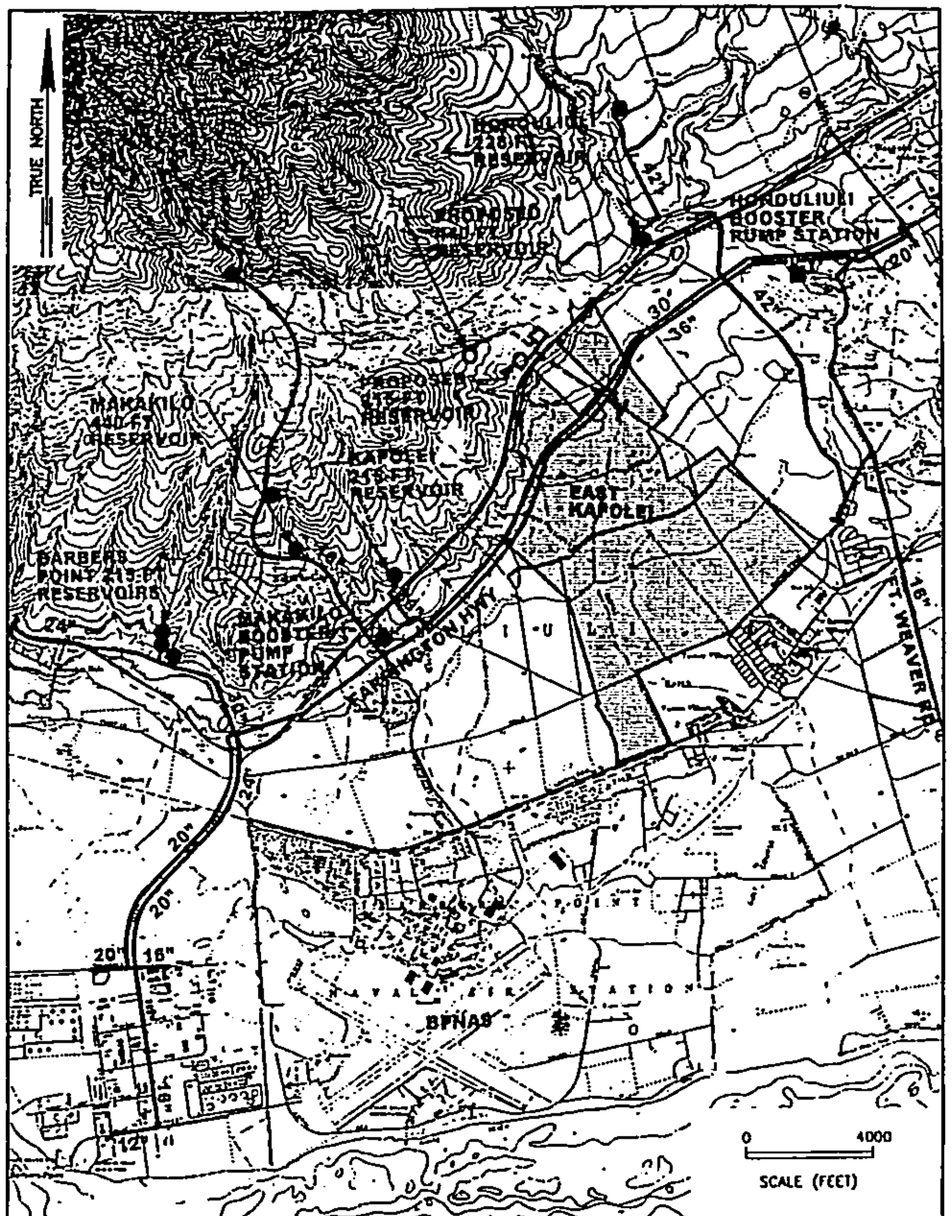
1.4 Existing Conditions

The East Kapolei area extends from elevations of 45-feet MSL on its makai boundaries up to 230-feet MSL above Farrington Highway. These elevations span two Board of Water Supply (BWS) service pressure zones, 215-feet and 440-feet. The portion of the project below the planned East-West Road is primarily within the 215-foot service elevation zone. Most of the remaining portion is within the 440-foot service elevation zone.

A map of the existing site condition is shown in Figure 1-1. The existing 228-foot Honouliuli reservoir sustains pressure for much of Ewa Villages and provides water to the Barber's Point 215-foot reservoir as well as the Kapolei 215-foot tank via the Honouliuli Booster Pumps. Existing BWS 30-inch and 36-inch transmission mains along Farrington Highway connect the series of 215-foot and 228-foot reservoirs.

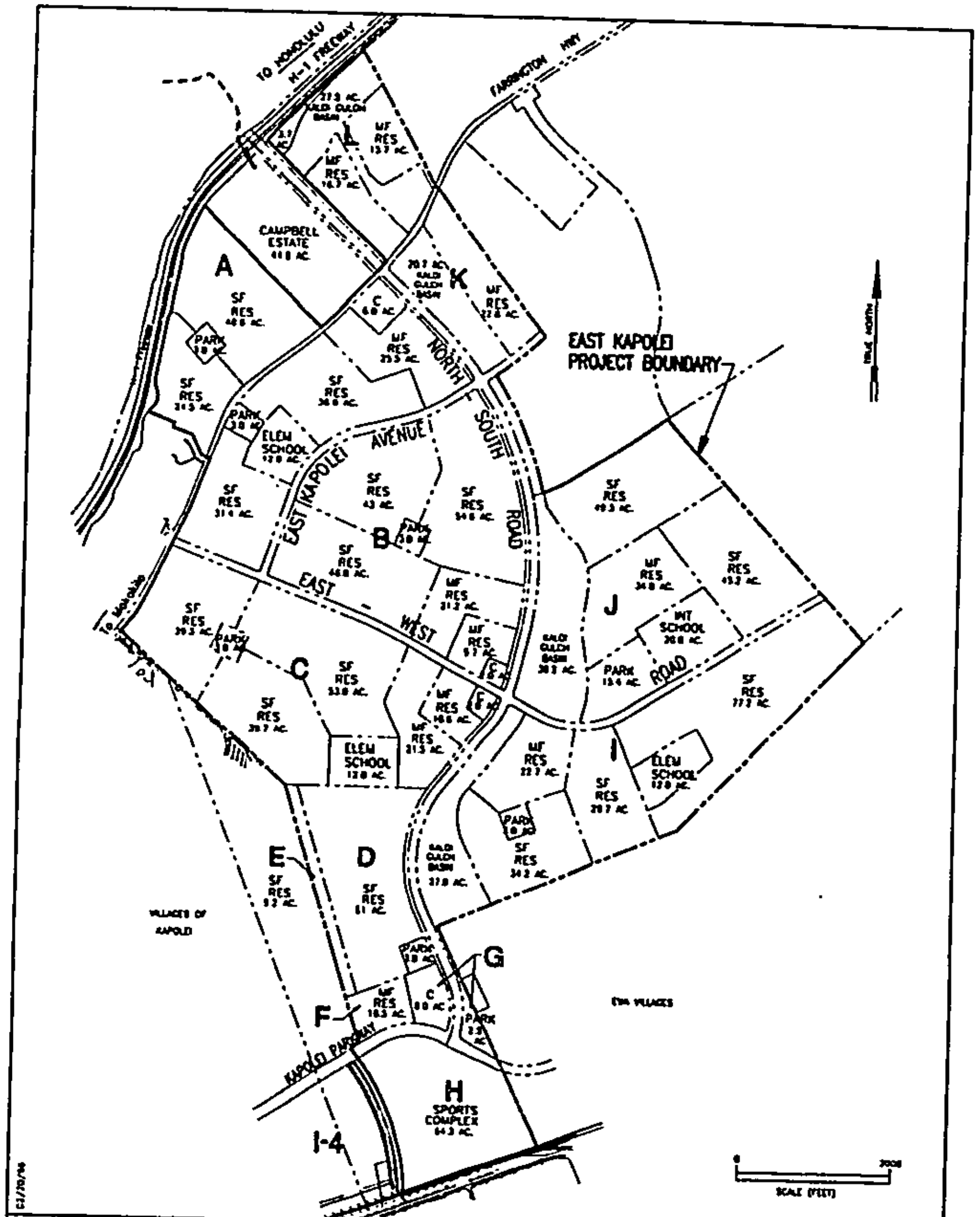
1.5 Developed Conditions

The proposed land use plan is shown on Figure 1-2. The proposed North-South Road provides a major arterial street connecting Ewa Villages, Villages of Kapolei and East Kapolei to the H-1 Freeway. Secondary or collector roads include the proposed East-West Road and East Kapolei Avenue (Collector Road 'A'). The "backbone" waterlines discussed in this master plan are generally limited to these roads. Discussion of waterlines internal to the individual parcels are left for the actual design phases of the project.



EXISTING SITE CONDITIONS

FIGURE 1-1
EAST KAPOLEI WATER MASTER PLAN
R.M. TOWILL CORPORATION



EAST KAPOLEI DEVELOPMENT PLAN	FIGURE 1-2 EAST KAPOLEI WATER MASTER PLAN R.M. TOWILL CORPORATION

SECTION 2
CRITERIA AND METHODOLOGY

2.1 Design Criteria

The design criteria for calculating water demand is from the Ewa Plain Water Development Corporation's (EPWDC) *Ewa Water Master Plan* (Reference 1), and is summarized in Table 2-1. This table provides both potable and non-potable average daily demand rates.

Factors of 1.5 for maximum daily demand and 3.0 for peak hour demand are applied to the average daily demand rate as given in Table 17 of the *Water System Standards* (Reference 2). For land areas served by a dual water system (potable and non-potable water), the average daily demand rate is increased by a factor of 1.2, for both potable and non-potable water. Some of the water demand rates were derived from the schedule in the *East Kapolei Master Plan Development Project* (Reference 3) and updated with material received from HFDC.

Pipelines sizes are determined by criteria set in the *Water System Standards*. Pipes are required to deliver the peak hour flow with a minimum residual pressure of 40 psi and the maximum daily flow plus fire flow with a minimum residual pressure of 20 psi. The maximum velocity in water mains, without fire flow, is 6 feet per second.

2.2 Methodology

The proposed potable water demands are calculated by land use areas and tabulated to determine the total potential water demand of the project. A proposed water system is evaluated under (1) peak hour flow and (2) maximum day plus fire flow conditions, where fire flows are applied to individual nodes throughout the system.

The water system is analyzed by the WATER® program by Civilsoft™.

TABLE 2-1
WATER SYSTEM DESIGN CRITERIA

Land Use	Unit Demand	All Potable System	Dual System			
			Avg. Water Use		Avg. Daily Demand	
			Potable	Non-Potable	Potable	Non-Potable
Residential -Single Family -Multi-Family Low Rise -Multi-Family High Rise	 GPD/Unit GPD/Unit GPD/Unit	 500 400 300	 345 276 207	 155 124 93	 414 331 248	 186 149 112
Commercial, Offices	GPD/Acre	3,000	1,800	1,200	2,160	1,440
Resort	GPD/Unit GPD/Acre	350 4,000	203 2,320	147 1,680	244 2,784	176 2,016
Parks	GPD/Acre	4,000	600	3,400	720	4,080
School	GPD/Student	60	35	25	42	30
Industrial	GPD/Acre	4,000	1,184	2,816	1,421	3,379
Commercial/Industrial	GPD/1,000 Ft²	100	60	40	72	48
Commercial/Residential	GPD/1,000 Ft²	120	83	37	100	44

PIPELINE, STORAGE, AND WELL PUMP SIZING CRITERIA

1. Demand Factors
   a. AVERAGE DAY DEMAND. For land uses to be served by a dual system, a 1.2 factor is applied to the AVERAGE WATER USE rates to derive the AVERAGE DAY DEMAND. For land uses served only by the potable system, AVERAGE WATER USE and AVERAGE DAY DEMAND are identical.
   b. MAXIMUM DAY DEMAND = (1.5) x AVERAGE DAY DEMAND.
   c. PEAK HOUR RATE = (3.0) x AVERAGE DAY DEMAND.
2. Fire protection can be met in either the potable or non-potable system subject to meeting all present fire protection standards.
3. Reservoir Size
   a. The potable reservoir volume shall be equivalent to MAXIMUM DAY DEMAND.
   b. The non-potable reservoir volume shall be equivalent to AVERAGE DAY DEMAND.
4. Potable and non-potable pipelines shall be sized for PEAK HOUR flow rates with a minimum residual pressure of 40 psi and maximum velocity in the main of 6 feet per second. Hydraulic analyses will utilize tank spillway elevations as the initial hydraulic grade line elevations. Pipelines providing fire protection shall also be sized for MAXIMUM DAY flow plus fire flow with a residual of 20 psi at the critical fire hydrant. Hydraulic analyses will use three-quarters full tank water surface elevations as initial hydraulic grade line elevations. Maximum static pressure of 125 psi.
5. Well pumps for potable and non-potable systems shall provide MAXIMUM DAY in an operating time of 16 hours.

SOURCE: "Ewa Water Master Plan," prepared by Belt Collins for the Ewa Plain Water Development Corporation, August 1987 (Reference 1).

SECTION 3
PROPOSED WATER DEMANDS

3.1 Potable Water Demands

The potable water demands by the East Kapolei Development are shown in Table 3-1, Table 3-2 and Table 3-3 and are summarized as follows:

Service Zone	Average (MGD)	Max. Day (MGD)	Peak (MGD)
215	2.24	3.37	6.74
440	2.30	3.44	6.89
TOTAL	4.54	6.81	13.63

The planned University of Hawaii West Oahu Campus (UHWOC) is calculated to have an average daily demand of 0.48 MGD, which brings the total to 5.02 MGD to be met by new or existing potable sources. The water source for the East Kapolei development and the University is currently being coordinated with the Board of Water Supply.

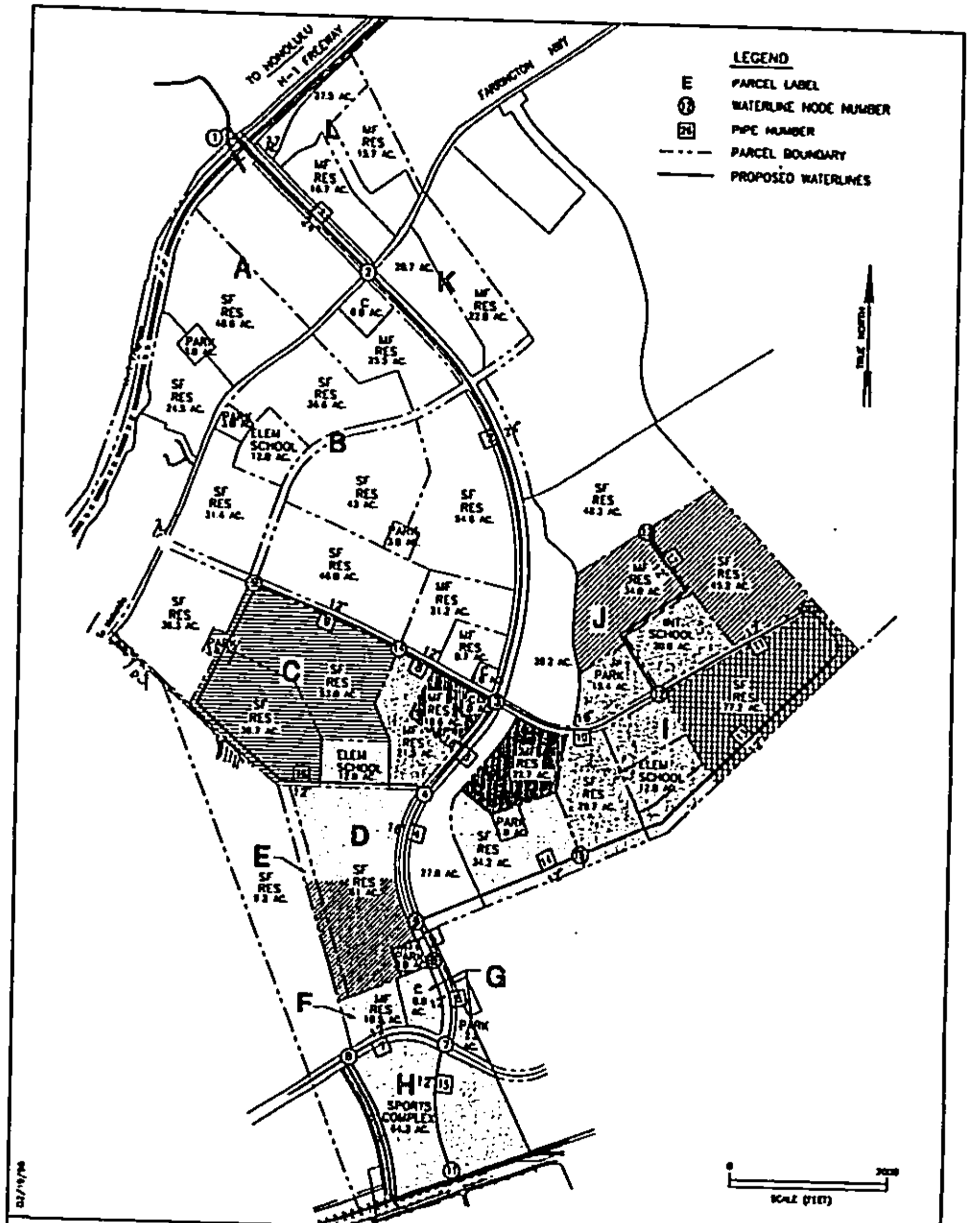
The East Kapolei project and the University of Hawaii West Oahu Campus are included in the recently approved *Ewa Development Plan*. The Board of Water Supply is presently requesting a water reservation from the State Commission on Water Resource Management to convert agricultural water allocations from the Waiawa-Waipahu aquifer to urban use. This is needed to serve the needs of the projects included in the Development Plan. There will be a re-allocation of water from agricultural uses by October 1998. When this occurs, the sources for the projects within the Ewa Development Plan can be identified.

3.2 Non-potable Water Demands

A non-potable water system will supplement the potable water system in meeting the total water demand. The non-potable system should provide brackish water and/or reclaimed water for irrigation, commercial, and industrial purposes. For obvious reasons, potable and non-potable water systems will be completely separate systems.

The areas identified for non-potable water use are given in Table 3-4. The North-South Road corridor, including the proposed drainage basins, the East-West Road, East Kapolei Avenue (Collector Road 'A') and some parks are planned to be irrigated by non-potable water. Parks that are proposed to be irrigated by non-potable water include the proposed sports complex and the 15-acre park site along the East-West Road. The calculated average daily non-potable water demand for the East Kapolei development is 0.95 MGD. Including the planned UHWOC, the average daily non-potable water demand is increased to a total of 2.55 MGD. The University campus is planned to be served by a dual (potable / non-potable) water system.

An analysis of facilities for the non-potable water system cannot be addressed in this master plan because of the uncertainty of non-potable water sources. A complete determination of demands can only be estimated at this time. More accurate demand calculations and non-potable system requirements will be addressed as detailed land use and landscaping plans are prepared.



EAST KAPOLEI - 215' SERVICE ZONE

FIGURE 3-1
EAST KAPOLEI WATER MASTER PLAN
R.M. TOWILL CORPORATION

Table 3-1
EAST KAPOLEI
PROJECTED POTABLE WATER DEMAND

Parcel	Unit Type	Acreage	Number of Units	Criteria (gal/unit)	Criteria (gal/acre)	Average Daily Demand (mgd)	Average Daily Demand (gpm)	Max Daily Demand (mgd)	Max Daily Demand (gpm)	Fire Flow (gpm)	Peak Daily Demand (mgd)	Peak Daily Demand (gpm)
A	Park	3.0			4,000	0.0120	8.3	0.0180	12.5	2,000	0.0360	25.0
	Comm(Campbell Est	44.9			3,000	0.1347	93.5	0.2021	140.3	4,000	0.4041	280.6
	Single Family	73.1	585	500		0.2924	203.0	0.4386	304.6	1,000	0.8772	609.1
	SUBTOTAL	121.0	585			0.4391	304.9	0.6587	457.4		1.3173	914.7
B	Park	6.0			4,000	0.0240	16.7	0.0360	25.0	2,000	0.0720	50.0
	Commercial	8.0			3,000	0.0240	16.7	0.0360	25.0	2,000	0.0720	50.0
	Elementary School	12.0	1200 @ 60 GPD/Student			0.0720	50.0	0.1080	75.0	2,000	0.2160	150.0
	Single Family	211.6	1693	500		0.8464	587.7	1.2696	881.6	1,000	2.5392	1,763.2
	Multi Family	56.4	677	400		0.2707	188.0	0.4061	282.0	1,500	0.8122	564.0
	SUBTOTAL	294.0	2,370			1.2371	859.1	1.8557	1,288.6		3.7114	2,577.2
C	Park	3.0			4,000	0.0120	8.3	0.0180	12.5	2,000	0.0360	25.0
	Commercial	2.0			3,000	0.0060	4.2	0.0090	6.2	2,000	0.0180	12.5
	Elementary School	12.0	1200 @ 60 GPD/Student			0.0720	50.0	0.1080	75.0	2,000	0.2160	150.0
	Single Family	132.0	1058	500		0.5280	366.6	0.7920	550.0	1,000	1.5840	1,099.9
	Multi Family	32.1	385	400		0.1541	107.0	0.2311	160.5	1,500	0.4622	321.0
	SUBTOTAL	181.1	1,441			0.7721	536.1	1.1581	804.2		2.3162	1,608.4
D	Park	3.0			4,000	0.0120	8.3	0.0180	12.5	2,000	0.0360	25.0
	Single Family	61.0	488	500		0.2440	169.4	0.3660	254.2	1,000	0.7320	508.3
	SUBTOTAL	64.0	488			0.2560	177.8	0.3840	266.6		0.7680	533.3
E	Single Family	9.2	74	500		0.0368	25.6	0.0552	38.3	1,000	0.1104	76.7
F	Multi Family	10.5	126	400		0.0504	35.0	0.0756	52.5	1,500	0.1512	105.0
G	Commercial	8.0			3,000	0.0240	16.7	0.0360	25.0	2,000	0.0720	50.0
	Park	2.5			4,000	0.0100	6.9	0.0150	10.4	2,000	0.0300	20.8
	SUBTOTAL	10.5	0			0.0340	23.6	0.0510	35.4		0.1020	70.8
H	Sports Complex	64.3			720	0.0463	32.1	0.0694	48.2	2,000	0.1389	96.4

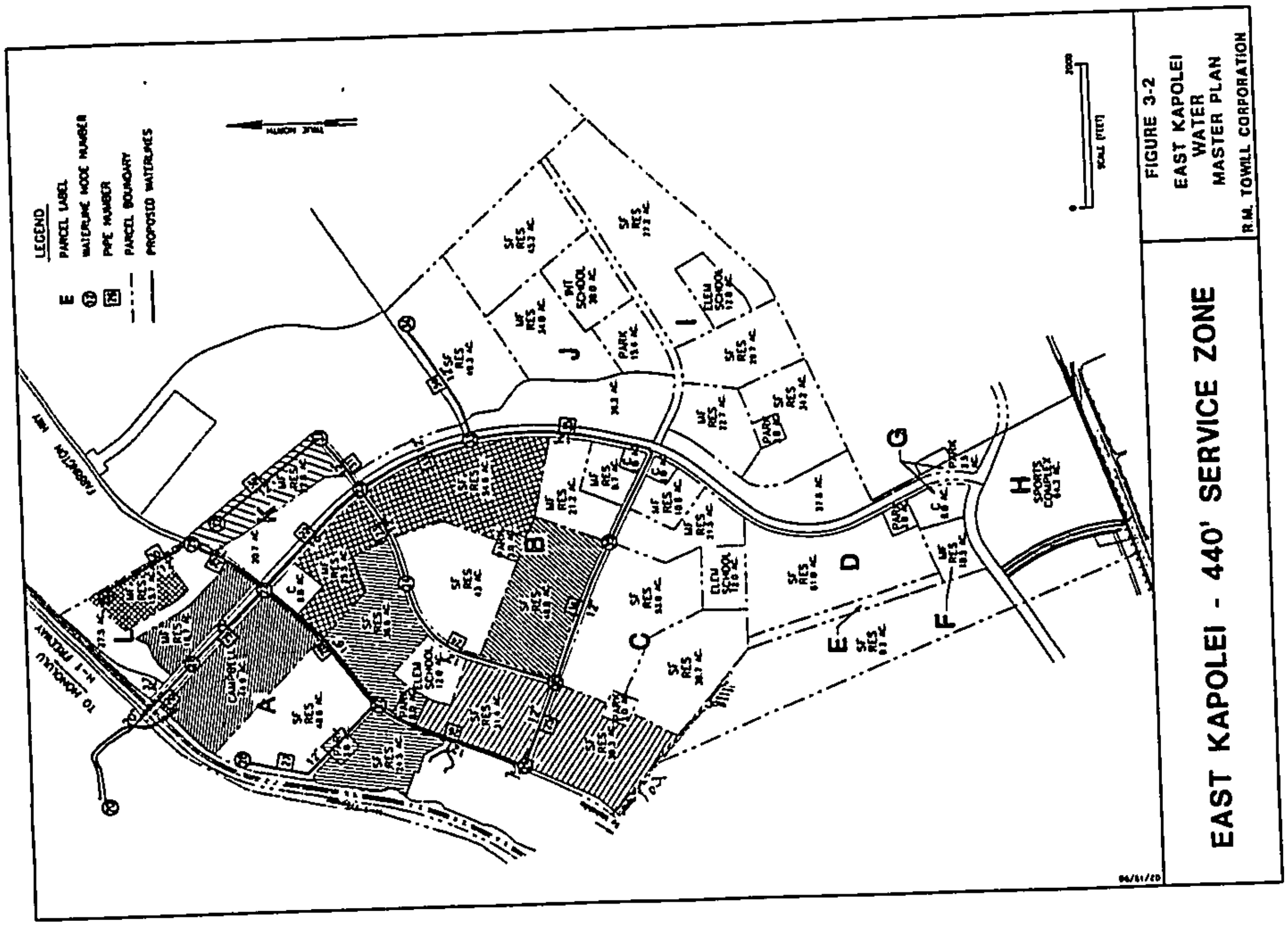


Table 3-1
EAST KAPOLEI
PROJECTED POTABLE WATER DEMAND

Parcel	Unit Type	Acreage	Number of Units	Criteria (gal/unit)	Criteria (gal/acre)	Average Daily Demand (mgd)	Average Daily Demand (gpm)	Max Daily Demand (mgd)	Max Daily Demand (gpm)	Fire Flow (gpm)	Peak Daily Demand (mgd)	Peak Daily Demand (gpm)
(CONTINUED)												
I	Park	3.0			4,000	0.0120	8.3	0.0180	12.5	2,000	0.0360	25.0
	Elementary School	12.0	1200 @ 60 GPD/Student			0.0720	50.0	0.1080	75.0	2,000	0.2160	150.0
	Single Family	141.1	1129	500		0.5644	391.9	0.8466	587.9	1,000	1.6932	1,175.8
	Multi Family	22.7	272	400		0.1090	75.7	0.1634	113.5	1,500	0.3269	227.0
	SUBTOTAL	178.8	1,401			0.7574	525.9	1.1360	788.9		2.2721	1,577.7
J	Park	15.4			720	0.0111	7.7	0.0166	11.5	2,000	0.0333	23.1
	Intermediate School	20.0	1600 @ 60 GPD/Student			0.0960	66.7	0.1440	100.0	2,000	0.2880	200.0
	Single Family	94.5	756	500		0.3780	262.5	0.5670	393.7	1,000	1.1340	787.4
	Multi Family	34.0	408	400		0.1632	113.3	0.2448	170.0	1,500	0.4896	340.0
	SUBTOTAL	163.9	1,164			0.6483	450.2	0.9724	675.3		1.9449	1,350.5
K	Multi Family	22.8	274	400		0.1094	76.0	0.1642	114.0	1,500	0.3283	228.0
L	Multi Family	32.4	389	400		0.1555	108.0	0.2333	162.0	1,500	0.4666	324.0
	TOTALS (W/O UHWOC)	1,152.5	8,311			4.5424	3,154.2	6.8136	4,731.4		13.6272	9,462.7
UH	University	100.0	8000 @ 60 GPD/Student			0.4800	333.3	0.7200	500.0	2,000	1.4400	999.9
	GRAND TOTAL	1,252.5	8,311			5.0224	3,487.6	7.5336	5,231.3		15.0672	10,462.7

The ultimate potable water demand is estimated at:

Average Daily Demand = 5.0 mgd
Maximum Daily Demand = 7.5 mgd
Peak Hourly Demand = 15.1 mgd

TABLE 3-2
PROJECTED POTABLE WATER DEMAND
215' ZONE

Node No.	Parcel	Unit Type	Acreage	Number of Units	Criteria (gal/unit)	Criteria (gal/acre)	Average Daily Demand (mgd)	Average Daily Demand (gpm)	Max Daily Demand (mgd)	Max Daily Demand (gpm)	Fire Flow (gpm)	Peak Hourly Demand (mgd)	Peak Hourly Demand (gpm)
3	C	Multi Family	10.6	127	400		0.0509	35.3	0.0763	53.0	1,500	0.1526	106.0
	C	Commercial	2.0			3,000	0.0060	4.2	0.0090	6.2	2,000	0.0180	12.5
	I	Multi Family	22.7	272	400		0.1090	75.7	0.1634	113.5	1,500	0.3269	227.0
		SUBTOTAL	35.3	400			0.1658	115.2	0.2488	172.7	5,000	0.4975	345.5
4	C	Elementary School	12.0	1200 @ 60 GPD/Student			0.0720	50.0	0.1080	75.0	2,000	0.2160	150.0
	D	Single Family	30.5	244	500		0.1220	84.7	0.1830	127.1	1,000	0.3660	254.2
	E	Single Family	4.6	37	500		0.0184	12.8	0.0276	19.2	1,000	0.0552	38.3
		SUBTOTAL	47.1	281			0.2124	147.5	0.3186	221.2	4,000	0.6372	442.5
5	D	Single Family	30.5	244	500		0.1220	84.7	0.1830	127.1	1,000	0.3660	254.2
	E	Single Family	4.6	37	500		0.0184	12.8	0.0276	19.2	1,000	0.0552	38.3
		SUBTOTAL	35.1	281			0.1404	97.5	0.2106	146.2	2,000	0.4212	292.5
6	D	Park	3.0			4,000	0.0120	8.3	0.0180	12.5	2,000	0.0360	25.0
		SUBTOTAL	3.0				0.0120	8.3	0.0180	12.5	2,000	0.0360	25.0
7	F	Multi Family	10.5	126	400		0.0504	35.0	0.0756	52.5	2,000	0.1512	105.0
	G	Commercial	8.0			3,000	0.0240	16.7	0.0360	25.0	2,000	0.0720	50.0
	G	Park	2.5			4,000	0.0100	7.0	0.0150	10.4	2,000	0.0300	20.8
	H	Sports Complex	64.3			720	0.0463	32.0	0.0694	48.2	2,000	0.1389	96.4
		SUBTOTAL	85.3	126			0.1307	90.7	0.1960	136.1	8,000	0.3921	272.3
9	C	Single Family	92.7	742	500		0.3708	257.0	0.5562	386.2	1,000	1.1124	772.5
	C	Park	3.0			4,000	0.0120	8.0	0.0180	12.5	2,000	0.0360	25.0
		SUBTOTAL	95.7	742			0.3828	265.0	0.5742	398.7	3,000	1.1484	797.4
10	I	Single Family	55.5	444	500		0.2220	154.0	0.3330	231.2	1,000	0.6660	462.5
12	I	Elementary School	12.0	1200 @ 60 GPD/Student			0.0720	50.0	0.1080	75.0	2,000	0.2160	150.0
	I	Single Family	51.4	411	500		0.2056	143.0	0.3084	214.2	1,000	0.6168	428.3
	J	Park	15.4			720	0.0111	7.7	0.0166	11.5	2,000	0.0333	23.1
	J	Intermediate School	20.0	1600 @ 60 GPD/Student			0.0960	67.0	0.1440	100.0	2,000	0.2880	200.0
		SUBTOTAL	98.8	411			0.3847	267.7	0.5770	400.7	7,000	1.1541	801.4
13	J	Single Family	45.2	362	500		0.1808	126.0	0.2712	188.3	1,000	0.5424	376.6
	J	Multi Family	34.0	408	400		0.1632	113.3	0.2448	170.0	1,500	0.4896	340.0
		SUBTOTAL	79.2	770			0.3440	239.3	0.5160	358.3	2,500	1.0320	716.6
14	C	Multi Family	21.5	258	400		0.1032	71.7	0.1548	107.5	1,500	0.3096	215.0
15	I	Single Family	34.2	274	500		0.1368	95.0	0.2052	142.5	1,000	0.4104	285.0
	I	Park	3.0			4,000	0.0120	8.3	0.0180	12.5	2,000	0.0360	25.0
		SUBTOTAL	37.2	274			0.1488	103.3	0.2232	155.0	3,000	0.4464	310.0
		GRAND TOTAL	593.7	3,965			2.2468	1,560.2	3.3702	2,340.3		6.7405	4,680.6

TABLE 3-3
PROJECTED POTABLE WATER DEMAND
440' ZONE

Node No.	Parcel	Unit Type	Acreage	Number of Units	Criteria (gal/unit)	Criteria (gal/acre)	Average Daily Demand (mgd)	Average Daily Demand (gpm)	Max Daily Demand (mgd)	Max Daily Demand (gpm)	Fire Flow (gpm)	Peak Hourly Demand (mgd)	Peak Hourly Demand (gpm)
21	A	Comm(Campbell Est)	44.9			3,000	0.1347	94	0.2021	140	4,000	0.4041	281
	L	Multi Family	16.7	200	400		0.0802	56	0.1202	83	1,500	0.2405	167
		SUBTOTAL	61.6	200			0.2149	149	0.3223	224	5,500	0.6446	448
22	B	Commercial	6.0			3,000	0.0180	12	0.0270	19	2,000	0.0540	37
23	B	Single Family	54.6	437	500		0.2184	152	0.3276	227	1,000	0.6552	455
	B	Multi Family	25.5	306	400		0.1224	85	0.1836	127	1,500	0.3672	255
		SUBTOTAL	80.1	743			0.3408	237	0.5112	355	2,500	1.0224	710
24	B	Single Family	43.0	344	500		0.1720	119	0.2580	179	1,000	0.5160	358
	B	Elementary School	12.0	1200 @ 60 GPD/Student			0.0720	50	0.1080	75	2,000	0.2160	150
		SUBTOTAL	55.0	344			0.2440	169	0.3660	254	3,000	0.7320	508
25	B	Single Family	46.0	368	500		0.1840	128	0.2760	192	1,000	0.5520	383
	B	Park	3.0			4,000	0.0120	8	0.0180	12	2,000	0.0360	25
		SUBTOTAL	49.0	368			0.1960	136	0.2940	204	3,000	0.5880	408
26	C	Single Family	39.3	314	500		0.1572	109	0.2358	164	1,000	0.4716	327
	B	Single Family	31.4	251	500		0.1256	87	0.1884	131	1,000	0.3768	262
		SUBTOTAL	70.7	566			0.2828	196	0.4242	295	2,000	0.8484	589
27	B	Single Family	36.6	293	500		0.1464	102	0.2196	152	1,000	0.4392	305
	B	Park	3.0			4,000	0.0120	8	0.0180	12	2,000	0.0360	25
	A	Single Family	24.5	196	500		0.0980	68	0.1470	102	1,000	0.2940	204
	A	Park	3.0			4,000	0.0120	8	0.0180	12	2,000	0.0360	25
		SUBTOTAL	67.1	489			0.2684	186	0.4026	280	6,000	0.8052	559
28	A	Single Family	48.6	389	500		0.1944	135	0.2916	202	1,000	0.5832	405
30	L	Multi Family	15.7	188	400		0.0754	52	0.1130	78	1,500	0.2261	157
32	K	Multi Family	22.8	274	400		0.1094	76	0.1642	114	1,500	0.3283	228
34	J	Single Family	49.3	394	500		0.1972	137	0.2958	205	1,000	0.5916	411
35	B	Multi Family	30.9	371	400		0.1483	103	0.2225	154	1,500	0.4450	309
	B	Commercial	2.0			3,000	0.0060	4	0.0090	6	2,000	0.0180	12
		SUBTOTAL	32.9	371			0.1543	107	0.2315	161	3,500	0.4630	321
		GRAND TOTAL	558.8	4,326			2.2956	1,594	3.4434	2,391		6.8867	4,782.2

TABLE 3-4
EAST KAPOLEI
PROJECTED NON-POTABLE WATER DEMAND

Parcel	Unit Type	Acreage	Number of Units	Criteria (gal/unit)	Criteria (gal/acre)	Average Daily Demand (mgd)	Average Daily Demand (gpm)	Max Daily Demand (mgd)	Max Daily Demand (gpm)	Fire Flow (gpm)	Peak Daily Demand (mgd)	Peak Daily Demand (gpm)
	Road Planter Areas	40.7			4,000	0.1628	113.0	0.2442	169.6		0.4884	339.1
H	Sports Complex	64.3			4,080	0.2623	182.2	0.3935	273.3		0.7870	546.5
I	Detension Basin	27.8			4,000	0.1112	77.2	0.1668	115.8		0.3336	231.7
J	Park	15.4			4,080	0.0628	43.6	0.0942	65.4		0.1885	130.9
	Detension Basin	39.2			4,000	0.1568	108.9	0.2352	163.3		0.4704	326.6
	SUBTOTAL	54.6				0.2196	152.5	0.3294	228.8		0.6589	457.5
K	Detension Basin	20.7			4,000	0.0828	57.5	0.1242	86.2		0.2484	172.5
L	Detension Basin	27.5			4,000	0.1100	76.4	0.1650	114.6		0.3300	229.2
	TOTALS (W/O UHWOC)	235.6				0.9488	658.8	1.4232	988.2		2.8463	1,976.5
UH	University of Hawaii	500.0	(total developed area - 100 ac. potable water usage)									
	open acres	300.0			4,000	1.2000	833.3	1.8000	1,249.9		3.6000	2,499.8
	landscaped	100.0			4,000	0.4000	277.8	0.6000	416.6		1.2000	833.3
	SUBTOTAL	400.0				1.6000	1,111.0	2.4000	1,666.6		4.8000	3,333.1
	GRAND TOTAL	635.6				2.5488	1,769.9	3.8232	2,654.8		7.6463	5,309.6

The ultimate non-potable water demand is estimated at

Average Daily Demand = 2.5 mgd
Maximum Daily Demand = 3.8 mgd
Peak Hourly Demand = 7.6 mgd

SECTION 4
PROPOSED WATER SYSTEM

4.1 System Description

The "backbone" water system plan for East Kapolei is shown in Figures 3-1 and 3-2. This proposed potable water system, which is planned for build-out by around 2020, consists of the major water lines that supply each of the individual development parcels.

The proposed water system within the 215-foot service pressure zone consists of a 24-inch main line originating from a proposed 215-foot reservoir, down along a portion of the North-South Road, feeding two interior 16-inch and 12-inch loops as illustrated in Figure 3-1. A proposed 12-inch main along Kapolei Parkway is intended to interconnect East Kapolei with the Villages of Kapolei.

The 440-foot service pressure zone is proposed to be serviced by a new 440-foot reservoir, and consists of a 20-inch water main from the reservoir, along the North-South Road to the proposed East Kapolei Avenue. A looped network consisting of 12-inch and 16-inch pipes along East-West Road, East Kapolei Avenue and Farrington Highway provide adequate pressure to the individual parcels within this pressure zone. See Figure 3-2.

4.2 Storage Requirements

When East Kapolei is fully developed, the total potable water storage requirement is calculated to be approximately 6.8 MG. This is equivalent to the calculated maximum daily demand for the entire East Kapolei project. Included in this amount is 0.20 MGD, considered for the Campbell Estate parcel above Farrington Highway which is "land-locked" by the East Kapolei development.

A 4.0 Million Gallon (MG) reservoir with a 215-foot elevation spillway will meet the 3.4 MG

requirement for the East Kapolei Development in the 215-foot service pressure zone, and a 4.0 MG reservoir with a 440-foot elevation spillway will meet the 3.4 MG storage requirement for the 440-foot service pressure zone. The proposed total storage is 8.0 MG, which allows for additional demands which may not be part of the current Development Plan.

It is proposed to connect the new 4.0 MG, 215-foot elevation reservoir to the existing BWS 36-inch water main along Farrington Highway, which originates at the 228-foot elevation Honouliuli Tank and sustains pressure from the Honouliuli Booster Pumps. A new booster pump at the 215-foot elevation is proposed to pump water to the new 4.0 MG, 440-foot elevation reservoir.

The UHWOC is estimated to require 0.72 MG of potable water storage at the 660-foot service pressure zone. It is anticipated that a booster pump at the 440-foot elevation will be required to supply the new 660-foot reservoir. This project is not included in the East Kapolei development.

4.3 System Analysis

The pipe sizes and locations used in the analyses were obtained from previously approved water master plans and construction drawings.

The computerized water analysis was performed using the proposed 215-foot and 440-foot reservoirs for storage and pressure. The two service pressure zones were analyzed individually. The inflow line for the proposed East Kapolei 215-foot reservoir is planned to be connected to the 36-inch water main along Farrington Highway and the 440-foot reservoir will be fed by booster pumps at the 215-foot level. However, in order to determine pipeline sizes the water system analysis considers only reservoir storage as the water source.

Figure 3-1 illustrates where the demands by each parcel are applied to water system nodes. The demand computations, node assignments and hydraulic analyses for each distribution system are contained in the Appendix.

The analysis concludes that the proposed water systems will be adequate during peak flow conditions since residual pressures within the development parcels are not lower than 40 psi and the velocity in the pipes do not exceed 6 fps. For the 215-foot service pressure zone, the lowest residual pressure of 39.6 psi occurred at Node 9, which is assigned the highest demand in the system. The pressures within the parcels assigned to this node are estimated to be above 40 psi because of their lower relative elevation as well as the fact that actual water demands will be spread out and pipe systems will be looped. For the 440-foot service zone, the lowest residual pressure of 42.9 psi occurred at Node 28, the highest node in the system.

The analysis concludes that the proposed water systems will be adequate during the maximum-daily demand with fire flows. In both service pressure zones, fire flows of 1,000, 1,500, 2,000 and 4,000 gpm were applied at various nodes within the system. Each event was independently analyzed and in all cases, residual pressures were calculated to be greater than 20 psi.

REFERENCES

1. *Ewa Water Master Plan* (Revised August 1987), prepared by Belt Collins and Associates for the Ewa Plain Water Development Corporation.

2. *Water System Standards, Vol. 1*, Board of Water Supply, City and County of Honolulu, 1985.

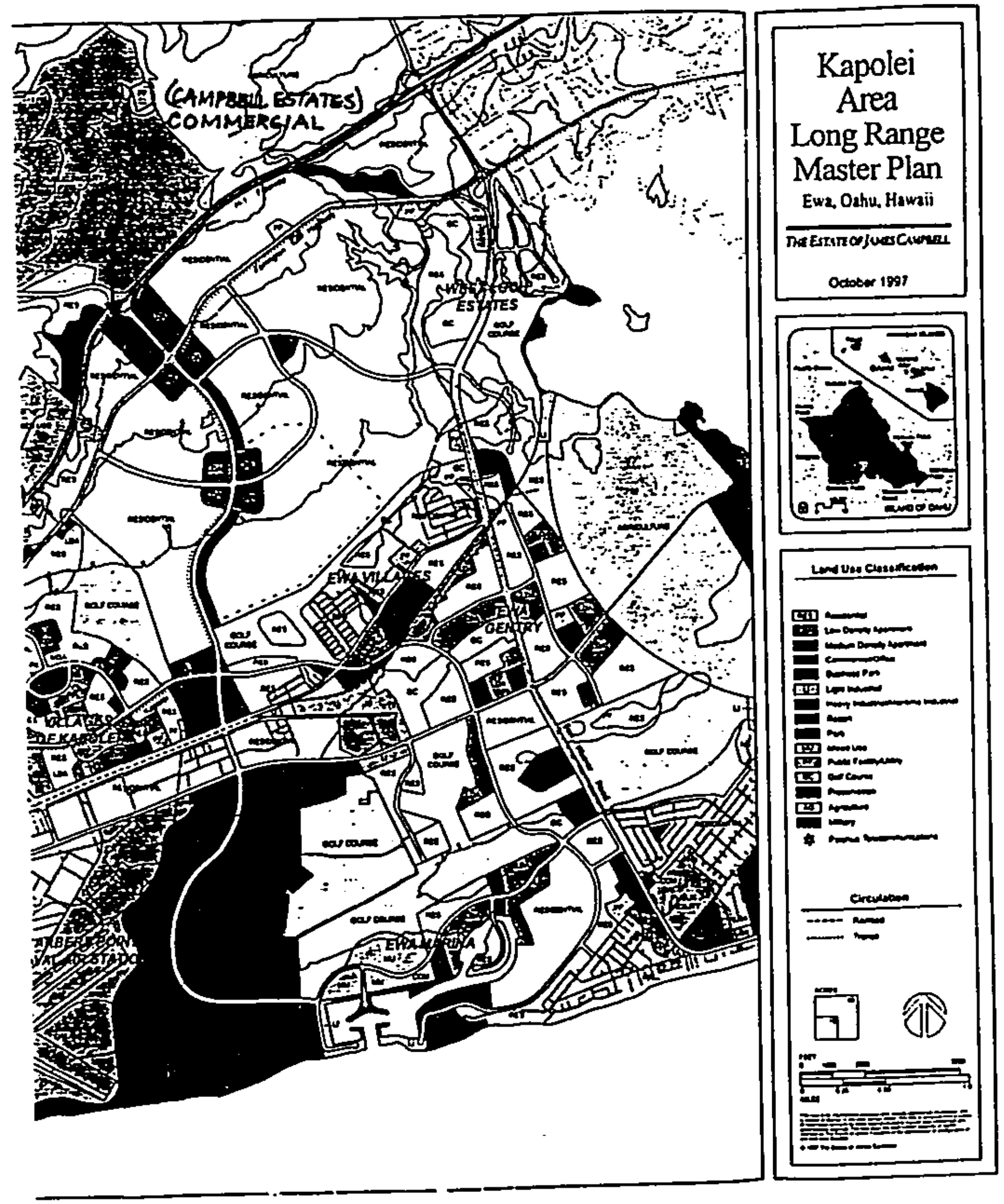
3. *East Kapolei Master Plan Development Project, Environmental Impact Statement, Notice of Preparation*, prepared by PBR Hawaii, for the Housing Finance and Development Corporation, State of Hawaii, March 1997.

4. *Villages of Kapolei Water Master Plan*, prepared by R.M. Towill Corporation, for the Housing Finance Development Corporation, State of Hawaii, April 1997.

5. *Water - Water System Network Analysis* computer program by Civilsoft™, Anaheim, California, November 1984.

6. *Ewa Villages Water Master Plan*, prepared by R.M. Towill Corporation, for the Department of Housing and Community Development, City and County of Honolulu, January 1996.

APPENDIX


Kapolei
Area
Long Range
Master Plan
Ewa, Oahu, Hawaii
THE ESTATE OF JAMES CAMPBELL
October 1997
(CAMPBELL ESTATES)
COMMERCIAL
EWA VILLAGES
EWA GENTRY
EWA MARINA
Land Use Classification
Circulation

EAST KAPOLEI POTABLE WATER SYSTEM (AVERAGE FLOW CONDITIONS-215'ZONE)

Data file name : ekave215.DAT

Hazen-Williams formula used

Iteration stops when max relative flow change is .00100 in any pi

Multiplicative factor of each consumption is 1.00000

0	Length	Diameter	Flow	Headloss	Height	Pressure	Ve
Units:	FEET	INCHES	US GPM	FEET	FEET	PSI	F

There are 16 pipes and 15 nodes

1 List of pipe information including resistance factor K

Pipe no	Nodes		Length FEET	Diameter INCHES	Roughness coeff	K
1	1	2	3000.00	24.00	130.00	.7273
2	2	3	6100.00	24.00	130.00	.1479
3	3	4	1500.00	16.00	120.00	.3038
4	4	5	2000.00	16.00	120.00	.4051
5	5	6	500.00	12.00	110.00	.4831
6	6	7	1200.00	12.00	110.00	.1159
7	7	8	1000.00	12.00	110.00	.9662
8	3	14	1450.00	12.00	110.00	.1401
9	14	9	1950.00	12.00	110.00	.1884
10	3	12	2250.00	16.00	120.00	.4558
11	12	10	2250.00	12.00	110.00	.2174
12	12	13	2850.00	12.00	110.00	.2753
13	10	15	4800.00	12.00	110.00	.4637
14	5	15	2400.00	12.00	110.00	.2318
15	7	11	2000.00	12.00	110.00	.1932
16	4	9	5300.00	12.00	110.00	.5120

1Node	Demand US GPM	Elevation FEET
1	.00000	215.00000
2	.00000	157.50000
3	115.20000	85.00000
4	147.50000	75.50000
5	97.50000	65.00000
6	8.30000	60.00000
7	90.70000	50.00000
8	.00000	50.00000
9	265.00000	105.00000
10	154.00000	75.00000
11	.00000	45.00000
12	267.70000	75.00000
13	239.00000	98.00000
14	71.70000	95.00000
15	103.30000	66.00000

1For checking purposes, note that the last node # is 15

0The total demand (to be met by water sources) is 1559.90

-

0Pump data for 1 pumps at source nodes

The number of data points for the pump curve is 3

0Node No.	No. P Parl	Elev of Pump	Pump Flows and Related Heads		
			0.	4000.	9000.
1	1	215.	0.	0.	0.

Net unbalanced flow in subnet 1 is .00012

The number of pseudo loops is 0

0	Loop #	Pipes in loop					
	1	-3	-16	9	8		
	2	-13	14	4	3	-10	-11

0 Bandwidth of matrix = 2

0 Number of loops = 2

0 Initial flows and corresponding HGLs at source nodes

0 Node	Flow	Pump HGL	Total HGL
1	-1559.900	.00	215.00

Iteration # 1 Max change in flow is 110.055 in loop # 1

Iteration # 2 Max change in flow is 16.024 in loop # 1

Iteration # 3 Max change in flow is .216 in loop # 1

Iteration # 4 Max change in flow is .000 in loop # 1

0 Number of iterations = 4

0 Final flows and corresponding HGLs at source nodes

0 Node	Flow	Pump HGL	Total HGL
1	-1559.900	.00	215.00

1

Pipe Dia INCHES	Up Node	Down Node	Pipe No.	Flow US GPM	Head Loss FEET	Velocity FT/SEC	Upstream HGL FEET
24.00	1	2	1	1559.900	.60	1.11	215.00
24.00	2	3	2	1559.900	1.21	1.11	214.40
16.00	3	4	3	576.695	.39	.92	213.19
16.00	4	5	4	335.381	.19	.54	212.80
12.00	5	6	5	99.000	.02	.28	212.61
12.00	6	7	6	90.700	.05	.26	212.58
12.00	7	8	7	.000	.00	.00	212.53
12.00	3	14	8	242.886	.37	.69	213.19
12.00	14	9	9	171.186	.26	.49	212.83
16.00	3	12	10	625.120	.69	1.00	213.19
12.00	12	10	11	118.420	.15	.34	212.51
12.00	12	13	12	239.000	.70	.68	212.51
12.00	10	15	13	-35.580	-.03	-.10	212.36
12.00	5	15	14	138.880	.22	.39	212.61
12.00	7	11	15	.000	.00	.00	212.53
12.00	4	9	16	93.814	.23	.27	212.80

1

Node	Elevation FEET	Demand US GPM	HGL FEET	Pressure PSI
1	215.00	-1559.90	215.00	.00
2	157.50	.00	214.40	24.63
3	85.00	115.20	213.19	55.50
4	75.50	147.50	212.80	59.44
5	65.00	97.50	212.61	63.90
6	60.00	8.30	212.58	66.05

7	50.00	90.70	212.53	70.36
8	50.00	.00	212.53	70.36
9	105.00	265.00	212.57	46.57
10	75.00	154.00	212.36	59.46
11	45.00	.00	212.53	72.53
12	75.00	267.70	212.51	59.53
13	98.00	239.00	211.81	49.27
14	95.00	71.70	212.83	51.01
15	66.00	103.30	212.39	63.37

0

Maximum unbalanced head in any loop .0000 In loop # 1
1

EAST KAPOLEI POTABLE WATER SYSTEM (PEAK DEMAND CONDITIONS-215'ZONE)

Data file name : ekwmp215.DAT

Hazen-Williams formula used

Iteration stops when max relative flow change is .00100 in any pipe

Multiplicative factor of each consumption is 3.00000

0	Length	Diameter	Flow	Headloss	Height	Pressure	Velo
Units:	FEET	INCHES	US GPM	FEET	FEET	PSI	FT/

There are 16 pipes and 15 nodes
1 List of pipe information including resistance factor K

Pipe no	Nodes		Length FEET	Diameter INCHES	Roughness coeff	K
1	1	2	3000.00	24.00	130.00	.72738E
2	2	3	6100.00	24.00	130.00	.14790E
3	3	4	1500.00	16.00	120.00	.30388E
4	4	5	2000.00	16.00	120.00	.40518E
5	5	6	500.00	12.00	110.00	.48311E
6	6	7	1200.00	12.00	110.00	.11595E
7	7	8	1000.00	12.00	110.00	.96621E
8	3	14	1450.00	12.00	110.00	.14010E
9	14	9	1950.00	12.00	110.00	.18841E
10	3	12	2250.00	16.00	120.00	.45582E
11	12	10	2250.00	12.00	110.00	.21740E
12	12	13	2850.00	12.00	110.00	.27537E
13	10	15	4800.00	12.00	110.00	.46378E
14	5	15	2400.00	12.00	110.00	.23189E
15	7	11	2000.00	12.00	110.00	.19324E
16	4	9	5300.00	12.00	110.00	.51209E

1Node	Demand US GPM	Elevation FEET
1	.00000	215.00000
2	.00000	157.50000
3	115.20000	85.00000
4	147.50000	75.50000
5	97.50000	65.00000
6	8.30000	60.00000
7	90.70000	50.00000
8	.00000	50.00000
9	265.00000	105.00000
10	154.00000	75.00000
11	.00000	45.00000
12	267.70000	75.00000
13	239.30000	98.00000
14	71.70000	95.00000
15	103.30000	66.00000

1For checking purposes, note that the last node # is 15
0The total demand (to be met by water sources) is 4680.60
-

```
0Pump data for  1  pumps at source nodes
 The number of data points for the pump curve is    3
0Node  No. P  Elev of      Pump Flows and
  No.  Parl    Pump        Related Heads
                         0.  4000.  9000.
   1   1      215.       0.     0.     0.
 Net unbalanced flow in subnet     1  is     .00000
 The number of pseudo loops is     0
0    Loop #          Pipes in loop
       1             -3  -16    9    8
       2            -13   14    4    3  -10  -11
0     Bandwidth of matrix =    2

0     Number of loops =     2

0 Initial flows and corresponding HGLs at source nodes
0 Node        Flow          Pump HGL       Total HGL
   1     -4680.600             .00          215.00

 Iteration #   1  Max change in flow is        330.141 in loop #   1

 Iteration #   2  Max change in flow is         48.068 in loop #   1

 Iteration #   3  Max change in flow is           .649 in loop #   1

 Iteration #   4  Max change in flow is           .000 in loop #   1
0     Number of iterations =    4
0 Final flows and corresponding HGLs at source nodes
0 Node        Flow          Pump HGL       Total HGL
   1     -4680.600             .00          215.00
1
```

Pipe Dia INCHES	Up Node	Down Node	Pipe No.	Flow US GPM	Head Loss FEET	Velocity FT/SEC	Upstream HGL FEET	Do
24.00	1	2	1	4680.600	4.55	3.32	215.00	
24.00	2	3	2	4680.600	9.26	3.32	210.45	
16.00	3	4	3	1730.229	3.01	2.76	201.19	
16.00	4	5	4	1006.304	1.47	1.61	198.17	
12.00	5	6	5	297.000	.18	.84	196.70	
12.00	6	7	6	272.100	.37	.77	196.52	
12.00	7	8	7	.000	.00	.00	196.14	
12.00	3	14	8	728.675	2.80	2.07	201.19	
12.00	14	9	9	513.576	1.97	1.46	198.38	
16.00	3	12	10	1876.096	5.25	2.99	201.19	
12.00	12	10	11	355.096	1.15	1.01	195.93	
12.00	12	13	12	717.900	5.36	2.04	195.93	
12.00	10	15	13	-106.904	-.27	-.30	194.79	
12.00	5	15	14	416.804	1.65	1.18	196.70	
12.00	7	11	15	.000	.00	.00	196.14	
12.00	4	9	16	281.424	1.76	.80	198.17	

1

Node	Elevation FEET	Demand US GPM	HGL FEET	Pressure PSI
1	215.00	-4680.60	215.00	.00
2	157.50	.00	210.45	22.92
3	85.00	345.60	201.19	50.30
4	75.50	442.50	198.17	53.10
5	65.00	292.50	196.70	57.01
6	60.00	24.90	196.52	59.10
7	50.00	272.10	196.14	63.26
8	50.00	.00	196.14	63.26
9	105.00	795.00	196.41	39.57
10	75.00	462.00	194.79	51.86
11	45.00	.00	196.14	65.43
12	75.00	803.10	195.93	52.35
13	98.00	717.90	190.58	40.08
14	95.00	215.10	198.38	44.76
15	66.00	309.90	195.05	55.87

```
0

 Maximum unbalanced head in any loop      .0000 In loop #   1
1
```

```
EAST KAPOLEI POTABLE WATER SYSTEM - 215' ZONE (MAX + FIRE AT NODE 12)

Data file name : ek215f12.DAT

Hazen-Williams formula used

Iteration stops when max relative flow change is      .00100 in any pipe

Multiplicative factor of each consumption is     1.50000

0          Length  Diameter    Flow    Headloss   Height   Pressure  Velo
 Units:    FEET    INCHES     US GPM    FEET       FEET      PSI      FT/


 There are     16 pipes and     15 nodes
1     List of pipe information including resistance factor K

     Pipe no     Nodes         Length     Diameter  Roughness coeff     K
                                FEET       INCHES
    ------------------------------------------------------------------------
        1        1     2      3000.00      24.00      130.00        .72738E
        2        2     3      6100.00      24.00      130.00        .14790E
        3        3     4      1500.00      16.00      120.00        .30388E
        4        4     5      2000.00      16.00      120.00        .40518E
        5        5     6       500.00      12.00      110.00        .48311E
        6        6     7      1200.00      12.00      110.00        .11595E
        7        7     8      1000.00      12.00      110.00        .96621E
        8        3    14      1450.00      12.00      110.00        .14010E
        9       14     9      1950.00      12.00      110.00        .18841E
       10        3    12      2250.00      16.00      120.00        .45582E
       11       12    10      2250.00      12.00      110.00        .21740E
       12       12    13      2850.00      12.00      110.00        .27537E
       13       10    15      4800.00      12.00      110.00        .46378E
       14        5    15      2400.00      12.00      110.00        .23189E
       15        7    11      2000.00      12.00      110.00        .19324E
       16        4     9      5300.00      12.00      110.00        .51209E
1Node          Demand          Elevation
               US GPM           FEET
 ------------------------------------------
     1          .00000        215.00000
     2          .00000        157.50000
     3       115.20000         85.00000
     4       147.50000         75.50000
     5        97.50000         65.00000
     6         8.30000         60.00000
     7        90.70000         50.00000
     8          .00000         50.00000
     9       265.00000        105.00000
    10       154.00000         75.00000
    11          .00000         45.00000
    12      1601.03000         75.00000
    13       239.30000         98.00000
    14        71.70000         95.00000
    15       103.30000         66.00000
1For checking purposes, note that the last node # is    15
0The total demand (to be met by water sources) is      4340.29
-
```

```
0Pump data for  1  pumps at source nodes
 The number of data points for the pump curve is      3
0Node  No. P  Elev of       Pump Flows and
 No.   Parl    Pump          Related Heads
                          0.  4000.  9000.
   1   1      215.     0.     0.     0.
 Net unbalanced flow in subnet     1  is     .00000
 The number of pseudo loops is     0
0     Loop #         Pipes in loop
        1           -3  -16    9    8
        2          -13   14    4    3  -10  -11
0     Bandwidth of matrix =    2

0     Number of loops =     2

0 Initial flows and corresponding HGLs at source nodes
0 Node         Flow          Pump HGL       Total HGL
   1      -4340.295            .00           215.00

 Iteration #   1  Max change in flow is        657.887 in loop #   2

 Iteration #   2  Max change in flow is        204.791 in loop #   2

 Iteration #   3  Max change in flow is         29.647 in loop #   2

 Iteration #   4  Max change in flow is           .679 in loop #   2

 Iteration #   5  Max change in flow is           .000 in loop #   2
0     Number of iterations =    5
0 Final flows and corresponding HGLs at source nodes
0 Node         Flow          Pump HGL       Total HGL
   1      -4340.295            .00           215.00
1
    Pipe   Up    Down   Pipe       Flow      Head    Velocity   Upstream   Do
    Dia   Node   Node    No.                 Loss                 HGL
   INCHES                         US GPM     FEET     FT/SEC      FEET
 ---------------------------------------------------------------------------
   24.00    1      2      1     4340.295     3.96     3.08      215.00
   24.00    2      3      2     4340.295     8.05     3.08      211.04
   16.00    3      4      3     1186.586     1.50     1.89      202.99
   16.00    4      5      4      872.469     1.13     1.39      201.49
   12.00    5      6      5      148.500      .05      .42      200.36
   12.00    6      7      6      136.050      .10      .39      200.31
   12.00    7      8      7         .000      .00      .00      200.20
   12.00    3     14      8      412.183      .98     1.17      202.99
   12.00   14      9      9      304.633      .75      .86      202.01
   16.00    3     12     10     2568.726     9.40     4.10      202.99
   12.00   12     10     11     -191.769     -.37     -.54      193.59
   12.00   12     13     12      358.950     1.48     1.02      193.59
   12.00   10     15     13     -422.769    -3.38    -1.20      193.96
   12.00    5     15     14      577.719     3.02     1.64      200.36
   12.00    7     11     15         .000      .00      .00      200.20
   12.00    4      9     16       92.867      .23      .26      201.49
1
     Node       Elevation       Demand         HGL         Pressure
                  FEET          US GPM         FEET           PSI
 ------------------------------------------------------------------------
      1          215.00       -4340.29        215.00           .00
      2          157.50            .00        211.04         23.18
      3           85.00         172.80        202.99         51.08
```

```
0Pump data for  1  pumps at source nodes
 The number of data points for the pump curve is     3
0Node  No. P  Elev of        Pump Flows and
 No.   Parl    Pump          Related Heads
                          0.   4000.   9000.
                          0.      0.      0.
  1    1      215.
 Net unbalanced flow in subnet     1  is     .00000
 The number of pseudo loops is     0
0     Loop #           Pipes in loop
        1           -3   -16     9      8
        2          -13    14     4      3   -10   -11
0     Bandwidth of matrix =    2

0     Number of loops =      2

0 Initial flows and corresponding HGLs at source nodes
0 Node        Flow           Pump HGL        Total HGL
   1     -3689.850             .00            215.00

 Iteration #   1  Max change in flow is          436.237 in loop #   2

 Iteration #   2  Max change in flow is          115.065 in loop #   2

 Iteration #   3  Max change in flow is           13.166 in loop #   2

 Iteration #   4  Max change in flow is             .184 in loop #   2
0     Number of iterations =      4
0 Final flows and corresponding HGLs at source nodes
0 Node        Flow           Pump HGL        Total HGL
   1     -3689.850             .00            215.00
1
```

Pipe Dia INCHES	Up Node	Down Node	Pipe No.	Flow US GPM	Head Loss FEET	Velocity FT/SEC	Upstream HGL FEET	Do
24.00	1	2	1	3689.850	2.93	2.62	215.00	
24.00	2	3	2	3689.850	5.96	2.62	212.07	
16.00	3	4	3	1088.002	1.28	1.74	206.11	
16.00	4	5	4	757.522	.87	1.21	204.83	
12.00	5	6	5	148.500	.05	.42	203.96	
12.00	6	7	6	136.050	.10	.39	203.91	
12.00	7	8	7	.000	.00	.00	203.80	
12.00	3	14	8	395.820	.90	1.12	206.11	
12.00	14	9	9	288.270	.68	.82	205.20	
16.00	3	12	10	2033.228	6.09	3.24	206.11	
12.00	12	10	11	-76.822	-.07	-.22	200.01	
12.00	12	13	12	1858.500	31.17	5.27	200.01	
12.00	10	15	13	-307.822	-1.88	-.87	200.08	
12.00	5	15	14	462.772	2.00	1.31	203.96	
12.00	7	11	15	.000	.00	.00	203.80	
12.00	4	9	16	109.230	.30	.31	204.83	

1

Node	Elevation FEET	Demand US GPM	HGL FEET	Pressure PSI
1	215.00	-3689.85	215.00	.00
2	157.50	.00	212.07	23.62
3	85.00	172.80	206.11	52.43
4	75.50	221.25	204.83	55.99
5	65.00	146.25	203.96	60.16
6	60.00	12.45	203.91	62.30
7	50.00	136.05	203.80	66.58
8	50.00	.00	203.80	66.58
9	105.00	397.50	204.53	43.08
10	75.00	231.00	200.08	54.15
11	45.00	.00	203.80	68.75
12	75.00	251.55	200.01	54.12
13	98.00	1858.50	168.84	30.67
14	95.00	107.55	205.20	47.71
15	66.00	154.95	201.96	58.86

```
0

 Maximum unbalanced head in any loop      .0056 In loop #   2
1
```

4	75.50	221.25	201.49	54.54
5	65.00	146.25	200.36	58.60
6	60.00	12.45	200.31	60.74
7	50.00	136.05	200.20	65.02
8	50.00	.00	200.20	65.02
9	105.00	397.50	201.26	41.67
10	75.00	231.00	193.96	51.50
11	45.00	.00	200.20	67.19
12	75.00	2401.54	193.59	51.34
13	98.00	358.95	192.11	40.74
14	95.00	107.55	202.01	46.33
15	66.00	154.95	197.34	56.86

0

Maximum unbalanced head in any loop .0000 In loop # 2

1

EAST KAPOLEI POTABLE WATER SYSTEM - 215' ZONE (MAX + FIRE AT NODE 13)

Data file name : ek215f13.DAT

Hazen-Williams formula used

Iteration stops when max relative flow change is .00100 in any pipe

Multiplicative factor of each consumption is 1.50000

0

Units:	Length	Diameter	Flow	Headloss	Height	Pressure	Velo
	FEET	INCHES	US GPM	FEET	FEET	PSI	FT/

There are 16 pipes and 15 nodes

1 List of pipe information including resistance factor K

Pipe no	Nodes		Length FEET	Diameter INCHES	Roughness coeff	K
1	1	2	3000.00	24.00	130.00	.72738E
2	2	3	6100.00	24.00	130.00	.14790E
3	3	4	1500.00	16.00	120.00	.30388E
4	4	5	2000.00	16.00	120.00	.40518E
5	5	6	500.00	12.00	110.00	.48311E
6	6	7	1200.00	12.00	110.00	.11595E
7	7	8	1000.00	12.00	110.00	.96621E
8	3	14	1450.00	12.00	110.00	.14010E
9	14	9	1950.00	12.00	110.00	.18841E
10	3	12	2250.00	16.00	120.00	.45582E
11	12	10	2250.00	12.00	110.00	.21740E
12	12	13	2850.00	12.00	110.00	.27537E
13	10	15	4800.00	12.00	110.00	.46378E
14	5	15	2400.00	12.00	110.00	.23189E
15	7	11	2000.00	12.00	110.00	.19324E
16	4	9	5300.00	12.00	110.00	.51209E

1Node	Demand US GPM	Elevation FEET
1	.00000	215.00000
2	.00000	157.50000
3	115.20000	85.00000
4	147.50000	75.50000
5	97.50000	65.00000
6	8.30000	60.00000
7	90.70000	50.00000
8	.00000	50.00000
9	265.00000	105.00000
10	154.00000	75.00000
11	.00000	45.00000
12	167.70000	75.00000
13	1239.00000	98.00000
14	71.70000	95.00000
15	103.30000	66.00000

1For checking purposes, note that the last node # is 15

0The total demand (to be met by water sources) is 3689.85

-

EAST KAPOLEI POTABLE WATER SYSTEM - 215' ZONE (MAX + FIRE AT NODE 14)

Data file name : ek215f14.DAT

Hazen-Williams formula used

Iteration stops when max relative flow change is .00100 in any pipe

Multiplicative factor of each consumption is 1.50000

0	Length	Diameter	Flow	Headloss	Height	Pressure	Velo
Units:	FEET	INCHES	US GPM	FEET	FEET	PSI	FT/

There are 16 pipes and 15 nodes

1 List of pipe information including resistance factor K

Pipe no	Nodes		Length FEET	Diameter INCHES	Roughness coeff	K
1	1	2	3000.00	24.00	130.00	.72738E
2	2	3	6100.00	24.00	130.00	.14790E
3	3	4	1500.00	16.00	120.00	.30388E
4	4	5	2000.00	16.00	120.00	.40518E
5	5	6	500.00	12.00	110.00	.48311E
6	6	7	1200.00	12.00	110.00	.11595E
7	7	8	1000.00	12.00	110.00	.96621E
8	3	14	1450.00	12.00	110.00	.14010E
9	14	9	1950.00	12.00	110.00	.18841E
10	3	12	2250.00	16.00	120.00	.45582E
11	12	10	2250.00	12.00	110.00	.21740E
12	12	13	2850.00	12.00	110.00	.27537E
13	10	15	4800.00	12.00	110.00	.46378E
14	5	15	2400.00	12.00	110.00	.23189E
15	7	11	2000.00	12.00	110.00	.19324E
16	4	9	5300.00	12.00	110.00	.51209E

1Node	Demand US GPM	Elevation FEET
1	.00000	215.00000
2	.00000	157.50000
3	115.20000	85.00000
4	147.50000	75.50000
5	97.50000	65.00000
6	8.30000	60.00000
7	90.70000	50.00000
8	.00000	50.00000
9	265.00000	105.00000
10	154.00000	75.00000
11	.00000	45.00000
12	267.70000	75.00000
13	239.30000	98.00000
14	1071.70000	95.00000
15	103.30000	66.00000

1For checking purposes, note that the last node # is 15

0The total demand (to be met by water sources) is 3840.30

-

0Pump data for 1 pumps at source nodes

The number of data points for the pump curve is 3

0Node No.	No. P Parl	Elev of Pump	Pump Flows and Related Heads		
			0.	4000.	9000.
1	1	215.	0.	0.	0.

Net unbalanced flow in subnet 1 is .00000

The number of pseudo loops is 0

0 Loop #	Pipes in loop					
1	-3	-16	9	8		
2	-13	14	4	3	-10	-11

0 Bandwidth of matrix = 2

0 Number of loops = 2

0 Initial flows and corresponding HGLs at source nodes

0 Node	Flow	Pump HGL	Total HGL
1	-3840.300	.00	215.00

Iteration # 1 Max change in flow is 790.159 in loop # 1

Iteration # 2 Max change in flow is 169.994 in loop # 1

Iteration # 3 Max change in flow is 13.090 in loop # 1

Iteration # 4 Max change in flow is .082 in loop # 1

0 Number of iterations = 4

0 Final flows and corresponding HGLs at source nodes

0 Node	Flow	Pump HGL	Total HGL
1	-3840.300	.00	215.00

1

Pipe Dia INCHES	Up Node	Down Node	Pipe No.	Flow US GPM	Head Loss FEET	Velocity FT/SEC	Upstream HGL FEET	Do
24.00	1	2	1	3840.300	3.16	2.72	215.00	
24.00	2	3	2	3840.300	6.42	2.72	211.84	
16.00	3	4	3	1265.253	1.69	2.02	205.42	
16.00	4	5	4	437.010	.31	.70	203.74	
12.00	5	6	5	148.500	.05	.42	203.42	
12.00	6	7	6	136.050	.10	.39	203.37	
12.00	7	8	7	.000	.00	.00	203.27	
12.00	3	14	8	1398.057	9.36	3.97	205.42	
12.00	14	9	9	-209.493	-.37	-.59	196.06	
16.00	3	12	10	1004.190	1.65	1.60	205.42	
12.00	12	10	11	243.690	.57	.69	203.77	
12.00	12	13	12	358.950	1.48	1.02	203.77	
12.00	10	15	13	12.690	.01	.04	203.20	
12.00	5	15	14	142.260	.23	.40	203.42	
12.00	7	11	15	.000	.00	.00	203.27	
12.00	4	9	16	606.993	7.30	1.72	203.74	

1

Node	Elevation FEET	Demand US GPM	HGL FEET	Pressure PSI
1	215.00	-3840.30	215.00	.00
2	157.50	.00	211.84	23.53
3	85.00	172.80	205.42	52.13
4	75.50	221.25	203.74	55.51
5	65.00	146.25	203.42	59.92

6	60.00	12.45	203.37	62.07
7	50.00	136.05	203.27	66.35
8	50.00	.00	203.27	66.35
9	105.00	397.50	196.43	39.58
10	75.00	231.00	203.20	55.50
11	45.00	.00	203.27	68.51
12	75.00	401.55	203.77	55.75
13	98.00	358.95	202.29	45.15
14	95.00	1607.55	196.06	43.75
15	66.00	154.95	203.20	59.39

0

Maximum unbalanced head in any loop .0033 In loop # 1
1

EAST KAPOLEI POTABLE WATER SYSTEM - 215' ZONE (MAX + FIRE AT NODE 7)

Data file name : ek215f7.DAT

Hazen-Williams formula used

Iteration stops when max relative flow change is .00100 in any pipe

Multiplicative factor of each consumption is 1.50000

0	Length	Diameter	Flow	Headloss	Height	Pressure	Velo
Units:	FEET	INCHES	US GPM	FEET	FEET	PSI	FT/

There are 16 pipes and 15 nodes
1 List of pipe information including resistance factor K

Pipe no	Nodes		Length FEET	Diameter INCHES	Roughness coeff	K
1	1	2	3000.00	24.00	130.00	.72738E
2	2	3	6100.00	24.00	130.00	.14790E
3	3	4	1500.00	16.00	120.00	.30388E
4	4	5	2000.00	16.00	120.00	.40518E
5	5	6	500.00	12.00	110.00	.48311E
6	6	7	1200.00	12.00	110.00	.11595E
7	7	8	1000.00	12.00	110.00	.96621E
8	3	14	1450.00	12.00	110.00	.14010E
9	14	9	1950.00	12.00	110.00	.18841E
10	3	12	2250.00	16.00	120.00	.45582E
11	12	10	2250.00	12.00	110.00	.21740E
12	12	13	2850.00	12.00	110.00	.27537E
13	10	15	4800.00	12.00	110.00	.46378E
14	5	15	2400.00	12.00	110.00	.23189E
15	7	11	2000.00	12.00	110.00	.19324E
16	4	9	5300.00	12.00	110.00	.51209E

1Node	Demand US GPM	Elevation FEET
1	.00000	215.00000
2	.00000	157.50000
3	115.20000	85.00000
4	147.50000	75.50000
5	97.50000	65.00000
6	8.30000	60.00000
7	1424.03000	50.00000
8	.00000	50.00000
9	265.00000	105.00000
10	154.00000	75.00000
11	.00000	45.00000
12	267.70000	75.00000
13	239.00000	98.00000
14	71.70000	95.00000
15	103.30000	66.00000

1For checking purposes, note that the last node # is 15
0The total demand (to be met by water sources) is 4339.85

```
0Pump data for  1  pumps at source nodes
 The number of data points for the pump curve is     3
0Node  No. P  Elev of       Pump Flows and
 No.   Parl     Pump        Related Heads
                         0.   4000.   9000.
   1    1     215.      0.      0.      0.
 Net unbalanced flow in subnet    1  is    -.00049
 The number of pseudo loops is     0
0     Loop #            Pipes in loop
        1              -3  -16     9     8
        2             -13   14     4     3  -10  -11
0     Bandwidth of matrix =    2

0     Number of loops =      2

0 Initial flows and corresponding HGLs at source nodes
0 Node        Flow          Pump HGL       Total HGL
    1     -4339.845             .00          215.00

 Iteration #    1  Max change in flow is          583.228 in loop #    2

 Iteration #    2  Max change in flow is          165.107 in loop #    2

 Iteration #    3  Max change in flow is           18.272 in loop #    2

 Iteration #    4  Max change in flow is             .239 in loop #    2
0      Number of iterations =    4
0 Final flows and corresponding HGLs at source nodes
0 Node        Flow          Pump HGL       Total HGL
    1     -4339.845             .00          215.00
1
```

Pipe Dia INCHES	Up Node	Down Node	Pipe No.	Flow US GPM	Head Loss FEET	Velocity FT/SEC	Upstream HGL FEET	Do
							215.00	
24.00	1	2	1	4339.845	3.96	3.08	211.04	
24.00	2	3	2	4339.845	8.05	3.08	202.99	
16.00	3	4	3	2149.553	4.50	3.43	198.49	
16.00	4	5	4	2050.085	5.50	3.27	192.99	
12.00	5	6	5	2148.495	7.15	6.10	185.83	
12.00	6	7	6	2136.045	16.98	6.06	168.85	
12.00	7	8	7	.000	.00	.00	202.99	
12.00	3	14	8	626.832	2.12	1.78	200.87	
12.00	14	9	9	519.282	2.01	1.47	202.99	
16.00	3	12	10	1390.660	3.02	2.22	199.97	
12.00	12	10	11	630.610	3.33	1.79	199.97	
12.00	12	13	12	358.500	1.48	1.02	196.65	
12.00	10	15	13	399.610	3.05	1.13	192.99	
12.00	5	15	14	-244.660	-.62	-.69	168.85	
12.00	7	11	15	.000	.00	.00	198.49	
12.00	4	9	16	-121.782	-.37	-.35		

1

Node	Elevation FEET	Demand US GPM	HGL FEET	Pressure PSI
				.00
1	215.00	-4339.85	215.00	23.18
2	157.50	.00	211.04	51.08
3	85.00	172.80	202.99	53.24
4	75.50	221.25	198.49	55.41
5	65.00	146.25	192.99	
6	60.00	12.45	185.83	54.47
7	50.00	2136.04	168.85	51.45
8	50.00	.00	168.85	51.45
9	105.00	397.50	198.86	40.63
10	75.00	231.00	196.65	52.66
11	45.00	.00	168.85	53.62
12	75.00	401.55	199.97	54.10
13	98.00	358.50	198.49	43.50
14	95.00	107.55	200.87	45.83
15	66.00	154.95	193.60	55.24

```
0

 Maximum unbalanced head in any loop      .0098 In loop #    2
1
```

EAST KAPOLEI POTABLE WATER SYSTEM - 215' ZONE (MAX + FIRE AT NODE 9)

Data file name : ek215f9.DAT

Hazen-Williams formula used

Iteration stops when max relative flow change is .00100 in any pipe

Multiplicative factor of each consumption is 1.50000

0 Units:	Length FEET	Diameter INCHES	Flow US GPM	Headloss FEET	Height FEET	Pressure PSI	Velo FT/

There are 16 pipes and 15 nodes
1 List of pipe information including resistance factor K

Pipe no	Nodes		Length FEET	Diameter INCHES	Roughness coeff	K
1	1	2	3000.00	24.00	130.00	.72738E
2	2	3	6100.00	24.00	130.00	.14790E
3	3	4	1500.00	16.00	120.00	.30388E
4	4	5	2000.00	16.00	120.00	.40518E
5	5	6	500.00	12.00	110.00	.48311E
6	6	7	1200.00	12.00	110.00	.11595E
7	7	8	1000.00	12.00	110.00	.96621E
8	3	14	1450.00	12.00	110.00	.14010E
9	14	9	1950.00	12.00	110.00	.18841E
10	3	12	2250.00	16.00	120.00	.45582E
11	12	10	2250.00	12.00	110.00	.21740E
12	12	13	2850.00	12.00	110.00	.27537E
13	10	15	4800.00	12.00	110.00	.46378E
14	5	15	2400.00	12.00	110.00	.23189E
15	7	11	2000.00	12.00	110.00	.19324E
16	4	9	5300.00	12.00	110.00	.51209E

1Node	Demand US GPM	Elevation FEET
1	.00000	215.00000
2	.00000	157.50000
3	115.20000	85.00000
4	147.50000	75.50000
5	97.50000	65.00000
6	8.30000	60.00000
7	90.70000	50.00000
8	.00000	50.00000
9	1598.33000	105.00000
10	154.00000	75.00000
11	.00000	45.00000
12	267.70000	75.00000
13	239.30000	98.00000
14	71.70000	95.00000
15	103.30000	66.00000

1For checking purposes, note that the last node # is 15
0The total demand (to be met by water sources) is 4340.29
-

```
0Pump data for  1  pumps at source nodes
 The number of data points for the pump curve is    3
0Node  No. P  Elev of      Pump Flows and
  No.  Parl    Pump         Related Heads
                       0.  4000.  9000.
   1   1     215.     0.     0.     0.
 Net unbalanced flow in subnet    1  is    .00000
 The number of pseudo loops is    0
0    Loop #         Pipes in loop
      1           -3  -16    9    8
      2          -13   14    4    3  -10  -11
0     Bandwidth of matrix =   2

0     Number of loops =    2

0 Initial flows and corresponding HGLs at source nodes
0 Node      Flow        Pump HGL      Total HGL
   1    -4340.295         .00        215.00

 Iteration #   1  Max change in flow is       1271.632 in loop #   1

 Iteration #   2  Max change in flow is        231.948 in loop #   1

 Iteration #   3  Max change in flow is          4.761 in loop #   1

 Iteration #   4  Max change in flow is           .002 in loop #   1
0     Number of iterations =    4
0 Final flows and corresponding HGLs at source nodes
0 Node      Flow        Pump HGL      Total HGL
   1    -4340.295         .00        215.00
1
```

Pipe Dia INCHES	Up Node	Down Node	Pipe No.	Flow US GPM	Head Loss FEET	Velocity FT/SEC	Upstream HGL FEET	Do
24.00	1	2	1	4340.295	3.96	3.08	215.00	
24.00	2	3	2	4340.295	8.05	3.08	211.04	
16.00	3	4	3	1621.986	2.67	2.59	202.99	
16.00	4	5	4	365.814	.23	.58	200.31	
12.00	5	6	5	148.500	.05	.42	200.09	
12.00	6	7	6	136.050	.10	.39	200.04	
12.00	7	8	7	.000	.00	.00	199.93	
12.00	3	14	8	1470.124	10.27	4.17	202.99	
12.00	14	9	9	1362.573	12.00	3.87	192.71	
16.00	3	12	10	1075.386	1.87	1.72	202.99	
12.00	12	10	11	314.886	.92	.89	201.11	
12.00	12	13	12	358.950	1.48	1.02	201.11	
12.00	10	15	13	83.886	.17	.24	200.19	
12.00	5	15	14	71.064	.06	.20	200.09	
12.00	7	11	15	.000	.00	.00	199.93	
12.00	4	9	16	1034.921	19.60	2.94	200.31	

1

Node	Elevation FEET	Demand US GPM	HGL FEET	Pressure PSI
1	215.00	-4340.29	215.00	.00
2	157.50	.00	211.04	23.18
3	85.00	172.80	202.99	51.08
4	75.50	221.25	200.31	54.03
5	65.00	146.25	200.09	58.48

6	60.00	12.45	200.04	60.62
7	50.00	136.05	199.93	64.91
8	50.00	.00	199.93	64.91
9	105.00	2397.49	180.71	32.77
10	75.00	231.00	200.19	54.20
11	45.00	.00	199.93	67.07
12	75.00	401.55	201.11	54.59
13	98.00	358.95	199.63	44.00
14	95.00	107.55	192.71	42.30
15	66.00	154.95	200.03	58.02

0

Maximum unbalanced head in any loop .0002 In loop # 1

1

EAST KAPOLEI POTABLE WATER SYSTEM (AVERAGE FLOW CONDITIONS-440'ZONE)

Data file name : ekave440.DAT

Hazen-Williams formula used

Iteration stops when max relative flow change is .00100 in any pipe

Multiplicative factor of each consumption is 1.00000

0	Length	Diameter	Flow	Headloss	Height	Pressure	Velo
Units:	FEET	INCHES	US GPM	FEET	FEET	PSI	FT/

There are 17 pipes and 16 nodes

1 List of pipe information including resistance factor K

Pipe no	Nodes		Length FEET	Diameter INCHES	Roughness coeff	K
20	20	21	3650.00	20.00	120.00	.24942E
21	21	22	1450.00	20.00	120.00	.99085E
22	22	23	2000.00	16.00	120.00	.40518E
23	23	24	1700.00	12.00	110.00	.16426E
24	24	25	2300.00	12.00	110.00	.22223E
25	25	26	1200.00	12.00	110.00	.11595E
26	26	27	2200.00	12.00	110.00	.21257E
27	27	28	2500.00	12.00	110.00	.24155E
28	22	27	2300.00	16.00	120.00	.46595E
29	22	29	1200.00	12.00	110.00	.11595E
30	29	30	1450.00	12.00	110.00	.14010E
31	23	31	500.00	12.00	110.00	.48311E
32	31	32	1850.00	12.00	110.00	.17875E
33	23	33	1800.00	12.00	110.00	.17392E
34	33	34	1800.00	12.00	110.00	.17392E
35	33	35	3950.00	12.00	110.00	.38165E
36	35	25	1950.00	12.00	110.00	.18841E

1Node	Demand US GPM	Elevation FEET
20	.00000	440.00000
21	149.00000	190.00000
22	12.00000	157.50000
23	237.00000	131.00000
24	169.00000	131.00000
25	136.00000	105.00000
26	196.00000	125.00000
27	186.00000	141.00000
28	135.00000	229.00000
29	.00000	164.00000
30	52.00000	190.00000
31	.00000	135.00000
32	87.00000	164.00000
33	.00000	112.00000
34	137.00000	112.00000
35	107.00000	95.00000

1For checking purposes, note that the last node # is 35
0The total demand (to be met by water sources) is 1603.00
~
0Pump data for 1 pumps at source nodes

```
 The number of data points for the pump curve is     3
0Node  No. P  Elev of       Pump Flows and
 No.   Parl    Pump         Related Heads
                          0.  4000.  9000.
  20    1      440.       0.     0.     0.
0 PRV #  in Pipe #  Ref source #   Working HGL    Hd-loss  ChkV action?
    1       20          20          340.00        .000     YES

 Net unbalanced flow in subnet     1  is     .00000
 The number of pseudo loops is     0
0     Loop #         Pipes in loop
        1           -24  -25  -26   28  -22  -23
        2           -35  -36   24   23  -33
0      Bandwidth of matrix =   2

0      Number of loops =     2

0 Initial flows and corresponding HGLs at source nodes
0 Node        Flow         Pump HGL       Total HGL
   20    -1603.000           .00          440.00

 Iteration #   1  Max change in flow is         145.634 in loop #   1

 Iteration #   2  Max change in flow is          11.233 in loop #   1

 Iteration #   3  Max change in flow is            .171 in loop #   2
0PRVs and/or Check valves become testable after    3 iterations

 PRV in pipe   20  turned on at iteration #   3

 Iteration #   4  Max change in flow is            .000 in loop #   1

 Iteration #   5  Max change in flow is            .000 in loop #   1
0      Number of iterations =    5
0 Final flows and corresponding HGLs at source nodes
0 Node        Flow         Pump HGL       Total HGL
   20    -1603.000           .00          440.00
1
```

Pipe Dia INCHES	Up Node	Down Node	Pipe No.	Flow US GPM	Head Loss FEET	Velocity FT/SEC	Upstream HGL FEET	Do
20.00	20	21	20	1603.000	100.00	1.64	440.00	
20.00	21	22	21	1454.000	.71	1.49	340.00	
16.00	22	23	22	786.906	.93	1.26	339.29	
12.00	23	24	23	244.171	.43	.69	338.35	
12.00	24	25	24	75.171	.07	.21	337.92	
12.00	25	26	25	-86.094	-.04	-.24	337.85	
12.00	26	27	26	-282.094	-.73	-.80	337.90	
12.00	27	28	27	135.000	.21	.38	338.63	
16.00	22	27	28	603.094	.66	.96	339.29	
12.00	22	29	29	52.000	.02	.15	339.29	
12.00	29	30	30	52.000	.02	.15	339.27	
12.00	23	31	31	87.000	.02	.25	338.35	
12.00	31	32	32	87.000	.07	.25	338.34	
12.00	23	33	33	218.735	.37	.62	338.35	
12.00	33	34	34	137.000	.16	.39	337.98	
12.00	33	35	35	81.735	.13	.23	337.98	
12.00	35	25	36	-25.265	-.01	-.07	337.85	

1

Node	Elevation FEET	Demand US GPM	HGL FEET	Pressure PSI
20	440.00	-1603.00	440.00	.00
21	190.00	149.00	340.00	64.94
22	157.50	12.00	339.29	78.70
23	131.00	237.00	338.35	89.76
24	131.00	169.00	337.92	89.58
25	105.00	136.00	337.85	100.80
26	125.00	196.00	337.90	92.16
27	141.00	186.00	338.63	85.55
28	229.00	135.00	338.42	47.37
29	164.00	.00	339.27	75.87
30	190.00	52.00	339.25	64.61
31	135.00	.00	338.34	88.02
32	164.00	87.00	338.27	75.44
33	112.00	.00	337.98	97.83
34	112.00	137.00	337.82	97.76
35	95.00	107.00	337.85	105.13

0

Maximum unbalanced head in any loop   .0000 In loop #   1
1

EAST KAPOLEI POTABLE WATER SYSTEM (PEAK DEMAND CONDITIONS-440'ZONE)

Data file name : ekwmp440.DAT

Hazen-Williams formula used

Iteration stops when max relative flow change is .00100 in any pipe

Multiplicative factor of each consumption is 3.00000

```
0        Length  Diameter   Flow    Headloss  Height  Pressure  Velo
Units:   FEET    INCHES     US GPM  FEET      FEET    PSI       FT/
```

There are 17 pipes and 16 nodes

1 List of pipe information including resistance factor K

Pipe no	Nodes		Length FEET	Diameter INCHES	Roughness coeff	K
20	20	21	3650.00	20.00	120.00	.24942E
21	21	22	1450.00	20.00	120.00	.99085E
22	22	23	2000.00	16.00	120.00	.40518E
23	23	24	1700.00	12.00	110.00	.16426E
24	24	25	2300.00	12.00	110.00	.22223E
25	25	26	1200.00	12.00	110.00	.11595E
26	26	27	2200.00	12.00	110.00	.21257E
27	27	28	2500.00	12.00	110.00	.24155E
28	22	27	2300.00	16.00	120.00	.46595E
29	22	29	1200.00	12.00	110.00	.11595E
30	29	30	1450.00	12.00	110.00	.14010E
31	23	31	500.00	12.00	110.00	.48311E
32	31	32	1850.00	12.00	110.00	.17875E
33	23	33	1800.00	12.00	110.00	.17392E
34	33	34	1800.00	12.00	110.00	.17392E
35	33	35	3950.00	12.00	110.00	.38165E
36	35	25	1950.00	12.00	110.00	.18841E

1Node	Demand US GPM	Elevation FEET
20	.00000	440.00000
21	187.00000	190.00000
22	25.00000	157.50000
23	240.00000	131.00000
24	169.00000	131.00000
25	136.00000	105.00000
26	205.00000	125.00000
27	190.00000	141.00000
28	135.00000	229.00000
29	.00000	164.00000
30	49.00000	190.00000
31	.00000	135.00000
32	87.00000	164.00000
33	.00000	112.00000
34	138.00000	112.00000
35	107.00000	95.00000

1For checking purposes, note that the last node # is 35

0The total demand (to be met by water sources) is 5004.00

-

0Pump data for 1 pumps at source nodes

```
 The number of data points for the pump curve is    3
0Node  No. P  Elev of      Pump Flows and
 No.   Parl   Pump         Related Heads
                        0.  4000.  9000.
 20    1      440.      0.     0.     0.
0 PRV #  in Pipe #  Ref source #  Working HGL   Hd-loss  ChkV action?
   1       20          20           340.00       .000     YES

 Net unbalanced flow in subnet   1  is   .00000
 The number of pseudo loops is   0
0    Loop #         Pipes in loop
      1         -24  -25  -26   28  -22  -23
      2         -35  -36   24   23  -33
0    Bandwidth of matrix =   2

0    Number of loops =   2

0 Initial flows and corresponding HGLs at source nodes
0 Node      Flow        Pump HGL      Total HGL
   20    -5004.000        .00          440.00

 Iteration #  1  Max change in flow is      449.254 in loop #  1

 Iteration #  2  Max change in flow is       35.236 in loop #  1

 Iteration #  3  Max change in flow is         .507 in loop #  2
0PRVs and/or Check valves become testable after   3 iterations

 PRV in pipe   20  turned on at iteration #   3

 Iteration #  4  Max change in flow is         .000 in loop #  2

 Iteration #  5  Max change in flow is         .000 in loop #  2
0     Number of iterations =   5
0 Final flows and corresponding HGLs at source nodes
0 Node      Flow        Pump HGL      Total HGL
   20    -5004.000        .00          440.00
1
```

Pipe Dia INCHES	Up Node	Down Node	Pipe No.	Flow US GPM	Head Loss FEET	Velocity FT/SEC	Upstream HGL FEET	Do
20.00	20	21	20	5004.000	100.00	5.11	440.00	
20.00	21	22	21	4443.000	5.63	4.54	340.00	
16.00	22	23	22	2386.645	7.29	3.81	334.37	
12.00	23	24	23	741.356	3.39	2.10	327.08	
12.00	24	25	24	234.356	.54	.66	323.69	
12.00	25	26	25	-244.355	-.31	-.69	323.14	
12.00	26	27	26	-859.355	-5.77	-2.44	323.45	
12.00	27	28	27	405.000	1.63	1.15	329.22	
16.00	22	27	28	1834.355	5.15	2.93	334.37	
12.00	22	29	29	147.000	.12	.42	334.37	
12.00	29	30	30	147.000	.14	.42	334.25	
12.00	23	31	31	261.000	.14	.74	327.08	
12.00	31	32	32	261.000	.53	.74	326.93	
12.00	23	33	33	664.289	2.93	1.88	327.08	
12.00	33	34	34	414.000	1.22	1.17	324.15	
12.00	33	35	35	250.289	1.05	.71	324.15	
12.00	35	25	36	-70.711	-.05	-.20	323.09	

1

Node	Elevation FEET	Demand US GPM	HGL FEET	Pressure PSI
20	440.00	-5004.00	440.00	.00
21	190.00	561.00	340.00	64.94
22	157.50	75.00	334.37	76.57
23	131.00	720.00	327.08	84.88
24	131.00	507.00	323.69	83.41
25	105.00	408.00	323.14	94.43
26	125.00	615.00	323.45	85.91
27	141.00	570.00	329.22	81.48
28	229.00	405.00	327.59	42.68
29	164.00	.00	334.25	73.70
30	190.00	147.00	334.10	62.38
31	135.00	.00	326.93	83.09
32	164.00	261.00	326.40	70.30
33	112.00	.00	324.15	91.84
34	112.00	414.00	322.93	91.31
35	95.00	321.00	323.09	98.74

0

Maximum unbalanced head in any loop .0000 In loop # 2

1

EAST KAPOLEI POTABLE WATER SYSTEM (PEAK DEMAND CONDITIONS-440'ZONE)

Data file name : ekwmp440.DAT

Hazen-Williams formula used

Iteration stops when max relative flow change is .00100 in any pipe

Multiplicative factor of each consumption is 3.00000

0	Length	Diameter	Flow	Headloss	Height	Pressure	Velo
Units:	FEET	INCHES	US GPM	FEET	FEET	PSI	FT/

There are 17 pipes and 16 nodes

1 List of pipe information including resistance factor K

Pipe no	Nodes		Length FEET	Diameter INCHES	Roughness coeff	K
20	20	21	3650.00	20.00	120.00	.24942E
21	21	22	1450.00	20.00	120.00	.99085E
22	22	23	2000.00	16.00	120.00	.40518E
23	23	24	1700.00	12.00	110.00	.16426E
24	24	25	2300.00	12.00	110.00	.22223E
25	25	26	1200.00	12.00	110.00	.11595E
26	26	27	2200.00	12.00	110.00	.21257E
27	27	28	2500.00	12.00	110.00	.24155E
28	22	27	2300.00	16.00	120.00	.46595E
29	22	29	1200.00	12.00	110.00	.11595E
30	29	30	1450.00	12.00	110.00	.14010E
31	23	31	500.00	12.00	110.00	.48311E
32	31	32	1850.00	12.00	110.00	.17875E
33	23	33	1800.00	12.00	110.00	.17392E
34	33	34	1800.00	12.00	110.00	.17392E
35	33	35	3950.00	12.00	110.00	.38165E
36	35	25	1950.00	12.00	110.00	.18841E

1Node	Demand US GPM	Elevation FEET
20	.00000	440.00000
21	149.00000	190.00000
22	12.00000	157.50000
23	237.00000	131.00000
24	169.00000	131.00000
25	136.00000	105.00000
26	196.00000	125.00000
27	186.00000	141.00000
28	135.00000	229.00000
29	.00000	164.00000
30	52.00000	190.00000
31	.00000	135.00000
32	76.00000	164.00000
33	.00000	112.00000
34	137.00000	112.00000
35	107.00000	95.00000

1For checking purposes, note that the last node # is 35

0The total demand (to be met by water sources) is 4776.00
-
0Pump data for 1 pumps at source nodes
The number of data points for the pump curve is 3

0Node No.	No. Parl	P	Elev of Pump	Pump Flows and Related Heads		
				0.	4000.	9000.
20	1		440.	0.	0.	0.

0 PRV #	in Pipe #	Ref source #	Working HGL	Hd-loss	ChkV action?
1	20	20	340.00	.000	YES

Net unbalanced flow in subnet 1 is .00000
The number of pseudo loops is 0

0 Loop #	Pipes in loop					
1	-24	-25	-26	28	-22	-23
2	-35	-36	24	23	-33	

0 Bandwidth of matrix = 2

0 Number of loops = 2

0 Initial flows and corresponding HGLs at source nodes

0 Node	Flow	Pump HGL	Total HGL
20	-4776.000	.00	440.00

Iteration # 1 Max change in flow is 441.639 in loop # 1

Iteration # 2 Max change in flow is 34.588 in loop # 1

Iteration # 3 Max change in flow is .524 in loop # 2
0PRVs and/or Check valves become testable after 3 iterations

PRV in pipe 20 turned on at iteration # 3

Iteration # 4 Max change in flow is .000 in loop # 1

Iteration # 5 Max change in flow is .000 in loop # 1
0 Number of iterations = 5
0 Final flows and corresponding HGLs at source nodes

0 Node	Flow	Pump HGL	Total HGL
20	-4776.000	.00	440.00

1

Pipe Dia INCHES	Up Node	Down Node	Pipe No.	Flow US GPM	Head Loss FEET	Velocity FT/SEC	Upstream HGL FEET	Do
20.00	20	21	20	4776.000	100.00	4.88	440.00	
20.00	21	22	21	4329.000	5.37	4.42	340.00	
16.00	22	23	22	2333.359	6.99	3.72	334.63	
12.00	23	24	23	735.769	3.34	2.09	327.64	
12.00	24	25	24	228.768	.52	.65	324.30	
12.00	25	26	25	-252.642	-.33	-.72	323.78	
12.00	26	27	26	-840.642	-5.54	-2.39	324.10	
12.00	27	28	27	405.000	1.63	1.15	329.64	
16.00	22	27	28	1803.642	4.99	2.88	334.63	
12.00	22	29	29	156.000	.13	.44	334.63	
12.00	29	30	30	156.000	.16	.44	334.50	
12.00	23	31	31	228.000	.11	.65	327.64	
12.00	31	32	32	228.000	.42	.65	327.53	
12.00	23	33	33	658.590	2.88	1.87	327.64	
12.00	33	34	34	411.000	1.20	1.17	324.76	
12.00	33	35	35	247.590	1.03	.70	324.76	
12.00	35	25	36	-73.410	-.05	-.21	323.72	

1

Node	Elevation FEET	Demand US GPM	HGL FEET	Pressure PSI
20	440.00	-4776.00	440.00	.00
21	190.00	447.00	340.00	64.94
22	157.50	36.00	334.63	76.68
23	131.00	711.00	327.64	85.13
24	131.00	507.00	324.30	83.68
25	105.00	408.00	323.78	94.71
26	125.00	588.00	324.10	86.19
27	141.00	558.00	329.64	81.66
28	229.00	405.00	328.01	42.86
29	164.00	.00	334.50	73.81
30	190.00	156.00	334.34	62.48
31	135.00	.00	327.53	83.35
32	164.00	228.00	327.11	70.61
33	112.00	.00	324.76	92.10
34	112.00	411.00	323.55	91.58
35	95.00	321.00	323.72	99.01

0

Maximum unbalanced head in any loop .0000 In loop # 1
1

EAST KAPOLEI POTABLE WATER SYSTEM - 440' ZONE (MAX + FIRE AT NODE 21)

Data file name : ek440f21.DAT

Hazen-Williams formula used

Iteration stops when max relative flow change is .00100 in any pipe

Multiplicative factor of each consumption is 1.50000

0 Units:	Length	Diameter	Flow	Headloss	Height	Pressure	Velo
	FEET	INCHES	US GPM	FEET	FEET	PSI	FT/

There are 17 pipes and 16 nodes

1 List of pipe information including resistance factor K

Pipe no	Nodes		Length FEET	Diameter INCHES	Roughness coeff	K
20	20	21	3650.00	20.00	120.00	.24942E
21	21	22	1450.00	20.00	120.00	.99085E
22	22	23	2000.00	16.00	120.00	.40518E
23	23	24	1700.00	12.00	110.00	.16426E
24	24	25	2300.00	12.00	110.00	.22223E
25	25	26	1200.00	12.00	110.00	.11595E
26	26	27	2200.00	12.00	110.00	.21257E
27	27	28	2500.00	12.00	110.00	.24155E
28	22	27	2300.00	16.00	120.00	.46595E
29	22	29	1200.00	12.00	110.00	.11595E
30	29	30	1450.00	12.00	110.00	.14010E
31	23	31	500.00	12.00	110.00	.48311E
32	31	32	1850.00	12.00	110.00	.17875E
33	23	33	1800.00	12.00	110.00	.17392E
34	33	34	1800.00	12.00	110.00	.17392E
35	33	35	3950.00	12.00	110.00	.38165E
36	35	25	1950.00	12.00	110.00	.18841E

1Node	Demand US GPM	Elevation FEET
20	.00000	440.00000
21	2815.66000	190.00000
22	12.00000	157.50000
23	237.00000	131.00000
24	169.00000	131.00000
25	136.00000	105.00000
26	196.00000	125.00000
27	186.00000	141.00000
28	135.00000	229.00000
29	.00000	164.00000
30	52.00000	190.00000
31	.00000	135.00000
32	76.00000	164.00000
33	.00000	112.00000
34	137.00000	112.00000
35	107.00000	95.00000

1For checking purposes, note that the last node # is 35

```
0The total demand (to be met by water sources) is      6387.99
-
0Pump data for  1  pumps at source nodes
 The number of data points for the pump curve is    3
0Node  No. P  Elev of       Pump Flows and
  No.  Parl    Pump         Related Heads
                        0.   4000.  9000.
  20   1      440.      0.     0.     0.
0 PRV #  in Pipe #  Ref source #   Working HGL    Hd-loss  ChkV action?
    1       20          20           340.00        .000    YES

 Net unbalanced flow in subnet    1  is    .00000
 The number of pseudo loops is    0
0    Loop #          Pipes in loop
       1          -24  -25  -26   28  -22  -23
       2          -35  -36   24   23  -33
0     Bandwidth of matrix =   2

0     Number of loops =     2

0 Initial flows and corresponding HGLs at source nodes
0 Node         Flow        Pump HGL      Total HGL
   20    -6387.990           .00          440.00

 Iteration #   1  Max change in flow is        220.819 in loop #   1

 Iteration #   2  Max change in flow is        17.294 in loop #   1
0PRVs and/or Check valves become testable after    2 iterations

 PRV in pipe   20  turned on at iteration #   2

 Iteration #   3  Max change in flow is          .262 in loop #   2

 Iteration #   4  Max change in flow is          .000 in loop #   1
0       Number of iterations =    4
0 Final flows and corresponding HGLs at source nodes
0 Node         Flow        Pump HGL      Total HGL
   20    -6387.990           .00          440.00
1
```

Pipe Dia INCHES	Up Node	Down Node	Pipe No.	Flow US GPM	Head Loss FEET	Velocity FT/SEC	Upstream HGL FEET	Do
20.00	20	21	20	6387.990	100.00	6.52	440.00	
20.00	21	22	21	2164.500	1.49	2.21	340.00	
16.00	22	23	22	1166.679	1.94	1.86	338.51	
12.00	23	24	23	367.884	.93	1.04	336.58	
12.00	24	25	24	114.384	.14	.32	335.65	
12.00	25	26	25	-126.321	-.09	-.36	335.51	
12.00	26	27	26	-420.321	-1.53	-1.19	335.60	
12.00	27	28	27	202.500	.45	.57	337.13	
16.00	22	27	28	901.821	1.38	1.44	338.51	
12.00	22	29	29	78.000	.04	.22	338.51	
12.00	29	30	30	78.000	.04	.22	338.48	
12.00	23	31	31	114.000	.03	.32	336.58	
12.00	31	32	32	114.000	.12	.32	336.54	
12.00	23	33	33	329.295	.80	.93	336.58	
12.00	33	34	34	205.500	.33	.58	335.78	
12.00	33	35	35	123.795	.29	.35	335.78	
12.00	35	25	36	-36.705	-.01	-.10	335.49	

1

Node	Elevation FEET	Demand US GPM	HGL FEET	Pressure PSI
20	440.00	-6387.99	440.00	.00
21	190.00	4223.49	340.00	64.94
22	157.50	18.00	338.51	78.36
23	131.00	355.50	336.58	88.99
24	131.00	253.50	335.65	88.59
25	105.00	204.00	335.51	99.79
26	125.00	294.00	335.60	91.17
27	141.00	279.00	337.13	84.90
28	229.00	202.50	336.68	46.61
29	164.00	.00	338.48	75.53
30	190.00	78.00	338.43	64.26
31	135.00	.00	336.54	87.25
32	164.00	114.00	336.43	74.64
33	112.00	.00	335.78	96.87
34	112.00	205.50	335.44	96.73
35	95.00	160.50	335.49	104.11

0

Maximum unbalanced head in any loop .0000 In loop # 1

1

EAST KAPOLEI POTABLE WATER SYSTEM - 440' ZONE (MAX + FIRE AT NODE 22)

Data file name : ek440f22.DAT

Hazen-Williams formula used

Iteration stops when max relative flow change is .00100 in any pipe

Multiplicative factor of each consumption is 1.50000

0 Units: Length FEET Diameter INCHES Flow US GPM Headloss FEET Height FEET Pressure PSI Velo FT/

There are 17 pipes and 16 nodes

1 List of pipe information including resistance factor K

Pipe no	Nodes		Length FEET	Diameter INCHES	Roughness coeff	K
20	20	21	3650.00	20.00	120.00	.24942E
21	21	22	1450.00	20.00	120.00	.99085E
22	22	23	2000.00	16.00	120.00	.40518E
23	23	24	1700.00	12.00	110.00	.16426E
24	24	25	2300.00	12.00	110.00	.22223E
25	25	26	1200.00	12.00	110.00	.11595E
26	26	27	2200.00	12.00	110.00	.21257E
27	27	28	2500.00	12.00	110.00	.24155E
28	22	27	2300.00	16.00	120.00	.46595E
29	22	29	1200.00	12.00	110.00	.11595E
30	29	30	1450.00	12.00	110.00	.14010E
31	23	31	500.00	12.00	110.00	.48311E
32	31	32	1850.00	12.00	110.00	.17875E
33	23	33	1800.00	12.00	110.00	.17392E
34	33	34	1800.00	12.00	110.00	.17392E
35	33	35	3950.00	12.00	110.00	.38165E
36	35	25	1950.00	12.00	110.00	.18841E

1Node	Demand US GPM	Elevation FEET
20	.00000	440.00000
21	149.00000	190.00000
22	1345.33000	157.50000
23	237.00000	131.00000
24	169.00000	131.00000
25	136.00000	105.00000
26	196.00000	125.00000
27	186.00000	141.00000
28	135.00000	229.00000
29	.00000	164.00000
30	52.00000	190.00000
31	.00000	135.00000
32	76.00000	164.00000
33	.00000	112.00000
34	137.00000	112.00000
35	107.00000	95.00000

1For checking purposes, note that the last node # is 35

```
0The total demand (to be met by water sources) is      4388.00
-
0Pump data for  1  pumps at source nodes
 The number of data points for the pump curve is     3
0Node  No. P  Elev of       Pump Flows and
 No.  Parl    Pump          Related Heads
                        0.  4000.  9000.
  20   1      440.      0.     0.     0.
0 PRV #  in Pipe #  Ref source #   Working HGL     Hd-loss  ChkV action?
    1       20          20           340.00         .000    YES

 Net unbalanced flow in subnet     1  is     .00000
 The number of pseudo loops is     0
0    Loop #         Pipes in loop
       1          -24  -25  -26   28  -22  -23
       2          -35  -36   24   23  -33
0     Bandwidth of matrix =   2

0     Number of loops =      2

0 Initial flows and corresponding HGLs at source nodes
0 Node        Flow          Pump HGL      Total HGL
  20    -4387.995             .00          440.00

 Iteration #   1  Max change in flow is         220.819 in loop #   1

 Iteration #   2  Max change in flow is          17.294 in loop #   1
0PRVs and/or Check valves become testable after    2 iterations

 PRV in pipe   20  turned on at iteration #   2

 Iteration #   3  Max change in flow is            .262 in loop #   2

 Iteration #   4  Max change in flow is            .000 in loop #   1
0     Number of iterations =    4
0 Final flows and corresponding HGLs at source nodes
0 Node        Flow          Pump HGL      Total HGL
  20    -4387.995             .00          440.00
1
```

Pipe Dia INCHES	Up Node	Down Node	Pipe No.	Flow US GPM	Head Loss FEET	Velocity FT/SEC	Upstream HGL FEET	Do
20.00	20	21	20	4387.995	100.00	4.48	440.00	
20.00	21	22	21	4164.495	5.00	4.25	340.00	
16.00	22	23	22	1166.679	1.94	1.86	335.00	
12.00	23	24	23	367.884	.93	1.04	333.07	
12.00	24	25	24	114.384	.14	.32	332.14	
12.00	25	26	25	-126.321	-.09	-.36	332.00	
12.00	26	27	26	-420.321	-1.53	-1.19	332.09	
12.00	27	28	27	202.500	.45	.57	333.62	
16.00	22	27	28	901.821	1.38	1.44	335.00	
12.00	22	29	29	78.000	.04	.22	335.00	
12.00	29	30	30	78.000	.04	.22	334.97	
12.00	23	31	31	114.000	.03	.32	333.07	
12.00	31	32	32	114.000	.12	.32	333.04	
12.00	23	33	33	329.295	.80	.93	333.07	
12.00	33	34	34	205.500	.33	.58	332.27	
12.00	33	35	35	123.795	.29	.35	332.27	
12.00	35	25	36	-36.705	-.01	-.10	331.98	

1

Node	Elevation FEET	Demand US GPM	HGL FEET	Pressure PSI
20	440.00	-4388.00	440.00	.00
21	190.00	223.50	340.00	64.94
22	157.50	2017.99	335.00	76.84
23	131.00	355.50	333.07	87.47
24	131.00	253.50	332.14	87.07
25	105.00	204.00	332.00	98.27
26	125.00	294.00	332.09	89.65
27	141.00	279.00	333.62	83.39
28	229.00	202.50	333.17	45.10
29	164.00	.00	334.97	74.01
30	190.00	78.00	334.92	62.74
31	135.00	.00	333.04	85.73
32	164.00	114.00	332.92	73.13
33	112.00	.00	332.27	95.35
34	112.00	205.50	331.93	95.21
35	95.00	160.50	331.98	102.59

0

Maximum unbalanced head in any loop   .0000 In loop #   1
1

EAST KAPOLEI POTABLE WATER SYSTEM - 440' ZONE (MAX + FIRE AT NODE 24)

Data file name : ek440f24.DAT

Hazen-Williams formula used

Iteration stops when max relative flow change is .00100 in any pipe

Multiplicative factor of each consumption is 1.50000

```
0
 Units:   Length  Diameter   Flow    Headloss  Height  Pressure  Velo
          FEET     INCHES   US GPM    FEET      FEET     PSI      FT/
```

There are 17 pipes and 16 nodes
1 List of pipe information including resistance factor K

Pipe no	Nodes		Length FEET	Diameter INCHES	Roughness coeff	K
20	20	21	3650.00	20.00	120.00	.24942E
21	21	22	1450.00	20.00	120.00	.99085E
22	22	23	2000.00	16.00	120.00	.40518E
23	23	24	1700.00	12.00	110.00	.16426E
24	24	25	2300.00	12.00	110.00	.22223E
25	25	26	1200.00	12.00	110.00	.11595E
26	26	27	2200.00	12.00	110.00	.21257E
27	27	28	2500.00	12.00	110.00	.24155E
28	22	27	2300.00	16.00	120.00	.46595E
29	22	29	1200.00	12.00	110.00	.11595E
30	29	30	1450.00	12.00	110.00	.14010E
31	23	31	500.00	12.00	110.00	.48311E
32	31	32	1850.00	12.00	110.00	.17875E
33	23	33	1800.00	12.00	110.00	.17392E
34	33	34	1800.00	12.00	110.00	.17392E
35	33	35	3950.00	12.00	110.00	.38165E
36	35	25	1950.00	12.00	110.00	.18841E

1Node	Demand US GPM	Elevation FEET
20	.00000	440.00000
21	149.00000	190.00000
22	12.00000	157.50000
23	237.00000	131.00000
24	1502.33000	131.00000
25	136.00000	105.00000
26	196.00000	125.00000
27	186.00000	141.00000
28	135.00000	229.00000
29	.00000	164.00000
30	52.00000	190.00000
31	.00000	135.00000
32	76.00000	164.00000
33	.00000	112.00000
34	137.00000	112.00000
35	107.00000	95.00000

1For checking purposes, note that the last node # is 35

```
0The total demand (to be met by water sources) is     4388.00
-
0Pump data for  1  pumps at source nodes
 The number of data points for the pump curve is     3
0Node  No. P  Elev of        Pump Flows and
 No.   Parl    Pump          Related Heads
                          0.   4000.   9000.
  20    1      440.       0.      0.      0.
0 PRV #  in Pipe #  Ref source #   Working HGL    Hd-loss   ChkV action?
    1       20          20           340.00        .000      YES

 Net unbalanced flow in subnet    1  is    .00000
 The number of pseudo loops is    0
0     Loop #          Pipes in loop
        1          -24  -25  -26   28  -22  -23
        2          -35  -36   24   23  -33
0       Bandwidth of matrix =    2

0       Number of loops =     2

0 Initial flows and corresponding HGLs at source nodes
0 Node      Flow         Pump HGL      Total HGL
   20    -4387.995          .00         440.00

 Iteration #    1  Max change in flow is         681.058 in loop #   2

 Iteration #    2  Max change in flow is         222.504 in loop #   2.

 Iteration #    3  Max change in flow is          29.016 in loop #   2

 Iteration #    4  Max change in flow is            .507 in loop #   2
0PRVs and/or Check valves become testable after    4 iterations

 PRV in pipe    20  turned on at iteration #    4

 Iteration #    5  Max change in flow is            .000 in loop #   2

 Iteration #    6  Max change in flow is            .000 in loop #   2
0      Number of iterations =    6
0 Final flows and corresponding HGLs at source nodes
0 Node      Flow          Pump HGL      Total HGL
   20    -4387.995          .00         440.00
1
```

Pipe Dia INCHES	Up Node	Down Node	Pipe No.	Flow US GPM	Head Loss FEET	Velocity FT/SEC	Upstream HGL FEET	Do
20.00	20	21	20	4387.995	100.00	4.48	440.00	
20.00	21	22	21	4164.495	5.00	4.25	340.00	
16.00	22	23	22	2544.035	8.20	4.06	335.00	
12.00	23	24	23	1440.004	11.59	4.09	326.80	
12.00	24	25	24	-813.491	-5.45	-2.31	315.21	
12.00	25	26	25	-748.960	-2.44	-2.12	320.65	
12.00	26	27	26	-1042.960	-8.26	-2.96	323.09	
12.00	27	28	27	202.500	.45	.57	331.35	
16.00	22	27	28	1524.460	3.65	2.43	335.00	
12.00	22	29	29	78.000	.04	.22	335.00	
12.00	29	30	30	78.000	.04	.22	334.97	
12.00	23	31	31	114.000	.03	.32	326.80	
12.00	31	32	32	114.000	.12	.32	326.77	

12.00	23	33	33	634.531	2.69	1.80	326.80
12.00	33	34	34	205.500	.33	.58	324.11
12.00	33	35	35	429.031	2.86	1.22	324.11
12.00	35	25	36	268.531	.59	.76	321.25

1

Node	Elevation FEET	Demand US GPM	HGL FEET	Pressure PSI
20	440.00	-4388.00	440.00	.00
21	190.00	223.50	340.00	64.94
22	157.50	18.00	335.00	76.84
23	131.00	355.50	326.80	84.76
24	131.00	2253.49	315.21	79.74
25	105.00	204.00	320.65	93.36
26	125.00	294.00	323.09	85.75
27	141.00	279.00	331.35	82.40
28	229.00	202.50	330.90	44.11
29	164.00	.00	334.97	74.01
30	190.00	78.00	334.92	62.74
31	135.00	.00	326.77	83.02
32	164.00	114.00	326.65	70.41
33	112.00	.00	324.11	91.82
34	112.00	205.50	323.77	91.68
35	95.00	160.50	321.25	97.94

0

Maximum unbalanced head in any loop .0000 In loop # 2

1

EAST KAPOLEI POTABLE WATER SYSTEM - 440' ZONE (MAX + FIRE AT NODE 28)

Data file name : ek440f28.DAT

Hazen-Williams formula used

Iteration stops when max relative flow change is .00100 in any pipe

Multiplicative factor of each consumption is 1.50000

0 Units:	Length FEET	Diameter INCHES	Flow US GPM	Headloss FEET	Height FEET	Pressure PSI	Velo FT/

There are 17 pipes and 16 nodes

1 List of pipe information including resistance factor K

Pipe no	Nodes		Length FEET	Diameter INCHES	Roughness coeff	K
20	20	21	3650.00	20.00	120.00	.24942E
21	21	22	1450.00	20.00	120.00	.99085E
22	22	23	2000.00	16.00	120.00	.40518E
23	23	24	1700.00	12.00	110.00	.16426E
24	24	25	2300.00	12.00	110.00	.22223E
25	25	26	1200.00	12.00	110.00	.11595E
26	26	27	2200.00	12.00	110.00	.21257E
27	27	28	2500.00	12.00	110.00	.24155E
28	22	27	2300.00	16.00	120.00	.46595E
29	22	29	1200.00	12.00	110.00	.11595E
30	29	30	1450.00	12.00	110.00	.14010E
31	23	31	500.00	12.00	110.00	.48311E
32	31	32	1850.00	12.00	110.00	.17875E
33	23	33	1800.00	12.00	110.00	.17392E
34	33	34	1800.00	12.00	110.00	.17392E
35	33	35	3950.00	12.00	110.00	.38165E
36	35	25	1950.00	12.00	110.00	.18841E

1Node	Demand US GPM	Elevation FEET
20	.00000	440.00000
21	149.00000	190.00000
22	12.00000	157.50000
23	237.00000	131.00000
24	169.00000	131.00000
25	136.00000	105.00000
26	196.00000	125.00000
27	186.00000	141.00000
28	801.66000	229.00000
29	.00000	164.00000
30	52.00000	190.00000
31	.00000	135.00000
32	76.00000	164.00000
33	.00000	112.00000
34	137.00000	112.00000
35	107.00000	95.00000

1For checking purposes, note that the last node # is 35

0The total demand (to be met by water sources) is 3387.99

0Pump data for 1 pumps at source nodes

```
 The number of data points for the pump curve is     3
0Node  No. P  Elev of       Pump Flows and
 No.   Parl    Pump         Related Heads
                          0.  4000.  9000.
  20   1      440.        0.     0.     0.
0 PRV #   in Pipe #  Ref source #   Working HGL     Hd-loss   ChkV action?
     1       20           20           340.00         .000     YES

 Net unbalanced flow in subnet     1  is      .00000
 The number of pseudo loops is     0
0     Loop #          Pipes in loop
        1           -24  -25  -26   28  -22  -23
        2           -35  -36   24   23  -33
0      Bandwidth of matrix =   2.

0      Number of loops =      2

0 Initial flows and corresponding HGLs at source nodes
0 Node        Flow          Pump HGL       Total HGL
   20    -3387.990             .00          440.00

 Iteration #    1  Max change in flow is          396.477  in loop #    1

 Iteration #    2  Max change in flow is           57.198  in loop #    1

 Iteration #    3  Max change in flow is             .816  in loop #    2
0PRVs and/or Check valves become testable after     3 iterations

 PRV in pipe    20  turned on at iteration #    3

 Iteration #    4  Max change in flow is             .001  in loop #    2

 Iteration #    5  Max change in flow is             .000  in loop #    2
0      Number of iterations =     5
0 Final flows and corresponding HGLs at source nodes
0 Node        Flow          Pump HGL       Total HGL
   20    -3387.990             .00          440.00
1
```

Pipe Dia INCHES	Up Node	Down Node	Pipe No.	Flow US GPM	Head Loss FEET	Velocity FT/SEC	Upstream HGL FEET	Do
20.00	20	21	20	3387.990	100.00	3.46	440.00	
20.00	21	22	21	3164.490	3.01	3.23	340.00	
16.00	22	23	22	1381.730	2.65	2.21	336.99	
12.00	23	24	23	489.103	1.57	1.39	334.35	
12.00	24	25	24	235.603	.55	.67	332.78	
12.00	25	26	25	88.730	.05	.25	332.23	
12.00	26	27	26	-205.270	-.41	-.58	332.18	
12.00	27	28	27	1202.490	12.21	3.41	332.59	
16.00	22	27	28	1686.760	4.41	2.69	336.99	
12.00	22	29	29	78.000	.04	.22	336.99	
12.00	29	30	30	78.000	.04	.22	336.96	
12.00	23	31	31	114.000	.03	.32	334.35	
12.00	31	32	32	114.000	.12	.32	334.31	
12.00	23	33	33	423.127	1.27	1.20	334.35	
12.00	33	34	34	205.500	.33	.58	333.08	
12.00	33	35	35	217.627	.81	.62	333.08	
12.00	35	25	36	57.127	.03	.16	332.26	

1

Node	Elevation FEET	Demand US GPM	HGL FEET	Pressure PSI
20	440.00	-3387.99	440.00	.00
21	190.00	223.50	340.00	64.94
22	157.50	18.00	336.99	77.70
23	131.00	355.50	334.35	88.03
24	131.00	253.50	332.78	87.35
25	105.00	204.00	332.23	98.37
26	125.00	294.00	332.18	89.69
27	141.00	279.00	332.59	82.94
28	229.00	1202.49	320.38	39.56
29	164.00	.00	336.96	74.87
30	190.00	78.00	336.91	63.60
31	135.00	.00	334.31	86.28
32	164.00	114.00	334.20	73.68
33	112.00	.00	333.08	95.70
34	112.00	205.50	332.74	95.56
35	95.00	160.50	332.26	102.71

0

Maximum unbalanced head in any loop   .0000 In loop #   2
1

EAST KAPOLEI POTABLE WATER SYSTEM - 440' ZONE (MAX + FIRE AT NODE 30)

Data file name : ek440f30.DAT

Hazen-Williams formula used

Iteration stops when max relative flow change is .00100 in any pipe

Multiplicative factor of each consumption is 1.50000

0 Units:	Length FEET	Diameter INCHES	Flow US GPM	Headloss FEET	Height FEET	Pressure PSI	Velo FT/

There are 17 pipes and 16 nodes
1 List of pipe information including resistance factor K

Pipe no	Nodes		Length FEET	Diameter INCHES	Roughness coeff	K
20	20	21	3650.00	20.00	120.00	.24942E
21	21	22	1450.00	20.00	120.00	.99085E
22	22	23	2000.00	16.00	120.00	.40518E
23	23	24	1700.00	12.00	110.00	.16426E
24	24	25	2300.00	12.00	110.00	.22223E
25	25	26	1200.00	12.00	110.00	.11595E
26	26	27	2200.00	12.00	110.00	.21257E
27	27	28	2500.00	12.00	110.00	.24155E
28	22	27	2300.00	16.00	120.00	.46595E
29	22	29	1200.00	12.00	110.00	.11595E
30	29	30	1450.00	12.00	110.00	.14010E
31	23	31	500.00	12.00	110.00	.48311E
32	31	32	1850.00	12.00	110.00	.17875E
33	23	33	1800.00	12.00	110.00	.17392E
34	33	34	1800.00	12.00	110.00	.17392E
35	33	35	3950.00	12.00	110.00	.38165E
36	35	25	1950.00	12.00	110.00	.18841E

1Node	Demand US GPM	Elevation FEET
20	.00000	440.00000
21	149.00000	190.00000
22	12.00000	157.50000
23	237.00000	131.00000
24	169.00000	131.00000
25	136.00000	105.00000
26	196.00000	125.00000
27	186.00000	141.00000
28	135.00000	229.00000
29	.00000	164.00000
30	1052.00000	190.00000
31	.00000	135.00000
32	76.00000	164.00000
33	.00000	112.00000
34	137.00000	112.00000
35	107.00000	95.00000

1For checking purposes, note that the last node # is 35
0The total demand (to be met by water sources) is 3888.00
-
0Pump data for 1 pumps at source nodes

The number of data points for the pump curve is 3

0Node No.	No. P Parl	Elev of Pump	Pump Flows and Related Heads		
			0.	4000.	9000.
20	1	440.	0.	0.	0.

0 PRV #	in Pipe #	Ref source #	Working HGL	Hd-loss	ChkV action?
1	20	20	340.00	.000	YES

Net unbalanced flow in subnet 1 is .00000
The number of pseudo loops is 0
0 Loop # Pipes in loop
1 -24 -25 -26 28 -22 -23
2 -35 -36 24 23 -33
0 Bandwidth of matrix = 2

0 Number of loops = 2

0 Initial flows and corresponding HGLs at source nodes

0 Node	Flow	Pump HGL	Total HGL
20	-3888.000	.00	440.00

Iteration # 1 Max change in flow is 220.819 in loop # 1

Iteration # 2 Max change in flow is 17.294 in loop # 1
0PRVs and/or Check valves become testable after 2 iterations

PRV in pipe 20 turned on at iteration # 2

Iteration # 3 Max change in flow is .262 in loop # 2

Iteration # 4 Max change in flow is .000 in loop # 1
0 Number of iterations = 4
0 Final flows and corresponding HGLs at source nodes

0 Node	Flow	Pump HGL	Total HGL
20	-3888.000	.00	440.00

1

Pipe Dia INCHES	Up Node	Down Node	Pipe No.	Flow US GPM	Head Loss FEET	Velocity FT/SEC	Upstream HGL FEET	Do
20.00	20	21	20	3888.000	100.00	3.97	440.00	
20.00	21	22	21	3664.500	3.94	3.74	340.00	
16.00	22	23	22	1166.679	1.94	1.86	336.06	
12.00	23	24	23	367.884	.93	1.04	334.12	
12.00	24	25	24	114.384	.14	.32	333.19	
12.00	25	26	25	-126.321	-.09	-.36	333.05	
12.00	26	27	26	-420.321	-1.53	-1.19	333.14	
12.00	27	28	27	202.500	.45	.57	334.67	
16.00	22	27	28	901.821	1.38	1.44	336.06	
12.00	22	29	29	1578.000	9.69	4.48	336.06	
12.00	29	30	30	1578.000	11.71	4.48	326.36	
12.00	23	31	31	114.000	.03	.32	334.12	
12.00	31	32	32	114.000	.12	.32	334.09	
12.00	23	33	33	329.295	.80	.93	334.12	
12.00	33	34	34	205.500	.33	.58	333.32	
12.00	33	35	35	123.795	.29	.35	333.32	
12.00	35	25	36	-36.705	-.01	-.10	333.04	

1

Node	Elevation FEET	Demand US GPM	HGL FEET	Pressure PSI

20	440.00	-3888.00	440.00	.00
21	190.00	223.50	340.00	64.94
22	157.50	18.00	336.06	77.30
23	131.00	355.50	334.12	87.93
24	131.00	253.50	333.19	87.53
25	105.00	204.00	333.05	98.72
26	125.00	294.00	333.14	90.10
27	141.00	279.00	334.67	83.84
28	229.00	202.50	334.22	45.55
29	164.00	.00	326.36	70.29
30	190.00	1578.00	314.65	53.96
31	135.00	.00	334.09	86.19
32	164.00	114.00	333.97	73.58
33	112.00	.00	333.32	95.81
34	112.00	205.50	332.99	95.67
35	95.00	160.50	333.04	103.05

0

Maximum unbalanced head in any loop .0000 In loop # 1
1

EAST KAPOLEI POTABLE WATER SYSTEM - 440' ZONE (MAX + FIRE AT NODE 35)

Data file name : ek440f35.DAT

Hazen-Williams formula used

Iteration stops when max relative flow change is .00100 in any pipe

Multiplicative factor of each consumption is 1.50000

0 Units:	Length	Diameter	Flow	Headloss	Height	Pressure	Velo
	FEET	INCHES	US GPM	FEET	FEET	PSI	FT/

There are 17 pipes and 16 nodes
1 List of pipe information including resistance factor K

Pipe no	Nodes		Length FEET	Diameter INCHES	Roughness coeff	K
20	20	21	3650.00	20.00	120.00	.24942E
21	21	22	1450.00	20.00	120.00	.99085E
22	22	23	2000.00	16.00	120.00	.40518E
23	23	24	1700.00	12.00	110.00	.16426E
24	24	25	2300.00	12.00	110.00	.22223E
25	25	26	1200.00	12.00	110.00	.11595E
26	26	27	2200.00	12.00	110.00	.21257E
27	27	28	2500.00	12.00	110.00	.24155E
28	22	27	2300.00	16.00	120.00	.46595E
29	22	29	1200.00	12.00	110.00	.11595E
30	29	30	1450.00	12.00	110.00	.14010E
31	23	31	500.00	12.00	110.00	.48311E
32	31	32	1850.00	12.00	110.00	.17875E
33	23	33	1800.00	12.00	110.00	.17392E
34	33	34	1800.00	12.00	110.00	.17392E
35	33	35	3950.00	12.00	110.00	.38165E
36	35	25	1950.00	12.00	110.00	.18841E

1Node	Demand US GPM	Elevation FEET
20	.00000	440.00000
21	149.00000	190.00000
22	12.00000	157.50000
23	237.00000	131.00000
24	169.00000	131.00000
25	136.00000	105.00000
26	196.00000	125.00000
27	186.00000	141.00000
28	135.00000	229.00000
29	.00000	164.00000
30	52.00000	190.00000
31	.00000	135.00000
32	76.00000	164.00000
33	.00000	112.00000
34	137.00000	112.00000
35	1440.33000	95.00000

1For checking purposes, note that the last node # is 35
0The total demand (to be met by water sources) is 4388.00
-
0Pump data for 1 pumps at source nodes

```
 The number of data points for the pump curve is     3
0Node  No. P  Elev of      Pump Flows and
  No.  Parl    Pump        Related Heads
                        0.  4000.  9000.
  20    1      440.     0.     0.     0.
0 PRV #  in Pipe #  Ref source #   Working HGL    Hd-loss  ChkV action?
    1       20         20            340.00        .000     YES

 Net unbalanced flow in subnet     1  is    .00000
 The number of pseudo loops is     0
0     Loop #        Pipes in loop
        1         -24  -25  -26   28  -22  -23
        2         -35  -36   24   23  -33
0      Bandwidth of matrix =   2

0      Number of loops =      2

0 Initial flows and corresponding HGLs at source nodes
0 Node        Flow          Pump HGL       Total HGL
   20     -4387.995           .00           440.00

 Iteration #   1  Max change in flow is        1323.893 in loop #   1

 Iteration #   2  Max change in flow is         247.378 in loop #   1

 Iteration #   3  Max change in flow is          26.138 in loop #   1

 Iteration #   4  Max change in flow is            .257 in loop #   1
0PRVs and/or Check valves become testable after   4 iterations

 PRV in pipe   20  turned on at iteration #   4

 Iteration #   5  Max change in flow is            .000 in loop #   1

 Iteration #   6  Max change in flow is            .000 in loop #   2
0     Number of iterations =    6
0 Final flows and corresponding HGLs at source nodes
0 Node        Flow          Pump HGL       Total HGL
   20     -4387.995           .00           440.00
1
```

Pipe Dia INCHES	Up Node	Down Node	Pipe No.	Flow US GPM	Head Loss FEET	Velocity FT/SEC	Upstream HGL FEET	Do
20.00	20	21	20	4387.995	100.00	4.48	440.00	
20.00	21	22	21	4164.495	5.00	4.25	340.00	
16.00	22	23	22	2473.375	7.79	3.95	335.00	
12.00	23	24	23	898.801	4.84	2.55	327.22	
12.00	24	25	24	645.301	3.55	1.83	322.37	
12.00	25	26	25	-819.620	-2.88	-2.33	318.83	
12.00	26	27	26	-1113.620	-9.32	-3.16	321.71	
12.00	27	28	27	202.500	.45	.57	331.03	
16.00	22	27	28	1595.120	3.97	2.55	335.00	
12.00	22	29	29	78.000	.04	.22	335.00	
12.00	29	30	30	78.000	.04	.22	334.97	
12.00	23	31	31	114.000	.03	.32	327.22	
12.00	31	32	32	114.000	.12	.32	327.19	
12.00	23	33	33	1105.074	7.52	3.14	327.22	
12.00	33	34	34	205.500	.33	.58	319.70	
12.00	33	35	35	899.574	11.27	2.55	319.70	

```
     12.00   35     25 |  36 |   -1260.920  -10.40  -3.58      308.43
1
```

Node	Elevation FEET	Demand US GPM	HGL FEET	Pressure PSI
20	440.00	-4388.00	440.00	.00
21	190.00	223.50	340.00	64.94
22	157.50	18.00	335.00	76.84
23	131.00	355.50	327.22	84.94
24	131.00	253.50	322.37	82.85
25	105.00	204.00	318.83	92.57
26	125.00	294.00	321.71	85.15
27	141.00	279.00	331.03	82.26
28	229.00	202.50	330.58	43.97
29	164.00	.00	334.97	74.01
30	190.00	78.00	334.92	62.74
31	135.00	.00	327.19	83.20
32	164.00	114.00	327.07	70.59
33	112.00	.00	319.70	89.91
34	112.00	205.50	319.36	89.77
35	95.00	2160.49	308.43	92.39

```
0

 Maximum unbalanced head in any loop      .0000 In loop #   2
1
```

Electrical Demands and Refuse Calculations

4. ELECTRICAL DEMANDS AND REFUSE CALCULATIONS

Node	Description	Parcel	Area (Ac)	Dens./ FAR	Units/SF	kwh/mo or SF	kva	Pop./Unit or SF	# refuse
	228 FOOT SERVICE ZONE								
2	Single Family	B	18.0	8.0	144	2	288	4	2,880
3	Multi-family	B	31.0	14.0	434	2	868	4	8,680
3	Commercial	B	2.0	2.0	174,240	0.01	1,742	0.10	87,120
3	Multi-family	A	31.0	14.0	434	2	868	4	8,680
3	Elementary School	A	12.0	0.3	130,680	0.01	1,307	0.0092	6,000
3	Commercial	A	2.0	2.0	174,240	0.01	1,742	0.10	87,120
3	Single Family	"200"	136.5	8.0	1,092	2	2,184	4	21,840
3	Multi-family	"200"	31.0	14.0	434	2	868	4	8,680
3	Park	"200"	8.0						
3	Single Family	G	51.5	8.0	412	2	824	4	8,240
3	Multi-family	G	31.0	14.0	434	2	868	4	8,680
3	Elementary School	G	12.0	0.3	130,680	0.01	1,307	0.0092	6,000
3	Single Family	H	70.0	8.0	560	2	1,120	4	11,200
3	Intermediate School	H	20.0	0.3	217,800	0.01	2,178	0.0064	7,000
4	Single Family	"73"	71.0	8.0	568	2	1,136	4	11,360
4	Park	"73"	3.0						
5	Multi-family	I-1	14.5	14.0	203	2	406	4	4,060
6	Commercial	I-2	11.0	2.0	958,320	0.01	9583.2	0.1	479,160
6	Park & Ride	I-3	22.0	14.0					
6	Baseball	I-4	35.0	0.1	152,460	0.01	1524.6	0.1	76,230
8	Single Family	A	132.5	8.0	1,060	2	2,120	4	21,200
8	Park	A	3.0						
8	Single Family	A	31.0	8.0	248	2	496	4	4,960
	Subtotal		779				31430.2 kva		869090

Node	Description	Parcel	Area (Ac)	Dens./ FAR	Units/SF	kva/Unit or SF	kva	Pop./Unit or SF	# Refuse
	440 FOOT SERVICE ZONE								
21	University	UH	991.0	0.02	863,359	0.01	8633.592	0.003185233	13,750
22	Multi-family	E	30.0	14.0	420	2	840	4	8,400
22	Commercial	E	6.0	2.0	522,720	0.01	5,227	0.10	261,360
22	Multi-family	C	13.0	14.0	182	2	364	4	3,640
22	Commercial	C	6.0	2.0	522,720	0.01	5,227	0.10	261,360
23	Single Family	C	18.5	8.0	148	2	296	4	2,960
23	Multi-family	C	13.0	14.0	182	2	364	4	3,640
23	Single Family	B	57.0	8.0	456	2	912	4	9,120
24	Single Family	B	37.0	8.0	296	2	592	4	5,920
25	Single Family	C	33.0	8.0	264	2	528	4	5,280
26	Single Family	D	66.5	8.0	532	2	1,064	4	10,640
26	Park	D	3.0						
26	Single Family	C	18.5	8.0	148	2	296	4	2,960
26	Park	C	3.0						
26	Elementary School	C	12.0	0.3	130,680	0.01	1,307	0.0092	6,000
27	Multi-family	F	26.0	14.0	364	2	728	4	7,280
	Subtotal		342.5				26378.792 kva		602310
	Total		1121.5				57808.992 kva		1471400 735.7

C. Agricultural Impact Assessment

East Kapolei Master Plan Development Project: Impact on Agriculture

Decision Analysts Hawaii, Inc.

East Kapolei Master Plan Development Project: Impact on Agriculture

PREPARED FOR:

Housing Finance & Development Corporation
State of Hawaii

PREPARED BY:

Decision Analysts Hawaii, Inc.

December 1996

CONTENTS

TABLES

FIGURE

Executive Summary

The East Kapolei Master Plan Development Project (the "Project") is a proposed 1,300-acre residential community that will be developed in the central portion of the Ewa Plain by the State Housing Finance and Development Corporation. Summarized below are the impacts on agriculture that will result from developing the Project.

Agricultural Conditions

Nearly all of the 1,300 acres is good for cultivating crops inasmuch as the agricultural conditions are favorable, and the location is a short trucking distance to Honolulu markets and, for exports, Honolulu Harbor and Honolulu International Airport.

Impact on Existing and Nearby Agricultural Operations

Until the mid-1990s, the entire 1,300-acre Project area was cultivated in sugarcane. Currently, about 1,100 acres are fallow and the remaining 200 acres are farmed by two operations which lease most of the farm lands on the Ewa Plain and in Kunia below the pineapple fields. Of the cultivated lands within and abutting the Project, the lands between Farrington Highway and the H-1 Freeway are under lease to the year 2005, and lands below Farrington Highway are under a 6-month renewable lease.

Once homes are developed near farm operations, about 380 additional acres will be fallowed in order to avoid (1) "nuisance problems" (dust, noise, airborne pesticides, etc.) which would affect residents of the new homes and (2) the expense of rerouting existing water irrigation lines for lands under a short-term lease. Nearly all of this additional land has agronomic conditions which are favorable for growing crops.

Thus the total amount of land that will be affected by the Project will be 1,680 acres (1,300 acres for the project and 380 additional acres fallowed). Of this amount,

about 580 acres *within and outside* the Project area will be withdrawn from active farming.

The economic activity associated with 580 acres of land used for growing produce could amount to about $5.8 million per year in gross revenues, 80 jobs, and $1.4 million in annual payroll. Even though two farms will be directly affected by the Project, there may be little or no island-wide loss in agricultural production, gross revenues, employment or payroll. This is because agricultural production is likely to be compensated for by (1) one or possible both of the two affected operations farming their remaining lands more intensively, and (2) farmers elsewhere on Oahu increasing their production to meet demand (e.g., new farmers using a portion of the 12,000 acres recently fallowed by Waialua Sugar Co. on the North Shore).

Impact on the Growth of Diversified Agriculture

Ample agricultural land will be available to accommodate the projected growth of diversified agriculture Statewide and on Oahu. This conclusion derives from the following: (1) a vast amount of agricultural land and water currently is available, having been freed from sugar and pineapple production in recent years; (2) additional sugarcane acreage and water may be freed in coming years; (3) some of the remaining sugar companies, if not most of them, are willing to make their lands available for profitable replacement crops to the extent that such crops exist; and (4) projected land requirements for diversified agriculture are modest compared to the land supply.

As the above indicates, the limiting factor to the growth of diversified agriculture will *not* be the *land supply*, but rather the *size of the market* for those crops that can be grown profitably in Hawaii. The proposed East Kapolei Master Plan Development Project involves too little land to affect this conclusion, and therefore is not expected to affect adversely the growth of diversified agriculture, Statewide or on Oahu.

EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT: Impact on Agriculture

INTRODUCTION

The East Kapolei Master Plan Development Project (referred to as "the Project" in this report) is a residential community proposed for development by the Housing Finance & Development Corporation of the State of Hawaii. The approximately 1,300-acre area ("the Project area"), in the central portion of the Ewa Plain, abuts the south side of the H-1 Freeway and is east of the Villages of Kapolei. Most of the Project area lies south of Farrington Highway, except for two parcels to the north.

This report addresses the impacts on agriculture that will result from developing the Project.

AGRICULTURAL CONDITIONS

Soil Types[1]

The land within the Project area consists of 13 soil types:

EaB	Ewa silty clay loam, 3 to 6% slopes;
EwC	Ewa stony silty clay, 6 to 12% slopes;
HxA	Honouliuli clay, 0 to 2% slopes;
HxB	Honouliuli clay, 2 to 6% slopes;
KlaB	Kawaihapai stony clay loam, 2 to 6% slopes;
KlbC	Kawaihapai very stony clay loam, 0 to 15% slopes;
KyA	Kunia silty clay, 0 to 3% slopes;
MnC	Mamala stony silty clay loam, 0 to 12% slopes;
MuB	Molokai silty clay loam, 3 to 7% slopes;
MuC	Molokai silty clay loam, 7 to 15% slopes;
rST	Stony land, 5 to 40% slopes;
WkA	Waialua silty clay, 0 to 3% slopes; and
WzA	Waipahu silty clay, 0 to 2% slopes.

For each soil type, Table 1 shows the approximate acreage, the possible agricultural uses, and two soil ratings (explained below). The predominate soil type, HxA, covers 906 acres, or 69.7% of the Project area. Two other soil types, WkA and HxB, cover an additional 113 acres and 104 acres respectively, or 8.7% and 8.0% of the Project area.

Soil Ratings

The soils within the Project area have been rated in terms of four classification systems that are commonly used in Hawaii: (1) Land Capability Grouping, (2) Agricultural Lands of Importance to the State of Hawaii, (3) Overall Productivity Rating, and (4) Proposed Land Evaluation and Site Assessment. These classification systems are discussed below and summarized in Figure 1.

(1) *Land Capability Grouping by the United States Department of Agriculture Soil Conservation Service (SCS).*[2]

This classification system rates soils according to eight levels, ranging from the highest classification level, I, to the lowest level, VIII. Assuming irrigation, the SCS Rating for each soil type is shown in Table 1.

For each classification, the acreage, percentage of the Project area, and limitations are:

Class I: Class I soils comprise about 1,059 acres, or about 81.5% of the Project area. Class I soils have few limitations that restrict their use.

Class IIe: Class IIe soils comprise about 185 acres, or about 14.2% of the Project area. Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices. The subclassification "e" indicates that the limitation is due to the risk of erosion.

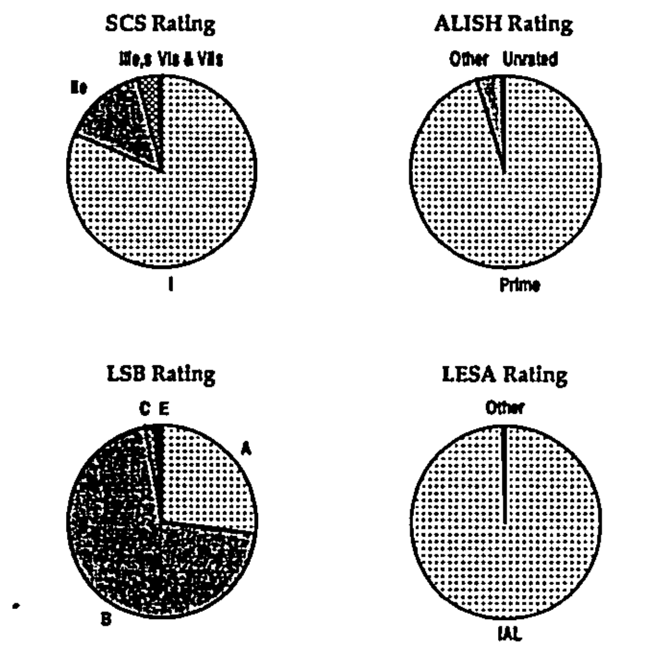
Class IIIe: Class IIIe soils comprise about 28 acres, or about 2.2% of the Project area. Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both. The subclassification "e" indicates that the soils are subject to severe erosion if they are cultivated and not protected.

Table 1.— EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT: SOIL TYPES, ACREAGES, AGRICULTURAL USES, AND SOIL RATINGS

Soil Type	Acres	Agricultural Uses	SCS Rating[1]	LESA Rating
EaB	62	Sugarcane, truck crops, pasture	IIe	85
EwC	9	Pasture	IIIe	77
HxA	906	Sugarcane, truck crops, pasture	I	87
HxB	104	Sugarcane, truck crops, pasture	IIe	85
KlaB	15	Sugarcane, truck crops, pasture	IIe	83
KlbC	4	Pasture	VIs	46
KyA	29	Sugarcane, pineapple[2]	I	95
MnC	22	Sugarcane, truck crops, pasture	IIIs	66
MuB	4	Sugarcane, pineapple,[2] pasture	IIe	88
MuC	18	Sugarcane, pineapple,[2] pasture	IIIe	81
rST	2	None	VIIs	30
WkA	113	Sugarcane, truck crops, pasture	I	93
WzA	12	Sugarcane	I	92
TOTAL	1,300			

1. Assuming irrigation, except for KlbC and rST which are not irrigated.
2. As discussed in the text, the Project is located at too low an elevation and temperatures are too warm for pineapple production.

Figure 1.—EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT: SOIL RATINGS



Class IIIs: Class IIIs soils comprise about 22 acres, or about 1.7% of the Project area. The subclassification "s" indicates that the limitation is due to stoniness, unfavorable texture, shallowness, or low water-holding capacity.

Class IV: No acreage.

Class V: No acreage.

Class VIs: Class VIs soils comprise about 4 acres, or about 0.3% of the Project area. These soils have severe limitations that make them generally unsuitable for cultivation. The subclassification "s" indicates that the limitation is due to stoniness or unfavorable texture.

Class VIIs: Class VIIs soils comprise about 2 acres, or about 0.2% of the Project area. These soils have very severe limitations that make them unsuitable for cultivation. The subclassification "s" indicates that the limitation is due to unfavorable texture, or extreme rockiness or stoniness.

(2) *Agricultural Lands of Importance in the State of Hawaii (ALISH), by the SCS, University of Hawaii (UH) College of Tropical Agriculture and Human Resources, and the State of Hawaii, Department of Agriculture.*[3]

This system classifies lands into three categories: (a) "prime" agricultural land which is land that is best suited for the production of crops because of its ability to sustain high yields with relatively little input and with the least damage to the environment; (b) "unique" agricultural land which is non-prime agricultural land that is currently used for the production of specific high-value crops; and (c) "other" agricultural land which is non-prime and non-unique agricultural land that is of importance to the production of crops.

Approximately 1,245 acres (95.4%) of the Project area are rated "prime," while 54 acres (4.1%) are rated "other." Six acres (0.5%) are "unrated."

(3) *Overall Productivity Rating, by the UH Land Study Bureau (LSB).*[4]

This classification rates soils according to five levels, with "A" representing the class of highest productivity and "E" the lowest.

Approximately 351 acres (27.0%) of the Project area are rated "A," 914 acres (70.3%) are rated "B," 16 acres (1.2%) are rated "C," and 18 acres (1.4%) are rated "E."

(4) *Proposed Land Evaluation and Site Assessment (LESA) System, by the State of Hawaii Land Evaluation and Site Assessment Commission.*[5]

Based on soil quality, locational attributes, improvements, nearby activities, and land-use plans, this proposed classification system would designate a sufficient amount of the better agricultural lands in order that projected agricultural goals can be met. If the LESA classification approach were applied, the designated lands would be termed "important agricultural lands" (IAL), and would include all lands having a rating of 66 or above, out of a possible total of 100. The LESA rating for each soil type is shown in Table 1.

Based on the proposed ratings, all but 6 acres of the Project area would be designated as IAL.

Taking all four of the above soil-rating systems into consideration, nearly all of the property is comprised of good soils.

Agricultural Uses for Soil Types

Suitable agricultural activities associated with the affected soil types include sugarcane, pineapple, truck crops and pasture (see Table 1). In the case of pineapple, however, the fields are at too low an elevation and temperatures are too warm to produce this crop; if the fruit were grown at this location it would burn.

Soil Characteristics

Most of the Project area has soils which have moderate-to-good machine tillability, are not stony, are more than 30 inches deep, are level or gently sloping, and are either moderately well-drained or well-drained.[4] Also, soils in Ewa tend to be black as opposed to the red soils of Central Oahu.

Elevation and Terrain

Most of the terrain is nearly level or moderately sloped, and ranges in elevation from 30 feet to 200 feet altitude.[4]

Climatic Conditions

The Project area is one of the sunniest areas on Oahu, having an average daily insolation of nearly 500 calories per square centimeter.[6] Rainfall averages near 20 inches per year.[7]

The average low temperature ranges from about 60° Fahrenheit in the winter to about 70° in the summer, while the average high temperature ranges from just under 80° in the winter to just under 90° in the summer.[7]

Irrigation Water

The area has been irrigated with groundwater. Pumping costs are relatively low given the short lift.

Access and Improvements

Current access to the Project area is via Farrington Highway and high-quality former cane-haul roads. Other improvements include a drip irrigation system and electrical power to drive pumps.

Locational Advantages

The fields are a short trucking distance to:

—the large Honolulu consumer market,

—Honolulu supply markets,

—the airport for air-freighting produce to overseas markets,

—Honolulu Harbor and Barbers Point Harbor for surface shipping of produce to overseas markets, and

—research support from the Hawaii Agriculture Research Center and the University of Hawaii.

Summary

Nearly all of the Project area would be good for cultivating crops inasmuch as the area offers favorable agricultural conditions and is in a desirable location.

Potential Crops

Crops grown for the *Hawaii market* which are climatically suited to low-elevation areas such as the Ewa Plain, and which have been profitable for some Hawaii farmers, include: bananas, green beans, bittermelon, mustard cabbage, pak choy, cabbage, cantaloupe, sweet corn, cucumbers, daikon, dasheen, honeydew, long eggplant, round eggplant, Manoa lettuce, lotus root, luau leaf, lychee, mango, dry onions, green onions, parsley, Chinese peas, green peppers, pomelos, pumpkins, hechima squash, hyotan squash, Italian squash, sweet potatoes, tomatoes, watercress, watermelons, alfalfa, feed corn for green chop, flowers, potted foliage, and plants for landscaping.

Climatic and other conditions in the central portion of the Ewa Plain are particularly well-suited for growing certain crops. For example, conditions favorable to cantaloupe and honeydew include: (1) hot, sunny weather (fosters rapid growth); (2) low rainfall which, in most years, falls primarily in a predictable 3-week period in late January and early February (planting is timed so as to avoid ripening during rainy periods because mold growing on wet fruit destroys an entire crop); (3) comparatively cool nights (which contribute to higher sugar content, more uniform webbing and better looking fruit); and (4) black soils (red soils stain the melon).

Potential low-elevation crops grown for the *export market* include: tropical fruits (if no fruit-fly infestation exists), a few vegetables grown for the winter market, flowers, potted foliage, seed crops, ginger root, and a few other crops.

Impact on Existing Agricultural Operations

Until the mid-1990s, the entire 1,300-acre Project area was cultivated in sugarcane by Oahu Sugar Co., Ltd. Currently, about 1,100 acres are fallow and the remaining 200 acres are farmed in produce crops by two of Oahu's larger farm operations. The impacts of the Project on these two agricultural operations are discussed below.

Sugarland Farms, Inc.

Sugarland Farms, Inc. ("Sugarland Farms") is part of a larger, owner-operated farm of more than 4,000 acres of leased land in Kunia and Ewa which employs about

100 people. Employment is expected to increase as the former sugarcane lands are fully converted to produce crops.

About 140 acres of the Project area—the two parcels north of Farrington Highway—are under lease to Sugarland Farms to the year 2005. Construction of homes on these parcels would likely precipitate commercial or residential development on 60 acres of Sugarland Farms land that are sandwiched between the two parcels, making a total of 200 acres being subject to development. In addition, Sugarland Farms has indicated that once homes are developed, they would stop farming another 180 acres abutting the Project area in order to avoid causing "nuisance problems" (dust, noise, airborne pesticides, etc.) to residents of the new homes. Thus, a total of 380 acres of farm land would be affected.

Although the owner-operator of Sugarland Farms leases a total of 4,000+ acres on Oahu, he anticipates that he would be unable to make up for the loss in production that would result from a 380-acre reduction in the size of his farm.

Aloun Farms

Aloun Farms leases about 1,500 acres in Ewa and Kunia and employs about 36 people. Employment is expected to increase as the former sugarcane lands are fully converted to produce crops.

About 60 acres of their farm is on the eastern side of the Project area and is leased under a 6-month renewable arrangement with the landowner. Once homes are developed, Aloun Farms would cease farming the 60 acres, plus another 140 acres east of the Project, for a total of 200 acres. The 140 additional acres would be fallowed to avoid the nuisance problems described above, and the expense the owner-operator would have to incur to reroute existing water irrigation lines.

Since Aloun Farms anticipates maintaining the same level of production and number of employees by farming their remaining 1,300 acres more intensively, they would suffer little or no loss in production as a result of the Project, unless their other farm lands in Ewa are significantly affected by development.

Combined Agricultural Impacts

A total of 380 acres of agricultural land *outside* the Project area will be fallowed; thus the total amount of land that will be affected by the Project will be 1,680 acres (1,300 acres for the Project area + 240 acres fallowed by Sugarland Farms + 140 acres fallowed by Aloun Farms). Nearly all of this additional acreage has land with high soil ratings, nearly level terrain, and climatic conditions which are favorable for crops. The area is also well-located for serving the Honolulu produce market.

A total of 580 acres of the 1,680 acres *within and outside* the Project area will be withdrawn from active farming (200 acres within the Project area + 240 acres fallowed by Sugarland Farms + 140 acres fallowed by Aloun Farms). The economic activity associated with 580 acres of land in produce could amount to about $5.8 million per year in gross revenues, 80 jobs, and $1.4 million in annual payroll. This is based on average gross revenues of $10,000 per acre, one job per 7.5 acres, and average salaries of $18,000 per year—estimates which are consistent with a weighted average of the two farm operations' gross revenues and payrolls.

Even though Aloun Farms and Sugarland Farms will be affected, there may be little or no island-wide loss in agricultural production, gross revenues, employment or payroll. This is because agricultural production is likely to be compensated for by (1) Aloun Farms and possibly Sugarland Farms using their remaining lands more intensively, and (2) farmers elsewhere on Oahu increasing their production to meet demand (for example, those who will be cultivating portions of the 12,000 acres recently released by Waialua Sugar Co. on the North Shore of Oahu).

Impact on the Growth of Diversified Agriculture

If the Project is developed, it will constitute a commitment of approximately 1,680 acres of high-quality agricultural land to a non-agricultural use, including land that would be fallowed to form a buffer between homes and farming activities. This commitment of land raises the question of whether the Project will affect adversely the growth of diversified agriculture in Hawaii—either immediately or over the long term.

As discussed in the Appendix, the supply of land available for diversified agriculture far exceeds projected demand, both Statewide and on Oahu. Statewide, the supply is approximately 177,000 acres and growing, while the projected 20-year demand

Statewide is just 41,000 acres. For Oahu, the supply exceeds 19,000 acres, while the 20-year demand is on the order of 10,000 acres.

Thus, the limiting factor to the growth of diversified agriculture will *not* be the *land supply*, but rather the *size of the market* for those crops that can be grown profitably in Hawaii. The proposed East Kapolei Master Plan Development Project involves too little land to affect this conclusion, and therefore is not expected to affect adversely the growth of diversified agriculture, Statewide or on Oahu.

CONSISTENCY WITH STATE AND COUNTY PLANS

The *Hawaii State Constitution*, the *Hawaii State Plan*, the *State Agriculture Functional Plan*, and the *General Plan of the City and County of Honolulu* call for preserving the economic viability of plantation agriculture and promoting the growth of diversified agriculture (see Table 2). To accomplish this, an adequate supply of agriculturally suitable lands and water must be assured.

With regard to *plantation agriculture*, development of the Project will have no impact on the sugar industry since sugar operations in the area were closed for reasons that are unrelated to the Project. Also, the Project will not affect pineapple operations since none occur at this low elevation.

With regard to *diversified agriculture*, development of the Project will not limit the growth of diversified agriculture since far more agricultural land has been released from plantation agriculture than has been absorbed by other activities. For the foreseeable future, the growth of diversified agriculture will be limited by the size of the market, not the land supply. Thus, the Project will not conflict with the major thrust of the diversified-agriculture portion of State and County Plans.

Regarding policies "...to preserve and protect agricultural lands," discussions in the Agriculture portion of the *State Functional Plan* recognize that redesignation of lands from Agriculture to Urban should be allowed "... upon a demonstrated change in economic or social conditions, and where the requested redesignation will provide greater benefits to the general public than its retention in ..." agriculture; that is, when an "overriding public interest exists."[8] The enormous contraction in plantation agriculture—resulting in the supply of agricultural land and water exceeding projected demand—constitutes a major change in economic and social conditions. Furthermore, the proposed development of homes will provide significant social benefits.

Table 2.—SELECTED STATE AND CITY OBJECTIVES, POLICIES, AND GUIDELINES RELATED TO AGRICULTURAL LANDS

HAWAII STATE CONSTITUTION (Article XI, Section 3):

> ...to conserve and protect agricultural lands, promote diversified agriculture, increase agricultural self-sufficiency and assure the availability of agriculturally suitable lands...

HAWAII STATE PLAN (Chapter 226, Hawaii Revised Statutes, as amended):[9,10]

Section 226-7 Objectives and policies for the economy--agriculture.

(a) Planning for the State's economy with regard to agriculture shall be directed towards achievement of the following objectives:

- (1) Viability in Hawaii's sugar and pineapple industries.
- (2) Growth and development of diversified agriculture throughout the State.
- (3) An agriculture industry that continues to constitute a dynamic and essential component of Hawaii's strategic, economic, and social well-being.

(b) To achieve the agricultural objectives, it shall be the policy of the State to:

- (2) Encourage agriculture by making best use of natural resources.
- (10) Assure the availability of agriculturally suitable lands with adequate water to accommodate present and future needs.
- (16) Facilitate the transition of agricultural lands in economically nonfeasible agricultural production to economically viable agricultural uses.

Table 2.—Selected State and City Objectives, Policies, and Guidelines Related to Agricultural Lands (continued)

Section 226-103 Economic priority guidelines.

(c) Priority guidelines to promote the continued viability of the sugar and pineapple industries:

(1) Provide adequate agricultural lands to support the economic viability of the sugar and pineapple industries.

(d) Priority guidelines to promote the growth and development of diversified agriculture and aquaculture:

(1) Identify, conserve, and protect agricultural and aquacultural lands of importance and initiate affirmative and comprehensive programs to promote economically productive agricultural and aquacultural uses of such lands.

(10) Support the continuation of land currently in use for diversified agriculture.

Section 226-104 Population growth and land resources priority guidelines.

(b) Priority guidelines for regional growth distribution and land resource utilization:

(2) Make available marginal or non-essential agricultural lands for appropriate urban uses while maintaining agricultural lands of importance in the agricultural district.

Section 226-106 Affordable Housing

Priority guidelines for the provision of affordable housing:

(1) Seek to use marginal or nonessential agricultural land and public land to meet housing needs of low- and moderate-income and gap-group households.

Table 2.—Selected State and City Objectives, Policies, and Guidelines Related to Agricultural Lands (continued)

AGRICULTURE STATE FUNCTIONAL PLAN (1991)[8]
(Functional plans are guidelines for implementing the State Plan. They are approved by the Governor, but not adopted by the State Legislature.)

Objective H: Achievement of Productive Agricultural Use of Lands Most Suitable and Needed for Agriculture.

Policy H(2): Conserve and protect important agricultural lands in accordance with the Hawaii State Constitution.

Action H(2)(a): Propose enactment of standards and criteria to identify, conserve, and protect important agricultural lands and lands in agricultural use.

Action H(2)(c): Administer land use district boundary amendments, permitted land uses, infrastructure standards, and other planning and regulatory functions on important agricultural lands and lands in agricultural use, so as to ensure the availability of agriculturally suitable lands and promote diversified agriculture.

CITY AND COUNTY OF HONOLULU
GENERAL PLAN, Objectives and Policies (Resolution No. 87-211)[11]

Economic Activity

Objective C. To maintain the viability of agriculture on Oahu.

Policy 4. Provide sufficient agricultural land in Ewa, Central Oahu, and the North Shore to encourage the continuation of sugar and pineapple as viable industries.

Policy 5. Maintain agricultural land along the Windward, North Shore, and Waianae coasts for truck farming, flower growing, aquaculture, livestock production, and other types of diversified agriculture.

References

[1] U.S. Department of Agriculture, Soil Conservation Service in cooperation with The University of Hawaii Agricultural Experiment Station. *Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii.* Washington, D.C. August 1972.

[2] U.S. Department of Agriculture, Soil Conservation Service in cooperation with The University of Hawaii Agricultural Experiment Station. *Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii.* Washington, D.C. August 1972.

[3] Harold L. Baker. *Agricultural Lands of Importance in the State of Hawaii.* University of Hawaii College of Tropical Agriculture and Human Resources, Honolulu, Hawaii. 1977.

[4] Land Study Bureau. *Detailed Land Classification, Oahu.* Honolulu, Hawaii. 1963.

[5] State of Hawaii Land Evaluation and Site Assessment Commission. *A Report on the State of Hawaii Land Evaluation and Site Assessment System.* Legislative Reference Bureau, Honolulu, Hawaii. February 1986.

[6] Department of Planning and Economic Development. "A Home-Owners Guide to Solar Water Heating on Oahu with Oahu Sunshine Map."

[7] Department of Geography, University of Hawaii. *Atlas of Hawaii, Second Edition,* University Press. 1983.

[8] Hawaii Department of Agriculture. *The Hawaii State Plan: Agriculture, State Functional Plan.* Honolulu, Hawaii. 1991.

[9] State of Hawaii, Office of State Planning, Office of the Governor. *The Hawaii State Plan, 1991.* Honolulu, Hawaii. 1991.

[10] Act 25, S.B. No. 1158, April 15, 1993.

[11] City and County of Honolulu, Department of General Planning. *General Plan Objectives and Policies.* Honolulu, Hawaii. 1992.

Appendix

Availability of Agricultural Lands in Hawaii

Appendix

Availability of Agricultural Lands in Hawaii

The availability of land for low-elevation diversified agriculture on Oahu and throughout the State is addressed below. The discussion covers potential low-elevation crops, land requirements, the supply of land available for diversified crops, and the outlook for the land market.

Potential Low-Elevation Crops

Crops grown for the *Hawaii market* which are climatically suited to low-elevation areas in Hawaii and which have been profitable for some Hawaii farmers, include: bananas, green beans, bittermelon, mustard cabbage, pak choy, cabbage, cantaloupe, sweet corn, cucumbers, daikon, dasheen, honeydew, long eggplant, round eggplant, Manoa lettuce, lotus root, luau leaf, lychee, mango, dry onions, green onions, parsley, Chinese peas, green peppers, pomelos, pumpkins, hechima squash, hyotan squash, Italian squash, sweet potatoes, tomatoes, watercress, watermelons, alfalfa, feed corn for green chop, flowers, potted foliage, and plants for landscaping.

Potential low-elevation crops grown for the export market include: tropical fruits (if no fruit-fly infestation exists), a few vegetables grown for the winter market, flowers, potted foliage, seed crops, ginger root, and a few other crops.

A great many additional crops can be grown in Hawaii's year-round subtropical climate, but few can be grown profitably on a commercial scale. The primary reasons for this unprofitability are given below.

- —Hawaii's subtropical climate is not well-suited to the commercial production of crops that grow better in the temperate mainland climates.
- —For certain crops, special hybrids adapted to Hawaii's subtropical climate have yet to be developed.

- —Crop pests are more prevalent and more expensive to control in Hawaii than they are on the mainland, where the cold winters kill many pests.
- —Fruit-fly infestations prevent exports of many crops.
- —Most soils in Hawaii's have low nutrient levels so therefore require high expenditures for fertilizer.
- —Hawaii suffers from high farm-labor costs, largely because the agriculture industry must compete against the visitor industry and related industries for its labor.
- —High overseas transportation costs increase the cost of importing agricultural supplies and equipment and, for export crops, shipping produce to market.
- —For a number of crops, consumption volumes are too small to support large, efficient farms.
- —Hawaii farmers must compete against efficient mainland farms which, in a number of cases, can deliver produce to Hawaii more cheaply than can be done locally because the mainland farms incur lower costs for land, labor, supplies, fertilizer, pest control, equipment, etc. Furthermore, some mainland farms benefit from large volumes and economies of scale.

Land Requirements for Diversified Agriculture

Based on projections made in 1991 by the State Department of Agriculture (DOA), additional Statewide land requirements to accommodate the growth of diversified agriculture to the year 2010 will amount to approximately 41,000 acres.[1] The projections suggest that about 83% of this new acreage will be required for macadamia nut and coffee orchards, while about 7,000 acres will be required to accommodate the growth of other diversified-agriculture crops.

The projections indicate that most of this growth in diversified agriculture will occur on the Neighbor Islands, while Oahu will require only about 1,000 acres, of which about half would be for bananas.

However, with the release of lands from sugar cultivation on Oahu, most of the 7,000-acre increase in crops other than macadamia nut and coffee orchards may occur on Oahu. Also, some production may relocate to Oahu from Molokai and other Neighbor Islands. With these adjustments, the demand for land on Oahu is on the order of 10,000 acres.

SUPPLY OF LAND FOR DIVERSIFIED AGRICULTURE—STATEWIDE

With regard to the Statewide supply of agricultural land, an enormous and growing supply of this land is available for diversified agriculture. Since 1968, over 215,000 acres of Hawaii's higher-quality agricultural land have been released from sugar and pineapple production.[2-4]

The amount of land released from sugar production may increase given that additional sugar plantations are struggling.

In addition, a portion of the existing sugarcane land is on hold awaiting the discovery of profitable replacement activities. This land also forms part of the supply of agricultural land available for profitable diversified-agriculture crops. Moreover, the greater the success of diversified agriculture, the greater the amount of land that will be released from plantations for diversified agriculture. Examples of sugarcane land being released for other crops include: macadamia nut orchards on land released from Mauna Kea Agribusiness Co., Inc; macadamia nut and citrus orchards on land released from Ka'u Agribusiness Co., Inc; macadamia nut orchards and pineapple operations on land released from Wailuku Agribusiness Co., Inc; coffee orchards on land released by McBryde; seed corn and nursery operations on land released from HC&S; and seed corn operations on land released from Kekaha Sugar Co., Ltd.

Some of the land that has been freed from plantation agriculture has been or is scheduled to be converted to urban, diversified-agriculture, and other uses. After making allowances for these conversions, uncommitted acreage which remains available for diversified agriculture amounts to about 177,000 acres.[5] Much of this land is fallow, or used for grazing, or is in some other low-value land-holding operation. Also, this acreage figure may increase as more land is released from sugar production.

Many of the lands freed, to be freed, or which can be freed from sugar and pineapple production have excellent agricultural qualities and climatic conditions, and are well-suited for a variety of crops. Also, water is available for most of these lands—particularly those which have been freed from sugar production.

Additional lands which have been made available for diversified agriculture are in government-sponsored agricultural parks throughout the State. Also, lava lands in Puna are particularly well-suited for growing papaya.

SUPPLY OF LAND FOR DIVERSIFIED AGRICULTURE—OAHU

Because of the closure of sugar operations on Oahu, a dramatic increase in the supply of land available for diversified agriculture has occurred.

Lands Released by Oahu Sugar Co., Ltd.

Some of the best lands in the State for diversified agriculture are the 10,500 acres recently released by Oahu Sugar Co., Ltd.[4] Most of these fields have good soils, the areas is sunny, and irrigation costs are low.[6] Furthermore, the lands are a short trucking distance to the large Honolulu market and, for export markets, to the Honolulu International Airport and Honolulu Harbor. However, over the next 20 years, as many as 3,500 acres of the OSCo lands may be urbanized.[5]

In addition, over 1,000 acres of fallowed land are in the foothills west of Kunia Road. OSCo stopped farming these fields in the early 1980s because of the high cost of pumping water to them.

Lands Released by Waialua Sugar Co., Inc.

Most of the 12,000 acres being released by the closure of Waialua Sugar Co., Inc. are also of high quality.[4] However, these lands are a longer trucking distance to the Honolulu markets.

Other Lands Available for Diversified Agriculture

Agricultural lands have yet to be fully utilized in Waimanalo, Waiahole Valley, Waikane Valley, Kahuku, Waianae and at the three State agricultural parks on Oahu.

In addition, the State plans to develop more agricultural parks on Oahu: Kunia Ag Park for truck crops (150 acres, 20 lots of 5 to 15 acres); Waiahole Ag Park for diversified crops (379 acres, 45 lots); and Kahuku Ag Park for livestock (750 to 900 acres).

OUTLOOK FOR THE DIVERSIFIED AGRICULTURE LAND MARKET

Based on the above assessment, ample agricultural land will be available to accommodate the projected growth of diversified agriculture Statewide and on Oahu. This conclusion derives from the following: (1) a vast amount of agricultural land and water currently is available, having been freed from sugar and pineapple production in recent years; (2) additional sugarcane acreage and water may be freed in coming years; (3) some of the remaining sugar companies, if not most of them, are willing to make their lands available for profitable replacement crops to the extent that such crops exist; and (4) projected land requirements for diversified agriculture are modest compared to the land supply.

As the discussion above indicates, the limiting factor to the growth of diversified agriculture will *not* be the *land supply*, but rather the *size of the market* for those crops that can be grown profitably in Hawaii.

REFERENCES—APPENDIX

[1] State Department of Agriculture. Unpublished projections. February 28, 1991. Harvested acres adjusted to planted acres by Decision Analysts Hawaii, Inc.
[2] Robert C. Schmitt. *Historical Statistics of Hawaii*. The University Press of Hawaii, Honolulu, Hawaii. 1977.
[3] Hawaii Agricultural Statistics Service. *Statistics of Hawaiian Agriculture 1991*. Honolulu, Hawaii. December 1992.
[4] Hawaiian Sugar Planters' Association. *Hawaiian Sugar Manual, 1993-1994*. Honolulu, Hawaii. 1994.
[5] Estimated by Decision Analysts Hawaii, Inc.
[6] Decision Analysts Hawaii, Inc. *Hawaii's Sugar Industry and Sugarcane Lands: Outlook, Issues and Options*. Prepared for the State of Hawaii, Department of Business and Economic Development. April 1989.

D. COMMISSION ON WATER RESOURCE MANAGEMENT STAFF REPORT

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

STAFF SUBMITTAL

for the meeting of the
COMMISSION ON WATER RESOURCE MANAGEMENT

May 14, 1997
Honolulu, Oahu

PROPOSED ESTABLISHMENT OF AQUIFER SYSTEMS AND
ADOPTION OF SUSTAINABLE CAPACITIES BY WELL
Ewa Caprock Ground Water Management Area, Oahu

BACKGROUND:

On September 28, 1979, the Board of Land and Natural Resources (BLNR) designated the Pearl Harbor Ground Water Control Area (Pearl Harbor GWCA; Judicial Boundaries of Ewa and Wahiawa Districts) pursuant to Chapter 177, HRS, Ground Water Use Act.

On March 22, 1985, the BLNR established subareas for the Pearl Harbor GWCA, including the Coastal Caprock Subarea.

In 1990, the Commission on Water Resource Management (Commission) adopted the Water Resources and Protection Plan (WRPP). The WRPP included, as required by HRS 174C-31(c), "*hydrologic units and their characteristics, including the quantity and quality of available resource...*". The WRPP did not include the brackish Ewa Caprock Aquifer as a hydrologic unit.

In the 1988-1992 timeframe, water use permits totalling 19.524 million gallons per day (mgd) were awarded in the Ewa Caprock Aquifer mainly to existing irrigation uses (eg. Oahu Sugar Co. (OSCo)). Other existing water use permits totaled 39.608 mgd for various salt water and brackish to saline water uses (chlorides > 1,000 mg/l).

On March 3, 1993, the Commission officially adopted the boundary of the entire brackish Ewa Caprock Aquifer as a separate aquifer within the existing designated ground water management area. Due to uncertainties regarding the aquifer's sustainable yield, the Commission did not adopt a sustainable yield estimate for the aquifer.

Since March 1993, the Commission has been awarding one-year interim permits for new uses for the Ewa Caprock Aquifer.

In November 1994, OSCo went out of business. Recognizing the fact that the Ewa Caprock Aquifer was supported by the irrigation practices of OSCo, an analysis of historic chloride and pumpage data was initiated to determine a new sustainable yield.

In May 1996, the staff completed a re-evaluation of the Ewa Caprock Aquifer sustainable yield. Based on the staff's analysis of historic data, the staff proposed the establishment of three (3) aquifer systems within the Ewa Caprock Aquifer: Puuloa, Kapolei, and Malakole (see Exhibit 1), with sustainable yields of 5 mgd, 3 mgd, and 1 mgd, respectively, to preserve chloride concentrations less than or equal to 1,000 mg/l.

On August 14, 1996, a public hearing was held on the proposed establishment of aquifer systems and sustainable yields for the caprock aquifer. Before the close of the public hearing, Hawaii Prince Golf Club (HPGC) submitted a written request for a contested case hearing on the proposed establishment of a 5 mgd sustainable yield for the Puuloa area. The written petition was received on August 23, 1996.

On August 29, 1996, a written proposal (Exhibit 2) was received from the Puuloa Caprock Users Group (PCUG), which included HPGC, Sogo Hawaii, Inc., Haseko, Gentry Homes, Ltd., and the Navy. PCUG requested 90 days to prepare and submit a draft nonpotable master plan (Plan) to the Commission, which would include a recommended plan to manage water use over a proposed two-year interim period.

On September 11, 1996, the Commission voted to:

1. Defer action on the sustainable yield for the Ewa Caprock Aquifer to the December 18, 1996 Commission meeting in order to consider the PCUG's draft nonpotable master Plan for the Puuloa area.

2. Require that the draft nonpotable master plan include each of the elements outlined in PCUG's proposal, be as specific as possible (eg. annual projections of all nonpotable supply requirements detailed by project and TMK area), encompass the entire Puuloa area and all users in Puuloa, and include a scenario complying with the proposed 5 mgd sustainable yield estimate. The Plan shall also address the current overpumpage at Well Nos. 1902-03 & 04 and Well No. 2001-05.

3. Extend the deadline to September 30, 1996 for the submittal of any additional data or evidence (related to ground water modelling, hydrologic data, or other) which a party wishes to have considered in setting the sustainable yield of the Ewa Caprock Aquifer.

On September 30, 1996, Haseko submitted water level and salinity data that had been collected by Tom Nance on Haseko's behalf in 1995. The data show that the caprock lens is very thin and withdrawals for irrigation uses are controlled by the chloride concentrations at individual well sites.

On November 6, 1996, the staff met with PCUG to discuss a preliminary draft Plan dated November 26, 1996. PCUG has expanded to include the City Department of Wastewater Management.

On December 4, 1996, the staff faxed comments regarding the draft Plan to the PCUG (Exhibit 3).

On December 6, 1996, the staff met with PCUG to further discuss the November 26, 1996 draft Plan. PCUG submitted a revised draft Plan, dated December 6, 1996.

On December 11, 1996, PCUG delivered a revised draft Plan, dated December 11, 1996.

On December 18, 1996, the Commission voted to:

1. Defer action on the proposed sustainable yields and aquifer systems for the Ewa Caprock Aquifer pending a workshop/briefing on the Plan.

2. Defer action on the pending applications for irrigation water uses and well construction/pump installation permits for the Ewa Caprock Aquifer pending a workshop/briefing on the Plan.

On January 8, 1997, the staff sent comments to PCUG regarding the December 11, 1997 draft Plan (Exhibit 4).

On January 15, 1997, the staff advised the Commission that a briefing on the Plan should be deferred until PCUG submits a plan that addresses the requirements of the Commission.

On January 27, 1997, PCUG submitted a new draft, dated January 22, 1997. PCUG now includes the State Housing Finance & Development Corporation, which has plans to develop a substantial amount of land in Puuloa.

On February 12, 1997, the Commission staff met with PCUG and The Estate of James Campbell, which is a permitted user and landowner of considerable undeveloped lands in Puuloa. The staff handed out review comments on the January 22, 1997 draft Plan (Exhibit 5) and presented a counter-proposal to the PCUG Plan (Exhibit 6).

<u>ANALYSIS/ISSUES</u>:

The Ewa Caprock Aquifer is currently undergoing a period of change in response to the large-scale modifications in land and water use as sugarcane is replaced by urban developments. There has been much effort involved in modelling the behavior of the caprock aquifer. In an effort to better understand the historical data upon which assessments of Ewa Caprock Aquifer dynamics are based, the existing data from basal and caprock wells that were used for sugarcane irrigation supply were compiled and analyzed by the staff.

Report CWRM-2 (Bauer, 1996), shows that chloride levels at OSCo caprock sources began to rise in the 1930's in response to average monthly pumpage at about 11 mgd (range from 5 to 15 mgd) and imported basal water of poor quality (Exhibit 7). To maintain suitable irrigation quality water, OSCo imported better quality water from basal sources in the mid-1930's. Following this basal importation, chlorides began to drop to more acceptable levels. Cessation of basal water importation with the shutdown of OSCo in 1994 has allowed the caprock to revert back to natural conditions, where the source of water is from basalt water leakage, recharge from rainfall, and storm runoff from the Waianae Mountains. These natural inputs argue for a low sustainable yield.

The efforts of the PCUG and recent data and analyses presented by Tom Nance on behalf of PCUG has provided additional insight into the hydrology of the Ewa Caprock Aquifer:

1. The Ewa Caprock Aquifer is a thin basal aquifer vulnerable to salinity intrusion (most salinity profiles indicate sharp salinity changes. Therefore, developable supply is wholly dependent on well location.

2. The Ewa Caprock Aquifer lens is very thin. Salinity intrusion, particularly for wells in the makai portion of the aquifer, is a significant limitation. However, if the withdrawal from the aquifer occurs primarily in mauka areas, the developable supply may be greater.

3. The aquifer's main source of recharge is ground water inflow from the basalt aquifer at the limestone's inland margin. The amount of this leakage cannot be determined with any confidence and is dependent upon the water levels within the basal aquifer.

4. The spatial distributions of chlorides don't fit into the simple concept embodied in management by a single sustainable yield number.

5. Sustainable yield is a theoretical number which assumes optimal well placement and is primarily a planning tool.

6. The magnitude of tidal influences are equal to or greater than pumping influences and thus makes water level monitoring as a means for estimating sustainable yield and regulating water use extremely difficult.

7. The aquifer is para-basal inland, that is, the aquifer's bottom is truncated by the poorly permeable clay layer underlying the upper limestone aquifer.

8. The hydrology of the Ewa Caprock Aquifer is sufficiently unique to warrant consideration of alternative regulatory considerations. This is particularly appropriate given the change in return irrigation availability of reclaimed water to supplement the naturally occurring recharge.

Sustainable yields for the Pearl Harbor and other aquifer systems were derived using John Mink's Robust Analytical Model (RAM), which assumes an initial and equilibrium head to calculate a sustainable yield. However, in light of the above findings, which show the Ewa Caprock Aquifer is substantially different from other basal ground water aquifers, the staff is recommending that the Commission adopt an interim management plan that sets a 1,000 mg/l chloride cap for individual irrigation wells instead of a sustainable yield number. This would define a sustainable capacity for each irrigation well. The current actual total aggregate of pumpage should not degrade the aquifer further. Management by individual well capacities is an attempt to refine management and an additional factor to consider in water resources regulation. Reasonable and beneficial use quantities would still be used to set allocations. After about one (1) to two (2) years of data collection, the benefits of this methodology may be assessed and reviewed by the Commission.

The staff feels that the chloride level of water pumped by each well is the best available indicator of source sustainability; it is also one of the criteria identified by the Water Code for regulating water use. Further, since this aquifer will only be used for irrigation purposes and not drinking water, a chloride cap would allow self-regulation of the wells. A minimum chloride standard should be established for industrial use wells to ensure industrial withdrawals, that do not require irrigation-quality water, will not impact irrigation wells in the designated water management area.

The basis for a 1,000 mg/l chloride cap derives from a ground water resources assessment study for Southern Oahu, Hawaii in which Vishner and Mink (1964) state that "*[n]o well-defined limits have been established for the quality of water suitable for irrigation on Oahu, but the consensus is that the major crop, sugarcane, cannot be grown economically if the water contains more than about 1,000 ppm of chloride*". Reference to a 1,000 mg/l sustained water quality for irrigation in the Ewa Plain is also made in Report R-79 (Yuen & Associates, Inc., 1989) and Report CWRM-2 (Bauer, 1996). The staff is not aware of any other studies that have been done to better define the limits of water quality suitable for irrigation on Oahu.

PCUG proposed chloride standards for individual wells based upon present and past data with a 1000 mg/l maximum and a 600 mg/l minimum. The staff feels that a 1,000 mg/l cap for all wells will provide adequate protection of the aquifer for irrigation and other nonpotable uses. A standard limit will also facilitate the Commission's monitoring and enforcement of permitted uses.

Given the difference in existing uses and planned future uses between the Puuloa, Kapolei, and Malakole areas, the staff is also recommending that the Commission adopt the proposed internal boundaries to define the Puuloa, Kapolei, and Malakole aquifer systems at this time.

RECOMMENDATIONS:

The staff recommends that the Commission:

1. Dismiss the request for a contested case hearing by Hawaii Prince Golf Club because there is no right to a contested case hearing on the proposed revision to the Hawaii Water Plan, Water Resources Protection Plan.

2. Adopt the aquifer systems for the Ewa Caprock Aquifer as shown in Exhibit 1 and direct the staff to amend the Hawaii Water Plan, Water Resources Protection Plan, to include the Malakole, Kapolei, and Puulon Aquifer Systems in the Ewa Caprock Sector.

3. Adopt a sustainable capacity for individual irrigation wells at 1,000 mg/l of chloride as an interim management plan, subject to review within two (2) years.

4. Direct the staff to work with the industrial users in the Ewa Plain to propose minimum chloride standards for industrial wells.

Respectfully submitted,

RAE M. LOUI
Deputy Director

Exhibit(s):
1 (Location Map)
2 (August 29, 1996 PCUG Proposal)
3 (CWRM Comments on 11/26/96 PCUG Draft Plan)
4 (CWRM Comments on 12/11/96 PCUG Draft Plan)
5 (CWRM Comments on 1/22/97 PCUG Draft Plan)
6 (CWRM Proposed Interim Management Plan)
7 (Graph of OSCo Pumpage and Chlorides, 1930-1995)

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

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

STAFF SUBMITTAL

for the meeting of the
COMMISSION ON WATER RESOURCE MANAGEMENT

May 14, 1997
Honolulu, Oahu

APPLICATIONS FOR WATER USE PERMITS
APPLICATIONS FOR WELL CONSTRUCTION/PUMP INSTALLATION PERMITS
Requests for New and Continued Nonpotable Urban Uses

ALLOCATION PLAN FOR WATER USE PERMITS
Ewa Caprock Ground Water Management Area, Oahu

APPLICANT(S):	LANDOWNER(S):
(Well Nos. 1905-08,10) The Estate of James Campbell 1001 Kamokila Blvd. Kapolei, HI 96707	Same
(Well Nos. 2003-04,07) State of Hawaii, Housing Finance & Development Corp. 7 Waterfront Plaza, Suite 300 500 Ala Moana Blvd. Honolulu, HI 96813	Same
(Well Nos. 2003-01,02,05) Kapolei People's Inc. 91-701 Farrington Hwy. Kapolei, HI 96707	Same
(Well Nos. 1900-02,17 to 20 & 1901-03) Hawaii Prince Golf Club 91-1200 Fort Weaver Rd. Ewa Beach, HI 96706	Same

(Well Nos. 2001-03,04,05,09,10 & 2002-15) Gentry Development Co. P.O. Box 295 Honolulu, HI 96809	Same
(Well No. 2001-07) The Arbors Association 91-920 La'aulu St., #1G Ewa Beach, HI 96706	Same
(Well No. 2001-08) Palm Villas II Association 91-1119 Mikohu St., #D Ewa Beach, HI 96706	Same
(Well No. 2002-12) Palm Court Association 91-1019 Puaniu St., #25R Ewa Beach, HI 96706	Same
(Well No. 1902-01) Haseko (Ewa), Inc. 820 Mililani St., Suite 810 Honolulu, HI 96813	Same

LOCATION MAP: See Exhibit 1

BACKGROUND:

A brief description of the proposed uses and background information are provided in Exhibit 2. Please refer to the previous item on this agenda, which provides additional pertinent background information on the Ewa Caprock situation.

ANALYSIS/ISSUES:

PCUG NONPOTABLE WATER MASTER PLAN

The staff's comments regarding the latest Puuloa Caprock Users Group (PCUG) Nonpotable Water Master Plan, dated January 22, 1997, are shown in Exhibit 3. Given the numerous outstanding issues and questions regarding the latest draft plan, and the fact that it is unsigned by the group members, the staff is not recommending that the Commission adopt the draft plan as a complete package.

However, the efforts of the PCUG have provided valuable information to the Commission on the hydrology of the caprock aquifer (refer to previous agenda item), future nonpotable demands, reclaimed water supply, and users' commitments to convert to reclaimed water. This has allowed the staff to develop a modified allocation and interim management plan for the Ewa Caprock Aquifer Systems (Exhibits 4 and 5). The objectives of the staff's proposed interim management plan are to:

- Protect the water resource
- Protect existing uses
- Conform to the county's land use plans for the area (ie. urbanization)
- Bring permitted uses more in line with actual uses
- Recognize the correlative rights of landowners

The details of the staff's proposed interim management plan and implementation thereof is discussed in the following sections.

AGRICULTURAL PERMITTED USES, PUULOA AQUIFER SYSTEM

Agricultural uses account for 10.630 mgd of current permitted uses in Puuloa. These water use permits were originally approved for Oahu Sugar Company's (OSCo) sugarcane agriculture, but have since been transferred to the respective landowners at the source locations. The current permitted users and allocations are shown in Exhibit 5 (Pre-1978 Permanent Permits).

With the exception of Haseko (Ewa), Inc. (Haseko), agricultural allocations have not been used since OSCo ceased operations. However, again with the exception of Haseko, agricultural permittees will not voluntarily relinquish any part of the allocations.

Haseko has indicated that, based on their agricultural acreage and projected demands, only 1.800 mgd of agricultural water is needed. Accordingly, the staff is recommending that the Commission reduce Haseko's agricultural use permit (WUP No. 192) by 0.860 mgd.

Assuming that the Commission has adopted the recommendation on the previous agenda item to establish a 1,000 mg/l chloride cap for irrigation wells, the staff recommends that the Commission require agricultural permittees to conduct a new pump test to confirm that the sources can sustain withdrawals at the current permitted amounts with chlorides less than or equal to 1,000 mg/l.

The Department of the Navy (Navy) and The Estate of James Campbell (Campbell) have both indicated an inability to conduct a pump test due to the lack of power, that they have no immediate plans to use the well, yet neither have proposed any reasonable alternative pump test procedure.

On the other hand, Haseko has indicated their willingness to perform a pump test and has proposed a pump test procedure. The staff and Haseko are in the process of working out an acceptable pump test; the final pump test procedure will be designed to address the sustainable well capacity and provide additional hydrologic information on the caprock aquifer. The staff

recommends that the Commission delegate the authority to the Commission staff to approve the final pump test procedure. Further, the staff recommends that the Commission require all agricultural permittees to conduct a pump test, similar to Haseko's, prior to reactivation of the wells to establish the sustainable capacity of the individual well source in accordance with the interim management plan. Haseko's preliminary pump test procedure is shown in Exhibit 6.

Finally, the staff is planning to recommend that the Commission revoke water use permits due to four (4) years continuous nonuse, as provided for in §174C-58(4) HRS. The dates on which these permits may begin to be revoked, assuming no new agriculture occurs on the former sugarcane lands and amounts are based on the twelve-month moving average withdrawal (12-MAV), are shown in Table 1:

Table 1. 4-Years Nonuse

Permittee	Well Name/No.	Permitted Use	4-yr Nonuse Begins
Campbell	EP 21/2000-01	2.08	10/98
Haseko	EP 27/1902-01	2.66	10/98
Navy	EP 23/2001-01	5.89	9/97
TOTALS		10.63	

The Commission may wish to consider that the 4-year nonuse is based on the day usage stopped, rather than using the 12-MAV as has been done in the past. This would speed the revocation period, but would deviate from past revocation policy and would allow the 4-year period of nonuse to be more easily extended.

APPLICATIONS FOR WATER USE PERMITS, PUULOA AQUIFER SYSTEM

Applications for water use permits in Puuloa are summarized in Exhibit 5 (Expired Interim Permits (1-yr)). Recommended allocations, based on either projected or actual usages, are also shown. Issues relating to the proposed interim management plan are discussed below:

- Request for Variance from 1,000 mg/l Chloride Cap

  Hawaii Prince Golf Club (Hawaii Prince) has requested a variance from the 1,000 mg/l chloride cap for existing irrigation wells that currently exceed the standard. Hawaii Prince is planning to jointly develop a new well, Area 30 Well (Well No. 2001-12), with Gentry Investment Co. to be located in the Ewa by Gentry project. During daytime hours, well water will be delivered to the Hawaii Prince golf course for irrigation use. At night, the well will provide irrigation supply for roadways, multi-family parcels, parks, and other common areas in Ewa by Gentry.

  Because there is no other feasible alternative source of nonpotable water for the existing Hawaii Prince golf course at this time, the staff recommends that the Commission approve the variance until the new Area 30 Well comes on line.

- <u>Requests for Variance from Non-Renewal of Unused Interim Permits</u>

Haseko and Gentry have requested variances from the staff's proposed interim management plan (Exhibit 4), which recommends denial without prejudice for unused one-year interim permits.

Haseko received approval for a one-year interim water use permit for 1.5 mgd for Well No. 1902-01 for golf course and landscape irrigation and dust control in July, 1994. No water has been used under this permit to date.

Gentry received approval for a one-year interim water use permit for 0.130 mgd for Well No. 2002-15 for landscape irrigation surrounding their proposed golf course in January, 1995. No water has been used under this permit to date. However, Gentry has stated that, because of the delays in obtaining the required water allocation and well permit, water for the initial planting and dust control is being provided by a BWS hook-up to a fire hydrant. Water use has averaged over .125 mgd for the past year. Gentry has recently received zoning approval for the golf course and is requesting an increase in permitted use to bring the total allocation to 0.690 mgd for the golf course and landscape irrigation.

To support their requests, these applicants have provided golf course plans and specifications and other documentation to show that the need for golf course irrigation water is imminent. Gentry states that uncertainty regarding the water allocation is the only thing that is holding up their golf course development. Haseko has submitted a schedule for the permitting of their golf course which shows a possible need for water as early as January, 1998. The staff feels that, based on the information provided, the demands for golf course and other irrigation water appears imminent.

Gentry also received approval for a one-year interim permit for 0.022 mgd for Well No. 2001-10 for landscape irrigation. The well construction and testing was recently completed. The condominium project is under construction and the first units will be occupied in May, 1997. Water use will commence shortly thereafter.

- <u>Request for Variance from Domestic Consumption Guideline</u>

Hawaii Prince has requested a variance from the 4,000 gpd/ac duty that the staff uses as a guideline for reasonable turf irrigation requirement (Domestic Consumption Guideline for Schools, Parks in Hawaii Water System Standards, 1985).

The recommended allocation for a new interim permit for Hawaii Prince (Exhibit 5) is derived from information provided by Hawaii Prince that supports an irrigation requirement for 4,700 gpd/ac for plant evapotranspiration based on rainfall and pan evaporation data, plus an additional 10% due to application inefficiencies because of the windy site, plus an additional 20% for leaching to avoid salt-buildup. The staff is <u>not</u> recommending approval for an additional 0.150 mgd requested by Hawaii Prince to offset evaporative losses from the 32-acres of open lake surfaces.

- <u>Reclaimed Water</u>

Reclaimed water is needed to address the current overallocation problem and for future nonpotable supply. The forecasted usage of nonpotable water by users in the Puuloa Aquifer System is at least 10 mgd by 2001, exceeding the recharge to the caprock aquifer.

The PCUG Plan indicates a commitment on the part of four (4) private users to utilize reclaimed water (Haseko, Gentry, Ewa Beach International Golf Club, and Hawaii Prince Golf Club). The 309 Consent Decree specifies a July 1, 1998 date for the reuse of 2.0 mgd, and these private users have indicated conversion to reclaimed water for specific amounts, totalling 1.0 mgd, by July, 1998.

However, we understand that the Department of Wastewater Management (DWM) is now looking towards a June 30, 1999 date for R-1 delivery. The PCUG plan shows a commitment by the private users to utilize 1.5 mgd by July, 1999. The staff recommends that the Commission attach a special condition to all water use permits approved for these users to sign a contract within 12 months with DWM to buy reclaimed water at the amounts specified in the PCUG plan for July, 1999. The schedule for reclaimed water may be reviewed at a later date as we get closer to the July 1, 1998 date for the first increment of reuse. A summary of the DWM Consent Order and Decree related to reuse and private users commitments are shown in Exhibit 7. If the Commission were to accept this extended period for reuse, it would also allow complete revocations of agricultural permits to be based on the 12-MAV, which has been the past policy of the Commission.

- <u>Conditions for a Water Use Permit</u>

Section 174C-49(a) of the State Water Code establishes seven (7) criteria that must be met to obtain a water use permit:

(1) Can be accommodated with the available water source.

Again, assuming the Commission has approved the staff's recommendation in the previous agenda item regarding the establishment of sustainable capacities for individual irrigation wells at 1,000 mg/l of chloride, as determined through a pumping test, then the proposed uses can be accommodated with the available water source.

(2) Is a reasonable-beneficial use as defined in section 174C-3.

Section 174C-3 HRS defines "reasonable-beneficial use" is

> *"...the use of water in such a quantity as is necessary for economic and efficient utilization, for a purpose, and in a manner which is both reasonable and consistent with the state and county land use plans and the public interest".*

The recommended allocations in Exhibit 5 are based on actual usage or projected demand using the Domestic Consumption Guideline (Hawaii Water System

Standards, 1985). Where a variance from this guideline has been requested and is reflected in Exhibit 5, the applicant has provided sufficient and appropriate justification. Other reasonable-beneficial use criteria are analyzed in the following sections.

(3) Will not interfere with any existing legal use of water.

The limitations in pumpage, imposed by the duty used to estimate reasonable water use and the 1,000 mg/l chloride cap, should preclude interference with other existing legal uses. Many of these uses are ongoing, and no claim of interference has occurred as yet. Finally, Standard Condition 3 for water use permits provides for modification or revocation of the permit if any interference with other existing legal uses results.

(4) Is consistent with the public interest.

These reasonable-beneficial uses of brackish, nonpotable water for golf course, landscape, and other urban irrigation uses, where no adverse impacts to other existing legal uses will result, are deemed to be in the public interest.

(5) Is consistent with state and county general plans and land use designations.

These proposed uses are consistent with the state and county general plans and land use designations.

(6) Is consistent with county land use plans and policies.

These proposed uses are consistent with county land use plans and policies.

(7) Will not interfere with the rights of the department of Hawaiian home lands as provided in section 221 of the Hawaiian Homes Commission Act.

All permits are subject to the prior rights of Hawaiian home lands. The Department of Hawaiian Home Lands (DHHL) and the Office of Hawaiian Affairs have reviewed this application. No objections or concerns were raised.

- Recommended Duration of New Interim Water Use Permits

The recommended duration of any new interim water use permits is to October, 1998 (to coincide with complete revocation of the Navy's permit and beginning revocation of other unused agricultural permits) or until such time that a significant change in permitted, actual, or projected uses or water supply occurs. It also provides a milestone date to check on the progress of wastewater reuse, the availability of which is now scheduled for July, 1999.

- Chloride Sampling Protocol

Assuming the Commission has approved the staff's recommendation in the previous agenda item regarding the establishment of sustainable capacities for individual irrigation wells at 1,000 mg/l of chloride, the staff recommends that the Commission condition all interim permits on weekly chloride sampling according the attached protocol (Exhibit 8). Weekly chloride measurements are desired for at least one (1) year so that the relation of water chemistry to the hydrology of the caprock may be better understood.

OTHER PERMITTED USES, PUULOA AQUIFER SYSTEM

- Sogo Hawaii, Inc./Puuloa Homes, Ltd. dba Ewa Beach International Golf Club for Well Nos. 1900-21,22 & 1959-08

Permanent permits have been approved for irrigation use for Ewa Beach International Golf Club for: 1) Well No. 1900-21 for 0.100 mgd and 2) Well Nos. 1900-22 & 1959-08 for 0.600 mgd.

A review of the pumpage data shows that actual pumpage at Well Nos. 1900-22 & 1959-08 has been consistently less than the 0.600 mgd allocation for the wells for about the last four (4) years (Exhibit 9). However, pumpage at Well No. 1900-21 is currently exceeding the 0.100 mgd allocation (Exhibit 10). We understand that all three (3) sources are located at the Ewa Beach International Golf Club (EBIGC) for the golf course irrigation supply.

In a letter dated April 7, 1997, we proposed that the allocations be combined under a single water use permit that would supersede the two (2) existing water use permits (WUP Nos. 170 and 367) to allow flexibility in pumping the wells and avoid overpumpage violations at Well No. 1900-21 in the future. We advised EBIGC that the staff would recommend that the Commission approve and issue a new interim permit for the three (3) sources, subject to the standard conditions and any special conditions that may be attached to caprock wells (EBIGC is a member of PCUG which has committed to conversion to R-1). If EBGIC would be amenable to this proposal, the staff would recommend that the Commission not pursue the current overpumpage at Well No. 1900-21 as a violation subject to fines.

We requested a written response to our April 7, 1997 letter in twenty (20) days, however, we understand that EBIGC is currently in the process of being sold, and our contact person, the golf course manager, has been terminated. The staff recommends deferring these issues to a later date when a new contact person can be identified. However, we will hold EBIGC to the water shortage plan that was previously submitted. (A water shortage plan for Puuloa is discussed below).

- DWM for Well Nos. 1902-03 & 04

  Pumpage at the Honouliuli Wastewater Treatment Plant has exceeded the 0.500 mgd allocation for the wells since the beginning of 1995 (Exhibit 11). We understand that DWM is currently limiting pumpage to 0.5 mgd and expects to be in compliance with the allocation by October, 1997. A water use permit was never issued.

  The staff recommends that the Commission find DWM in violation of WUP No. 160 for exceeding their allocation limit and establish a fine of $500 per day for the overpumpage violation beginning in June, 1996, the date on which DWM was first notified of the violation, to present. The cash fine would amount to $174,000. In the alternative, DWM may adhere to milestones, to be worked out by the Commission staff in conjunction with DWM staff, to ensure R-1 availability by June 30, 1999.

WATER SHORTAGE PLAN, PUULOA AQUIFER SYSTEM

The staff is also recommending that the Commission adopt a water shortage plan for the Puuloa Aquifer System. Administrative Rule 13-171-42 provides:

- "(a) *The commission shall formulate a plan for implementation during periods of water shortage. As a part of the plan, the commission shall adopt a reasonable system of permit classification according to source of water supply, method of extraction or diversion, use of water, or a combination thereof.*

  (b) In accordance with this chapter, the commission may impose such restrictions on one or more classes of permits as may be necessary to protect the water resources of the area from serious harm and to restore them to their previous condition.

  (c) All permittees, unless exempted by the commission, shall submit a water shortage plan outlining how it will reduce its own water use in case of a shortage. Every water shortage plan shall be subject to approval or modification by the commission."

That staff proposes a permit classification system according to type of use. The highest priority of nonpotable use will be agriculture because the State's policy is to promote agriculture, and also because agricultural correlative uses are assured through the 1978 Constitutional Amendment. The second priority in water use is golf course irrigation because of the economic impacts that may result from inadequate water supply. The lowest priority in water use is landscape irrigation and dust control.

Although it is uncertain whether a water shortage could occur given the proposed 1,000 mg/l chloride caps on individual wells, the staff feels that the current situation in the caprock warrants a water shortage plan that can be implemented immediately in the event of unforeseen circumstances that may require area-wide cutbacks in pumpage.

The priorities assigned to each permitted use and the maximum reductions indicated in the individual users' water shortage plans are shown in the last two columns of Exhibit 5. Individual water shortage plans outline smaller initial cutbacks (ie. 10% to 30%), however under the most severe shortage situations, Exhibit 5 shows the maximum reduction in Puuloa Aquifer System pumpage will be at least 3.718 mgd.

Water shortage plans were requested from all of the users in Puuloa, with the exception of USFWS. Some of the users have requested extensions (Navy, DWM). Others have not responded to our request (Gentry Homeowners Associations). The staff will continue to work with these users to come up with their individual plans. Submittal of water shortage plans are a condition of the water use permits. We appreciate the concessions made by the users who have submitted reasonable water shortage plans.

The staff recommends that the Commission delegate the authority to the Chairperson to approve or modify individual water shortage plans, pursuant to §13-171-42(c) HAR. For the Puuloa Aquifer System water shortage plan, the staff recommends that the Commission approve the proposed permit classification system and delegate the authority to the Chairperson to approve the regional water shortage plan.

APPLICATIONS FOR WELL CONSTRUCTION/PUMP INSTALLATION PERMITS, PUULOA AQUIFER SYSTEM

There are two (2) pending applications for well construction/pump installation permits in Puuloa:

- Gentry Golf Course Well (Well No. 2002-15)
- Gentry Keanui Area 30 Well (Well No. 2001-12)

In adopting the Hawaii Well Construction and Pump Installation Standards on January 23, 1997, the Commission also delegated the authority to the Chairperson to approve well construction and well modification permit applications statewide, unless the Chairperson determines that the matter should be decided by the Commission. However, because no sustainable yield was established for Puuloa and it appears to be overallocated, the staff is submitting these applications to the full Commission for approval.

In the event that the Commission approves the staff's proposed interim management plan, which provides for the establishment of chloride caps instead of a sustainable yield number, then future well construction permit applications may be approved administratively, prior to pump installation and water use permit approvals, which would require Commission action.

APPLICATIONS FOR WATER USE PERMITS, KAPOLEI AQUIFER SYSTEM

Exhibit 13 shows current total allocations in this system to be 2.946 mgd. Chlorides in this area are actually improving, which indicates that an overallocation situation does not exist in this area, unlike the Puuloa Aquifer System. Since a potential overallocation situation does not exist in this area, the staff recommends that the Commission approve the pending requests for new interim permits, as described in the applications and Exhibit 2, for the requested amounts:

Table 2. Summary of Water Use Permit Applications, Kapolei Aquifer System

Applicant	Well Name/No.	Recommended Allocation (mgd)	Proposed Use
Campbell Estate	Kapolei Irr (1905-08,10)	0.302	Landscape Irrigation
State HFDC	Kapolei Irr C-1,D (2003-04,07)	0.494	Dust Control, Irrigation
Kapolei People's Inc.	Kapolei Irr A,B,E (2003-01,02,05)	1.000	Golf Course Irrigation
TOTAL		1.796	

Section 174C-49(a) of the State Water Code establishes seven (7) criteria that must be met to obtain a water use permit:

(1) Can be accommodated with the available water source.

Again, assuming the Commission has approved the staff's recommendation in the previous agenda item regarding the establishment of sustainable capacities for individual irrigation wells at 1,000 mg/l of chloride, as determined through a pumping test, then the proposed uses can be accommodated with the available water source.

(2) Is a reasonable-beneficial use as defined in section 174C-3.

Section 174C-3 HRS defines "reasonable-beneficial use" is

> "*...the use of water in such a quantity as is necessary for economic and efficient utilization, for a purpose, and in a manner which is both reasonable and consistent with the state and county land use plans and the public interest*".

The recommended allocations in Table 2 are based on actual usage or projected demand using the Domestic Consumption Guideline (Hawaii Water System Standards, 1985). Where a variance from this guideline has been requested and is reflected in Exhibit 5, the applicant has provided sufficient and appropriate justification. Other reasonable-beneficial use criteria are analyzed in the following sections.

(3) Will not interfere with any existing legal use of water.

The limitations in pumpage, imposed by the duty used to estimate reasonable water use and the 1,000 mg/l chloride cap, should preclude interference with other existing legal uses. Many of these uses are ongoing, and no claim of interference has occurred as yet. Finally, Standard Condition 3 for water use permits provides for modification or revocation of the permit if any interference with other existing legal uses results.

(4) Is consistent with the public interest.

These reasonable-beneficial uses of brackish, nonpotable water for golf course, landscape, and other urban irrigation uses, where no adverse impacts to other existing legal uses will result, are deemed to be in the public interest.

(5) Is consistent with state and county general plans and land use designations.

These proposed uses are consistent with the state and county general plans and land use designations.

(6) Is consistent with county land use plans and policies.

These proposed uses are consistent with county land use plans and policies.

(7) Will not interfere with the rights of the department of Hawaiian home lands as provided in section 221 of the Hawaiian Homes Commission Act.

All permits are subject to the prior rights of Hawaiian home lands. The Department of Hawaiian Home Lands (DHHL) and the Office of Hawaiian Affairs have reviewed this application. No objections or concerns were raised.

RECOMMENDATIONS:

The staff recommends that the Commission:

1. Modify WUP No. 192 for Haseko (Ewa), Inc. by reducing the permitted use amount from 2.660 mgd to 1.800 mgd and by replacing the conditions of WUP No. 192 with the standard conditions shown in Attachment A, and the following special condition:

   a. Standard Condition 18 for interim water use permits shall not apply.

2. Require Haseko (Ewa), Inc. to conduct a pump test within one (1) month from the date of this submittal to confirm that the source can sustain withdrawals at the modified permitted amount without exceeding 1,000 mg/l of chloride.

a. Delegate the authority to the Commission staff to approve or modify the proposed pump test procedure.

3. Require The Estate of James Campbell to propose a pump test and conduct such test prior to reactivation of Well No. 2000-01 to confirm that the source can sustain withdrawals at the current permitted amount without exceeding 1,000 mg/l of chloride.

   a. Delegate the authority to the Commission staff to approve or modify the proposed pump test procedure.

4. Require the Department of Navy to propose a pump test, to be approved by the Commission staff, and conduct such test prior to reactivation of Well No. 2001-01 to confirm that the source can sustain withdrawals at the current permitted amount without exceeding 1,000 mg/l of chloride.

   a. Delegate the authority to the Commission staff to approve or modify the proposed pump test procedure.

5. Approve the issuance of interim permits for the Puuloa Aquifer System to the applicants listed above for the reasonable-beneficial uses and sources described in the applications for the Recommended Allocations shown in Exhibit 5, subject to the standard water use permit conditions in Attachment A and the following special conditions:

   a. The duration of the interim permits shall be to October, 1998 or until such time that a significant change in permitted, actual, or projected use or water supply occurs.

   b. Require adherence to the chloride sampling protocol shown in Exhibit 8 and the submittal of weekly chloride data.

   c. Require adherence to the Conservation Conditions shown in Exhibit 12.

   d. Require the following PCUG members to sign a contract within twelve (12) months with the City Department of Wastewater Management to buy reclaimed water by July 1, 1999 for the cumulative amounts specified in Exhibit 7 (Pro-Rata Share):

      1) Gentry Investment Co. - Commitment to use a total of 0.430 mgd of R-1 by July, 1999 for a corresponding reduction in allocation for Well No. 2002-15 and Well No. 2001-10.

      2) Haseko (Ewa), Inc. - Commitment to use a total of 0.40 mgd of R-1 by July, 1999 for a corresponding reduction in allocation for Well No. 1902-01.

      3) Hawaii Prince Golf Club - Commitment to use a total of 0.40 mgd of R-1 by July, 1999 for a corresponding reduction in allocation for Well Nos. 1900-02, 17 to 20 & 1901-03.

      4) Ewa Beach International Golf Club - Commitment to use a total of 0.27 mgd of R-1 by July, 1999 for a corresponding reduction in allocation for Well Nos. 1900-21,22 & 1959-08.

6. Find the Department of Wastewater Management in violation of WUP No. 160 for exceeding their allocation limit.

7. Impose a fine of $500 per day for the overpumpage violation in Recommendation 6 for the period beginning in June, 1996, the date on which DWM was first notified of the violation, to present ($174,000). In the alternative, DWM may adhere to milestones, to be worked out by the Commission staff in conjunction with DWM staff, to ensure R-1 availability by June 30, 1999.

8. Approve a permit classification system for the Puuloa Aquifer System by type of use, with agriculture the highest priority use, followed by golf course irrigation, followed by landscape irrigation and dust control.

9. Delegate the authority to the Chairperson to approve individual water shortage plans and the regional water shortage plan for the Puuloa Aquifer System.

10. Approve well construction permits for the following wells, subject to the standard conditions shown in Attachment B, and any special conditions that may be required to ensure compliance with the Hawaii Well Construction and Pump Installation Standards (January 1997).

   a. Gentry Golf Course Well (Well No. 2002-15)
   b. Gentry Area 30 Well (Well No. 2001-12)

11. Approve the issuance of interim water use permits for the Kapolei Aquifer System to the applicants listed above for the reasonable-beneficial uses and sources described in the applications for requested quantities shown in Exhibit 2, subject to the standard water use permit conditions in Attachment A and the following special conditions:

   a. The duration of the interim permits shall be to October, 1998 or until such time that a significant change in permitted, actual, or projected use or water supply occurs.

   b. Require adherence to the chloride sampling protocol shown in Exhibit 8 and the submittal of weekly chloride data.

c. Require adherence to the Conservation Conditions shown in Exhibit 12.

Respectfully submitted,

W. Roy Hardy

for RAE M. LOUI
Deputy Director

Attachment(s):
A (Standard Conditions for a Water Use Permit)
B (Standard Conditions for a Well Construction Permit)

Exhibit(s):
1 (Location Map)
2 (Summary of Pending Water Use Permit Applications)
3 (CWRM Comments on January 22, 1997 PCUG Plan)
4 (Interim Management Plan)
5 (Allocation Plan)
6 (Preliminary Pump Test Procedure for Agricultural Wells)
7 (DWM Consent Order and Decree)
8 (Chloride Sampling Protocol)
9 (Graph of Pumpage for Well No. 1900-21)
10 (Graph of Pumpage for Well Nos. 1900-22 & 1959-08)]
11 (Graph of Pumpage for Well Nos. 102-03 & 04)
12 (Conservation Conditions)
13 (Current Permitted Uses, Kapolei Aquifer System)

E. Flora / Fauna

EAST KAPOLEI MASTER PLAN

BIOLOGICAL SURVEY

Prepared by: Kenneth M. Nagata
For: PBR Hawaii
17 September 1996

INTRODUCTION

The project site occupies approximately 1300 acres in Honouliuli, Ewa District, Oahu. It encompasses the former sugar cane lands mauka of Varona Village from approximately 60' elevation, up to Farrington Highway. Two sections extend mauka to the H-1 Freeway. The west is bordered by the Kapolei development and the east boundary runs through abandoned sugar cane fields.

Ripperton and Hosaka (1942) classified the vegetation of the region as one of lowland shrub with a coastal fringe of kiawe trees (Prosopis pallida). Because of the arid conditions of the region the vegetation cover is generally sparse. Dominant shrubs include klu (Acacia farnesiana), koa-haole (Leucaena leucocephala) and 'ilima (Sida fallax) and the herb layer generally consists of annual grasses such as bristly foxtail (Setaria verticillata), swollen fingergrass (Chloris barbata) and feather fingergrass (Chloris virgata). In the foothills mauka of the flat lowlands where rainfall is more abundant the vegetation is denser and the herb layer includes Spanish needle (Bidens pilosa), false mallow (Malvastrum coromandelianum), cockelbur (Xanthium strumarium) and pili (Heteropogon contortus) in addition to the annual grasses of the lowlands.

Several recent surveys have been conducted in certain portions of the subject property and in the adjacent lands. In 1990 Funk completed a biological survey of the land immediately east and makai of the project site, including the village of Ewa (Funk 1990). Among the vegetation types recognized were Sugar Cane Fields, Ruderal Fields and Fallow Fields. These communities were characterized by actively cultivated sugar cane fields, abandoned cane fields, common "weedy" introduced plants and lowland wayside species including those mentioned by Ripperton and Hosaka (1942). Similar vegetation was found in the region immediately east of the subject property where common wayside species including koa-haole, Guinea grass (Panicum maximum) and cultivated and abandoned sugar cane fields were found to be prevalent (Funk 1994). Many of these same species were also present in the area between Varona Village and the golf course just makai of the project site (Nagata 1996) and in Kaloi Gulch (Nagata 1994).

METHODS AND MATERIAL

A walk-through survey was conducted in all plant communities between mid-September and early October, 1996 to determine the floristic compostition of the project site. Transects were established throughout the site and all plants observed were recorded and their relative abundance determined. In conjunction with the plant survey a cursory inventory of animals was also made. All birds and mammals observed along the transects were recorded and listening posts were established at regular intervals. No quantitative analyses was attempted, however, and nests were not investigated.

RESULTS

FLORA

Virtually all of the lowlands and foothills in the Ewa-Honouliuli region has been altered by the cultivation of sugar cane. In the past several years certain lands have been taken out of sugar and put to other use, eg. diversified agriculture, urbanization, fallowing. Consequently, the vegetation of these lands are entirely secondary and the vegetation in the region is largely determined by the history of cultivation (or disturbance) on each individual parcel of land, ie. how long the cane field has been abandoned, whether the land was recently tilled, etc. Based mostly on these criteria, eight plant communities were recognized. Although these are drawn with discreet boundaries on the vegetation map it must be remembered that such finite boundaries do not exist in nature. Rather, each community exists as a continuum wth one blending into another. Furthermore, the survey was conducted during the dry season. Species composition and vegetational cover will differ somewhat during the rainy season.

Abandoned Cane Fields (ACF)

This is the largest vegetation type in the project site, representing the most recently abandoned sugar cane fields. Here, sugar cane generally accounts for about 50% of the total vegetational cover. In some areas the cane is 15' tall, robust and still very dense. In most areas, however, the cane is senile, less than 7' tall and accounts for as little as 30% of the total vegetational cover. In fields that have been abandoned for a longer period or where growing conditions were not optimal the clumps of cane are mostly dead or dying. Even in these fields these decrepit clumps are still in distinct rows. The vegetation between clumps usually consist of a mixed herb cover of 'ilima, Guinea grass, radiate fingergrass (Chloris radiata), 'uhaloa (Waltheria indica), hoary abutilon (Abutilon incanum), fuzzy rattlepod (Crotalaria incana), peria (Momordica charantia var. abbreviata) and nut grass (Cyperus rotundus). Total vegetational cover is generally about 75-90%; only where the cane is vigorous and dense is the cover up to 100%.

In some areas such as along the Ewa boundary fence the abundance of cane

is very low and the vegetation approaches that of the Fallow Fields. Here the vegetation is more open with more exposed ground. 'Ilima, 'uhaloa, peria, hoary abutilon and little bell (Ipomoea triloba) are abundant.

Fallowed Fields

The Fallowed Fields are those sugar cane fields which have been abandoned for such a long time that almost no living cane remain. Dead and dying clumps generally constitute less than 5% of the total cover. Dead cane stalks may litter the ground and planting furrows may still be evident but these fields are often difficult to recognize as sugar cane fields without close examination. Two Fallowed Fields subcommunities were recognized depending on the relative abundance of grasses.

Fallowed Fields Mixed Herb Association (Fmh)

Typically the vegetation in this community is less than 4' tall and consists of a mixture of 'uhaloa, radiate fingergrass, 'ilima, hoary abutilon, false mallow, buffelgrass (Cenchrus ciliaris), golden crown-beard (Verbesina encelioides) and coat buttons (Tridax procumbens). Small isolated stands of dying cane occur in certain portions of this community. Small patches of Guinea grass and/or radiate fingergrass can also be found. These grasses along with swollen fingergrass (Chloris barbata), sourgrass (Digitaria insularis) and Natal redtop (Rhynchelytrum repens) are especially common in the mauka portions of this community. Along the road delineating the makai boundary the vegetational cover is only about 50%. Pa'uohi'iaka (Jacquemontia ovalifolia) is common in this open area. Several stands of dead or dying cane also occur here.

Fallowed Fields Grassland Association (Fg)

In certain areas the fallowed cane fields are dominated by Guinea grass and/or radiate fingergrass. Almost no standing cane remain although the furrows are still more or less intact and fallen cane stalks are occasional throughout the community. In most areas the grass cover is 100% but small communities and individuals of 'ilima, hoary abutilon and false mallow are scattered through certain portions and swollen fingergrass and sourgrass are common in other areas.

Abandoned Fields (A)

Several former cane fields in the mauka portion along Palehua Road and between Farrington Highway and the H-1 Freeway have been tilled or graded sometime in the past. The ground is quite level with few stones and although some sugar cane is resprouting the planting furrows are gone. These fields were probably planted in some crop in years past but are now overgrown with mostly 'uhaloa, fuzzy rattlepod, nut grass and little bell. In one field mauka of Farrington Highway Guinea grass is abundant but in most of the Abandoned Fields this species is not quite so prevalent. Re-sprouting sugar cane is also common in the mauka portion of this field. Golden crown-beard, peria and hoary abutilon are common in some of the fields.

Cultivated Fields (C)

Cultivated Fields are fields which have been recently plowed, actually planted in a crop (other than sugar cane), or which have been put to some urban use. Of the five fields designated as Cultivated Fields, three have been recently plowed. The vegetation in these consist mostly of seedling little bell, peria, fuzzy rattlepod, 'uhaloa, castor bean (Ricinus communis), graceful spurge (Chamaesyce hypericifolia) and re-sprouting nut grass. Vegetational cover is about 25-50%. In two fields watermelons (Citrellus lanatus) have been planted and along the Ewa boundary fence an approximately two-acre site has been graded and turned into a parking lot. Approximately half of this field has been paved with gravel. Most of the vegetation in this portion consist of Amaranthus viridis and nut grass. The vegetation in the ungravelled portion consist of peria, nut grass, 'uhaloa, radiate fingergrass, false mallow and re-sprouting sugar cane.

Grasslands (GR)

Grasslands represent those lands which apparently have not been tilled, graded or planted in any crop including sugar cane. This community exists only on the steepest slopes just makai of the H-1 Freeway and is the smallest of all the vegetation types in the project site. The vegetation is one of Guinea grass 1-2' tall with emergent klu, koa-haole and kiawe. On eroded slopes, 'ilima, false mallow, 'uhaloa, Beorhavia coccinea, garden spurge (Chamaesyce hirta) and virgate mimosa (Desmanthus virgatus) are found in small numbers.

Gulch Association (GU)

Kaloi Gulch together with its tributary Hunehune Gulch represents the only natural drainage system in the project site. The vegetation in the gulches is characterized by extremely dense stands of Guinea grass 5-10' tall. So dense is this layer that very few other species are present. In the makai portion the predominant arborescent species is castor bean which grows to about 15' height. Koa-haole 20-30' tall replaces castor bean as the dominant overstory in the mauka sections of the gulch system. In the mauka portion of Hunehune Gulch ivy gourd (Coccinea grandis) is abundant, often completely enshrouding the Guinea grass and koa-haole. Paragrass (Brachiaria mutica), wood rose (Herremia tuberosa),

moon flower (Ipomoeaalba) and peria are also found but only in small to moderate numbers.

Roadside Vegetation (R)

Numerous plant species are found along the paved and gravel roads. More species are found in this community than in any other in the project site. Guinea grass and radiate fingergrass are abundant. 'Uhaloa and nut grass are also found in large numbers and many other species including castor bean, fuzzy rattlepod, buffelgrass, graceful spurge, virgate mimosa, peria, lion's ear (Leonotis nepetifolia), Australian saltbush (Atriplex semibaccata), goosegrass (Eleusine indica), Natal redtop (Rhynchelytrum repens) and stinkgrass (Eragrostis cilianensis) are found in smaller numbers. This is not considered a significant plant community and its total area is very small.

Native Plant Communities

As a result of decades of sugar cultivation, virtually all of the vegetation in the project iste is secondary in nature. Of the 99 plant species recorded two are indigenous ('ilima, pa'uohi'iaka), two are probably indigenous ('uhaloa, hoary abutilon) and one is endemic (ko'oloa'ula, Abutilon menziesii). Of these, 'ilima, 'uhaloa and hoary abutilon are dominant or co-dominant in several plant communities and are significant elements in the vegetation in the site as a whole. Pa'uohi'iaka is found in small to moderate numbers in four vegetation types and is common in certain areas in the Fallowed Fields Mixed Herb community. It frequently grows in association with 'ilima, 'uhaloa and hoary abutilon. They do not, however, represent native plant communities. Rather, these native or possibly native species are well adapted to arid lowlands and are able to recolonize disturbed sites.

Except for ko'oloa'ula, all of the native species in the site are common lowland species in Hawaii. Ko'oloa'ula, on the other hand, is a rare and endangered species once endemic to Lanai, Maui, Oahu and Hawaii. It is now extinct on Hawaii.

Endangered Species

At least 38 individuals of the federally listed endangered species ko'oloa'ula were recorded from the site. Most of these (28) were in the Abandoned Cane Fields, six were in the Fallowed Fields Mixed Herb Association and four were in the Fallowed Fields Grassland Association. Approximate locations are indicated on Figure 2. All of these plants were healthy and most were flowering and/or fruiting.

Ko'oloa'ula was first submitted for listing as an endangered species in 1976 (Fed. Reg. 1976). The Endangered Species Act Amendments of 1978 required that the list of candidates for endangered status be withdrawn after two years and in 1979 ko'oloa'ula was withdrawn from consideration (Fed. Reg. 1979). In 1980 it was resubmitted as a top priority Category 1 candidate (Fed. Reg. 1980) and in 1985 the U.S. Fish and Wildlife Service proposed to list it as an endangered species (Fed. Reg. 1985). On Sept. 26, 1986 it was formally listed (Fed. Reg. 1986) and is now protected under the provisions of the Endangered Species Act of 1973, as amended, and the Hawaii State Revised Statutes.

Significant wild populations of ko'oloa'ula are found on Lanai and Maui but its occurrence on Oahu is somewhat of an enigma. It was known from a single plant discovered in an abandoned sugar cane field mauka of Hawaii Raceway Track at Barbers Point in 1981 and more recently from another individual at the Lualualei Naval Magazine (D. Herbst, pers. comm.). Both of these occurrences as well as the current discovery are from highly disturbed environments. The Barbers Point location is approximately four miles from the project site and the Lualualei site is at least 15 miles away. Ko'oloa'ula was not found in any of the prior surveys in the immediate area (Funk 1990, 1994; Nagata 1994, 1996).

FAUNA

Mammals

No mammals were observed in the site. It is probable, however, that field mice (Mus musculus), mongoose (Herpestris auropunctatus) and one or more species of rats (Rattus spp.) are found in the property. In addition, pig trails were observed in several plant communities.

Birds

Seventeen species of birds were observed in the site. To be considered a sighting, the individual must be observed perched or on the ground and not merely flying overhead. In addition, owl pellets were found in the Fallowed Fields Grassland Association community. It is not known, however, whether these are from the barn owl (Tyto alba) or pueo (Asio flammeus). Fifteen species are introduced, one is a common migratory species (Pacific golden-plover) and one is indigenous (Black-crowned night heron).

ARDEIDAE

Cattle egret (Bubulcus ibid)

Eight individuals were observed in the Abandoned Fields mauka of Farrington

Highway. On 4 October the Abandoned Field community immediately makai of the Cultivated Field east of Palehua Road was being plowed. Nearly 100 cattle egrets were seen feeding in the freshly tilled ground.

Black-crowned night heron (Nycticorax nycticorax)

Two young birds were flushed out of Hunehune Gulch near Plantation Road. As there was no water in either Hunehune Gulch or Kaloi Gulch it is not known whether these individuals are residents of the area or whether they are transients. The black-crowned night heron is indigenous to Hawaii.

CHARADRIIDAE

Pacific golden-plover (Pluvialis dominica)

The Pacific golden-plover is a migratory species which commonly spends its winters in Hawaii. Many were observed in the site. Thirty-two were counted in exposed areas in the Abandoned Cane Fields. Most of these were in the open site near the Ewa boundary. Twenty-six were observed in various areas in the Fallowed Fields Mixed Herb Association - six of them from the exposed areas near the makai boundary road. Twenty-six were seen in the Cultivated Areas. Of these, 20 were in the "parking lot" at the Ewa boundary.

COLUMBIDAE

Rock dove (Columba livia)

Three were observed in the exposed sections of the Fallowed Field Mixed Herb Association in the makai portion of the site.

Barred dove (Geopelia striata)

Many were seen in all but two vegetation types. They were most abundant along the paved roads.

Lace-neck dove (Streptopelia chinensis)

This is the most widespread species in the property. It was found in moderate numbers in all vegetation types.

FRINGILLIDAE

Red-crested cardinal (Paroaria coronata)

Three individuals were seen in koa-haole shrubs along Plantation Road.

Kentucky cardinal (Richmondena cardinalis)

One individual was seen in the Fallowed Fields Mixed Herb Association.

PHASIANIDAE

Francolin (_Francolinus_ sp.)

About a dozen were seen in the Abandoned Cane Fields near Kaloi Gulch in the makai portion of the property. These birds ran and hid too quickly for a positive identification to species.

Ring necked pheasant (_Phasianus colchicus_)

Three pairs were flushed from the Abandoned Cane Fields and one pair was flushed from the Abandoned Fields along Palehua Road.

PLOCEIDAE

House finch (_Carpodacus mexicanus_)

About 20 were seen in the property, mostly along the roadways.

Orange-cheeked waxbill (_Estrilda melpoda_)

These were seen in small numbers in the Fallowed Fields Mixed Herb Association, Abandoned Fields and along the roadways.

Black-headed mannikin (_Lonchura malacca_)

Black-headed mannikins were seen in moderate numbers in the Abandoned Cane Fields, Fallowed Fields communities and along the roadways.

Rice bird (_Lonchura punctulata_)

Rice birds were seen in moderate to small numbers in all but two plant communities. They were most common along the roadways and in the Fallowed Fields Grassland Association.

PYCNONOTIDAE

Red-vented bulbul (_Pycnonotus cafer_)

The red-vented bulbul was the second most widespread species in the site. It was found in small to moderate numbers in all vegetation types except the Cultivated Fields.

STURNIDAE

Common mynah (_Acridotheres tristis_)

Only three were seen in the Abandoned Cane Fields in the makai portion of the property.

ZOSTEROPIDAE

Japanese white-eye (_Zosterops japonicus_)

Japanese white-eyes were found in small numbers mostly along the roadways.

SUMMARY

The vegetation in the project site consists of sugar cane, lowland shrubs and herbs and grasses. The vast majority of the 99 species recorded from the property is non-native. Only three native species (one endemic, two indigenous) and two possibly indigenous species were encountered but with the exception of the endemic ko'oloa'ula these were present in moderate to large numbers. Native species constitute a rather significant element of the vegetation. However, no native plant communities are present. As a result of decades of sugar cultvation the vegetation is entirely secondary and the native ('ilima, pa'uohi'iaka) or possibly native (hoary abutilon, 'uhaloa) species which are so common in the site are merely recolonizing an already completely altered habitat. According the the U.S. Fish and Wildlife Service the endangered species ko'oloa'ula can also be included as secondary in origin.

The various plant communities in the site serve as an excellent refuge and feeding site for 17 bird species. Fifteen are introduced urban, field or game birds, one is indigenous (black-crowned night heron) and one is a common migratory species (Pacific golden-plover). Many of the birds including the plover are present in moderate to large numbers.

The proposed project will result in the loss of large numbers of 'ilima, pa'uohi'iaka, 'uhaloa and hoary abutilon. These are all common lowland species and theirs is not considered a significant loss to the native flora. The project will also result in the loss of habitat for a large number of Pacific golden-plovers and two black-crowned night herons. At least 38 individuals of the endangered ko'oloa'ula will be affected by the project. The disposition of these will be determined through consultation with the State of Hawaii Division of Forestry and Wildlife as prescribed by the Hawaii Endangered Species Law.

RECOMMENDATIONS

Because of the presence of the federally endangered ko'oloa'ula in the project site, consultation with the Hawaii State Department of Land and Natural Resources Division of Forestry and Wildlife is required under the provisions of the State Endangered Species Law before any grubbing can commence. Similar discussions with the U.S. Fish and Wildlife Service is also recommended. These consultations will essentially determine the fate of the proposed project and what mitigating measures will be required to preserve the ko'oloa'ula.

The plant survey was conducted at 80% coverage and although a more intensive search was conducted in the vicinity of each ko'oloa'ula there is a high probability that more individuals are present in the site. It is therefor recommended that a 100% survey be undertaken in selected areas as indicated in Figure 2.

LITERATURE CITED

Berger, A.J. 1981. Hawaiian Birdlife. 2nd ed. Univ. Press of Hawaii. Honolulu. 260 pp.

Federal Register. 1976. 41 FR 24523; June 16, 1976.

________. 1979. 44 FR 70796; December 10, 1979.

________. 1980. 45 FR 82480; December 15, 1980.

________. 1985. 50 FR 28876; July 16, 1985.

________. 1986. 51 FR 34412; September 26, 1986.

Funk, E. 1990. Biological Resources Survey Report for Ewa Villages Development. Prepared for R.M. Towill Corp. 20 pp.

______. 1994. Biological Resources Survey Report for Schuler Homes East Kapolei Project, East Kapolei, Oahu, Hawaii. Prepared for Schuler Homes, inc. 15 pp.

Nagata, K.M. 1994. Kaloi Gulch Vegetation Survey. unpublished. 1 pp.

______. 1996. Varona Village Biological Survey. Prepared for PBR Hawaii. 14 pp.

Neal, M.C. 1965. In Gardens of Hawaii. Bernice P. Bishop Museum Special Publ. 50. Bishop Museum Press. Honolulu. 924 pp.

St. John, H. 1973. List and Summary of the Flowering Plants in the Hawaiian Islands. Pac. Trop. Bot. Gard. Mem. No 1. Lawai. 579 pp.

Wagner, W.L., D.R. Herbst & S.H. Sohmer. 1990. Manual of the Flowering Plant of Hawaii. 2 vols. Univ. of Hawaii Press & Bishop Museum Press. Honolulu. 1853 pp.

PLANT SPECIES CHECKLIST

Families are arranged alphabetically in two groups: Monocotyledons and Dicotyledons. Genera and species are arranged alphabetically within each family. Taxonomy, common names and status follow those of Neal (1965), St. John (1973) or Wagner et. al. (1990). The abundance determinations are relative and are subject to the judgement of the investigator.

EXPLANATION OF SYMBOLS

Species Status:

- E - Endemic to the Hawaiian Islands, ie. occurring naturally nowhere else in the world.
- I - Indigenous, ie. native to the Hawaiian Islands but also occurring naturally elsewhere.
- X - Exotic (alien), ie. plants introduced after the Western discovery of the islands.
- P - Polynesian introductions, ie. plants introduced before the Western discovery of the islands.

Relative Abundance Ratings:

- A - ABUNDANT, generally the major or dominant species in a given area.
- C - COMMON, generally distributed throughout a given area in large numbers.
- O - OCCASIONAL, generally distributed through a major portion of a given area, but in small numbers.
- U - UNCOMMON, observed uncommonly but more than 10 times in a given area.
- R - RARE, observed 2 to 10 times in a given area.

Vegetation Types:

- ACF - Abandoned Cane Fields
- Fmh - Fallowed Fields Mixed Herb Association.
- Fg - Fallowed Fields Grassland Association
- A - Abandoned Fields
- C - Cultivated Fields
- GR - Grasslands
- GU - Gulch Association
- R - Roadside Vegetation

ANIMAL SPECIES CHECKLIST

Families are arranged alphabetically and genera and species are arranged alphabetically within each family. Taxonomy follows that of Berger (1981). Quantitative techniques were not employed and thus only presence is recorded in each vegetation type.

EXPLANATION OF SYMBOLS

Species Status:

- M - Migratory species.
- I - Indigenous, ie. native to the Hawaiian Islands but also occurring naturally elsewhere.
- X - Exotic (alien), ie. animals introduced after the Western discovery of the islands.

Vegetation Types:

- ACF - Abandoned Cane Fields
- Fmh - Fallowed Fields Mixed Herb Association
- Fg - Fallowed Fields Grassland Association
- A - Abandoned Fields
- C - Cultivated Fields
- GR - Grasslands
- GU - Gulch Association
- R - Roadside Vegetation

LEGEND FOR FIGURE 1

ACF	C
Fmh	GR
Fg	GU
A	R

LEGEND FOR FIGURE 2

Approximate location of Ko'oloa'ula

Suggested area of intensive survey

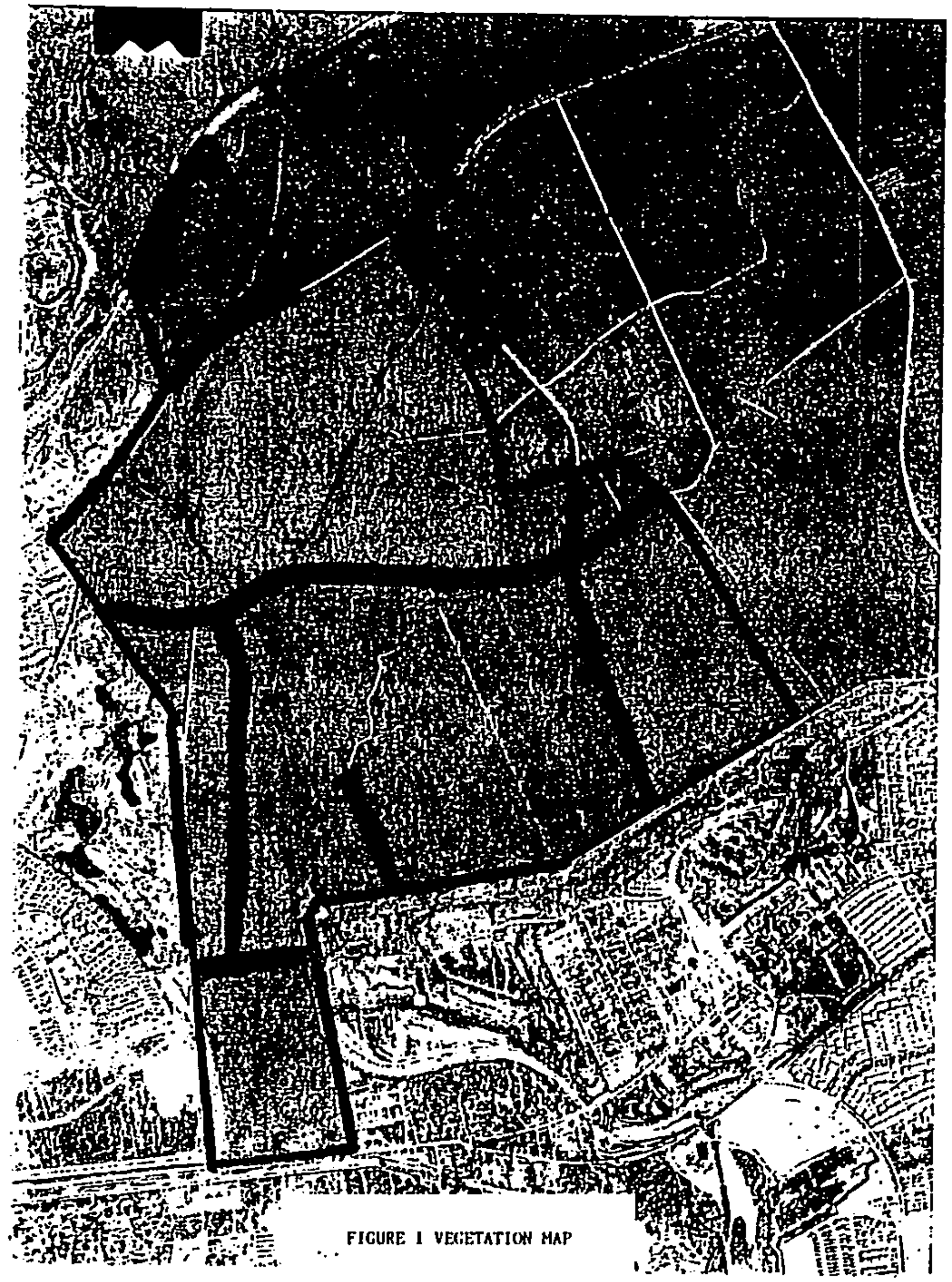


FIGURE 1 VEGETATION MAP

C H E C K L I S T O F P L A N T S

SCIENTIFIC NAME	COMMON NAME	STATUS	ACT	FaH	Fg	A	C	Ci	CU	R
CHECKLIST OF ANIMALS										
ARDEIDAE										
Bubulcus ibis	Cattle egret	I	-	-	-	I	I	-	-	-
Nycticorax nycticorax	Black-crowned night heron	I	-	-	-	-	-	-	-	I
CHARADRIIDAE										
Pluvialis dominica	Pacific golden-plover	M	I	I	-	-	I	-	-	-
COLUMBIDAE										
Columba livia	Rock dove	I	-	I	-	-	-	-	-	-
Geopelia striata	Barred dove	I	I	I	I	I	I	-	-	I
Streptopelia chinensis	Lace-neck dove	I	I	I	I	I	I	I	I	I
FRINGILLIDAE										
Paroaria coronata	Red-crested cardinal	I	-	-	-	-	-	-	-	I
Richmondena cardinalis	Kentucky cardinal	I	-	I	-	-	-	-	-	-
PHASIANIDAE										
Francolinus sp.	Francolin	I	I	-	-	-	-	-	-	-
Phasianus colchicus	Ring-necked pheasant	I	I	-	-	I	-	-	-	-
PLOCEIDAE										
Carpodacus mexicanus	House finch	I	I	-	-	-	-	-	-	I
Estrilda melpoda	Orange-cheeked waxbill	I	-	I	-	I	-	-	-	I
Lonchura malacca	Black-headed mannikin	I	I	I	I	-	-	-	-	I
L. punctulata	Rice bird	I	I	I	I	I	-	I	-	I
PYCNONOTIDAE										
Pycnonotus cafer	Red-vented bulbul	I	I	I	I	I	-	I	I	I
STURNIDAE										
Acridotheres tristis	Common mynah	I	I	-	-	-	-	-	-	-
ZOSTEROPIDAE										
Zosterops japonicus	Japanese white eye	I	I	I	-	-	-	-	-	I

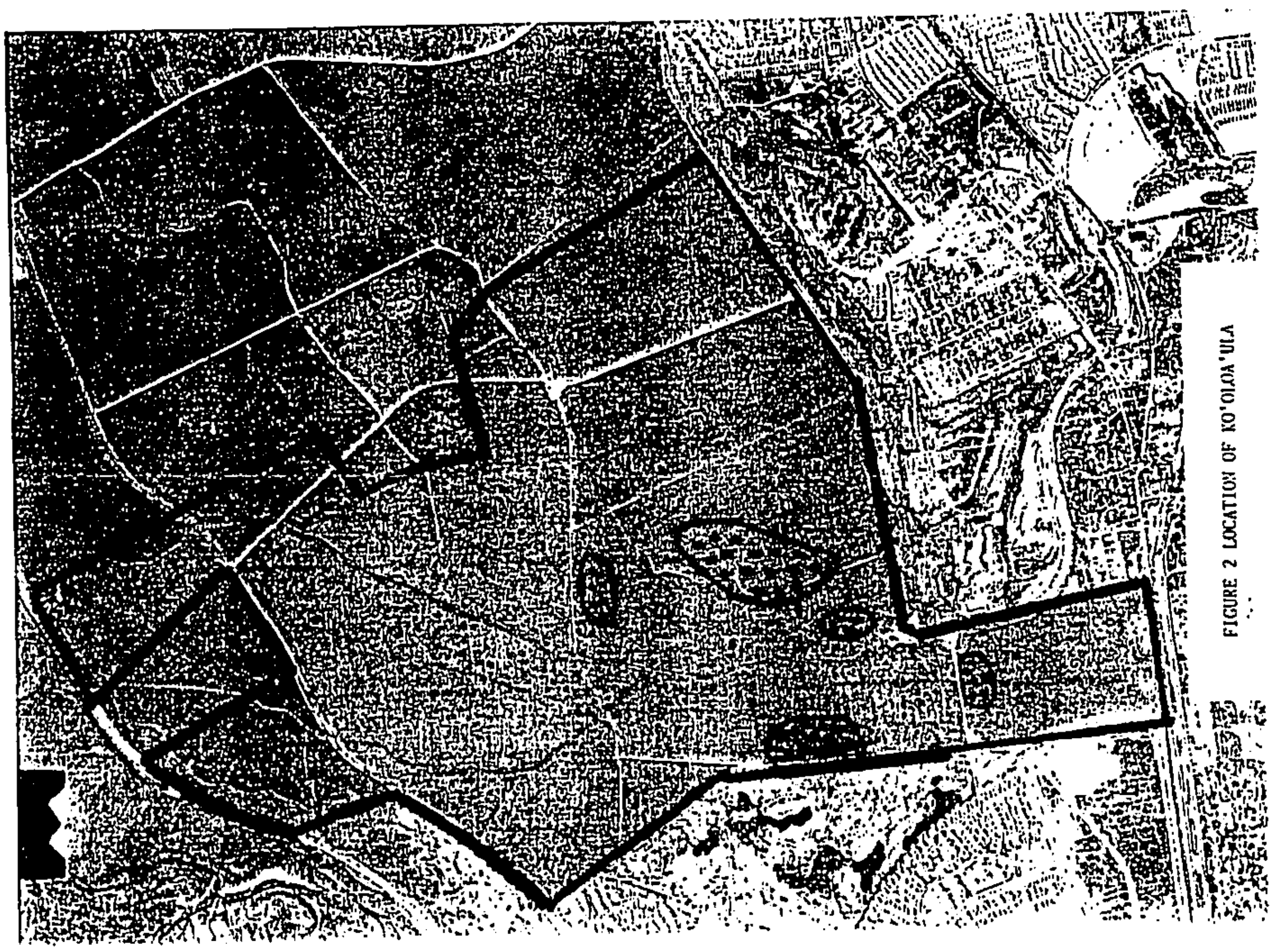


FIGURE 2 LOCATION OF KO'OLOA'ULA

C H E C K   L I S T   O F   P L A N T S

SCIENTIFIC NAME	COMMON NAME	STATUS			ACT	FaH	Fe	A	C	CR	CU	R
FABACEAE												
Desmodium tortuosum (Sw.) DC.	Florida beggarweed	I			-	-	-	-	-	-	-	U
Erythrina sp.		I			-	-	-	-	-	-	R	R
Indigofera spicata Forssk.	Creeping indigo	I			-	-	-	-	-	-	-	U
I. suffruticosa Mill.	Indigo	I			U	U	U	R	-	-	-	U
Lablab purpureus (L.) Sweet	Hyacinth bean	I			R	R	-	-	-	-	-	U
Leucaena leucocephala (Lam.) de Wit	Koa-haole	I			U	U	U	U	-	O	A	U
Macroptilium lathyroides (L.) Urban	Cow pea	I			U	U	-	-	U	-	-	R
Pithecellobium dulce (Roxb.) Benth.	'Opiuma	I			R	R	-	-	-	-	-	R
Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	Kiawe	I			-	R	-	-	-	R	-	U
Senna occidentalis (L.) Link	Coffee senna	I			-	R	-	-	-	-	-	-
Vigna sesquipedalis Wight	Long bean	I			R	-	-	-	-	-	-	-
LAMIACEAE												
Leonotis nepetifolia (L.) R. Br.	Lion's ear	I			O	U	R	U	U	U	-	U
MALVACEAE												
Abutilon grandifolium (Willd.) Sweet	Hairy abutilon	I			-	-	-	-	-	U	-	U
A. incanum (Link) Sweet	Hoary abutilon	I?			C	C	C	O	R	U	-	-
A. menziesii Seem.	Ko'oloa'ula	E		ENDANGERED	U	R	-	-	-	-	-	-
Malvastrum coromandelianum (L.) Garcke	False mallow	I			U	C	O	O	C	U	-	O
Sida ciliaris L.		I			-	-	-	-	-	-	-	U
S. fallax Walp.	'Ilima	I			C	A	C	U	-	U	-	R
S. rhombifolia L.	Cuba jute	I			-	U	-	-	-	-	-	U
S. spinosa L.	Prickly sida	I			-	U	-	R	-	U	-	U
MORACEAE												
Morus sp.		I			R	-	-	-	-	-	-	-
NYCTAGINACEAE												
Boerhavia coccinea Mill.		I			O	O	R	U	U	U	-	U
PASSIFLORACEAE												
Passiflora foetida L.	Love-in-a-mist	I			U	-	U	O	R	U	-	U
PORTULACACEAE												
Portulaca oleracea L.	Pigweed	I			U	U	U	R	U	U	-	-
PRIMULACEAE												
Anagallis arvensis L.	Scarlet pimpernel	I			R	-	-	-	-	-	-	-
SOLANACEAE												
Datura stramonium L.	Jimson weed	I			-	-	-	-	-	-	R	-
Lycopersicon pimpinellifolium Mill.	Currant tomato	I			U	R	-	U	U	-	-	U
Nicotiana glauca R.C. Graham	Tree tobacco	I			U	R	R	-	-	-	-	U
STERCULIACEAE												
Waltheria indica L.	'Uhaloa	I?			C	A	O	C	O	U	-	C

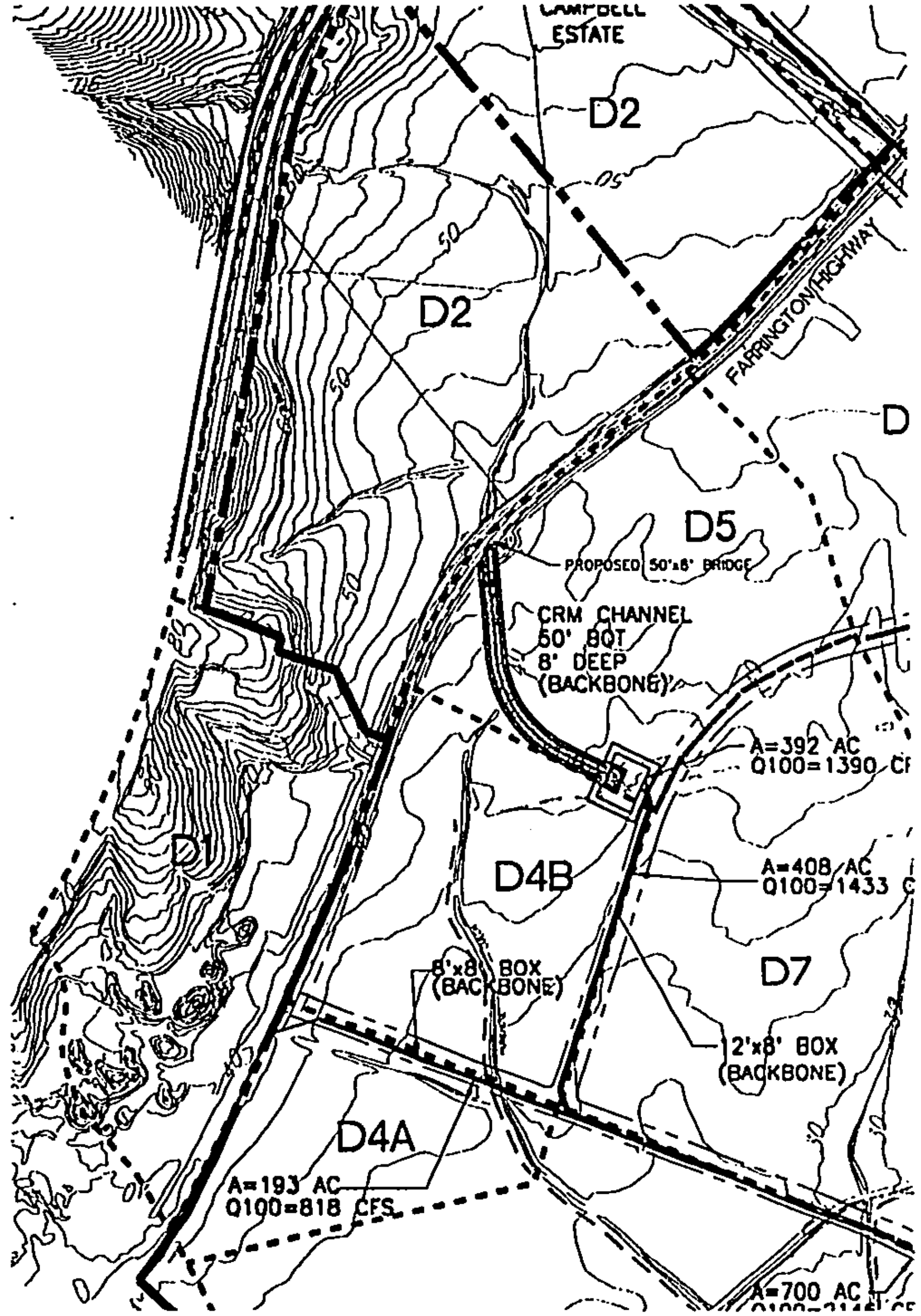
C H E C K   L I S T   O F   P L A N T S

SCIENTIFIC NAME	COMMON NAME	STATUS			ACT	FaH	Fe	A	C	CH	CU	R
TILIACEAE												
Triumfetta semitriloba Jacq.	Sacramento bur	I			-	-	-	-	-	-	-	R
ZYGOPHYLLACEAE												
TRIBULUS TERRESTRIS L.	Puncture vine	I			-	R	-	-	R	-	-	O

APPENDIX D

BACKBONE DRAINAGE SYSTEM HYDRAULIC SIZING

- HEC-2 Computations for CRM Channel
- Hunehune Stream Channel Improvements
- Box Drain Sizing and Hydraulic Data



```
1*****************************************
*  HEC-2 WATER SURFACE PROFILES          *
*                                        *
*  Version  4.6.2;  May 1991             *
*                                        *
*  RUN DATE   23JUL97   TIME   07 55:43  *
******************************************
```

```
******************************************
*  U.S. ARMY CORPS OF ENGINEERS
*  HYDROLOGIC ENGINEERING CENTER
*  609 SECOND STREET, SUITE D
*  DAVIS, CALIFORNIA 95616-4687
*        (916) 756-1104
******************************************
```

```
X     X XXXXXXX  XXXXX           XXXXX
X     X X       X     X         X     X
X     X X       X                     X
XXXXXXX XXXX    X         XXXXX   XXXXX
X     X X       X               X
X     X X       X     X         X
X     X XXXXXXX  XXXXX          XXXXXXX
```

```
1
  23JUL97     07:55:43                                          PAGE   1

                                       THIS RUN EXECUTED 23JUL97   07:55:43

**************************************
 HEC-2 WATER SURFACE PROFILES

 Version  4.6.2;  May 1991
**************************************

T1      EAST KAPOLEI BACKBONE DRAINAGE SYSTEM
T2      HUNEHUNE STREAM-CRM CHANNEL CONNECTING FARRINGTON HWY AND BOX DRAIN
T3      PLATE 6  FLOOD PROFILE - SUBCRITICAL RUN
T4      FILE NAME:  CRM-CHAN.DAT

J1  ICHECK    INQ     NINV    IDIR    STRT   METRIC   HVINS     Q      WSEL     FQ

        0       2        0       0       0       0        0      0   107.86      0

J2  NPROF   IPLOT    PRFVS   XSECV   XSECH     FN    ALLDC    IBW    CHNIM   ITRACE

        1       0       -1       0       0       0       -1      0       0       0

J3  VARIABLE CODES FOR SUMMARY PRINTOUT

   110      150

QT      1     1390
NC  0.025    0.025    0.025     0.1      0.3
X1    100        4        0     135
GR  114.0        0    89.58       0    89.58     195    114.0     195

QT      1     1250
X1    200        4        0      82      150     150      150
GR    125        0      117      16      117      66      125      82

X1    300        4        0      82      280     300      290
GR 129.39        0   121.39      16   121.39      66   129.39      82

X1    400        4        0      82      220     260      240
GR 133.02        0   125.02      16   125.02      66   133.02      82

X1    500        4        0      82      275     275      275
GR 137.18        0   129.16      16   129.18      66   137.18      82

X1    600        6        0      82      180     100      140
BT     -6        0    143.7   139.3       16   143.7    131.3      16   143.7   139.3
BT              66    143.7   139.3       66   143.7    131.3      82   143.7   139.3
GR  143.7        0    139.3       0    131.3      16    131.3      66   139.3      82
GR  143.7       82
1
  23JUL97     07:55:43                                          PAGE   2
```

```
X1    700        6        0      82       40      40       40
BT     -6        0    143.7  139.44       16   143.7   131.44      16   143.7  139.44
BT              66    143.7  139.44       66   143.7   131.44      82   143.7  139.44
GR  143.7        0   139.44       0   131.44      16   131.44      66  139.44      82
GR  143.7       82
1
  23JUL97     07:55:43                                          PAGE   3

   SECNO    DEPTH    CWSEL    CRIWS    WSELK     EG       HV       HL     OLOSS   L-BANK ELEV
   Q        QLOB     QCH      QROB     ALOB      ACH      AROB     VOL    TWA     R-BANK ELEV
   TIME     VLOB     VCH      VROB     XNL       XNCH     XNR      WTN    ELMIN   SSTA
   SLOPE    XLOBL    XLCH     XLOBR    ITRIAL    IDC      ICONT    CORAR  TOPWID  ENDST

*PROF 1

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS
0

CCHV=    .100 CEHV=     .300
*SECNO 100.000
  100.000   18.28   107.86   90.74   107.86   107.86     .00     .00     .00   114.00
   1390.0      .0   1390.0      .0       .0   3544.6      .0      .0      .0   114.00
      .00     .00      .39     .00     .000     .025    .000    .000   89.58      .00
  .000001      0.       0.      0.        0       16       0     .00  195.00   195.00

*SECNO 200.000

3301 HV CHANGED MORE THAN HVINS

7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
  200.000    2.59   119.59  119.59      .00   120.78    1.19     .00     .36   125.00
   1250.0      .0   1250.0      .0       .0    142.8      .0     6.4      .4   125.00
      .00     .00     8.75     .00     .000     .025    .000    .000  117.00    10.82
  .007058    150.     150.    150.        0       17       0     .00   60.35    71.18

*SECNO 300.000
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
  300.000    2.58   123.97  123.97      .00   125.17    1.19    2.05     .00   129.39
   1250.0      .0   1250.0      .0       .0    142.6      .0     7.3      .8   129.39
      .01     .00     8.77     .00     .000     .025    .000    .000  121.39    10.83
  .007095    280.     290.    300.        0        5       0     .00   60.34    71.17

*SECNO 400.000
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
  400.000    2.59   127.61  127.61      .00   128.80    1.19    1.70     .00   133.02
   1250.0      .0   1250.0      .0       .0    142.7      .0     8.1     1.2   133.02
       02     .00     8.76     .00     .000     .025    .000    .000  125.02    10.83
  .007086    220.     240.    260.        0        5       0     .00   60.34    71.17

1
  23JUL97     07:55:43                                          PAGE   4

   SECNO    DEPTH    CWSEL    CRIWS    WSELK     EG       HV       HL     OLOSS   L-BANK ELEV
   Q        QLOB     QCH      QROB     ALOB      ACH      AROB     VOL    TWA     R-BANK ELEV
   TIME     VLOB     VCH      VROB     XNL       XNCH     XNR      WTN    ELMIN   SSTA
   SLOPE    XLOBL    XLCH     XLOBR    ITRIAL    IDC      ICONT    CORAR  TOPWID  ENDST

*SECNO 500.000
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
  500.000    2.59   131.77  131.77      .00   132.96    1.19    1.95     .00   137.18
   1250.0      .0   1250.0      .0       .0    142.6      .0     9.8     1.6   137.18
      .03     .00     8.76     .00     .000     .025    .000    .000  129.18    10.83
  .007090    275.     275.    275.        0        5       0     .00   60.34    71.17
```

CHECK LIST OF PLANTS

SCIENTIFIC NAME	COMMON NAME	STATUS	RELATIVE ABUNDANCE							
			ACF	Fah	Fg	A	C	GR	CU	R
CHECKLIST OF PLANTS										
MONOCOTYLEDONES										
CYPERACEAE										
Cyperus rotundus L.	Nut grass	I	O	C	O	C	C	-	-	C
POACEAE										
Bothriochloa pertusa (L.) A. Camus	Pitted beardgrass	I	U	U	U	-	-	-	-	U
Brachiaria mutica (Forssk.) Stapf	Paragrass	I	U	U	U	R	-	-	U	U
Cenchrus ciliaris L.	Buffelgrass	I	U	C	-	U	R	U	U	U
Chloris barbata (L.) Sw.	Swollen fingergrass	I	U	U	C	U	-	U	-	C
C. radiata (L.) Sw.	Radiate fingergrass	I	C	C	A	U	-	U	-	A
Cynodon dactylon (L.) Pers.	Bermuda grass	I	-	-	-	R	R	-	-	U
Digitaria insularis (L.) Mez ex Ekman	Sourgrass	I	U	U	U	U	-	-	U	R
Echinochloa crus-galli (L.) P. Beauv.	Barnyard grass	I	U	-	-	-	-	-	-	U
Eleusine indica (L.) Gaertn.	Goosegrass	I	U	U	-	U	-	-	-	U
Eragrostis cilianensis (All.) Link	Stinkgrass	I	R	-	-	R	-	-	-	U
E. tenella (L.) P. Beauv. ex Roem. & Schult.	Japanese lovegrass	I	-	-	-	-	-	-	-	U
Leptochloa uninervia (K. Presl) Hitchc.		I	U	-	-	-	-	-	-	-
Panicum maximum Jacq.	Guinea grass	I	C	U	A	C	U	A	A	A
Rhynchelytrum repens (Willd.) Hubb.	Natal redtop	I	U	U	R	R	R	-	R	U
Saccharum officinarum L.	Sugar cane	I	A	U	U	R	-	-	-	R
Setaria verticillata (L.) P. Beauv.	Bristly foxtail	I	-	-	-	R	-	-	R	-
Sorghum halepense (L.) Pers.	Johnson grass	I	-	-	U	U	-	-	-	U
DICOTYLEDONES										
AMARANTHACEAE										
Achyranthes aspera L.		X	U	-	-	-	-	-	-	R
Alternanthera caracasana Kunth	Mat chaff flower	X	-	R	-	-	-	-	-	U
Amaranthus spinosus L.	Spiny amaranth	X	U	U	-	U	R	-	-	R
A. viridis L.		X	U	U	-	U	U	-	-	U
ANACARDIACEAE										
Mangifera indica L.	Mango	I	-	-	-	-	-	-	-	R
Schinus terebinthifolius Raddi	Christmas berry	I	-	-	-	-	-	-	-	R
ASCLEPIADACEAE										
Calotropis gigantea (L.) W.T. Aiton	Crown flower	I	-	R	R	-	-	-	-	-
ASTERACEAE										
Bidens pilosa L.	Spanish needle	I	U	-	-	U	-	-	-	U
B. pilosa var. minor (Bl.) Sherff		I	U	-	-	-	-	-	-	-
Conyza bonariensis (L.) Cronq.	Hairy horseweed	I	U	-	-	-	-	-	-	-
Emilia fosbergii Nicolson	Flora's paintbrush	I	U	-	-	-	U	-	-	R
Flaveria trinervia (Spreng.) C. Mohr		I	-	-	-	-	-	-	-	R
Lactuca serriola L.	Prickly lettuce	I	U	U	-	R	-	-	-	-
Pluchea indica (L.) Less.	Indian fleabane	I	U	U	U	-	-	-	-	-
P. x fosbergii Cooperr. & Galang		I	-	U	R	-	-	-	-	-
P. symphytifolia (Mill.) Gillis	Sourbush	I	U	U	U	-	-	-	-	U
Sonchus asper (L.) J. Hill	Prickly sow thistle	I	R	-	-	-	-	-	-	-

CHECK LIST OF PLANTS

SCIENTIFIC NAME	COMMON NAME	STATUS	RELATIVE ABUNDANCE							
			ACF	Fah	Fg	A	C	GR	CU	R
ASTERACEAE										
Sonchus oleraceus L.	Sow thistle	X	R	-	-	-	U	-	-	-
Tridax procumbens L.	Coat buttons	X	U	C	U	U	U	-	-	U
Verbesina encelioides (Cav.) Benth. & Hook.	Golden crown-beard	X	U	C	-	U	R	-	-	U
Xanthium strumarium L.	Cocklebur	X	R	-	-	-	R	-	-	U
BIGNONIACEAE										
Spathodea campanulata Beauv.	African tulip	I	R	R	-	-	-	-	-	-
BORAGINACEAE										
Heliotropium procumbens var. depressum (Cham.) Fosb.		X	-	-	-	-	-	U		U
CAPPARACEAE										
Cleome gynandra L.	Wild spider flower	I	-	-	-	-	R	-	-	-
CHENOPODIACEAE										
Atriplex semibaccata R. Br.	Australian saltbush	X	-	-	-	R	-	-	-	U
A. suberecta Verd.		X	U	U	-	-	-	-	-	U
CONVOLVULACEAE										
Convolvulus arvensis L.	Field bindweed	I	U	U	-	-	U	-	-	U
Ipomoea alba L.	Moon flower	X	-	-	-	-	-	-	U	-
I. cairica (L.) Sweet	Koali	X?	-	R	-	-	-	-	-	-
I. obscura (L.) Ker-Gawl		X	U	U	-	-	-	-	-	U
I. triloba L.	Little bell	I	U	U	U	A	A	-	-	U
Jacquemontia ovalifolia (Choisy) H. Hallier	Pa'uohi'iaka	I	U	U	U	-	-	-	-	U
Merremia aegyptia (L.) Urb.	Hairy merremia	X?	U	U	-	U	U	-	-	-
M. tuberosa (L.) Rendle	Wood rose	I	-	-	-	-	-	-	R	-
CUCURBITACEAE										
Citrullus lanatus (Thunb.) Matsum. & Nakai	Watermelon	I	-	-	-	-	U	-	-	-
Coccinia grandis (L.) Voigt	Ivy gourd	I	O	U	U	U	U	R	A	U
Cucumis dipsaceus Ehrenb. ex Spach	Teasel gourd	I	-	R	-	-	-	-	-	-
Momordica charantia L. var. abbreviata	Peria	I	O	O	U	O	C	-	U	O
EUPHORBIACEAE										
Chamaesyce hirta (L.) Millsp.	Garden spurge	I	-	R	R	-	U	U	-	O
C. hypericifolia (L.) Millsp.	Graceful spurge	I	O	U	U	O	O	-	-	O
C. hyssopifolia (L.) Small		I	-	-	R	R	-	-	-	U
Euphorbia cyathophora J.A. Murray	Mexican fire plant	I	-	-	-	-	-	-	-	R
E. heterophylla L.	Kaliko	I	-	-	-	U	U	-	-	-
Ricinus communis L.	Castor bean	I	U	-	U	U	O	-	C	O
FABACEAE										
Acacia farnesiana (L.) Willd.	Klu	I	-	-	R	R	-	U	R	R
Cassia sp.		I	-	U	-	-	-	-	-	-
Chamaecrista nictitans (L.) Moench	Japanese tea	I	-	-	-	-	R	-	-	R
Crotalaria incana L.	Fuzzy rattlepod	I	O	U	O	C	U	U	-	U
C. pallida Aiton	Smooth rattlepod	I	R	R	U	-	-	-	-	U
Desmanthus virgatus (L.) Willd.	Virgate mimosa	I	U	U	U	U	-	-	-	U

CHAR & ASSOCIATES
Botanical/Environmental Consultants
4471 Puu Panini Ave.
Honolulu, Hawaii 96816
(808) 734-7828

January 1997

SUMMARY OF FINDINGS
KO'OLOA'ULA ON EAST KAPOLEI PROJECT SITE
'EWA DISTRICT, ISLAND OF O'AHU

INTRODUCTION

The ko'oloa'ula (Abutilon menziesii), a member of the hibiscus or mallow family (Malvaceae), is a much-branched shrub up to 6 to 9 ft. tall, which is covered by velvety, stellate pubescence. The heart-shaped leaves are silvery-green and the attractive flowers are maroon. It is uncommon and occurs in dryland habitats (Wagner et al. 1990). Today, the largest population is found on Lana'i (about 600 plants) in koa haole scrub. Five small populations occur on Maui on 'a'a lava and also on red soils in a large gulch adjacent to sugar cane fields. One population occurs at Puako on the island of Hawai'i. On O'ahu, a single plant was found in abandoned sugar cane fields near the Campbell Industrial Park. Recently, a single plant was found on the Navy's Lualualei facility in kiawe/Guinea grass scrub.

In 1986, the species was federally listed as endangered. All plants on the federal list are automatically added to the state endangered species list. In its natural habitat the ko'oloa'ula plants are threatened by browsing animals (cattle, goats, axis deer), competition from weedy introduced plants, fires, predation by introduced insects, loss of native pollinators, and development (U.S. Fish and Wildlife Service 1994).

Because the plant is attractive and is easy to cultivate (seeds and cuttings), it was once sold by several plant nurseries as "red 'ilima" prior to its listing.

A new populaion of the ko'oloa'ula was recently discovered by Nagata while conducting a survey of the HFDC's East Kapolei project site in September and October 1996. Nagata recorded at least 38 ko'oloa'ula plants from the southwest corner of the project site (Figure 1). Collections of the plants were deposited by Nagata at the Bishop Museum.

A survey to verify and to more accurately inventory and map the plants found by Nagata was conducted in December 1996. This survey followed an unusually heavy rainfall in November 1996 which lasted for about 10 days.

RESULTS

Three colonies of plants were identified in the field and mapped (Figure 2). We could not locate the northern-most colony mapped by Nagata.

Colony A: This colony consists of 6 large, mature (flowering/budding) plants, 2 to 6 ft. tall, and 2 juvenile (young, immature) plants, 1 to 1.5 ft. tall.

Colony B: This colony is found along the golf course fence. About half (11 plants) are composed of juvenile plants, most of which have probably sprouted and grown since the November rains. The remaining plants (10) are mature individuals.

Colony C: This is the largest colony and is found near the power

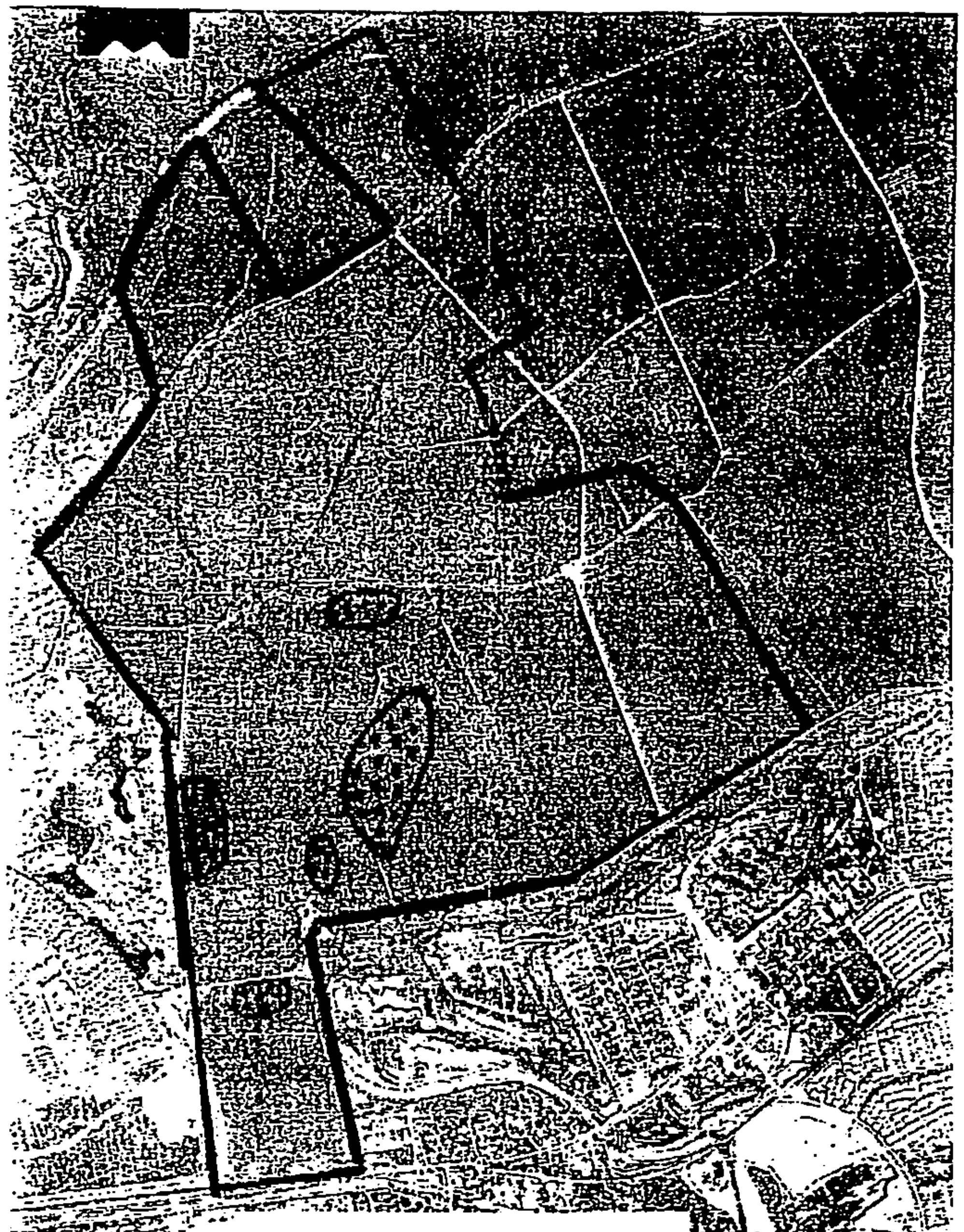


FIGURE 1. LOCATION OF KO'OLOA'ULA (from Nagata 1996).

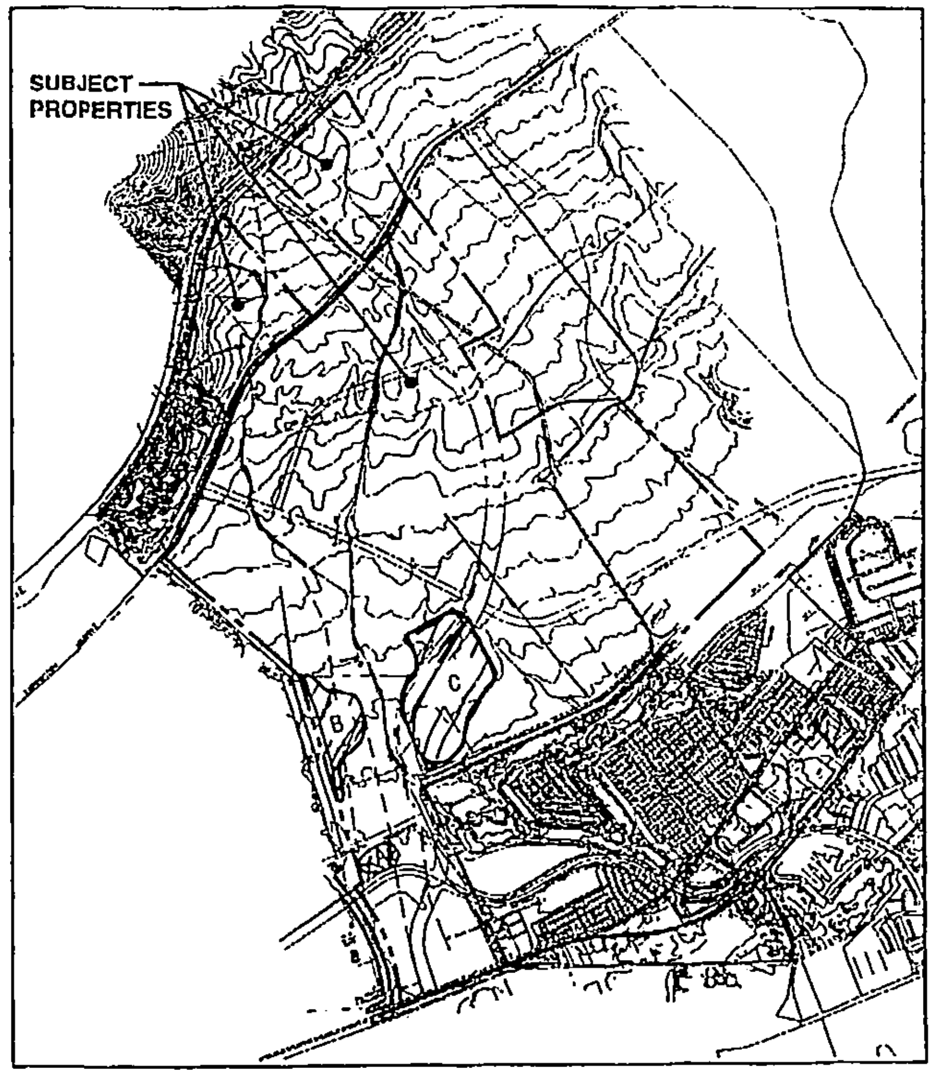


FIGURE 2

LOCATION OF KO'OLOA'ULA DURING THIS SURVEY.

0 1000 2000 FEET

PBR

line. Nagata maps it as two separate colonies. But after the more intensive survey, we located plants between the two colonies and have thus lumped them into one larger colony. The majority of the plants are centered around an overgrown, coral-lined cane haul road. A few plants cross under the power line and extend north of the power line for a short distance. The colony consists of 55 large, mature plants (many of them 4 to 6 ft. tall), and 4 juvenile plants.

DISCUSSION AND RECOMMENDATIONS

A total of 88 ko'oloa'ula plants were found during the recent study to flag and inventory the plants on the East Kapolei site. There are a large number of juvenile plants, most of which sprouted and established themselves since the unusually heavy rainfall in November 1996. The number of plants will most likely increase during this rainy season (November 1996 to about February 1997).

It is recommended that a mitigation plan be initiated as soon as possible as the mature plants will continue to set seeds and the colonies will continue to expand in area.

The larger plants can be easily cultivated from seeds and cuttings while the smaller plants can be dug up and transplanted. It is recommended that an area be set aside for the conservation of these plants. An excellent location would be within the power line corridor. A greenway or belt of vegetation with the ko'oloa'ula could be established here. A few plants already occur within this corridor.

References

U.S. Fish and Wildlife Service. 1994. Lana'i plant cluster recovery plan: *Abutilon eremitopetalum*, *Abutilon menziesii*, *Cyanea macrostegia* ssp. *gibsonii*, *Cyrtandra munroi*, *Gahnia lanaiensis*, *Phyllostegia glabra* var. *lanaiensis*, *Santalum freycinetianum* var. *lanaiensis*, *Tetramolopium remyii*, and *Viola lanaiensis*. Portland, Or.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1990. Manual of the flowering plants of Hawai'i. 2 vols. University of Hawai'i Press and B.P. Bishop Museum Press, Honolulu. B.P. Bishop Museum Special Publication 83.

F. Habitat Conservation Plan

East Kapolei Master Plan Habitat Conservation Plan for Abutilon Menziesii

State of Hawai'i
Housing Finance
Development Corporation

June 1998

East Kapolei Master Plan Habitat Conservation Plan for Abutilon Menziesii

State of Hawai'i
Housing Finance
Development Corporation

Prepared by

PBR HAWAII

Land Planning, Landscape Architecture
Environmental Studies

June 1998

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

ROY S. OSHIRO
EXECUTIVE DIRECTOR

IN REPLY REFER TO
98:DEV/2316

June 25, 1998

TO: The Honorable Michael Wilson, Chairperson
Board of Land and Natural Resources

THRU: The Honorable Kazu Hayashida, Director
Department of Transportation

FROM: Roy S. Oshiro, Executive Director

SUBJECT: Habitat Conservation Plan for Abutilon Menziesii
East Kapolei Master Plan and North-South Road Projects
Kapolei, Ewa District, Oahu, Hawaii

The development of the above-referenced projects at Kapolei would affect a population of Abutilon menziesii, or ko'oloa'ula, an endangered plant species, which has become established on the property since the termination of sugar cultivation by Oahu Sugar Company, Ltd. in 1995.

The enclosed Draft Habitat Conservation Plan ("HCP") for Abutilon menziesii has been prepared with the guidance of your staff at the Division of Forestry and Wildlife and staff at the U.S. Fish and Wildlife Service. We are requesting the review of the HCP by the Endangered Species Recovery Committee followed by plan acceptance by the Board of Land and Natural Resources. Since this is the first HCP to be processed under the amended Chapter 195D, we would like to request a meeting with you to discuss the processing procedures and schedule.

This request is made by the Housing Finance and Development Corporation (HFDC) through the Department of Transportation since the East Kapolei Master Plan and North-South Road projects would affect the same population of plants.

If you have any questions, please call me at 587-0641, or Mr. Steve Thomas, Project Manager, at 587-0541.

Enclosure (1)

HFDC

TABLE OF CONTENTS

PAGE

LIST OF TABLES

LIST OF FIGURES

APPENDICES

PREFACE

Abutilon menziesii, or Ko'oloa'ula, was recently discovered on lands at Kapolei on the 'Ewa Plain of O'ahu, Hawai'i. *Abutilon menziesii*, a federally listed endangered species, is also one of nine endangered species included in the *Lanai Plant Cluster Recovery Plan* (U.S. Fish and Wildlife Service 1994). The Lanai Recovery Plan describes the plant and establishes strategies with the intended goal to downlist and eventually delist the plant.

Within the same area, the State of Hawai'i Housing Finance Development Corporation ("HFDC") is proposing to develop 1,300 acres of State-owned land as the East Kapolei Master Plan project, a residential and mixed use development. In addition to the East Kapolei Master Plan project, the North-South Road, a federal aid highway, would also affect a portion of the same population of *Abutilon menziesii*. The projects are independent of each other and are proposed by separate governmental agencies with separate funding sources.

This Habitat Conservation Plan ("HCP") addresses the impacts to these projects on *Abutilon menziesii* in response to federal and State requirements pertaining to threatened and endangered species. The measures which are described herein are designed to accommodate the major State of Hawai'i and City and County of Honolulu land use initiative -- the development of Kapolei as the secondary urban center in the state -- while simultaneously mitigating the impacts to the endangered species and promoting its recovery.

This HCP is an "umbrella plan" and includes measures to address the impacts to *Abutilon menziesii* from development of the East Kapolei Master Plan and the North-South Road. The HCP's primary emphasis is on the East Kapolei Master Plan project and a separate plan, entitled *North-South Road Mitigation Plan for Abutilon Menziesii*, is attached to this HCP as Appendix A. The reviewer is referred to Appendix A for detailed information on the North-South Road impacts on the endangered plant and proposed mitigative measures.

Reference is also made to the East Kapolei Master Plan Environmental Impact Statement (PBR Hawaii 1998) and the North-South Road Environmental Assessment (Review Draft) (Parsons Brinckerhoff 1997) for technical information on the proposed developments.

EXECUTIVE SUMMARY

Chapter 195D, *Hawaii Revised Statutes*, as amended, allows the Board of Land and Natural Resources ("BLNR") to enter into an agreement with a landowner for the purpose of preparing and implementing a Habitat Conservation Plan ("HCP"). This HCP provides a description of the development actions proposed at property in Kapolei on the Ewa Plain which would impact *Abutilon menziesii* and proposes a series of mitigative strategies to address the impacts.

Abutilon menziesii, known by its Hawaiian name Ko'oloa'ula, and its common name "red ilima", was recently discovered at Kapolei on former sugarcane land. Hence, this population is referred to as the "Kapolei population". *Abutilon menziesii* has been federally listed as an endangered species since 1986 and is now protected under the provisions of the federal Endangered Species Act of 1973, as amended, and Chapter 195D, *Hawaii Revised Statutes*, as amended. *Abutilon menziesii* is one of nine endangered species included in the *Lanai Plant Cluster Recovery Plan* (US Fish and Wildlife Service, 1994), (referred to in this document as the "Lanai Recovery Plan").

A major land use development at this location is proposed by the State of Hawai'i Housing Finance Development Corporation ("HFDC"), known as the East Kapolei Master Plan. This project is intended to further the State of Hawai'i and City and County of Honolulu goal of developing a secondary urban center at Kapolei.

In addition, the State Department of Transportation ("DOT") is proposing to develop the North-South Road ("Roadway"), a federal-aid highway, which would be a principal arterial roadway providing regional access to the Interstate H-1 Freeway. The North-South Road would bisect the East Kapolei Master Plan project area. Although the two projects are independent of each other, each would affect the Kapolei population of *Abutilon menziesii*. A separate detailed *North-South Road Mitigation Plan for Abutilon Menziesii* has been prepared and is intended to be an independent mitigation plan which would be implemented by the Hawai'i Department of Transportation apart from mitigation measures which would be implemented through the subject HCP for the East Kapolei Master Plan project.

This HCP serves as an "umbrella plan" for the Kapolei *Abutilon* population and would be implemented in concert with the development of the East Kapolei Master Plan and the North-South Road projects. The two projects recognize the Kapolei population as a single population. This HCP therefore, includes a summary of the impacts and mitigative strategies described in the North-South Road mitigation plan which is attached in its entirety as Appendix A.

Habitat Conservation Plan Objectives

The objectives of this plan are threefold: (1) describe the existing conditions; (2) describe the potential impacts of development on *Abutilon menziesii*; and (3) describe the strategies and actions to mitigate the impacts. The format of this HCP follows the requirements of Chapter 195D-21, *Hawaii Revised Statutes*, for Habitat Conservation Plans.

The Presence of Abutilon Menziesii on the Property

The property was previously cultivated in sugarcane for nearly a century. According to Oahu Sugar Company, sugarcane was last harvested on the property in 1994, prior to the permanent closure of the company in Spring 1995 (E. Nii, personal communication 1998). Typical of sugarcane grown in Hawai'i, the variety grown on this field was the two-year variety which requires a pre-harvest fire to reduce the leaf bulk before the cane stalks are mechanically harvested. Generally, cane fires in each field lasted 20 to 30 minutes. The now abandoned fields at the subject property were exposed to cane fires every two years during nearly ten decades of cane cultivation.

Presently, the property is described as a disturbed site characterized by the dominance of alien weed species interspersed with abandoned sugar cane. Therefore, the discovery of *Abutilon menziesii* in September 1996 by Nagata approximately two years after the last cane harvest is seen as an enigma (Nagata 1996). Nagata's reconnaissance survey covered 80 percent of the property. A subsequent count by Char in December 1996 following an unusually wet period in November and December 1996 recorded 88 plants. The Nagata and Char survey reports are attached as Appendix B and Appendix C. In December 1997 Nagata conducted a comprehensive survey and recorded 86 plants on-site. One plant was observed off-site at Renton Road which is located to the south of the project site. The December 1997 survey produced taxonomic data and a precise surveyed map of the plants.

The 86 plants are spatially distributed in four clusters in the central and southern portions of the 1,300 acre property and are described as Clusters A, B, C, and D.

Landownership

The 1,300 acre property encompassed by the proposed East Kapolei Master Plan development is State of Hawai'i land presently held by the State Department of Land and Natural Resources. The property was previously leased to Oahu Sugar Company, Limited. Upon expiration of the lease in 1995, sugar cane cultivation at this location (and all other Oahu Sugar fields) ended and the land was transferred to the State. A portion of the North-South Road property is owned by the DLNR and a portion is owned by the Estate of James Campbell. *Abutilon* is present only on the State-owned portion.

The planned developments will require property conveyance from DLNR to HFDC and DOT. The conveyance actions are anticipated to be concluded prior to the commencement of construction.

Development of the subject property will eventually distribute ownership to multiple parties. The ultimate land ownership for public facilities (i.e., schools, parks, drainage improvements, roadways) will be by the State, County, or community associations. Residential subdivision lots and commercial parcels would eventually be owned by individual owners.

Role of the Master Developer

HFDC, as the Master Developer of the East Kapolei Master Plan, would implement the HCP and handle all issues related to *Abutilon menziesii* on the property, with the exception of the plants which are located within the construction zone of the North-South Road. The *North-South Road Mitigation Plan for Abutilon Menziesii* will be implemented by the State Department of Transportation in the course of the development of the roadway.

The Master Developer would sell to developers large improved developable lots which would not be encumbered by the endangered species. For example, the Department of Hawaiian Home Lands, a developer of homes for awards to native Hawaiians, will develop 200 acres of the East Kapolei property. The DHHL selected parcels presently contain *Abutilon menziesii*, but only would develop the large lots after the Master Developer has implemented the measures described in this HCP and properly mitigated all endangered species issues on the DHHL lots.

A trust fund would be established by HFDC to fund the implementation of the HCP for a duration to cover the construction impact period (estimated to be 10 years) and the long-term management period. Quantification of the long-term management period is defined by the attainment of the HCP measurable goals in concert with the goals of the Lanai Recovery Plan.

Project Development Description and Preliminary Schedule

The goal of the Master Developer is to complete the infrastructure improvements of the 1,300 acre property and to sell large lots for the development of residential subdivisions and small commercial parcels. The Department of Hawaiian Home Lands would develop 200 acres for native Hawaiian residential homestead awards. Additionally, the net revenues raised from a 500-acre portion of the HFDC project will partially support development of the new University of Hawai'i West O'ahu Campus which is proposed to be located mauka of the H-1 Freeway and the East Kapolei Master Plan project.

As described in the *North-South Road Mitigation Plan for Abutilon Menziesii*, the goal of the State DOT in developing the North-South Road, a federal-aid highway, is to construct a new major arterial roadway to support the regional network of roadways. The North-South Road would traverse the East Kapolei Master Plan area between the H-1 Freeway (located to the north) and a future segment of Kapolei Parkway (located to the south). Construction of the North-South Road will be coordinated with the construction of the drainage infrastructure of the East Kapolei Master Plan.

Construction on the currently vacant land is expected to occur in increments and continue over a 20-year development period. Once developed, the lands will be irretrievably committed to urban land uses. Based on the preliminary project construction schedule, the initial construction is anticipated to commence in early 1999. On-site mitigative actions for *Abutilon menziesii* are therefore planned to begin following the approval of the HCP and prior to any construction activity. Each increment of construction grading is anticipated to begin after all plants in the construction zone have been properly re-located or otherwise mitigated.

Impact to Abutilon Menziesii

The incremental development of the East Kapolei Master Plan project is expected to result in incidental take of all of the existing plants on the property over a period of 10 years. The take would involve disruption to the plants at their existing locations for cultivation at an onsite nursery facility. Cultivation methods would include air-layering of plants, taking of cuttings, seed collection and germination, and plant re-location. Therefore, a series of on-site and off-site strategies are proposed in this HCP to mitigate for the impacts on the plants during the 10-year period of major impact between late 1998/early 1999 to 2008 and the long-term management period. The duration of the long-term management period will be tied to the accomplishment of the measurable goals which include the establishment of a relocated permanent population of *Abutilon menziesii* in the drainage / open space corridor of the project site.

The centerpiece of the HCP is the establishment of an onsite Nursery Facility where *Abutilon* will be propagated for the eventual relocation back to the project when construction impacts have ceased. Successful implementation of this plan would significantly increase the numbers of new plants and likely increase the vigor of the new plants due to the cultivated status. In addition, the focus of the North-South Road Mitigation Plan is to distribute plant propagules to approved offsite garden facilities to protect from any catastrophic events which may affect *Abutilon menziesii* onsite.

Whereas, the cumulative impact of the actions of the East Kapolei Master Plan and North-South Road projects on *Abutilon menziesii* on Oahu would transfer the Kapolei population from wild status to cultivated status initially. It is expected that within the cultivated habitat in the drainageway, plant vigor will increase. In addition, progeny from the Kapolei population would be distributed to Oahu facilities at a minimum of two approved locations. It is also expected that the successful implementation of this HCP would significantly increase the numbers of *Abutilon menziesii* on Oahu.

The HCP is formatted by the guidelines of Chapter 195D-21, *Hawaii Revised Statutes*. In addition, recommendations received from the DLNR Division of Forestry and Wildlife and the US Fish and Wildlife Service during pre-consultation have been incorporated.

HABITAT CONSERVATION PLAN

(1) Identify the geographic area encompassed by the plan; the ecosystems, natural communities, or habitat types within the plan area that are the focus of the plan; and the endangered, threatened, proposed, and candidate species known or reasonably expected to be present in those ecosystems, natural communities, or habitat types in the plan area.

(1a) Geographic Area Encompassed by the Plan

The geographic area encompassed by the HCP is at Kapolei, 'Ewa District, O'ahu, Hawai'i (*Figure 1*). The subject property is bounded on the north by Farrington Highway and H-1 Freeway, to the west by the Villages of Kapolei and Kapolei Golf Course, to the south and southeast by Ewa Villages, and to the east by fallowed agricultural land. It encompasses former sugar cane lands mauka of Varona Village from approximately 60 feet mean sea level (MSL) at Mango Tree Road up to 200 MSL at the H-1 Freeway. The site also contains an existing Hawaiian Electric Company, Inc. (HECO) powerline easement.

(1b) Ecosystems, Natural Communities, or Habitat Types within the Plan Area

The Ewa Plain experiences light rainfall with a mean annual rainfall of about 20 inches per year, most of which occurs between the months of November and April. Based on more than 50 years of data collected at the Ewa Plantation, average annual daily minimum and maximum temperatures in the project area are 65°F and 84°F, respectively. Under the current condition as fallow agricultural land, the relatively inconsequential levels of evapo-transpiration which occurs from scrub vegetation produces little cooling effect.

The project area was formerly cultivated as sugarcane land and is now characterized as a disturbed coastal dry ecosystem. The vegetation of the region is generally lowland shrub with a coastal fringe of kiawe trees. In the past several years the project lands and surrounding lands have been taken out of sugar cane cultivation and put to other uses (e.g. urbanization, diversified agriculture, fallowed fields). Consequently, the vegetation on these lands are entirely secondary and the vegetation in the region is largely determined by the history of cultivation (or disturbance) on each parcel of land.

Nagata (1996) has identified eight plant communities within the 1,300 acre project area: 1) Abandoned Cane Fields, 2) Fallowed Fields Mixed Herb Association, 3) Fallowed Fields Grassland Association, 4) Abandoned Fields, 5) Cultivated Fields, 6) Grasslands, 7) Gulch Association, and 8) Roadside Vegetation.

Within the project and plan area there are 80 to 100 plant species common to former sugar cane lands (Nagata 1996, Char 1997). Survey reports by Nagata and Char are attached as Appendices A and B. Of the species recorded, only two are indigenous ('ilima and pa'uohi'iaka), two are probably indigenous ('uhaloa and hoary abutilon) and one, the subject plant, *Abutilon menziesii*, is endemic. The vast number consists of non-native species dominated by clumps of sugar cane, lowland shrubs, and herbs and grasses.

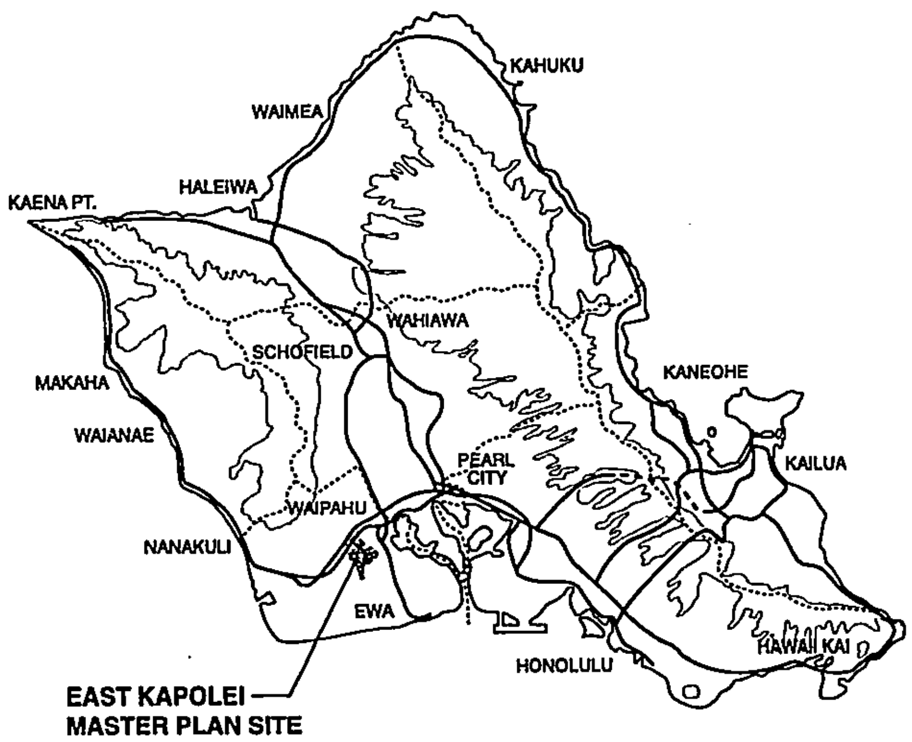


FIGURE 1
REGIONAL LOCATION MAP
HFDC EAST KAPOLEI MASTER PLAN

(1c) The endangered, threatened, proposed, and candidate species known or reasonably expected to occur in the ecosystems, natural communities, or habitat types in the plan area.

Abutilon menziesii, also known by its Hawaiian name ko'oloa'ula, is a shrub in the mallow family (Malvaceae) with light green heart-shaped leaves and characteristic small dark red flowers. *Abutilon* is also commonly referred to as the "red 'ilima." Photographs in Figure 2 show *Abutilon menziesii* and the Kapolei habitat.

Abutilon menziesii has been federally listed as an endangered species since 1986 and is now protected under the provisions of the federal Endangered Species Act of 1973, as amended, and Chapter 195D, *Hawaii Revised Statutes*, as amended. *Abutilon menziesii* is one of nine endangered species included in the *Lanai Plant Cluster Recovery Plan* (US Fish and Wildlife Service, 1994). The Lanai Recovery Plan describes the plant and strategies with the intended goal to delist the plant.

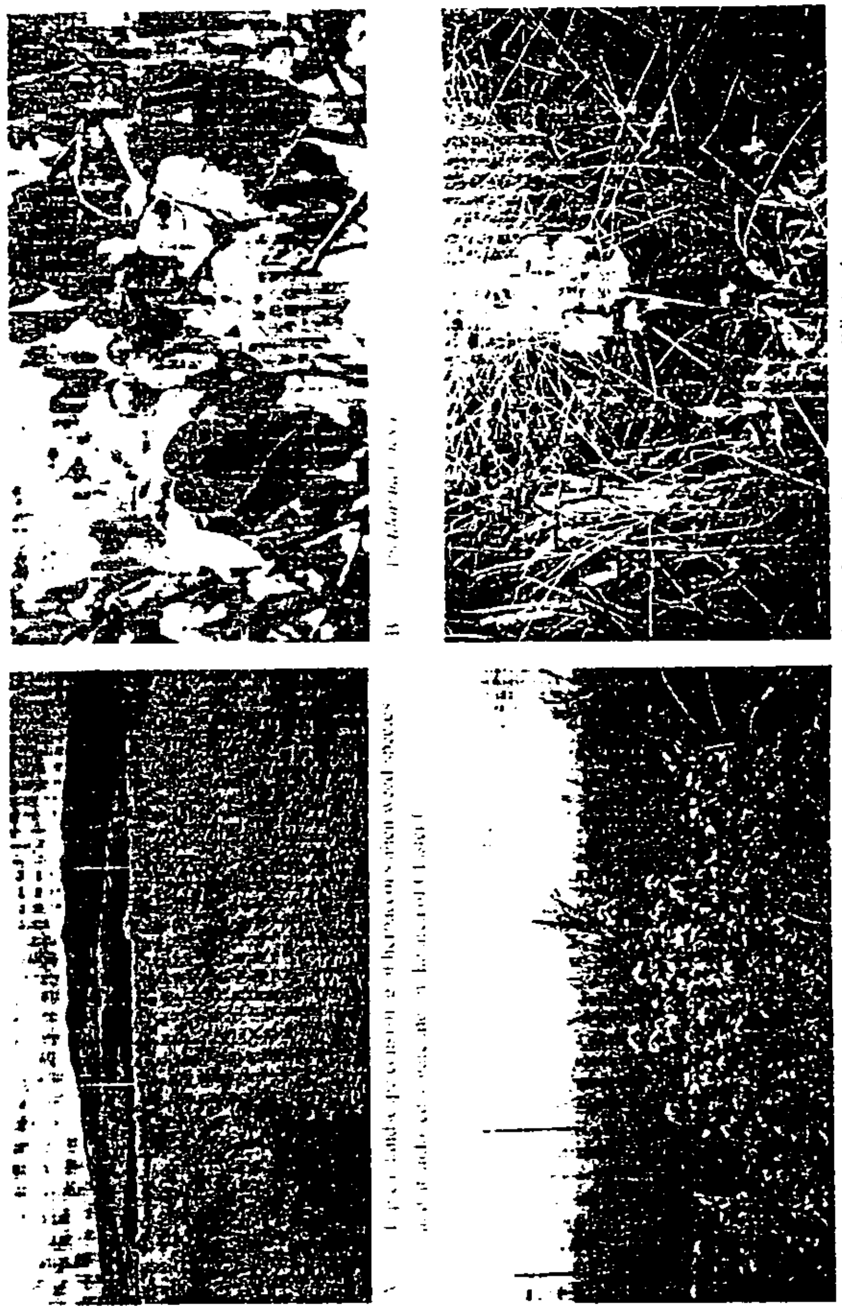
Of the nine taxa described in the *Lanai Plant Cluster Recovery Plan*, *Abutilon menziesii* is ranked second because of the chance it has of recovery due to its larger population size and its resistance to some of the current threats, and, provided with appropriate management, its relatively good chance of recovery. Other populations identified in the Lanai Recovery Plan are on Lanai, the Big Island, and on Maui.

Botanical surveys have been conducted on the East Kapolei property by Nagata and Char. At the time of the Nagata survey in September 1996, 38 *Abutilon menziesii* plants were recorded in a reconnaissance survey covering 80 percent of the property. After the unusually heavy rains of November 1996, Char (1997) in a 100 percent survey of the areas described by Nagata in recorded approximately 88 plants at approximately the same locations as Nagata. In December 1997 Nagata performed a detailed survey and count which was followed by precise mapping. The survey and count resulted in 87 plants, 86 on the subject property and one (1) plant at an off-site location at Renton Road adjacent to the southern boundary of the project and is not included in this plan. The plants are in three clusters (Clusters A, B, and C) in the southwest area of the site; one additional plant (Cluster D) was also identified (Figure 3).

Table 1. ***Abutilon menziesii*** **Population at Kapolei**

Cluster	No. of Plants
A	10
B	14
C	61
D	1
TOTAL	86

Cluster A consists of 10 individuals and is located at the southern end of the project site. An existing dirt road situated in an east to west direction provides access to these plants.



D Young *Abutilon menziesii* (Cluster A)

FIGURE 2
PHOTOGRAPHS: ABUTILON MENZIESII
HFDC EAST KAPOLEI MASTER PLAN

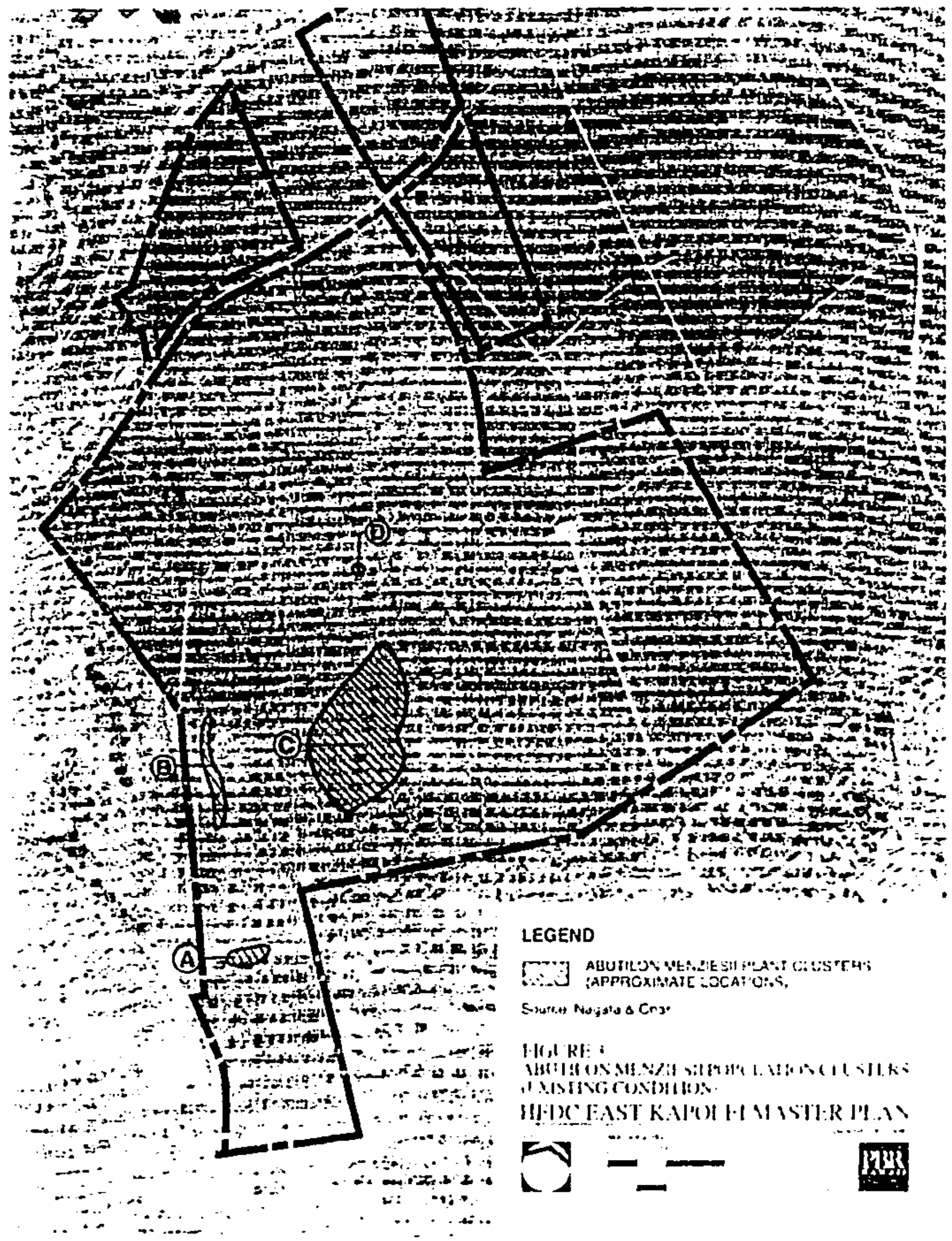


FIGURE 3
ABUTILON MENZIESII POPULATION CLUSTERS (EXISTING CONDITION)
HFDC EAST KAPOLEI MASTER PLAN

Cluster B consists of 14 individuals located along the western boundary of the property which is marked by a chain-link fence. Individuals in this cluster are spread in a north-south direction and is accessed from the dirt road near Cluster A at the southern end.

Cluster C, the largest cluster consisting of 61 plants occurs in the general area under the powerline easement and to the east of the powerline easement. The cluster is accessed from Mango Tree Road which is situated in an east-west direction. Several land uses would affect Cluster C, therefore three sub-areas identified as C-1, C-2 and C-3 have been designated.

Table 2. Cluster C (Sub-Areas)

Sub-Cluster	No. of Plants	Land Use
C-1	14	North-South Road
C-2	7	Drainage/Open Space Corridor
C-3	40	Residential (DHHL)
TOTAL	61	

Cluster D consists of a single plant in the central area of the site.

At this location in the dry 'Ewa area, the mature *Abutilon* plants are 2.5 feet to 3.5 feet. The plants range from juvenile to mature individuals (Nagata 1997). A large proportion of the population consisting of 74% were taller than three feet, 20% were between 2 and 3 feet, and only 6% were between 1 to 2 feet. No seedlings or plants under 1 foot were identified. In December 1997, 37% of the plants were flowering and/or fruiting (Nagata 1997).

(2) Describe the activities contemplated to be undertaken within the plan area with sufficient detail to allow the department to evaluate the impact of the activities on the particular ecosystems, natural communities, or habitat types within the plan area that are the focus of the plan.

(2a) Describe the activities to be undertaken within the plan area in sufficient detail

The overall project goals and objectives established by the State Legislature and the State of Hawai'i Housing Finance and Development Corporation (HFDC) are essentially two fold: 1) to create more housing, recreational, and support facilities in the Ewa Development Plan area for residents of Hawaii, and; 2) to generate income from State-owned land in support of a new West O'ahu Campus for the University of Hawai'i which is planned mauka of the H-1 Freeway.

The concept for the East Kapolei Master Plan Development Project has been fully described in the Environmental Impact Statement (EIS) for the project. The Master Plan includes a mix of single-family, multi-family, commercial, public facility, (e.g. school parcels), parks, open space, and recreational land uses. A major sports complex is also planned makai of Kapolei Parkway. The Conceptual Development Plan is depicted as Figure 4. The conceptual land use allocation is shown in Table 3.

Table 3. East Kapolei Master Plan Land Use Allocation

Land Use	Area (Acres)*
Single Family	722.5
Multi-Family	210.9
Commercial	18.0
Sports Complex/Park-and-Ride	64.3
Parks	35.9
Schools	56.0
Misc. Roads/Open Space	192.4
TOTAL	1,300

* The acres shown here are approximate and are for general planning purposes only.

To achieve the stated objectives, large-lot residential parcels would be developed with required major infrastructure and sold by HFDC to individual developers. None of the proposed land uses (i.e. residential, commercial) will be developed by HFDC. Rather, dwelling units and small neighborhood commercial parcels will be developed by the private sector in accordance with the East Kapolei Master Plan. The number of actual units developed, their type, and pricing will be dependent on market conditions at the time of development and applicable zoning restrictions.

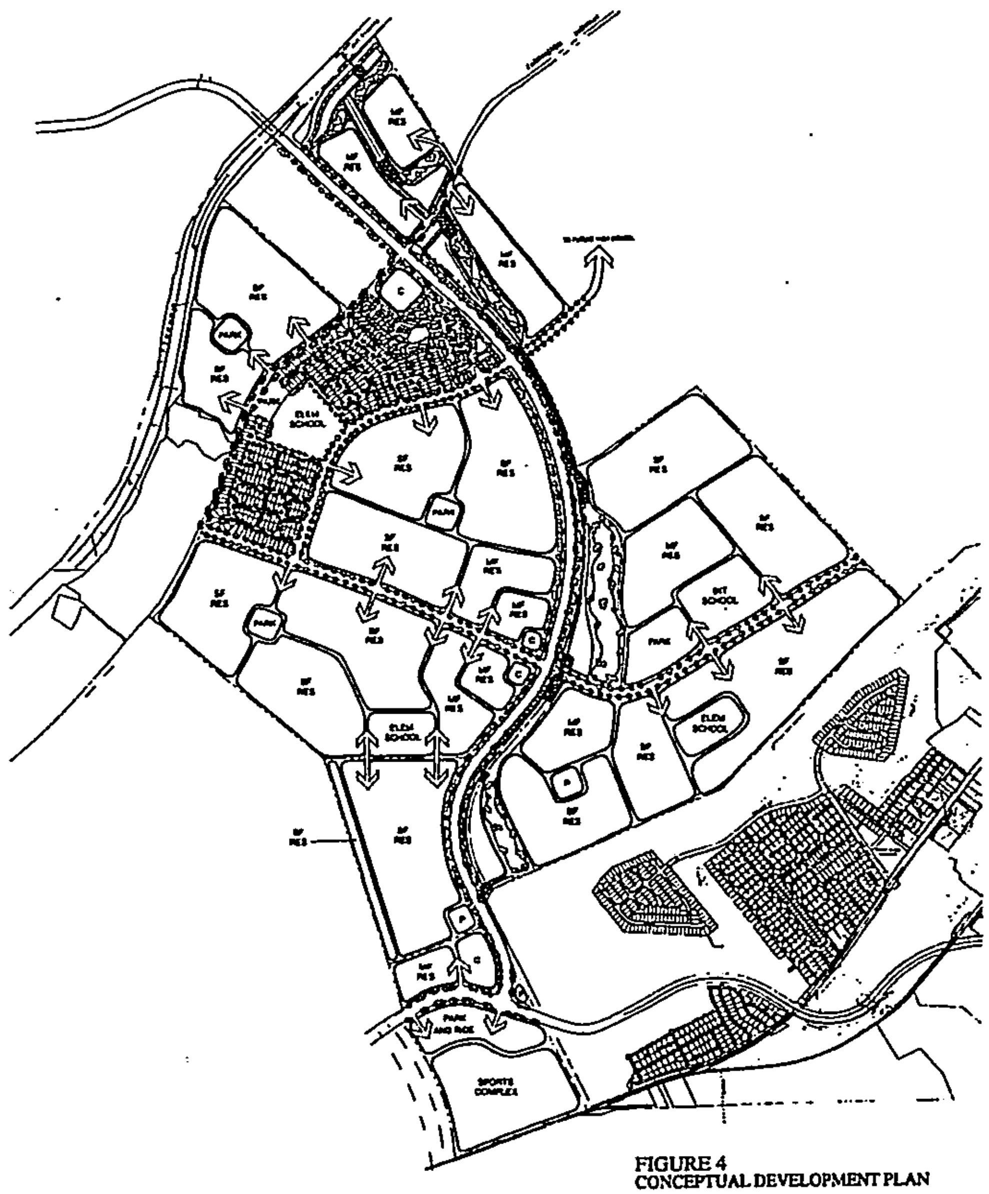


FIGURE 4
CONCEPTUAL DEVELOPMENT PLAN
HFDC EAST KAPOLEI MASTER PLAN

However, all developers will be required to comply with applicable City zoning regulations and the City's affordable housing policy.

Backbone infrastructure consisting of major roadways (but not including the North-South Road), a large park-and-ride facility, implementation of a drainage system, water and wastewater system master plans, expansion of electrical and communication systems, and development of open space recreation areas will be provided by HFDC. Detailed site plans and development programs for the area will be implemented by future developers. The North-South Road will be developed as a separate project by the state and federal Departments of Transportation.

Drainageway/Open Space Corridor. The project master plan envisions an open space recreational and drainage corridor parallel to the proposed North-South Road. The proposed drainage facilities will establish an open space buffer between the major North-South Road transportation corridor and other future residential development planned for the area. On-site retention basins within the drainageway are also planned to serve as an aesthetic and functional drainage element. The drainage basins and adjoining open space areas, will offer extensive grassed and landscaped recreation land available to the community. The drainage function of the open space corridor will be utilized only during periods of intense rainfall.

North-South Road Project. A new major collector roadway identified as the North-South Road is planned adjacent to and toward the west of the corridor delineated by the existing power line electrical easement. The proposed roadway would be a principal arterial providing regional access to the Interstate H-1 Freeway. It would connect the H-1 Freeway to a future segment of Kapolei Parkway, a distance of approximately 3.6 km (2.2 miles), and it would include an interchange with the freeway. The new road would include three vehicular lanes in each direction, a planting median, and sidewalks on both sides. The overall width to accommodate all components of the roadway is 116-feet. Detailed descriptions for the Roadway are included in Appendix A.

(2b) Evaluate the impact of the activities on the particular ecosystems, natural communities, or habitat types within the plan area that are the focus of the plan

The development of the project would result in incremental direct and indirect impacts on *Abutilon* as master plan components are developed over the 10-year period. Ultimately, all 86 plants within the Kapolei population would be affected by incidental take. The take on the plants, however, would be incremental and occur in phases of plant propagule collection (e.g. seeds, air layer clones, cuttings) and the eventual translocation of the parent plant. Details are described as mitigative measures and are further described in Section 3.

Generally, the phased construction activities would include earthwork (e.g. grubbing and grading), stockpiling, sediment and erosion control, mobile equipment movement, parking and servicing, paving, grassing and landscaping. Indirect impacts to the surrounding plant clusters which would occur include an increased risk of fire during the construction period. Mitigative measures to address the indirect impacts are described in Section 3.

(3) Identify the steps that will be taken to minimize and mitigate all negative impacts,' including without limitation the impact of any authorized incidental take, with consideration of the full range of the species on the island so that cumulative impacts associated with the take can be adequately assessed; and the funding that will be available to implement those steps.

Described below are the details of the core elements of this HCP, including the mitigative steps and strategies to impact for the incremental take of Abutilon menziesii at Kapolei. A summary of the strategies and measures is attached as Appendix D.

(3a) Full range of the species on O'ahu.

A collection (Char 81.002, BISH) from an abandoned canefield at Barbers Point, 'Ewa, O'ahu, made in 1981 probably represents an escape from cultivation (Wagner et al 1990). At that time all cultivated plants were descendent from the Puako, Hawai'i, population; this population was later destroyed by cattle during an unusually dry year (Wagner et al 1990). More recently the Lanai plants were brought into cultivation. However, it is also believed that due to differences in leaf morphology of progeny from this plant as compared to other populations, it may represent a separate population (Hobdy in FWS 1994). A more recent reporting has been made of a single individual on Navy property at Lualualei (Moribe 1998, personal communication). Also, Ewa Villages Golf Course staff have stated that *Abutilon menziesii* also occur on the golf course (Personal communication, 1997). The Ewa Villages Golf Course property is adjacent to the property proposed for the North-South Road and East Kapolei Master Plan developments.

Whether the subject population at Kapolei is descendent of the Barbers Point plant or from the Puako population, or is native to this area is unknown at this time. Future investigations as part of the HFDC program may help to determine the origin of the Kapolei population.

Abutilon is also present in several botanical collections on O'ahu including the Waimea Arboretum & Botanical Garden, the Honolulu Botanical Gardens, and the Department of Land and Natural Resources native garden located at the Kalanimoku Building.

Abutilon was reportedly available for sale at three commercial nurseries in the state (HPCC 1992 in FWS 1994) until its listing as an endangered species. Plants reportedly thrive and bloom regularly under nursery conditions. Propagation by seed and cuttings is successful (Boche, Aikane Nursery, Kapaau, Kauai, in FWS 1994) and air layers are been reported to be 95 percent successful (Woolliams 1998, Waimea Arboretum, personal communications).

(3b) Identify the funding that will be available to implement the proposed measures and actions.

The Housing Finance Development Corporation is proposing to set up a Trust Fund (subject to the approval of the HFDC Board) that would generate sufficient revenues to fund the implementation of the HCP. The Trust Fund would provide the required funds to implement the measures during the 10-year construction period and the post-construction long-term management period.

In addition, future funding for other specialized research may be sought through other collaborative state and federal programs such as Section 6 of the Endangered Species Act. Over the long term, the operation and management of the East Kapolei Master Plan HCP (i.e., research, management, maintenance), may qualify for Endangered Species Act, Section 6 funding for the implementation of a recovery plan. The Section 6 program provides federal funds to States on a year to year basis. Section 6 initiatives are State driven, thus, coordination between DLNR, HFCD, FWS, and a third party researcher would be necessary.

(3c) Identify the steps that will be taken to minimize and mitigate all negative impacts, including without limitation the impact of any authorized incidental take.

The steps to implement the HCP include actions which could be implemented independently, concurrently, or consecutively in accordance with the master plan development phasing schedule: The strategies under consideration in this Habitat Conservation Plan include on-site and off-site mitigation steps which would be implemented in accordance with the project development phasing schedule and would include the strategies shown in Table 4:

Table 4. "Umbrella Plan" Steps to Assess the Development Impacts on Kapolei Population of *Abutilon menziesii*

Strategies	Mitigation Strategies and Measures
1	Determine Master Plan development schedule and mitigation phasing sequence
2	Determine staffing requirements
3	Interim management of existing population of *Abutilon menziesii* prior to construction
4	Locate off-site facilities for re-location of *Abutilon menziesii*
5	Establish on-site nursery for re-location and propagation of *Abutilon menziesii*
6	Transplant *Abutilon menziesii* to constructed on-site drainageway/open space corridor
7	Long-term protection and management of permanent *Abutilon menziesii* populations
8	Incorporate *Abutilon menziesii* into project landscaping
9	Conduct essential research

Strategy 1. <u>Determine Master Plan development schedule and mitigation phasing sequence</u>

The East Kapolei Master Plan project is planned to be phased generally over a 20-year period (1999 to 2020). The impact to the *Abutilon* population will, however, occur over the first 10 years of the project, generally from 1999 to 2008.

Four population clusters identified as A, B, C, and D presently exist on the central and southwestern portion of the property (Figure 5). Population C, the largest cluster, is further identified as C-1, C-2,

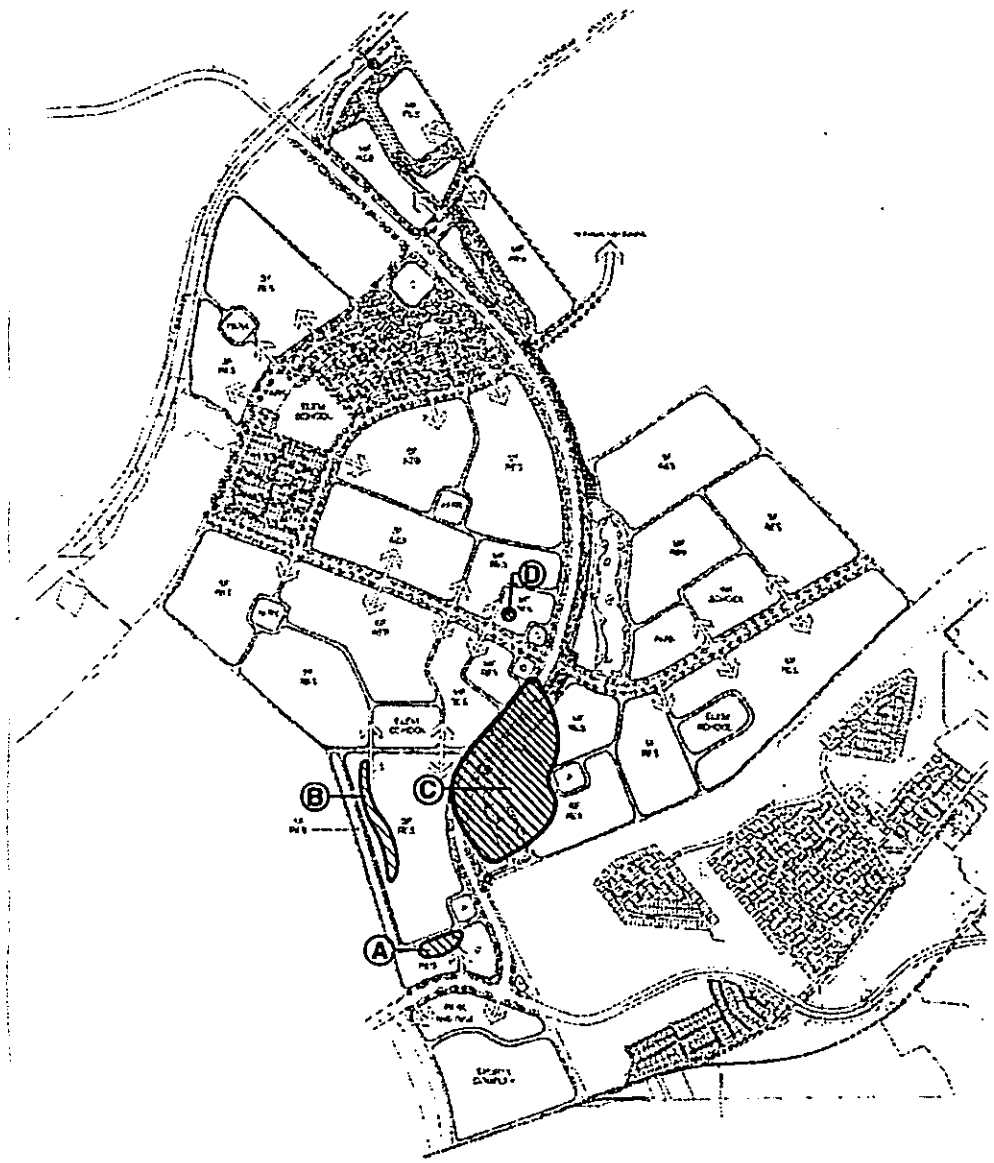


FIGURE 5
ABUTILON MENZIESII PLANT CLUSTER MAP
HFDC EAST KAPOLEI MASTER PLAN

and C-3. The C-1 portion of population cluster C is located within the North-South Road construction zone and the C-2 portion is planned for drainage infrastructure development by HFDC. Both the roadway and the drainage improvements are planned to be developed in the earliest phases of the project (1999 to 2000). The remaining clusters (A, B, C-3, and D) are projected to be developed for residential and commercial use as early as 1999 through 2008.

The master plan project schedule has been evaluated to determine when each of the *Abutilon* clusters would be affected. The schedule provided is the best information currently available, however, it may be subject to change. The impact would occur early 1999 and 2008 during the major infrastructure development period and during the development of the Phase 1 large residential lots in the southwestern portion of the property where *Abutilon* are concentrated. The existing plant clusters are expected to be affected in the order listed in the following table.

Table 5. Development Impacts and Phasing Schedule*

Development Phase	Impact Period	Cluster	No. Plants	Land Use	Responsibility
Drainage Improvements	1999 - 2001	C-2	6	Drainage	HFDC
North-South Road	1999 - 2001	C-1	14	Roadway	DOT
Phase 1	1999 - 2005	A	10	Residential, Comm'l	HFDC
Phase 1	2001 - 2005	B	14	Residential (DHHL)	HFDC
Phase 1	2001 - 2005	D	1	Residential	HFDC
Phase 2	2005 - 2008	C-3	41	Residential (DHHL)	HFDC

* Schedule is subject to change

The Department of Hawaiian Home Lands (DHHL) will be developing lots for residential homestead awards for qualified Native Hawaiians who are on their wait-list. As shown in Table 5, the master plan development schedule would incrementally impact the existing populations of *Abutilon menziesii*, with all of the impact anticipated to occur between 1999 to 2008.

Strategy 2. Determine staffing requirements

An important component of this plan is the establishment of an on-site nursery facility which would be staffed by experienced endangered species consultants to implement the plan. The nursery facility is described in Strategy 5.

The endangered species consultant staff would be retained and be paid by funds generated by the Housing Finance Development Corporation. Generally, the project will be staffed during the period of impact on *Abutilon menziesii* from 1999 to 2008.

2.1 <u>On-Site Consultant Project Manager</u>

The Consultant Project Manager (Project Manager) will be an overall coordinator responsible for the implementation of the Plan. The Project Manager will be a botanist or horticulturist experienced in the successful recovery of endangered species and will be responsible for all aspects of the Habitat Conservation Plan. The Project Manager would be responsible for implementing the fieldwork and the nursery operations. The Project Manager will supervise the Field Support Staff and cooperate with the Researcher. The Project Manager will responsibly manage the allocated budget and prepare reports as required by the plan. The Project Manager will report to the Housing Finance Development Corporation.

2.2 <u>Consultant Field Support Staff</u>

The Consultant Field Support Staff (Field Support Staff) will assist the Project Manager on an as-needed basis and be responsible for carrying out the field work as requested by the Project Manager to implement the plan. It is desirable, but not required, that the Field Support Staff be experienced in endangered species recovery work. The Field Support Staff will report to the Project Manager.

2.3 <u>Researcher</u>

The Researcher may be an individual or other entity (i.e., educational or research institution or program) experienced in endangered plant species research. The Researcher would be responsible for review of the existing research on *Abutilon menziesii* and would perform additional research which would focus on the recovery efforts related to the East Kaploei Master Plan population. The Researcher and the Project Manager would cooperate in their work responsibilities. The Researcher will report to the Housing Finance Development Corporation.

Strategy 3. <u>Interim management of existing population prior to construction</u>

The impact to the existing population clusters is expected to occur incrementally over the initial ten years of the project. Interim management measures will therefore be taken to secure and manage the population clusters prior to construction impact in the surrounding area. Management measures include weed control, fire protection, predation and disease control, and monitoring of the populations.

As development affects the existing populations, the plants would be established at off-site approved facilities (e.g. Waimea Arboretum & Botanical Gardens, City and County of Honolulu, Honolulu Botanical Gardens, Lyon Arboretum, Leeward Community College) and at an on-site nursery facility. Propagated plants from the on-site nursery facility will be permanently incorporated into the drainageway/open space areas. The drainageway/open space area consisting of 150 acres and designed for the 100-year flood will provide a permanent habitat for *Abutilon menziesii* which have been known to be frequently exposed to severe drought and periodic flooding (US Fish and Wildlife Service 1994).

Measures to protect the existing population clusters on the property will be taken to eliminate the short-term threats prior to commencement of construction activities.

3.1 <u>Secure habitat for current populations</u>.

3.1.1 *Identify all existing clusters.* Surveys of all possible occurrences of *Abutilon menziesii* would be conducted and individual plants and plant clusters flagged. Occurrence data, including presence in or absence from previously - reported sites (as well as site notes) and all relevant information for newly-reported occurrences, would be carefully documented. Detailed site information (including maps and plant data) would be compiled for each site.

3.1.2 *Identify any new clusters.* Any new clusters would include areas adequate for buffer zones and fire breaks would be identified and targeted for protection and management.

3.2 <u>Manage current populations</u>.

Management of habitat would include control of threats to the existence of *Abutilon menziesii.*

3.2.1 *Implement weed control.* Weed control would be implemented. Control methods may include mechanical and hand-pulling. Weed control would begin upon HCP approval and availability of funding. Weed control would be ongoing and sites monitored periodically to determine when additional intervention is necessary.

Control efforts would be supervised by a Project Manager experienced in safe control methods. Also, care would be taken to protect associated native species, as well as the endangered species, during weed removal.

3.2.2 *Provide necessary fire protection.* The threat of fire is perhaps, the most profound environmental threat to *Abutilon menziesii* on the East Kapolei property. Firebreaks approximately 10 feet wide around plant clusters would be created annually at the start of the dry season.

In addition, fire threats associated with construction activities would be minimized through a construction worker awareness program, and creation of firebreaks approximately 10-feet wide adjacent to all construction areas.

3.2.3 *Control predation and disease.* Threats associated with predation by rodents and host-specific pests would be monitored and control of such pests would be implemented.

Control Chinese rose beetle (Adoretus sinicus) as needed. If the Chinese rose beetle is observed on the plants, it would be controlled to prevent damage to the plants. The degree of threat would be determined by the Project Manager through field observations to determine the urgency of implementation of control measures. After effective control measures for the Chinese rose beetle are determined, an ongoing program of implementation and monitoring would be established, as determined by the Project Manager.

Control hibiscus scale as needed. If hibiscus scale is observed it would be controlled to prevent damage to the plants. The degree of threat is to be determined by field observations of the Project Manager who would determine the urgency of implementation of control measures. After effective control measures are determined, an ongoing program of implementation and monitoring would be established, as determined by the Project Manager.

Strategy 4. <u>Locate off-site facilities for propagation of *Abutilon menziesii*</u>

Off-site facilities for the propagation of *Abutilon* have been identified in the event of any catastrophic event (e.g. fire, etc.) which may threaten the entire population at Kapolei. Fourteen (14) plants in a portion of Cluster C, identified as C-1, which would be affected by the construction of the North-South Road have been designated for off-site cultivation. To accomplish this strategy, the *North-South Road Mitigation Plan for Abutilon Menziesii* (attached as Appendix A) has identified measures to address direct and indirect impacts within the Roadway construction zone. The Mitigation Plan would be implemented by the State Department of Transportation (DOT).

The initial focus of the Mitigation Plan is the generation of plant propagules from the existing 14 plants within a three to four month period prior to construction for eventual cultivation at two O'ahu gardens. Propagation methods would include seed germination and cultivation from air layer clones. These activities would be handled by an Endangered Species Consultant who would be a botanist or horticulturist experienced in the successful recovery of endangered species. The Endangered Species Consultant would be retained by the State DOT.

Two O'ahu gardens would receive the propagation source materials and cultivate them over a three-year period through a program which would be funded by the State Department of Transportation. After three years, the plants would become part of the permanent collection of the gardens.

Preliminary discussions have been held with the Waimea Arboretum & Botanical Garden and the City Honolulu Botanical Gardens for the off-site locations. Other candidate facilities include Lyon Arboretum and the Leeward Community College Native Garden. A final selection will be made in consultation with staff of the DLNR Division of Forestry and Wildlife and the U.S. Fish and Wildlife Service.

Strategy 5. <u>Establish on-site nursery facility for propagation of *Abutilon menziesii*</u>

The establishment of an on-site nursery facility is a key strategy of the HCP which would allow efficient implementation of the plant propagation measures. HFDC has designated a two-acre area to establish a nursery for propagation of *Abutilon.* The nursery site is located at the southern end of the project site makai of the Kapolei Parkway extension and adjacent to the proposed ballpark facility (Figure 6).

Plants and plant propagules would be collected prior to any construction impact and taken to the nursery for cultivation. The cultivated plants would eventually be permanently planted in the drainageway/open space corridor when the construction disturbance is ended.

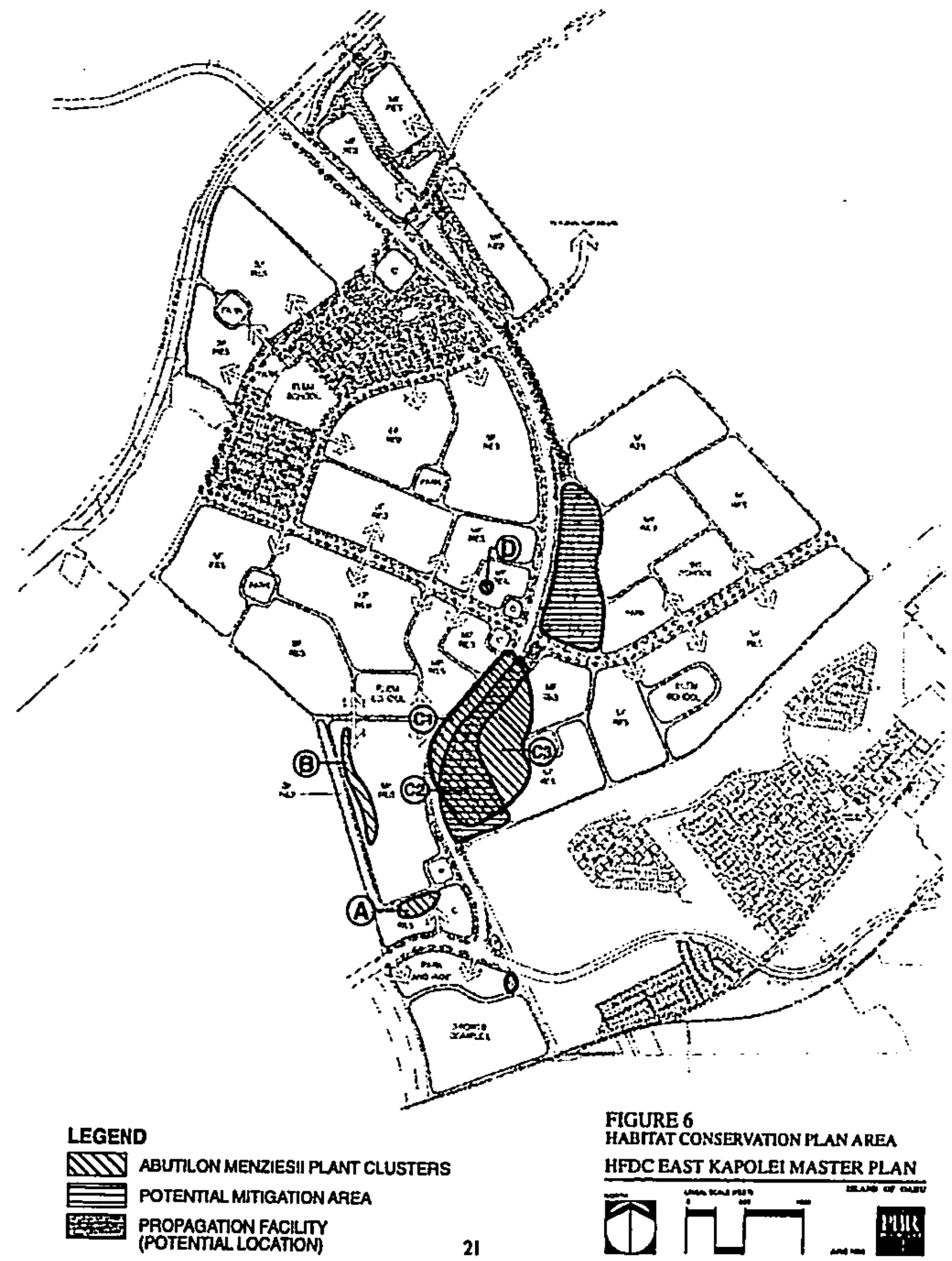


FIGURE 6
HABITAT CONSERVATION PLAN AREA
HFDC EAST KAPOLEI MASTER PLAN

The nursery program would be overseen and implemented by a Project Manager (described in Strategy 2) who would also oversee the field operations. A combination of cultivation methods include the following options: 1) the collection of seeds for germination and storage banking, 2) propagation of new plants by air layers and cuttings, and 3) re-location of plants through transplanting.

A collection of living plants of *Abutilon menziesii* would be maintained at the nursery facility. The origin of materials for living plant collections may be seeds, vegetative propagules, or plants from tissue culture. The Lanai Recovery Plan (FWS 1994) states, "It is possible that in a very few generations in cultivation, selective pressures quite different than those in natural settings can affect the overall genetic makeup of the population. Therefore, material that is destined for reintroduction to wild areas should be cultivated under conditions that resemble as closely as possible what we know as natural conditions. When possible, it is best to use first (or second) generation progeny from wild-collected plants as material for reintroductions. These concerns emphasize the importance of documentation of lineage and cultivation conditions for all cultivated plants".

The on-site nursery facility share the same natural conditions as the location of the existing plants. The methods selected for cultivation and re-introduction would include first generation progeny from the existing wild plants. All collected materials would be labeled accurately as to exact origin, collection date, etc. The cultivated population would establish a pool of genetic resources for permanent reintroduction to the drainageway.

- *Seed Collection and Propagation.* Although approximately 37 percent of the existing plants were flowering and fruiting, seeds were not successfully germinating (Nagata 1997). This may have been due to the recent dry El Nino weather conditions. Under cultivated conditions, however, *Abutilon menziesii* seeds are known to germinate readily in a cinder medium in as little as one week, and grow quickly after transplanting to individual containers.

  Seeds of *Abutilon menziesii* would be collected from existing wild plants and nursery cultivated plants (when they flower and fruit). Some of the seeds would be entrusted to seed banks (e.g. National Tropical Botanical Gardens) for long-term storage using the best available techniques for preservation. Seeds in long-term storage would be periodically tested for viability.

  Seeds would also be germinated for propagation at the on-site nursery and an average of four clones per original seeding parent or second generation plant would be established at the nursery for later reintroduction into the drainageway.

  Seed collection will be in accordance with guidelines from DLNR. Material (along with applicable collection data) would be obtained from as many sites as feasible (if such collection is not deemed to have an adverse effect on each cluster in order to maintain the broadest possible complement of genetic stock.

- *Air-Layering.* Air-layering is a horticultural technique to produce fairly large plants from another plant in a short period of time. This technique is commonly used on ornamental and native hibiscus (Bornhorst 1996) and is known to be 90 percent effective for this species, which

is also in the same Malvaceae family (Woolliams, personal communication 1997). Air-layers in the Ewa climate may require three to four months to develop roots, although rooting may also occur in four to six weeks if the weather conditions are right.

An average of four air-layers will be taken from the existing parent plants with a goal to yield approximately 288 air-layers.

- *Transplanting Parent Plant.* After seeds have been collected, and air-layered branches removed, the parent plant would be pruned for additional cuttings. The parent plant would be transplanted into pots and taken to the nursery. While the success rate for survival of transplanted plants is believed to be poor (Woolliams, personal communication 1997), all of the plants are planned to be transplanted and data recorded to ascertain long-term survival, reproductivity, plant vigor, etc. In the event that transplanting of the parent plant is determined to be ineffective, and survival, plant vigor, and reproductivity are found to be marginal, consultation with the DLNR Division of Forestry and Wildlife and the Fish and Wildlife Service will be initiated to determine if transplanting should be continued. This decision would be measured against the results of the other propagation methods.

- *Soil Seed Bank.* A soil seed bank will be implemented in the mitigation actions. *Abutilon* seeds may have a long dormancy in the soil. Therefore, efforts will be made to collect soil which may contain seeds. The top 3" to 4" of soil from the immediate area surrounding the plants to be impacted would be collected and stored. Samples of top soil would then be spread thinly in raised beds at the nursery facility and watered in preliminary germination trials. Successful germinations would be planted for eventual relocation to the drainageway. Preliminary trials would give an indication of the efficacy of this component and help to determine if soil banking should continue.

- *Tissue culture.* Tissue culture would be explored if an organization with a micropropagation laboratory requests plant materials for research, cultivation, or other reason. Tissue culture or clones may be a used to preserve genetic material. Plants to be cultured would be selected and meristem tissue collected from each only after having set up facilities to receive such material. At least four clones from each individual would be established in an appropriate ex-situ or on-site nursery. Tissue from cultivated plants from first-generation seed could also be used.

In addition, the existence of cultivated plants could in the future (i.e., when downlisted or delisted) provide a propagated source of the "red ilima" for which there may be a horticultural demand as ornamentals and for lei making.

Strategy 6. <u>Transplant *Abutilon menziesii* to on-site drainage/open space corridor</u>

The existing intermittent Kaloi Gulch and the proposed drainage improvements are described in the East Kapolei Master Plan EIS. The inadequacy of the existing Kaloi requires the creation of a new, realigned drainageway to function for conveyance of stormwaters of 100-year events. The proposed new drainage system will become part of the regional improvements to Kaloi Gulch being implemented by other downstream landowners. The development of the drainage improvements would be the responsibility of HFDC. The eventual ownership of the drainage system and its maintenance and management responsibility is undetermined at this time, therefore HFDC would maintain responsibility until a permanent owner is identified.

The proposed East Kapolei Master Plan's drainage/open space corridor of approximately 150 acres will serve two purposes: 1) to be used as an undeveloped grassed drainageway to convey surface flows during intense storm events, and 2) to be used for passive open space recreation. The drainage is expected to convey storm runoff only during high rainfall periods. Existing wild populations of *Abutilon menziesii* are known to inhabit areas which are prone to dryness and flooding (FWS 1994).

Cultivated plants from the nursery would be permanently relocated to this corridor upon the completion of construction. *Abutilon menziesii* will be planted in clusters in the drainageway (see Figure 6). If appropriate, *Abutilon menziesii* will be integrated with other native species common to the area. Such other plants could include the following: 'a'ali'i (Dodonaea viscosa); ma'o (Gossypium tomentosum), the native cotton; naio (Myoporum sandwicense var. Stellatum), false sandalwood; and 'ilima or 'ilima papa (Sida fallax).

The consultant Project Manager (see Strategy 2) through HFDC will be responsible for the implementation of this action and will coordinate any future owner of the drainage system.

Strategy 7. Long-term protection and management of permanent *Abutilon menziesii* population

As plants are transplanted into the drainageway for permanent re-location, long-term management measures would be implemented to protect the "new" population. It is anticipated that the original pre-development 86 plants (Nagata 1997) would be increased to over 300 individuals through propagation, an increase of over 400 percent to establish a permanent wild population. Management of the permanent habitat within the drainageway would be on-going until the population is established. This population is expected to contribute towards the recovery goals established in the Lanai Recovery Plan.

The long-term protection and management period is defined as the period after all plants from the nursery facility have been permanently relocated to the drainageway until the population is stable with a minimum of 100 mature individuals. See below (Section 7.3.1) for additional discussion of the Fish and Wildlife Service criteria for delisting and downlisting. The management measures during this period would include the following:

7.2 Protection and management measures.

7.2.1 *Conduct essential alien plant control.* The control of alien weeds is essential to habitat management. Habitat disturbance by weed removal activities would be taken to avoid or minimize direct damage to the environment. Weed control methods may include mechanical and hand-pulling. Local herbicide application would be implemented only if determined to be absolutely necessary. Weed control would begin immediately for each cluster until control is achieved in the full management site. Weed control would be

ongoing; sites would be monitored periodically to determine when additional intervention is necessary.

Control efforts would be supervised by the Project Manager experienced in safe control methods. Also, care would be taken to protect associated native species during weed removal.

Introduction of seeds of invasive alien plants will be monitored to minimize the establishment of alien weed species in critical areas.

7.2.2 *Provide necessary fire protection.* Plans to protect each site from fire would be developed. "Fire-free" zones would be established, with residents and other users apprised through signage of the hazards of smoking and open flames in sensitive areas. Firebreaks with a minimum width of 10 to 20 feet would be constructed around fire prone areas, wherever feasible.

7.2.3 *Control predation and disease.* Other threats include predation by host-specific pests. Monitoring and control of such pests would be implemented.

Chinese rose beetle (Adoretus sinicus). If the Chinese rose beetle is observed on the plants, it would be controlled to prevent damage to the plants. The degree of threat determined by field observations would determine the urgency of implementation of control measures. After effective control measures for the Chinese rose beetle are determined, an ongoing program of implementation and monitoring would be established.

Hibiscus scale. If hibiscus scale is observed, it would be controlled to prevent damage to the plants. The degree of threat determined by field observations would determine the urgency of implementation of control measures. After effective control measures are determined, an ongoing program of implementation and monitoring would be established.

7.2.4 *Ensure availability of pollination vectors.* Based on research findings, measures would be established to ensure that pollination vectors remain available. If natural pollination vectors are determined to be missing or in inadequate supply, measures necessary to ensure the availability of alternate pollination vectors would be determined and executed.

7.2.5 *Educational.awareness through signage.* The drainage/open space area will be utilized for recreational uses and will be designed with hiking and bike paths. Therefore, interpretive signage will be placed within these areas to promote public educational awareness of *Abutilon menziesii* in the area. Other signage will inform visitors of precautions that should be taken to avoid disturbance to *Abutilon* (e.g. no smoking, cleaning of boots and clothing, the importance of staying on existing trails).

7.2.6 *Monitor status of cultivated populations.* Permanent plots around every occurrence would be set up and mapped by size class in order to establish baseline information regarding population size and local distribution patterns as well as the occurrence of other species in the vicinity. Individual plants may also be tagged as appropriate for monitoring purposes. Data collection should include quantities and locations of all extant plants, as well as any other relevant observations regarding habitat or situation. Plots should be set up to allow point- and/or line-intercept monitoring methods as appropriate for each situation. Information such as changes in numbers of plants by size class, changes in vigor of individual plants, and changes or disturbances would be recorded. In addition to normally-scheduled field checks, populations would be checked after occurrences of any possible catastrophe or other unusual event by which *Abutilon menziesii* may have been affected.

7.3 Duration of long-term protection and management

The duration of long-term management and protection for *Abutilon menziesii* at the drainageway will be tied to the goals established in the Lanai Recovery Plan. Funding for long-term management will be through the HFDC trust fund dedicated to *Abutilon menziesii*.

7.3.1 *Lanai Plant Cluster Recovery Plan.* According to the Lanai Recovery Plan, *Abutilon menziesii* is considered to be a "long-lived perennial" because its life span is believed to be greater than 10 years. In prioritizing the nine Lanai taxa for recovery, *Abutilon menziesii* is ranked second because of the better chance it has of recovery due to its larger existing population size in the State and its resistance to some of its current threats. And, provided with appropriate management, its relatively good chance of recovery (FWS 1994). The Lanai Recovery Plan contains interim objectives as well as objectives for downlisting and delisting.

- *Interim Objectives.* The interim objectives for the nine Lanai taxa, including *Abutilon menziesii*, include a minimum of three stable populations of each taxa on Lanai, and at least one population on one other island where they now occur or occurred historically. In addition to the Lanai population and the subject Kapolei population, other populations occur on Maui and the island of Hawai'i. Each of the populations must be naturally reproducing and increasing in number, with a minimum of 25 mature individuals per population for long-lived perennials.

- *Downlisting Objectives.* For downlisting, a total of five to seven populations of each taxon, including *Abutilon menziesii*, should be documented on Lanai and at least one other island where they now occur or occurred historically. In certain cases, however, a particular taxon may be eligible for downlisting even if all five to seven of the populations are on only one island, provided all of the other recovery criteria have been met and the populations in question are widely distributed and secure enough that one might reasonably conclude that the taxon is not in danger of extinction throughout all or a significant part of its range.

  Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered.

- *Delisting Objectives.* For delisting, a total of 8 to 10 populations of each taxon, including *Abutilon menziesii*, should be documented on Lanai and at least one other island where they now occur or occurred historically. As with downlisting, there may be cases in which a particular taxon may be eligible for delisting even if all 8 to 10 of the populations are one island, provided all of the other recovery criteria have been met and the populations in questions are widely distributed and secure enough that one might reasonably conclude that the taxon is not likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

  Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials. Each population must persist at this level for a minimum of five consecutive years.

7.3.2 *Long-term Funding.* The HFDC trust fund which will be established to implement the Habitat Conservation Plan during the construction impact period will also fund the long-term management period. After the construction impact period, which would include the planting of the plants into the drainageway to create a permanent habitat, the funds would be transferred to a natural resource agency to continue the implementation of the long-term management tasks until the recovery goals for downlisting or delisting on O'ahu are reached.

Strategy 8. Incorporate *Abutilon menziesii* into project landscaping

With the successful propagation of *Abutilon menziesii* at the nursery and when the numbers have exceeded 100 mature individuals, *Abutilon menziesii* would also be located within the project (e.g. parks, schools) as elements of the urban landscape. This potential mitigation measure would only be feasible, however, if these plants could be freely relocated, propagated, trimmed and maintained as hedges and ornamental plantings at the discretion of the landowner or developer as part of the approved mitigation plan and not be subject to the rigorous requirements of the Endangered Species Act. It is notable that prior to the federal listing in 1986, *Abutilon menziesii* was propagated by commercial nurseries as a "red ilima".

Strategy 9. Conduct essential research

The research component would focus on the "cultivation aspects" of *Abutilon menziesii* to attain the goals and successfully implement this HCP. A review of past research studies would be made and appropriately applied to this project.

Research may include studies of various aspects of life history, habitat, pollinators, reproductive biology, optimum requirements for growth, requirements for population viability, and control of threats to better understand the requirements necessary for perpetuation of these plants. Such additional knowledge would allow more appropriate management and assessment techniques to be developed.

9.1 Collect diagnostic data on crucial associated ecosystem components.

Diagnostic data to include:

1) Composition of flora and invertebrate, bird, and other fauna populations within the existing clusters to gain an understanding of any relationships between these organisms and *Abutilon menziesii.*

2) Comparison of such information collected over time correlated with data from monitored populations of *Abutilon menziesii* in known locations to provide insight into the required and/or preferred habitat for the endangered plants.

9.2 Study various aspects of growth.

Study aspects of growth of *Abutilon menziesii* including:

1) Growth and mortality of seedlings, air-layers, cuttings, transplanted parent plants;
2) Growth of mature plants, including seasonal changes, optimum conditions and limiting factors;
3) Seasonal differences in temperature and light needs;
4) Water sources and requirements; and
5) Soil and nutrient requirements.

9.3 Study reproductive viability.

To allow the best management strategy for *Abutilon menziesii* to be developed, determine factors affecting the reproductive viability including:

1) Breeding systems including self-compatibility;
2) Pollination vectors; and
3) Preferred conditions for flowering and seed set.

9.4 Determine the degree of threats posed by the nature of interactions with selected diseases/ introduced species.

To better manage *Abutilon menziesii* and its habitat, determine the effects of introduced pests as well as the mechanisms of impact.

9.4.1 *Determine the degree of threat posed by the Chinese rose beetle (Adoretus sinicus) to Abutilon menziesii.* The degree of threat posed by the Chinese rose beetle would be determined by research into the life history of *Abutilon menziesii* in conjunction with field observations of the damage by this pest. Information gathered would become the basis for decisions regarding the urgency of implementation of control measures.

9.4.2 *Determine the degree of threat posed by hibiscus scale to Abutilon menziesii.* The degree of threat posed by hibiscus scale would be determined by research into the life history of *Abutilon menziesii* in conjunction with field observations of the damage by this pest. Information gathered would become the basis for decisions regarding the urgency of implementation of control measures.

9.4.3 *Determine mechanisms of impact of other diseases or pests.* If diseases or introduced pests with negative impacts on *Abutilon menziesii* are discovered other than those listed, effects and mechanisms of each would be determined. Research into mechanisms of impact of alien species, and any others that may be threats, would be performed as deemed necessary by the Project Manager.

9.5 Determine effective control methods to combat selected diseases/introduced species.

Determination needs to be made of control methods to combat insect pests that may adversely affect *Abutilon menziesii.*

9.5.1 *Determine effective control methods for the Chinese rose beetle (Adoretus sinicus) on Abutilon menziesii.* If the Chinese rose beetle is determined to pose a threat to *Abutilon menziesii*, research into effective control methods for the Chinese rose beetle would be undertaken, ensuring that the control measures do no adversely affect it.

9.5.2 *Determine effective control methods for hibiscus scale on Abutilon menziesii.* If the hibiscus scale is determined to pose a threat to *Abutilon menziesii*, research into effective control methods for the hibiscus scale on the appropriate *Abutilon* species would be undertaken, ensuring that the control measures do no adversely affect it.

(4) Identify those measures or actions to be undertaken to protect, maintain, restore, or enhance the ecosystems, natural communities, or habitat types within the plan area; a schedule for implementation of the actions or measures, including monitoring, are undertaken in accordance with the schedule.

(4a) Measures or actions to be undertaken to protect, maintain, restore, or enhance the ecosystems, natural communities, or habitat types

Short-term and long-term measures and actions which would affect the existing *Abutilon menziesii* population have been described in Section 3 above. The strategies outline the measures and actions of the HCP for the existing habitat, the interim nursery period, and the long-term period of the relocated permanent habitat within the drainageway. The following strategies are relevant:

Strategy 3: Interim management of existing population of *Abutilon menziesii* prior to construction

Strategy 4: Locate off-site facilities for re-location of *Abutilon menziesii*

Strategy 5: Establish on-site nursery for re-location and propagation of *Abutilon menziesii*

Strategy 6: Transplant *Abutilon menziesii* to constructed on-site drainageway/open space corridor

Strategy 7: Long-term protection and management of permanent *Abutilon menziesii* populations

Strategy 9: Conduct essential research

(4b) A schedule for implementation of the proposed measures and actions.

Also discussed previously and described in detail in Section 3, the major impacts to *Abutilon menziesii* would occur over the initial 10 years of the 20-year project buildout period. This schedule is based on the best available information at this time and may be subject to change, therefore, the mitigative strategies and measures which are proposed, therefore, are not tied to specific dates but to development actions, although conceptual dates are indicated in Strategy 1. The long-term management period is described in Strategy 7, and would be tied to achieving the goals of the subject HCP relative to the recovery goals described in the *Lanai Plant Cluster Recovery Plan.*

Strategy 1: Determine Master Plan development schedule and mitigation phasing sequence

Strategy 7: Long-term protection and management of permanent *Abutilon menziesii* populations

(5) Be consistent with the goals and objectives of any approved recovery plan for any endangered species or threatened species known or reasonably expected to occur in the ecosystems, natural communities, or habitat types in the plan area.

Abutilon menziesii is one of nine taxa included in the *Lanai Plant Cluster Recovery Plan* (US Fish and Wildlife Service, 1994). This subject Habitat Conservation Plan utilizes the Recovery Plan guidelines and incorporates them into the strategies described in Section 3.

(6) ***Provide reasonable certainty that the ecosystems, natural communities, or habitat types will be maintained in the plan area, throughout the life of the plan, in sufficient quality, distribution, and extent to support within the plan area those species typically associated with the ecosystems, natural communities, or habitat types, including any endangered, threatened, proposed, and candidate species known or reasonably expected to be present in the ecosystems, natural communities, or habitat types within the plan area.***

With the implementation of Strategies 1 - 9 described in Section 3 of the subject HCP, there is reasonable certainty that the ecosystems, natural communities, or habitat types in support of *Abutilon menziesii* would be maintained at Kapolei.

Considering the offsite (North-South Road) and onsite (East Kapolei Master Plan) mitigation measures planned, the maximum number of trials through seed germination, air-layering, cuttings, and transplanting would yield approximately 800 opportunities for cultivating plants from the original 86 existing plants over the 10-year impact period. In addition, seeds in banked storage would provide future opportunities to propagate potential plants.

We recognize that the propagation methods proposed may yield different levels of success. For example, seeds and air-layering are known to be more viable than cuttings and transplanting of existing parent plants. Therefore, the research component of this HCP (Strategy 9) would evaluate the best cultivation methods for this species.

When the construction disturbance has ended within the areas designated for the reintroduction, the plants from the nursery facility will be returned to the property to be permanently established in the drainage/open space corridor. In addition, plantings will also be utilized for landscaping in the residential and public areas (i.e., schools and parks). Moreover, seeds and cuttings would be deposited at approved botanical gardens.

(7) ***Contain objective, measurable goals, the achievement of which will contribute significantly to the protection, maintenance, restoration, or enhancement of the ecosystems, natural communities, or habitat types; time frames within which the goals are to be achieved; and provisions for monitoring (such as field sampling techniques) and evaluating progress in achieving the goals quantitatively and qualitatively.***

(7a) *Objective measurable goals*

The impact to *Abutilon menziesii* at Kapolei will occur over a period of 10 years and will affect the plant clusters (e.g. A, B, C-1, C-2, C-3, and D) incrementally as described in Section 3, Strategy 1. Prior to the impact, however, propagules will be taken from the plants and cultivated at the nursery facility (as described in Section 3, Strategy 5). The propagation methods include seed germination, air-layers, cuttings, and transplanting of the existing parent plant.

The propagules would be collected over time. For example, seed collection would be continuous and on-going, air-layers and cuttings would be taken at least four months prior to the increment of construction impact, and transplanting of the parent plant would be accomplished prior to the impact. Based on data collected in 1997 (Nagata 1997), the proposed plan projects that the existing 86 plants would generate approximately 800 opportunities for plant propagation as shown in Table 6.

Table 6. Generation of Potential Progeny from the Kapolei Population of *Abutilon Menziesii*

Impact Period*	Cluster	No. Plants	Seeds*** 37% x 4/plant	Air-layers (4 / Plant)	Cuttings (4 / Plant)	Transplant Parent
1999 - 2001	C-2	6	10	0	24	6
1999 - 2001	C-1 (Offsite)**	14	20	56	N/A	N/A
1999 - 2005	A	10	15	40	40	10
2001 -2005	B	14	20	56	56	14
2001 - 2005	D	1	0	4	0	1
2005 - 2008	C-3	41	60	164	164	41
Potential	Progeny	(797)	125	316	284	72

* Schedule is subject to change
** North-South Road Mitigation Plan measurable goals are described in Appendix A
*** Based on 1997 data (37% of plants were flowering/fruiting)

The seeds that are collected will be distributed to appropriate gardens and other approved facilities for storage and germination. Distribution records would be kept.

In addition, soil seed germination trials will be done. Until the trials are begun, it is uncertain what the germination rate will be.

The survival rate of the 800± propagules is expected to vary according to the method of propagation. According to information available, rates of survival of progeny vary from high to low with seed-germinated and air-layered plants being higher than plants that are started from cuttings or existing plants that are transplanted.

The HCP has conservatively set survival rates at 50% for seed-germinated and air-layered plants and 5% for cuttings and transplanted plants. Based on these rates, it is expected that 235 plants would survive. Of these, approximately 25% (of the totalpopulation) or 109 would flower and bear seeds.

Table 7. Estimated Survival Rates of Propagated *Abutilon Menziesii*

Cluster	Seeds			Air Layers			Cuttings		Transplant Parent		TOTAL
	No.	50% survival	25% reproduce	No.	50% survival	25% reproduce	No.	50% survival	No.	50% survival	
C-2	10	5	2	0	--	--	21	1	6	0	
C-1 (offsite)	20	10	5	56	28	14	N/A	N/A	N/A	N/A	
A	15	7	3	40	20	10	40	2	10	0	
B	20	10	5	56	28	14	56	2	14	0	
D	0	N/A	N/A	0	N/A	N/A	0	N/A	1	0	
C-3	60	30	15	164	82	41	164	8	41	2	
No. of Plants	125			316			284		72		797
Survival		62			158			13		2	235
Reproduce			30				79				109

The estimated survival rates shown are based on available information (Nagata 1997, Char 1996). The 25% reproductive rate is possibly conservative, based on the 37% of the existing population which were flowering and fruiting (Nagata 1997). However, 25% was selected because the environmental conditions would change due to the proposed impacts. No information is currently available on establishing new plants in the wild since the change in the number of plants between 1996 (Char 1996) and 1997 (Nagata 1997) has remained stable.

(7b) Timeframe within which goals are to be achieved

The East Kapolei Master Plan project is planned as a long-term project with a buildout of 20 years. The development schedule on which this HCP is based relies on the best available information at this time. Since real estate development is market driven, the schedule is subject to change in the future. Based on the schedule described in Strategy 1 of Section 3, the impacts to *Abutilon menziesii* are anticipated incrementally over a 10-year period. Mitigation measures, will therefore, be implemented incrementally; and, subsequently, the goals will be achieved in steps.

The off-site mitigation program for the North-South Road is planned as a three-year program. The goals are expected to be achieved during this period.

(7c) Provisions for monitoring and evaluating progress

As required by Chapter 195D-21(f), HRS, "Participants in a Habitat Conservation Plan shall submit an annual report to the Department of Land and Natural Resources within 90 days of each fiscal year ending June 30, that includes a description of activities and accomplishments, analysis of the problems and issues encountered in meeting or failing to meet the objectives set forth in the HCP, areas needing technical advice, status of funding, and plans and management objectives for the next fiscal year, including any proposed modifications thereto."

The reporting process will meet or exceed the statutory requirements. Reports during the interim management period on the existing wild population will be prepared to meet the annual reporting requirements. Thereafter, reports will be prepared following the construction impact on affected clusters. During the maintenance period, reports will be prepared semi-annually initially to track and document the success or failure of the measures. After the technical procedures have been perfected, reports will be prepared annually. Reports will be submitted to the BLNR.

(8) Provide for an adaptive management strategy that specifies the actions to be taken periodically if the plan is not achieving its goals.

As noted above in (Section 3, Strategy 7, (7c)), the proposed report preparation exceeds the statutory requirement of an annual report. The increase from annual to semi-annual reporting would allow review and evaluation of the measures which are succeeding and failing in meeting the stated goals. If any measure is not achieving the HCP goal, early identification would allow HFDC, the Master Developer, to coordinate and consult with the DLNR Division of Forestry and Wildlife and assess the situation. Necessary steps to address any problem and corrective actions would be identified and implemented to be able to achieve the stated goals.

REFERENCES

Bornhorst, H. L. 1996. *Growing Native Hawaiian Plants: A How-to Guide for the Gardener.* Bess Press, Honolulu, HI.

Char, W.P. 1997. *Botanical Resources Study, North South Road Corridor (H-1 Freeway to Kapolei Parkway), 'Ewa District, Island of O'ahu.* Honolulu, HI.

Char, W.P. 1997. *Summary of Findings: Ko'oloa'ula on East Kapolei Project Site, 'Ewa District, Island of O'ahu. Honolulu, HI.*

Nagata, K. 1996. *East Kapolei Master Plan Biological Survey.* Honolulu, HI.

Nagata, K. 1997. Data Survey. Honolulu, HI.

Parsons Brinckerhoff. 1997. *North-South Road Draft Environmental Assessment* (Review Draft). Honolulu, HI.

PBR Hawaii. 1997. *East Kapolei Master Plan Project: Environmental Impact Statement Notice of Preparation.* Prepared for Housing Finance Development Corporation. Honolulu, HI.

PBR Hawaii. 1998. *East Kapolei Master Plan Project: Draft Environmental Impact Statement.* Prepared for Housing Finance Development Corporation. Honolulu, HI.

PBR Hawaii. 1998. *North-South Road Mitigation Plan for Abutilon Menziesii.* Prepared for Parsons Brinckerhoff and State of Hawai'i Department of Transportation. Honolulu, HI.

U. S. Fish and Wildlife Service. 1994. *Lanai Plant Cluster Recovery Plan: Abutilon eremitopetalum, Abutilon menziesii, Cyanea macrostegia ssp. Gibsonii, Cyrtandra munroi, Gahnia lanaiensis, Phyllostegia glabra var. Lanaiensis, Santalum freycinetianum var. Lanaiensis, Tetramolopium remyi, and Viola lanaiensis.* U.S. Fish and Wildlife Service, Portland, OR.

Wagner, W. L., D. R. Herbst, S. H. Sohmer. 1990. *Manual of the Flowering Plants of Hawaii.* Bishop Museum, Honolulu, HI.

APPENDICES

APPENDIX A
NORTH-SOUTH ROAD
MITIGATION PLAN FOR ABUTILON MENZIESII

North – South Road Mitigation Plan for Abutilon Menziesii

Prepared for:
Parsons Brinckerhoff Quade & Douglas, Inc.
and
State of Hawaii
Department of Transportation

June 1998

TABLE OF CONTENTS

LIST OF TABLES

LIST OF EXHIBITS

LIST OF APPENDICES

PREFACE

Abutilon menziesii, or Ko'oloa'ula, was recently discovered on lands at Kapolei in the Ewa District on Oahu, Hawaii. *Abutilon menziesii* is a federally listed endangered species. It is one of nine endangered species included in the *Lanai Plant Cluster Recovery Plan* (U.S. Fish and Wildlife Service, 1994), also referred herein as the Lanai Recovery Plan. The Lanai Recovery Plan describes the plant and strategies with the intended goal to downlist, and eventually, to delist the plant. A population of 86 *Abutilon menziesii* plants was identified in 1996 on the subject lands which were in sugar cane cultivation for nearly a century when agricultural operations on the property ceased in 1994.

The proposed North-South Road ("Roadway") would be an arterial roadway which is planned as a federal-aid highway. The development of the roadway would directly affect 14 plants within the population. The planned development of the North South Road is in accordance with the long range plans of the State of Hawaii and City and County of Honolulu policies to direct growth to Kapolei, the secondary urban center within the Ewa District.

In addition to the North-South Road, the East Kapolei Master Plan residential development by the State Housing Finance Development Corporation ("HFDC") would also affect the same population of *Abutilon menziesii*. The projects are independent of each other and proposed by separate governmental agencies with separate funding sources.

According to the Lanai Recovery Plan, populations of *Abutilon menziesii* have been recorded on Lanai, Maui, and Hawaii. Prior to the recent discovery of *Abutilon menziesii* at Kapolei (Nagata 1996, 1997, and Char 1996), only a few plants were believed to occur on Oahu in recent years.

This Mitigation Plan ("Plan") was developed in response to federal and State requirements pertaining to threatened and endangered species. The measures which are described in this Plan are designed to accommodate the development of the North-South Road while simultaneously mitigating the impacts to *Abutilon menziesii* and promoting its recovery.

This Plan is intended to be an independent Mitigation Plan which would be implemented by the Hawaii Department of Transportation apart from mitigation measures which may be implemented through the HFDC East Kapolei project. The federal government will participate in the funding to implement this mitigation plan, through the Federal Highway Administration. However, this Plan is designed to be consistent with the Habitat Conservation Plan ("HCP") for the East Kapolei Master Plan project which addresses the impacts of development on the total population of *Abutilon* at Kapolei. Consequently, the HFDC Habitat Conservation Plan is referred to as an "umbrella plan", which also includes the Mitigation Plan measures for the North-South Road.

EXECUTIVE SUMMARY

Informal Section 7 Consultation (in accordance with provisions of the federal Endangered Species Act) was initiated in September 1997 to address the potential impacts of the North-South Road ("Roadway") on *Abutilon menziesii*. This Mitigation Plan has been prepared in partial fulfillment of the requirements of a Biological Assessment required by the federal Endangered Species Act, 50 CFR 402.12, to evaluate the development impacts of the project on all listed species, proposed species, and critical habitats that may be present in the project area.

In addition, to fulfill the requirements of the State Endangered Species Act, a Habitat Conservation Plan ("HCP") addressing *Abutilon menziesii* at Kapolei has also been prepared. The HCP is being coordinated with the Biological Assessment. In particular, the provisions of the Habitat Conservation Plan, as they relate to the North-South Road, are identical to the mitigation provisions specified in this Plan.

Mitigation Plan Objectives

The objectives of this Mitigation Plan ("Plan") are threefold: (1) describe the existing conditions of the Kapolei *Abutilon menziesii* population; (2) describe the potential development impacts of the North-South Road on *Abutilon menziesii*; and (3) describe the proposed mitigative actions.

This Plan provides a description of the North-South Road development actions proposed at property in Kapolei in the Ewa District on Oahu which would impact *Abutilon menziesii*, and proposes mitigative actions to address the impacts. The conservation measures for *Abutilon menziesii* described in this Plan have been incorporated into the scope of the proposed project.

Both the North-South Road and the East Kapolei Master Plan are intended to further the State of Hawaii and City and County of Honolulu goals of developing a secondary urban center at Kapolei. Although the two projects are independent of each other, both projects would affect the same population of *Abutilon menziesii*, albeit to different degrees.

The Presence of Abutilon Menziesii on the Property

The property had been cultivated in sugarcane for nearly a century. According to Oahu Sugar Company, sugarcane was last harvested on the property in 1994, prior to the permanent closure of the company in Spring 1995. Typical of sugarcane grown in Hawaii, the variety grown on this field was the two-year variety which requires a pre-harvest fire to reduce the leaf bulk before the cane stalks are mechanically harvested. Generally, cane fires in each field lasted 20 to 30 minutes. The now abandoned fields at the subject property were exposed to cane fires every two years during nearly ten decades of cane cultivation.

In September 1996, *Abutilon menziesii* was discovered by Nagata (1996) approximately two years after the last cane harvest. Nagata's reconnaissance survey covered 80 percent of the property. A subsequent count by Char in December 1996, following an unusually wet period in November and December 1996, recorded 88 plants. Char (1997) in a botanical survey for the North-South Road corridor cited *Abutilon menziesii* as a species of concern (Appendix A). In December 1997 Nagata conducted a comprehensive survey and recorded 86 plants on-site. One (1) plant was observed off-site at Renton Road which is located to the south of the project site. The December 1997 survey produced taxonomic data and a precise surveyed map of the plants.

The total population consists of 86 individuals (Nagata 1997). Fourteen (14) plants or 16 percent of the population would be affected by the construction of the North-South Road. The remaining 72 plants (84 percent) are on the East Kapolei Master Plan site. This Plan addresses the direct and indirect impacts of the Roadway construction on the sub-population nearest the Roadway and provides a mitigation response to address the impacts. A separate Habitat Conservation Plan addresses the impacts of the East Kapolei Master Plan project on the total Kapolei population, including the plants within the North-South Road construction zone.

Landownership

The linear corridor of the North-South Road is currently owned in part by the State of Hawaii and in part by the Estate of James Campbell ("EJC"). *Abutilon menziesii* is present on the southern State-owned portion and not the northern Campbell Estate portion. This State of Hawaii land is currently held by the Department of Land and Natural Resources ("DLNR"). The property was previously leased to Oahu Sugar Company and upon expiration of the lease in 1995, sugar cane cultivation at this location and all other Oahu Sugar Company fields ended.

The planned development of the North-South Road would require conveyance of property from DLNR and the EJC to the State Department of Transportation ("DOT"). The conveyance of the DLNR portion by Executive Order is anticipated to be concluded in 1998, prior to the commencement of construction.

Project Development Description

The proposed roadway would be a principal arterial providing regional access to the Interstate H-1 Freeway. The North-South Road would connect the H-1 Freeway (located to the north) to a future segment of Kapolei Parkway (located to the south), a distance of approximately 3.6 km (2.2 miles),

and it would include an interchange with the freeway. The new road would include three vehicular lanes in each direction, a median and sidewalks on both sides. North-South Road would share a corridor with a transit easement and new drainage improvements. However, the establishment of the transit easement and the drainage improvements are to be constructed by HFDC in the development of the East Kapolei Master Plan.

The Draft Environmental Assessment for the North-South Road is being submitted as part of the Biological Assessment. The Draft EA fully describes the roadway, its potential impacts, proposed mitigative measures, and project alternatives.

Impact of the Project on Abutilon menziesii

The development of the Roadway would result in direct destruction of 14 plants. The destruction of the plants, however, would occur only after plant propagules (e.g. seeds and air layer clones) are taken from each plant in numbers substantially greater than the 14 plants. The plant propagules would be taken to two off-site gardens which specialize in the cultivation of endangered plant species, and the propagules would be integrated into their permanent collections. Indirect impacts to the immediately adjacent plants in Cluster C include an increased risk of fire during the construction period. Detailed mitigative measures are described in the Mitigation Plan section of this report.

Project Schedule

Construction of the Roadway is presently anticipated to commence in mid-1999. On-site mitigative actions for *Abutilon menziesii* would begin three to four months prior to any grading activities. Off-site activities at the garden locations would continue for three years. Thereafter, the plants would be integrated into the permanent collections of the off-site gardens. Roadway construction would begin after all propagules from plants in the construction zone have been removed. The construction of this phase of the roadway is expected to be completed by early 2001.

Relationship of the North-South Road Mitigation Plan to the Umbrella Plan

The Kapolei population of *Abutilon menziesii* would be affected by the North-South Road and the East Kapolei Master Plan project. As such, a Habitat Conservation Plan has been prepared by HFDC for the East Kapolei Master Plan, which addresses the impacts of the residential development on *Abutilon menziesii*. The HFDC plan serves as an "umbrella plan" which covers the entire population on the property, including the plants within the North-South Road zone.

Attached to the HFDC HCP umbrella plan are appendices which are applicable to the subject Mitigation Plan. They including the following: 1) the subject *North-South Road Mitigation Plan for Abutilon Menziesii* (Appendix A, PBR Hawaii 1998), 2) *East Kapolei Master Plan Biological Survey* (Appendix B, Nagata 1996), 3) *Summary of Findings: Ko'oloa'ula on East Kapolei Project Site* (Appendix C, Char 1996), and 4) Summary of Proposed Mitigation Measures for the Kapolei Population (Appendix D). Appendix D includes the mitigation measures of the North-South Road.

The subject Mitigation Plan for the Roadway is a component of the umbrella plan. This Plan can stand alone and be successfully implemented in the event that the East Kapolei Master Plan is delayed. It addresses only the plants that would be affected (directly and indirectly) by the Roadway.

MITIGATION PLAN

The format of this Mitigation Plan ("Plan") generally follows the guidelines of Legislative House Bill 1292, on which the amended Chapter 195D, *Hawaii Revised Statutes* is based. The recommendations of the State DLNR Division of Forestry and Wildlife and the US Fish and Wildlife Service are included in this Plan.

(1) Identify the geographic area encompassed by the plan; the ecosystems, natural communities, or habitat types within the plan area that are the focus of the plan; and the endangered, threatened, proposed, and candidate species known or reasonably expected to be present in those ecosystems, natural communities, or habitat types in the plan area.

(1a) Geographic Area Encompassed by the Plan

The geographic area encompassed by the Plan is at Kapolei, Ewa District, Oahu, Hawaii (Exhibit 1) on lands presently owned by the State of Hawaii and the Estate of James Campbell (Exhibit 2). *Abutilon menziesii* is present on the southern portion owned by the State but not the northern Campbell Estate portion. The North-South Road project construction zone is generally a linear corridor approximately 116 feet wide, totaling approximately six acres. It encompasses former sugar cane lands mauka of Varona Village from approximately 60 feet mean sea level (MSL) at Mango Tree Road up to 200 MSL at the H-1 Freeway. *Abutilon* is present only along the southern 2,400 feet length of the 2.2-mile long roadway corridor.

The North-South Road alignment is adjacent and parallel to an existing Hawaiian Electric Company, Inc. ("HECO") power line easement.

(1b) Ecosystems, Natural Communities, or Habitat Types within the Plan Area

The project area was formerly cultivated as sugarcane land and is now characterized as a disturbed coastal dry ecosystem. The vegetation of the region is generally lowland shrub with a coastal fringe of kiawe trees. In the past several years, project and surrounding lands have been taken out of sugar cane cultivation and put to other uses (e.g. urbanization, diversified agriculture, fallowed fields). Consequently, vegetation on these lands is entirely secondary and the vegetation in the region is largely determined by the history of cultivation (or disturbance) on each individual parcel of land.

Within the project and Plan area there are 80 to 100 plant species common to former sugar cane lands (Nagata 1996, Char 1997). Survey reports by Nagata and Char are attached as Appendices A and B. Of the species recorded, only two are indigenous ('ilima and pa'uohi'iaka), two are probably indigenous ('uhaloa and hoary abutilon) and one, the subject plant, *Abutilon menziesii*, is endemic.

The vast number consists of non-native species dominated by clumps of sugar cane, lowland shrubs, and herbs and grasses.

The Ewa Plain experiences light mean annual rainfall of about 20 inches per year, most of which occurs between November and April. Based on more than 50 years of data collected at the Ewa Plantation, average annual daily minimum and maximum temperatures in the project area are 65°F and 84°F, respectively. Extreme minimum and maximum temperatures were 47°F and 93°F. Under the current condition as fallow agricultural land, the relatively inconsequential levels of evapotranspiration which occurs from scrub vegetation produces little cooling effect.

(1c) The endangered, threatened, proposed, and candidate species known or reasonably expected to occur in the ecosystems, natural communities, or habitat types in the plan area.

Abutilon menziesii, also known by its Hawaiian name ko'oloa'ula, is a shrub in the mallow family (Malvaceae). At this location in the dry Ewa area, mature plants are 2.5 feet to 3.5 feet tall with silvery heart-shaped leaves and characteristic dark red flowers. *Abutilon* is also commonly referred to as the "red 'ilima."

Nagata (1997) surveyed three general clusters of plants (Clusters A, B, and C) and one lone plant (Cluster D) for a total of 86 plants within the area proposed by the State for urban development (Exhibit 3). Cluster C, the largest cluster, occurs in the general area under and to the east of the powerline easement. The plants in all clusters are sparsely scattered within discrete areas totaling approximately 80 acres. One (1) plant was observed off-site at Renton Road adjacent to the southern boundary of the project and is not included in this Plan.

Table 1.
***Abutilon menziesii* Population at Kapolei**

Cluster	No. of Plants
A	10
B	14
C	61
D	1
TOTAL	86

The plants range from juvenile to mature individuals (Nagata 1997). A large proportion of the population (74%) were taller than three feet, 20% were between 2 and 3 feet, and only 6% were

between 1 and 2 feet. No seedlings or plants under 1-foot were identified. In December 1997, 37% of the plants were flowering and/or fruiting (Nagata 1997).

Fourteen (14) of the plants in Cluster C nearest the powerline easement would be affected by the construction of the North-South Road. *Abutilon menziesii* occur in three clusters in the vicinity of the North-South Road zone; however, only a portion of Cluster C is affected.

Table 2.
Cluster C (Sub-Areas)

Sub-Cluster	No. of Plants	Land Use
C-1	14	North-South Road
C-2	7	Drainage/Open Space Corridor
C-3	40	Residential
TOTAL	61	

(2) Describe the activities contemplated to be undertaken within the plan area with sufficient detail to allow the department to evaluate the impact of the activities on the particular ecosystems, natural communities, or habitat types within the plan area that are the focus of the plan.

The proposed roadway would be a principal arterial providing regional access to the Interstate H-1 Freeway. It would connect the H-1 Freeway to a future segment of Kapolei Parkway, a distance of approximately 3.6 km (2.2 miles), and it would include an interchange with the freeway. The new road would include three vehicular lanes in each direction, a planting median, and sidewalks on both sides. The overall width to accommodate all components of the roadway is 116-feet (Exhibit 4).

The North-South Road is fully described in the Draft Environmental Assessment which is included in the Biological Assessment for Section 7 Consultation. The Draft EA fully describes the Roadway, its potential impacts, and the proposed mitigative measures.

Construction activities would affect 14 individuals in the Roadway construction zone. Construction activities would include earthwork (e.g. grubbing and grading), stockpiling, sediment and erosion control, mobile equipment movement, laying pavement, and parking.

The development of the Roadway would destroy 14 plants. The destruction of the plants, however, would occur only after plant propagules (e.g. seeds and air layer clones) are taken from each plant in numbers substantially greater than the 14 plants. Indirect impacts to the adjacent plant cluster (Cluster C) would include an increased risk of fire during the construction period.

(3) Identify the steps that will be taken to minimize and mitigate all negative impacts, including without limitation the impact of any authorized incidental take, with consideration of the full range of the species on the island so that cumulative impacts associated with the take can be adequately assessed; and the funding that will be available to implement those steps.

(3a) Full range of the species on Oahu

A collection (Char 81.002, BISH) from an abandoned canefield at Barbers Point, Ewa, Oahu, made in 1981 probably represents an escape from cultivation (Wagner et al 1990). At that time all cultivated plants were descendent from the Puako, Hawaii, population; this population was later destroyed by cattle during an unusually dry year (Wagner et al 1990). More recently the Lanai plants were brought into cultivation. However, it is also believed that due to differences in leaf morphology of progeny from this plant as compared to other populations, it may represent a separate population (Hobdy in FWS 1994). A more recent reporting has been made of a single individual on Navy property at Lualualei (Moribe 1998, personal communication). Also, Ewa Villages Golf Course staff have stated that *Abutilon menziesii* also occur on the golf course (Golf course staff 1997, personal communication). The Ewa Villages Golf Course property is adjacent to the property proposed for the North-South Road and East Kapolei Master Plan developments.

Whether the subject population at Kapolei is descended from the Barbers Point plant or from the Puako population, or is native to this area, is unknown at this time. Future investigations as part of the HFDC program may help to determine the origin of the Kapolei population.

A. menziesii is also present in several botanical collections on Oahu including the Waimea Arboretum & Botanical Garden, the Honolulu Botanical Gardens, and the Department of Land and Natural Resources native garden located at the Kalanimoku Building.

Abutilon menziesii was reportedly available for sale at three commercial nurseries in the state (Hawaii Plant Conservation Council 1992 in FWS 1994) until its listing as an endangered species. Plants reportedly thrive and bloom regularly under cultivated conditions. Propagation by seed and cuttings is successful (Boche, Aikane Nursery, Kapaau, Kauai, in FWS 1994) and air layers are been reported to be 95 percent successful (Woolliams 1998, Waimea Arboretum, personal communication).

(3b) Identify the steps that will be taken to minimize and mitigate all negative impacts, including without limitation the impact of any authorized incidental take.

Four sub-population clusters identified as A, B, C, and D presently exist on the central and southwestern portion of the East Kapolei Master Plan property. Cluster C, the largest cluster, is further identified as C-1, C-2, and C-3. As shown in Table 2 above, the C-1 portion of population Cluster C is located within the North-South Road construction zone and C-2 within the East Kapolei Master Plan drainage and open space corridor. The C-3 portion will be developed as a residential subdivision. Commencement of the roadway construction in early 1999 would follow the construction grading of the drainage improvements which are planned to be developed in the earliest phase of the project (late 1998 or early 1999).

(3c) Mitigation Steps and Measures

Several of the steps described below have already been completed to assess the resource to develop strategies for mitigation and the information obtained formed the basis of the preparation of this Plan.

The strategies proposed in this Mitigation Plan include the following on-site and off-site mitigation steps which would be implemented and coordinated with the project development phasing schedule:

Table 3.
Steps to Assess the Development Impacts and Mitigative Measures for *Abutilon Menziesii*

Steps	Mitigation Steps and Measures
1	Determine North-South Road development schedule, impacts, and mitigation phasing sequence
2	Interim management measures: Data collection prior to construction (i.e., survey, mapping)
3	Identify off-site nursery facilities for permanent or temporary re-location of *Abutilon menziesii*
4	Determine methods of propagation (e.g. seed collection/germination, air-layer clones)
5	Management measures prior to the incidental take
6	Construction period management measures
7	Provide funding for a period of three (3) years for off-site cultivation

Each of the 7 steps which make up this Mitigation Plan is described below:

1. **Determine North-South Road development schedule and mitigation phasing sequence**

The North-South Road would be constructed over a two year period between mid-1999 to early-2001. Freeway interchange construction would occur after Roadway construction. However, the interchange would be located beyond the range of *Abutilon*. The direct impact to *Abutilon menziesii* from Roadway construction would occur at the beginning of the first construction increment in mid-1999 due to grading. The plant clusters in the Kapolei population are expected to be affected in the order listed in Table 4.

Table 4.
Schedule* of Development Impacts to *Abutilon menziesii* at Kapolei

Development Phase	Start Date	Sub-Population Area	Land Use
1. Drainage Improvements (by HFDC)	1999-2001	C-2	New drainage channel
2. North-South Road	1999-2001	C-1	Roadway
3. East Kapolei Master Plan (by HFDC)	2000-2008	A, B, C-3, D	Residential; Comm'l

* Schedule is preliminary and subject to change

As shown in Tables 1 and 2, Cluster C consists of 61 plants. The impact of roadway construction would be destruction of 14 plants which would require mitigation at the earliest possible date. The indirect impact of Roadway construction on the remaining area of Cluster C would be mitigated as described below in Step 6. The remaining *Abutilon menziesii* (Clusters A, B, and D) would not be affected by the North-South Road.

2. **Data collection (i.e., survey, mapping) prior to construction**

A comprehensive survey of all plants in the Kapolei population was made by Nagata (December 1997). Data on the plants in Cluster C are attached as Appendix C.

All possible occurrences of *Abutilon menziesii* at the Kapolei population has been identified and individual plants have been flagged.

3. **Identify off-site nursery facilities for permanent re-location of *Abutilon menziesii***

The US Fish and Wildlife Service (Harper 1997), in a review of the East Kapolei Master Plan Draft Habitat Conservation Plan, encouraged the distribution of plant materials to off-site facilities in the event of a catastrophic event at Kapolei. In addition, FWS has required the North-South Road project to prepare a Mitigation Plan which is independent of the HFDC HCP in the event that the HFDC project is delayed or does not proceed.

Two off-site botanical gardens have been identified and approached and are willing to participate in a mitigation program with DOT for the 14 plants which would be affected by the construction of the North South Road. The facilities are: 1) Waimea Arboretum & Botanical Gardens, and 2) Honolulu Botanical Gardens. The privately funded and operated Waimea Arboretum & Botanical Garden is the appointed conservatory for *Abutilon menziesii*. The Honolulu Botanical Gardens is a facility of the City and County of Honolulu with gardens in Honolulu (Foster Garden and Liliuokalani Garden), Kaneohe (Hoomaluhia), Wahiawa, and Koko Crater. The Koko Crater and Liliuokalani Garden have drier climates and would be appropriate locations for the cultivation of *Abutilon*.

Other appropriate facilities on Oahu include the Lyon Arboretum in Manoa and the Leeward Community College Native Garden in Pearl City. The final selection of the off-site nurseries would be made through further consultation with the Fish and Wildlife Service and the DLNR Division of Forestry and Wildlife.

An Endangered Species Consultant (e.g. Keith Woolliams Consultancy), shall be contracted to handle all preliminary procedures to generate propagation materials to distribute to the off-site nurseries for permanent accession into their collections. Therefore, the Endangered Species Consultant will also coordinate with the offsite gardens. The Endangered Species Consultant shall be a botanist or horticulturist experienced in the successful recovery of endangered species and would be responsible for all aspects of generating the propagules for off-site plantings as described in this document. The Endangered Species Consultant would report to the State Department of Transportation.

4. **Determine methods of propagation**

The methods of propagation have been selected through discussions with botanists with *Abutilon* menziesii experience at Waimea Arboretum & Botanical Garden and Honolulu Botanical Gardens. The methods would include: 1) air-layered clones, and (2) seed propagation. Propagules would be accessed into collections at the approved off-site nurseries.

Seed Collection and Germination. Seeds would be collected and germinated so that approximately 20 seedlings would be grown. Additional collected seeds would be banked for long-term storage using the best available techniques for preservation. Seeds in long-term storage would be periodically tested for viability.

Air-layering. Affected plants would be examined and air-layers would be taken from healthy stems which are about one-half inch in diameter. Three to four months prior to development, all affected plants within the Roadway would be prepared and air-layered. An average of four air-layered clones from the 14 plants would be taken with a goal of generating approximately 56 clones. According to Keith Woolliams (Personal communication 1998), the success rate for survival of *Abutilon menziesii* air layers is about 95 percent. The air layering process would require 8 to 12 weeks depending on climatic conditions. Successful air-layers would be accessed into the collections of the approved off-site nurseries.

Cultivated Specimens. The off-site cultivated specimens from both seed and air layers would establish a pool of genetic resources for reintroduction in the future to appropriate sites and to safeguard against loss of the material due to potential catastrophes at the Kapolei population.

Sacrifice of the Remnant Mother Plants. The survival rate of a transplanted plant is known to be very low (5 to 10 percent, Wooliams, personal communication 1998). Therefore, after the propagules (e.g. air-layers and seeds) have been collected from the 14 plants within the Roadway zone, the remaining remnant plants would not be relocated to the two off-site garden locations. The exception to this would be if the HFDC nursery facility (discussed in the East Kapolei HCP) is already in operation, which, based on current schedules, is not expected. Only then would these remnant mother plants be potted and cared for at the HFDC facility.

5. Interim management measures prior to incidental take

Interim management measures would be implemented during the three to four month period of air-layer preparation to secure and manage the impacted area prior to construction. Management measures include monitoring, weed control, fire protection, and predation and disease control, as necessary.

- Weed control. Weed control would be implemented at the discretion of the Endangered Plant Consultant to provide optimal conditions during the air layering period. Control methods may include hand-pulling and possibly local herbicide application.
- Fire protection. Fire breaks around air-layered plants would be created during the dry season.

- Control predation and disease. Threats not already addressed include predation by Chinese rose beetles and Hibiscus scale. Monitoring and control of such pests would be implemented.

  Chinese rose beetle (Adoretus sinicus). If the Chinese rose beetle is observed on the plants, it would be controlled to prevent damage to the plants. The degree of threat, determined by field observations, would determine the urgency of implementation of control measures.

  Hibiscus scale. Hibiscus scale, if observed on air layered plants, would be controlled to prevent damage to the plants. The degree of threat, determined by field observations, would determine the urgency of implementation of control measures.

6. Construction period management measures

Measures would be taken during roadway construction to minimize the indirect impact associated with fire risk. Measures would include the preparation of a Fire Control Plan by the roadway contractor for review by the State Department of Transportation, the Department of Land and Natural Resources, and the Fish and Wildlife Service. The plan would include the construction of a fire break just inside of the roadway right-of-way (after flagging and protecting with physical barriers the *Abutilon* individuals outside the roadway construction zone). The Fire Control Plan would address such topics as construction worker education, reporting and response procedures in the event of a fire, and procedures for the storage and disposal of flammable materials, including matches and cigarettes.

7. Provide funding for a period of three (3) years for off-site cultivation

Funding requirements to implement this plan include compensation to the Endangered Species Consultant and to the off-site nurseries, if required, for the propagation *Abutilon* plants (from air layers and seeds) for a period of three years.

The funding source to implement this Mitigation Plan would be capital construction funds from the State Department of Transportation, including funds administered by the Federal Highway Administration. The funding would cover the initial work of the Endangered Species Consultant to generate the plant propagules and three years of cultivation at the off-site nurseries. After the three years covered under the Mitigation Plan, the plants would be integrated into the permanent collections of the participating gardens.

In the event that an off-site nursery is affected through funding cuts or other events which would jeopardize the continuance of their participation in the subject program, the off-site nursery would consult with the Hawaii Association of Botanical Gardens, and plants would be dispensed to other appropriate gardens in the State. The cost of the program to the State Department of Transportation should this contingency occur is not expected to change.

(4) Identify those measures or actions to be undertaken to protect, maintain, restore, or enhance the ecosystems, natural communities, or habitat types within the plan area; a schedule for implementation of the actions or measures, including monitoring, are undertaken in accordance with the schedule.

(4a) Measures or actions to be undertaken to protect, maintain, restore, or enhance the ecosystems, natural communities, or habitat types

All 14 *Abutilon menziesii* which are in the area proposed for the construction of the Roadway would be removed. To assure the survival of the gene pool, propagation materials including seeds and air layered clones would be collected by the Endangered Species Consultant followed by cultivation of the propagation materials at two off-site botanical gardens. Measures and actions are described above.

The remaining *Abutilon* plants (72 plants) within the Kapolei population would not be directly affected by the construction of the Roadway. Indirect effects include risks during the construction period as addressed above. Specific measures which pertain directly to these plants are described in the Habitat Conservation Plan for the East Kapolei Master Plan.

(4b) A schedule for implementation of the proposed measures and actions.

The primary mitigation measure for propagation of *Abutilon* plants involves seed collection and cloning through air layering to produce propagules for off-site cultivation prior to the commencement of construction. A period of three to four months is required for adequate root development in the air layers. Seed collection would be on-going during the three to four month period. Thereafter, the off-site cultivation period would continue for three years, whereupon the plants would become part of the permanent collection of the off-site nurseries.

(5) Be consistent with the goals and objectives of any approved recovery plan for any endangered species or threatened species known or reasonably expected to occur in the ecosystems, natural communities, or habitat types in the plan area.

Abutilon menziesii is included as one of nine taxa in the *Lanai Plant Cluster Recovery Plan* (US Fish and Wildlife Service 1994). The preparation of this Mitigation Plan and the HFDC "umbrella" Habitat Conservation Plan has relied on the *Lanai Plant Cluster Recovery Plan* as a guide.

(6) Provide reasonable certainty that the ecosystems, natural communities, or habitat types will be maintained in the plan area, throughout the life of the plan, in sufficient quality, distribution, and extent to support within the plan area those species typically associated with the ecosystems, natural communities, or habitat types, including any endangered, threatened, proposed, and candidate species known or reasonably expected to be present in the ecosystems, natural communities, or habitat types within the plan area.

The construction activities of the North-South Road would permanently displace 14 plants which are within the Roadway construction zone. The incidental take of the plants, however, would be mitigated by the approximately 76 new plants which would be cultivated from seeds and air layered clones from the affected plants. The mitigation plants would be cultivated at two off-site botanical gardens and become part of their permanent collections. Source materials from these plants would be available to other gardens.

(7) Contain objective, measurable goals, the achievement of which will contribute significantly to the protection, maintenance, restoration, or enhancement of the ecosystems, natural communities, or habitat types; time frames within which the goals are to be achieved; and provisions for monitoring (such as field sampling techniques) and evaluating progress in achieving the goals quantitatively and qualitatively.

(7a) Objective measurable goals

Assessment criteria for determining measures of success would include but not be limited to the following:

Survival / Mortality / Reproductive rates of cultivated plants at the offsite gardens. Records would be kept by the botanical gardens of all air layered and seed germinated plants. These records would contribute information to better understand the life cycle and biology of *Abutilon* menziesii in cultivated environments. The life cycle for *Abutilon menziesii* is not clearly known according to the Lanai Recovery Plan (FWS 1994); however *Abutilon* is considered a long-lived perennial with a life span greater than 10 years (FWS 1994).

Measurable goals would include:
- 50 percent survival rate of air-layered plants during the three year mitigation period
- Flowers/fruit in 50 percent of air-layered plants during the three-year mitigation period
- 50 percent survival rate of germinated seeds collected from the 14 plants during the three-year mitigation period
- Flowers/fruit in 50 percent of plants germinated from collected seeds during the three-year mitigation period

Monitoring and evaluating progress in achieving the goals. Annual evaluations and reports would be prepared by the two botanical gardens to document the survival, mortality, and reproductive rates of the mitigation plantings. Reports would be prepared annually and be completed before the end of the quarter following the previous full year of cultivation and submitted to State Department of Transportation. Reports would be submitted by the State DOT to the US Fish and Wildlife Service and to the Board of Land and Natural Resources.

(7b) Timeframe within which goals are to be achieved

The off-site mitigation program for the North-South Road is planned as a three-year program. The goals are expected to be achieved during this period.

(7c) Provisions for monitoring and evaluating progress

Provisions for monitoring and evaluating progress would be made available to the resources agencies through the annual reports and by field inspections.

(8) Provide for an adaptive management strategy that specifies the actions to be taken periodically if the plan is not achieving its goals.

The State DOT would coordinate and consult with the Fish and Wildlife Service and the DLNR Division of Forestry and Wildlife at the end of each year to assess the success or failure of the program. Necessary steps to address problems and to take corrective actions would be identified and implemented at each of the botanical gardens to be able to achieve the goals established.

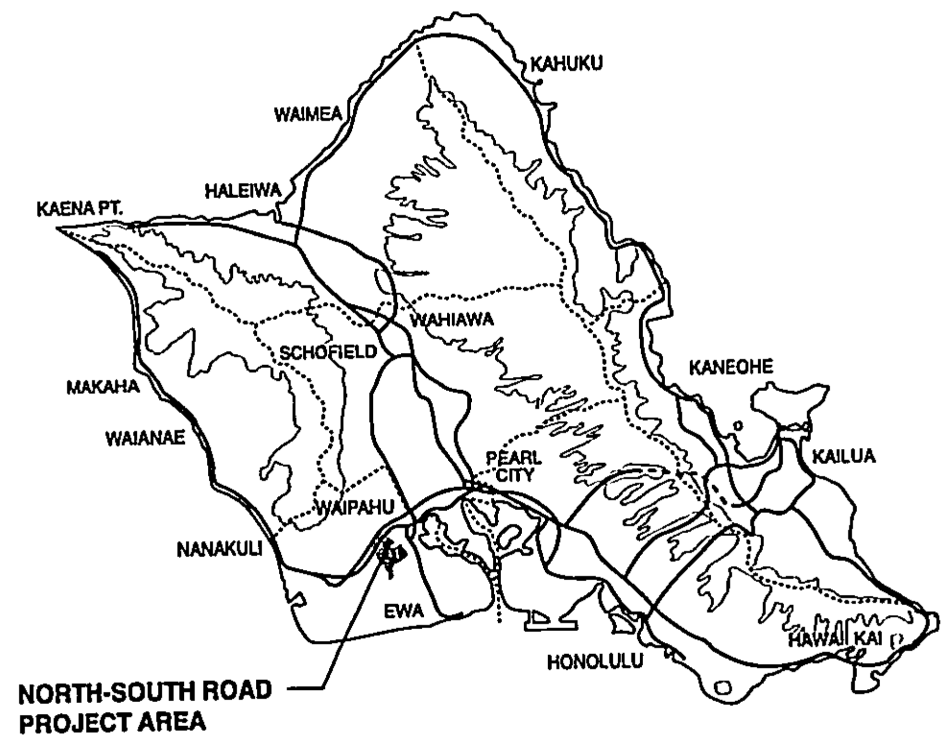


EXHIBIT 1
REGIONAL LOCATION MAP
NORTH/SOUTH ROAD

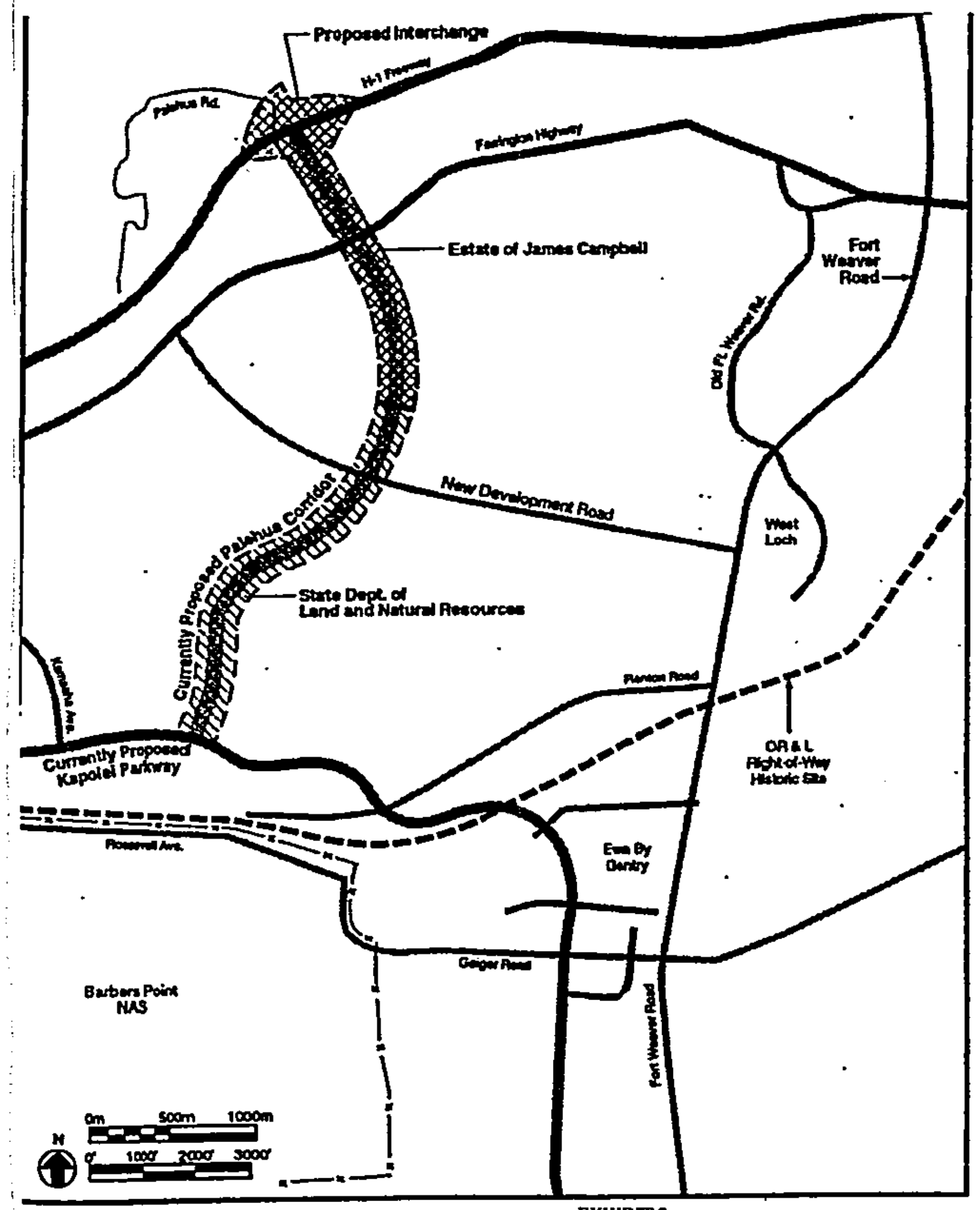
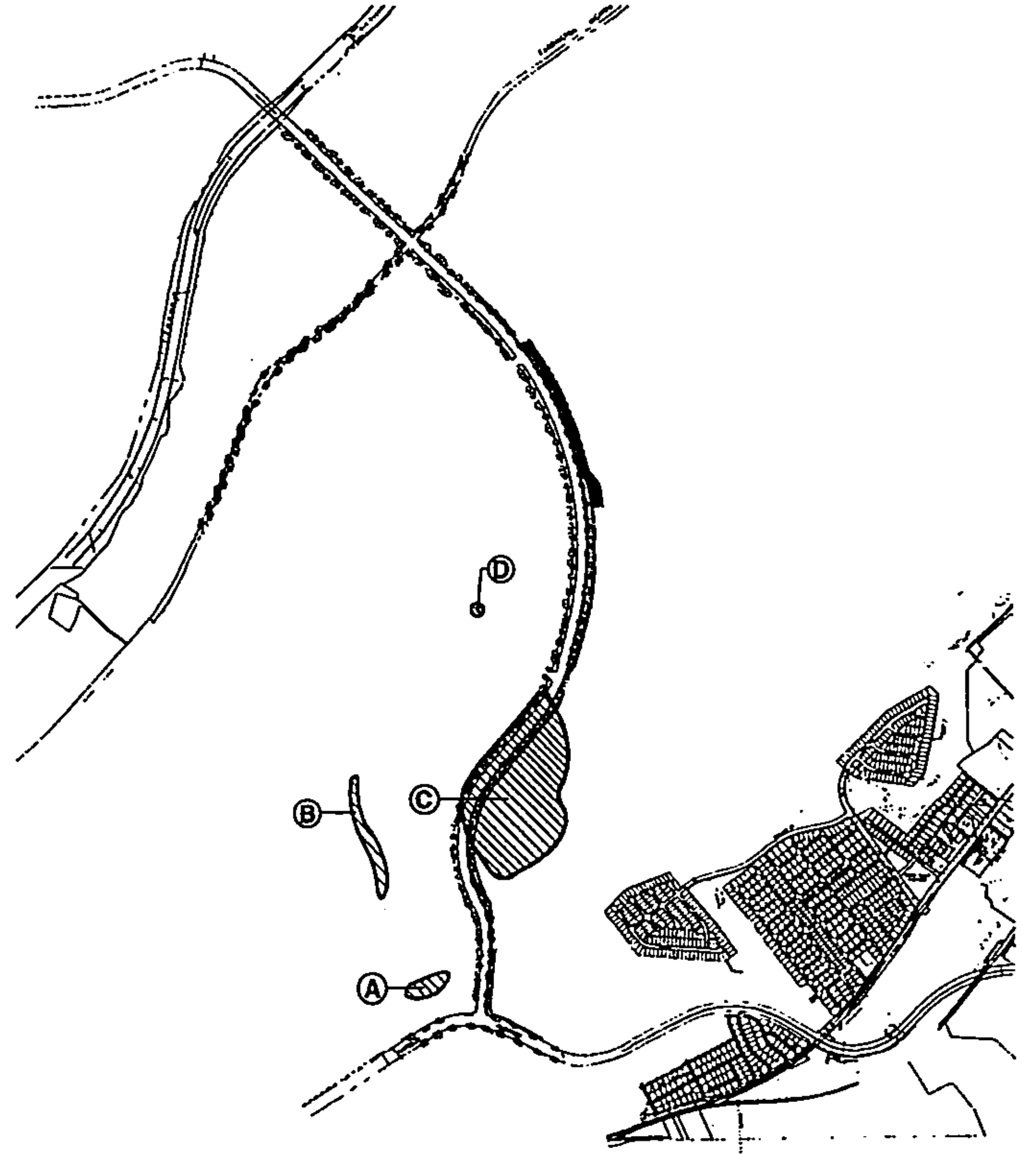


EXHIBIT 2
LAND OWNERSHIP
NORTH/SOUTH ROAD

Source: Parsons Brinckerhoff Quade & Douglas, Inc.

June 1996



LEGEND

ABUTILON MENZIESII PLANT CLUSTERS

EXHIBIT 3
MITIGATION PLAN AREA
NORTH/SOUTH ROAD

June 1996

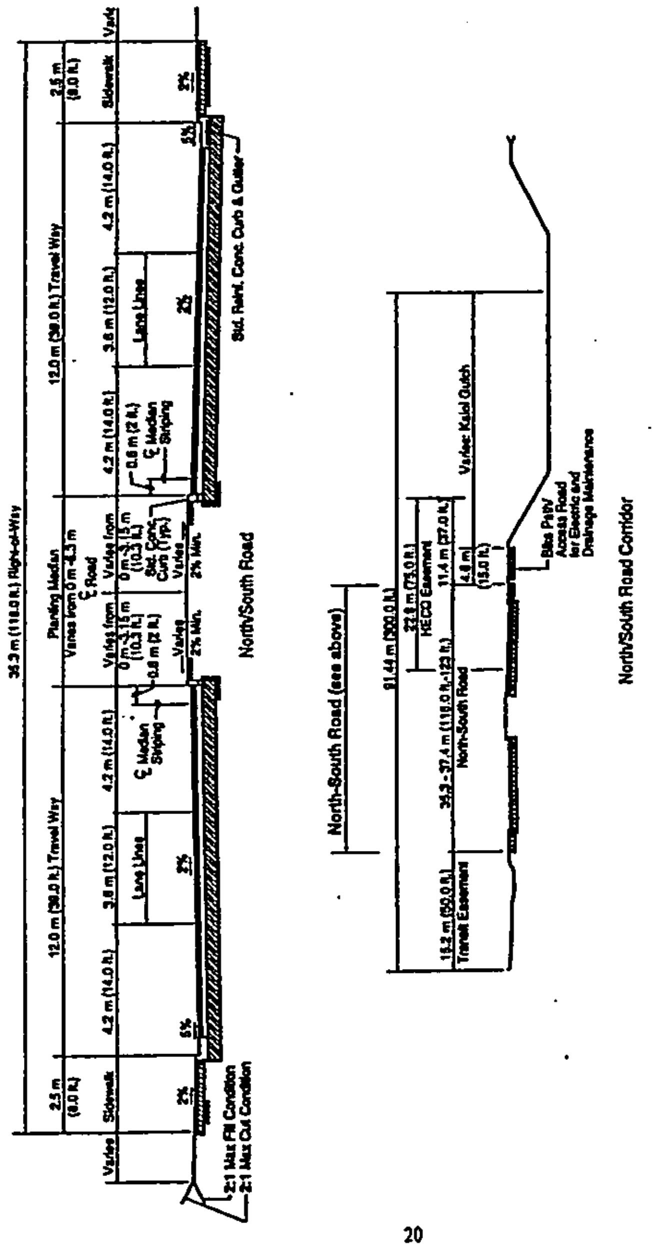


EXHIBIT 4
ROADWAY SECTION
NORTH/SOUTH ROAD

June 1996

Source: Parsons Brinckerhoff Quade & Douglas, Inc.

APPENDIX A

NORTH-SOUTH ROAD CORRIDOR STUDY

Ewa, Oahu, Hawaii

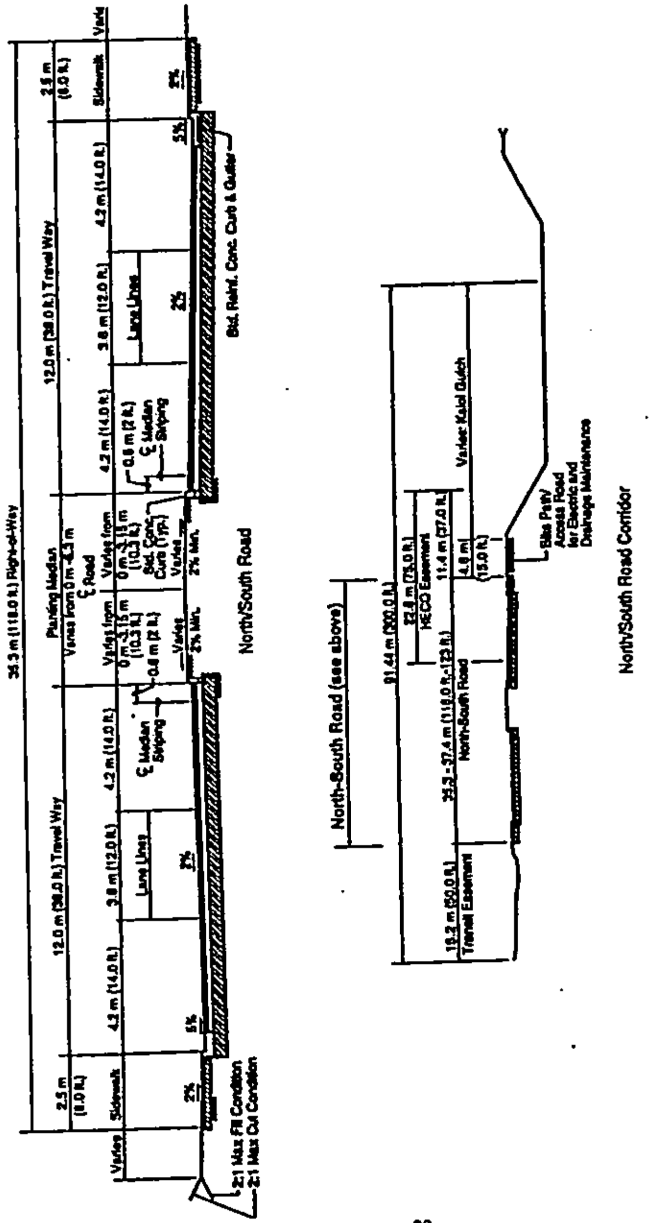
Project No. HWY-0-01-92

BOTANICAL SURVEY REPORT

October 1997

PARSONS BRINCKERHOFF *KAKU ASSOCIATES* *R.M. TOWILL CORPORATION*

RECEIVED AS FOLLOWS



Source: Parsons Brinckerhoff Quade & Douglas, Inc.

EXHIBIT 4
ROADWAY SECTION
NORTH/SOUTH ROAD

APPENDIX A

NORTH-SOUTH ROAD CORRIDOR STUDY

Ewa, Oahu, Hawaii
Project No. HWY-0-01-92

BOTANICAL SURVEY REPORT

October 1997

PARSONS BRINCKERHOFF
KAKU ASSOCIATES
R.M. TOWILL CORPORATION

NORTH-SOUTH ROAD CORRIDOR STUDY
Ewa, Oahu, Hawaii
Project No. HWY-0-01-92

Botanical Survey Report

Prepared for:

State of Hawaii
Department of Transportation
869 Punchbowl Street
Honolulu, Hawaii 96813

City and County of Honolulu
Department of Transportation Services
Pacific Park Plaza
711 Kapiolani Boulevard, Suite 1200
Honolulu, Hawaii 96813

Submitted by:

Parsons Brinckerhoff Quade & Douglas, Inc.
Pacific Tower, Suite 3000
1001 Bishop Street
Honolulu, Hawaii 96813

October 1997

PBQD Reference: 16218A - Product 8.6A

BOTANICAL RESOURCES STUDY
NORTH-SOUTH ROAD CORRIDOR
(H-1 FREEWAY TO KAPOLEI PARKWAY)
'EWA DISTRICT, ISLAND OF O'AHU

by

Winona P. Char

CHAR & ASSOCIATES
Botanical Consultants
Honolulu, Hawai'i

Prepared for:
PARSONS BRINCKERHOFF

October 1997

BOTANICAL RESOURCES STUDY
NORTH-SOUTH ROAD CORRIDOR
(H-1 FREEWAY TO KAPOLEI PARKWAY)
'EWA DISTRICT, ISLAND OF O'AHU

INTRODUCTION

The botanical resources found on the North-South road corridor from its proposed interchange with Interstate Route H-1 to its terminus at the proposed Kapolei Parkway is presented in this report. The majority of the alignment crosses sugar cane fields which are no longer in cultivation. Although sugar cane cultivation ceased two to three years ago, there are still a few remnant clumps of sugar cane in the area between Farrington Highway and Waimanalo Road. However, in most places the former fields are now overgrown with Guinea grass or mixed scrub vegetation. A narrow band of koa haole scrub can be found along old irrigation ditches, drainageways, and roadways.

A reconnaissance-level field study was conducted in June 1996, and later in December 1996 during the rainy season. The primary objectives of the field studies were to:

1) provide a description of the vegetation found on the undeveloped portions of the corridor;
2) inventory the flora;
3) search for threatened and endangered plants as well as species of concern; and
4) identify areas of potential environmental problems or concerns and propose appropriate mitigation measures.

One Federal and State listed endangered species, the ko'oloa'ula (Abutilon menziesii), was found during the field studies and is discussed in more detail in the "Endangered Plants" section of the report.

SURVEY METHODS

Prior to undertaking the field studies, a search was made of the pertinent literature to familiarize the principal investigator with other botanical studies conducted in the general area. The roadway alignment maps and a recent colored aerial photograph of the study area were examined to determine vegetation cover patterns, terrain characteristics, access, boundaries, and reference points.

A walk-through survey method was used. Notes were made on plant distributions and associations, substrate types, drainage, topography, exposure, etc. Plant identifications were made in the field; plants which could not be positively identified were collected for later determination in the herbarium (University of Hawai'i, Manoa - HAW), and for comparison with the recent taxonomic literature.

The species recorded during the field studies are indicative of the season ("rainy" vs. "dry") and the environmental conditions at the time of the studies. A survey taken at a different time of the year and under varying environmental conditions would no doubt yield slight variations in the species list, especially of the weedy, annual taxa.

DESCRIPTION OF THE VEGETATION

In the U.S. Fish and Wildlife Service sponsored 'Ewa Plains' Botanical Survey (Char and Balakrishnan 1979), the vegetation along the roadway corridor was mapped as "C", sugar cane fields.

On areas which were not actively cultivated, koa haole shrubland and mixed grass-shrubland were found. Since that survey, O'ahu Sugar Company, Ltd., has ceased cultivating the fields, and much of the 'Ewa Plains has been developed for the second city of Kapolei.

In the discussion below, the vegetation along the proposed North-South road corridor is described from mauka to makai, that is, from its proposed interchange with Interstate Route H-1 to its makai terminus at Kapolei Parkway. Locations are referenced to existing roads and landmarks as the corridor had not been flagged and staked at the time of the field studies. A checklist of all those plants inventoried during the field work is presented at the end of the report.

Vegetation along the corridor

At the interchange with H-1, dense koa haole shrubs (Leucaena leucocephala) border the highway and cover the southwest portion of the interchange. Clumps of Guinea grass (Panicum maximum), 3 to 5 ft. tall, form a thick cover between the shrubs. Scattered through this koa haole/Guinea grass scrub are trees of kiawe (Prosopis pallida) and 'opiuma (Pithecellobium dulce). Along Kalo'i Gulch, there are a few Java plum (Syzygium cumini) and kukui (Aleurites moluccana) trees among the koa haole thickets. Upslope of the highway are former sugar cane fields now overgrown with Guinea grass and buffel grass (Cenchrus ciliaris).

Between Interstate Route H-1 and Farrington Highway, the former sugar cane fields are now overgrown with buffel grass. A few clumps of the taller Guinea grass can be seen scattered here and there. Koa haole shrubs and a few kiawe trees line the edges of the grassy fields. A few of the fields had been planted earlier

with other crops such as watermelons, but in December these fields were overgrown with low mats of pink bindweed (Ipomoea triloba) and clumps of other weedy species such as cocklebur (Xanthium strumarium), apple of Peru (Nicandra physalodes), kaliko (Euphorbia heterophylla), etc.

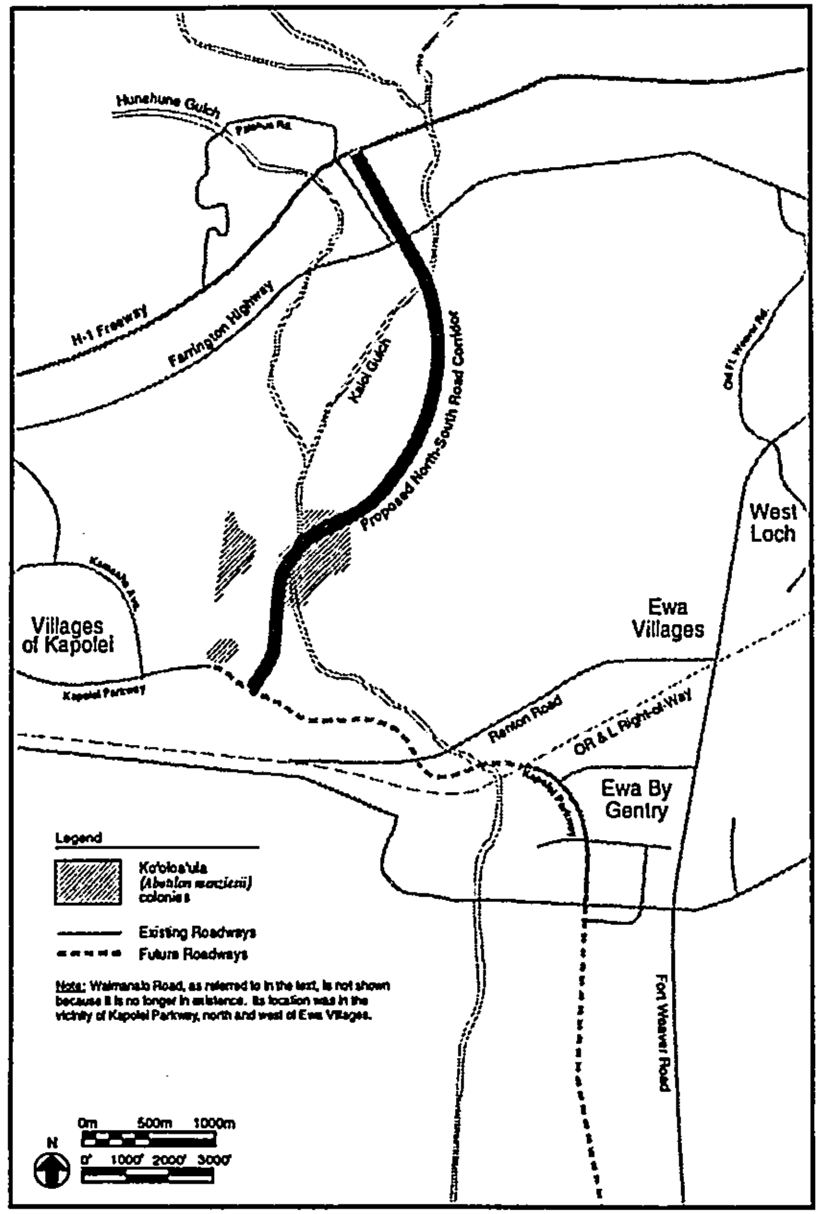
On the State-owned lands between Farrington Highway and Waimanalo Road, the cane fields were the most recently fallowed and so there are still a few areas with remnant clumps of sugar cane plants (Saccharum officinarum), from 5 to 7 ft. tall. Where the plants collect runoff water in low lying areas, the sugar cane cover is somewhat dense. Where the soil is drier and cracked, there are only dead, dried out clumps of cane. The abandoned fields have been invaded by a mixed scrub composed of swollen fingergrass (Chloris barbata) and a number of other weedy species which include 'uhaloa (Waltheria indica), 'ilima (Sida fallax), hoary abutilon (Abutilon incanum), currant tomato (Lycopersicon pimpinellifolium), Guinea grass, lion's ear (Leonotis nepetifolia), coat buttons (Tridax procumbens), pink bindweed, castor bean (Ricinus communis), etc. In some places, Guinea grass has formed a dense cover, 3 to 6 ft. tall, with only a few other species present. Kalo'i and Makakilo Gulches, now reduced to somewhat narrow drainage channels, support koa haole shrubs and thick tangles of ivy gourd vine (Coccinia grandis).

ENDANGERED PLANTS

Because the 'Ewa Plains have been extensively disturbed by agricultural activities for such a long period of time, there are few places which support native plant communities. The few places with native plants tend to be found on areas with karst or limestone topography; since these areas do not have soil they were unsuitable for agriculture. Two listed endangered species which occur today in such habitats are the 'Ewa Plains 'akoko (Chamaesyce skottsbergii) and Achyranthes rotundata. Both are found only on limestone sites within Campbell Industrial Park and Barbers Point Naval Air Station (Char and Balakrishnan 1979; Traverse Group, Inc., 1988). One plant of the endangered ko'oloa'ula (Abutilon menziesii) was found in an overgrown sugar cane field near Kalaeloa Boulevard in the industrial park (Char and Balakrishnan 1979; Wagner et al. 1990; U.S. Fish and Wildlife Service 1994). There are historical records of two listed endangered species, the 'awiwi (Centaurium sebaeoides) and 'ihi'ihi (Marsilea villosa), and two species of concern, the 'ihi (Portulaca villosa) and pu'uka'a (Torulinium odoratum ssp. auriculatum), in the vicinity of the proposed corridor (B. Harper, USFWS, 01 February 1996 letter).

During the field studies for the State Housing Finance and Development Corporation's (HFDC) East Kapolei project, in September and October 1996, 38 plants of the endangered ko'oloa'ula were found by Ken Nagata, botanist, on the southwest corner of the HFDC project site. The plants occur primarily in mixed scrub and also in areas with remnant clumps of sugar cane. A survey to verify the findings and to more accurately inventory and map the plants was conducted in December 1996 (Char 1997). This December survey followed an unusually heavy period of rainfall in November 1996 in which the 'Ewa area received more than 20 inches of rainfall in about 10 days; average rainfall for the 'Ewa area is 20 inches per year.

A total of 88 ko'oloa'ula plants were flagged and inventoried; the plants occur in three colonies, located fairly close to each other. A large number of juvenile plants which had sprouted after the November rains were found. Some of the ko'oloa'ula plants lie within the proposed North-South road corridor where it follows near the existing HECO powerline (Figure 1).



Distribution of the Endangered Plant Ko'oloa'ula (Abutilon menziesii)
NORTH-SOUTH ROAD CORRIDOR STUDY
Botanical Survey Report
FIGURE 1

DISCUSSION AND RECOMMENDATIONS

The majority of the proposed North-South Road corridor will cross over former sugar cane fields now overgrown with weedy scrub and scattered koa haole thickets. These areas have little of botanical interest as they have been disturbed (under cultivation) for a long period of time and are dominated by introduced or alien plant species. The only area of concern is that portion of the corridor which will cross through the endangered ko'oloa'ula population.

A mitigation plan which would relocate the affected ko'oloa'ula plants is being prepared.

LITERATURE CITED

Char, W.P. 1997. Summary of findings, Ko'oloa'ula on East Kapolei project site, 'Ewa District, island of O'ahu. Prepared for PBR Hawai'i. January 1997.

Char, W.P. and N. Balakrishnan. 1979. 'Ewa Plains Botanical Survey. U.S. Fish and Wildlife Service. Contract No. 14-16-0001-78171. 119 pp. + maps.

Traverse Group, Inc. 1988. Natural resources management plan, Naval Air Station, Barbers Point. Prepared for Pacific Division, Naval Facilities Engineering Command. Contract No. N6274-86-C-0538.

U.S. Fish and Wildlife Service. 1995. Lana'i plant cluster recovery plan: Abutilon eremitopetalum, Abutilon menziesii, Cyanea macrostegia ssp. gibsonii, Cyrtandra munroi, Gahnia lanaiensis, Phyllostegia glabra var. lanaiensis, Santalum freycinetianum var. lanaiensis, Tetramolopium remyi, and Viola lanaiensis. U.S. Fish and Wildlife Service, Portland, OR. 138 pp. September 1995.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1990. Manual of the flowering plants of Hawai'i. 2 vols. University of Hawai'i Press and B.P. Bishop Museum Press, Honolulu. B.P. Bishop Museum Special Publication 83.

Wagner, W.L. and D.R. Herbst. 1995. Contributions to the Flora of Hawai'i. IV. New Records and Name Changes. Bishop Museum Occasional Papers 42: 13-27.

SPECIES LIST -- North-South Road Corridor (H-1 Freeway to Kapolei Parkway)

The following checklist is an inventory of the plants observed on the undeveloped lands within the proposed roadway corridor. The plants are arranged alphabetically by families within each of two groups: Dicots and Monocots. The taxonomy and nomenclature of the flowering plants follow the most recent treatment of the Hawaiian flora by Wagner et al. (1990) and new additions to the flora in Wagner and Herbst (1995).

The following information is provided for each species:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name(s), when known.
3. Biogeographic status. The following symbols are used:
   - E = endemic = native only to the Hawaiian Islands.
   - I = indigenous = native to the Hawaiian Islands and also elsewhere throughout the Pacific and/or tropics.
   - I? = questionably indigenous = data not clear if introduced or if arrival here by natural means, but weight of evidence suggests probably indigenous.
   - P = Polynesian = plants originally of Polynesian introduction prior to Western contact (Cook's discovery of the islands in 1778).
   - X = introduced or alien = all those plants brought to the islands by humans, intentionally or accidentally, after Western contact (1778).
   - X? = questionably introduced = dates of introduction unclear or very early, may be indigenous or of Polynesian introduction.

Scientific name	Common name	Status
DICOTS		
ACANTHACEAE (Acanthus family)		
Asystasia gangetica (L.) T. Anders.	Chinese violet	X
AIZOACEAE (Fir-marigold family)		
Trianthema portulacastrum L.		X
AMARANTHACEAE (Amaranthus family)		
Achyranthes aspera L.		X
Amaranthus spinosus L.	spiny amaranth, pakai kuku	X
Amaranthus viridis L.	slender amaranth, pakai	X
ANACARDIACEAE (Mango family)		
Schinus terebinthifolius Raddi	Christmas berry	X
ASCLEPIADACEAE (Milkweed family)		
Calotropis procera (Aiton) W.T. Aiton	blue crown flower	X
ASTERACEAE (Daisy family)		
Bidens pilosa L.	Spanish needle, beggars tick, ki	X
Conyza bonariensis (L.) Cronq.	hairy horseweed, 'ilioha	X
Emilia fosbergii Nicolson	Flora's paintbrush, red pualele	X
Pluchea indica (L.) Less.	Indian pluchea	X
Pluchea carolinensis (Jacq.) G. Don	pluchea, sourbush	X
Sonchus oleraceus L.	common sowthistle, pua-lele	X
Tridax procumbens L.	coat buttons	X
Verbesina encelioides (Cav.) Benth. & Hook.	golden crownbeard	X
Vernonia cinerea (L.) Less.	little ironweed	X
Xanthium strumarium var. canadense (Mill.) Torr. & A. Gray	cocklebur, kikania	X
BIGNONIACEAE (Bignonia family)		
Spathodea campanulata P. Beauv.	African tulip tree	X
CHENOPODIACEAE (Goosefoot family)		
Atriplex suberecta Verd.	saltbush	X
Chenopodium murale L.	'aheahea	X

Scientific name	Common name	Status
CONVOLVULACEAE (Morning-glory family)		
Ipomoea obscura (L.) Ker-Gawl.	field bindweed	X
Ipomoea triloba L.	pink bindweed, little bell	X
Merremia aegyptia (L.) Urb.	hairy merremia, koali kua hulu, kuahulu	X?
CUCURBITACEAE (Gourd family)		
Coccinia grandis (L.) Voigt	ivy gourd, scarlet-fruited gourd	X
Momordica charantia L.	wild bittermelon	X
EUPHORBIACEAE (Spurge family)		
Aleurites moluccana (L.) Willd.	kukui, tutui	P
Chamaesyce hirta (L.) Millsp.	hairy spurge	X
Chamaesyce hypericifolia (L.) Millsp.	graceful spurge	X
Chamaesyce prostrata (Ait.) Small	prostrate spurge	X
Euphorbia heterophylla L.	kaliko	X
Phyllanthus debilis Klein ex Willd.	niruri	X
Ricinus communis L.	castor bean, pa'aila, koli	X
FABACEAE (Pea family)		
Crotalaria incana L.	fuzzy rattlepod, kukae-hoki	X
Crotalaria pallida Aiton	smooth rattlepod, pika-kani	X
Desmanthus virgatus (L.) Willd.	slender mimosa	X
Indigofera suffruticosa Mill.	indigo, 'iniko	X
Indigofera spicata Forssk.	creeping indigo	X
Leucaena leucocephala (Lam.) de Wit	koa haole	X
Macroptilium lathyroides (L.) Urb.	wild bean, cow pea	X
Phaseolus sp.		X
Pithecellobium dulce (Roxb.) Benth.	'opiuma	X
Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	kiawe	X
Senna pendula (Humb. & Bonpl. ex Willd.) H. Irwin & Barneby	senna	X
LAMIACEAE (Mint family)		
Leonotis nepetifolia (L.) R. Br.	lion's ear	X
MALVACEAE (Mallow family)		
Abutilon grandifolium (Willd.) Sweet	hairy abutilon, ma'o	X
Abutilon incanum (Link) Sweet	ma'o, hoary abutilon	I?

Scientific name	Common name	Status
Abutilon menziesii Seem.	ko'oloa'ula	E
Malvastrum coromandelianum (L.) Garcke	false mallow	X
Sida fallax Walp.	'ilima	I
Sida rhombifolia L.		X
MYRTACEAE (Myrtle family)		
Syzygium cumini (L.) Skeels	Java plum	X
NYCTAGINACEAE (Four-o'clock family)		
Boerhavia coccinea Mill.	red-flowered boerhavia	X
PASSIFLORACEAE (Passion flower family)		
Passiflora foetida L.	running pop, pohapoha	X
PORTULACACEAE (Purslane family)		
Portulaca oleracea L.	pigweed, 'akulikuli kula	X
SOLANACEAE (Nightshade family)		
Lycopersicon pimpinellifolium (Jusl.) Mill.	currant tomato	X
Nicandra physalodes (L.) Gaertn.	apple of Peru	X
Nicotiana glauca R.C. Graham	tree tobacco, paka	X
Solanum americanum Mill.	glossy nightshade, popolo, 'olohua	I?
STERCULIACEAE (Cacao family)		
Waltheria indica L.	'uhaloa, hi'aloa, kanakaloa	I?
ZYGOPHYLLACEAE (Creosote bush family)		
Tribulus terrestris L.	puncture vine, goat head	X
MONOCOTS		
COMMELINACEAE (Dayflower family)		
Commelina benghalensis L.	hairy honohono	X
CYPERACEAE (Sedge family)		
Cyperus rotundus L.	nut sedge, nutgrass	X
POACEAE (Grass family)		
Bothriochloa pertusa (L.) A. Camus	pitted beardgrass	X
Brachiaria mutica (Forssk.) Stapf	California grass	X

Scientific name	Common name	Status
Brachiaria subquadriparia (Trin.) Hitchc.		X
Cenchrus ciliaris L.	buffel grass	X
Cenchrus echinatus L.	common sandbur, 'ume'alu, mau'u kuku	X
Chloris barbata (L.) Sw.	swollen fingergrass, mau'u lei	X
Chloris radiata (L.) Sw.	plush grass	X
Cynodon dactylon (L.) Pers.	Bermuda grass, manienie	X
Dactyloctenium aegyptium (L.) Willd.	beach wiregrass	X
Digitaria insularis (L.) Mez. ex Ekman	sourgrass	X
Eleusine indica Gaertn.	goose grass, wire grass	X
Leptochloa uninervia (Presl.) Hitchc. & Chase	leptochloa	X
Melinis repens (Willd.) Zizka	Natal redtop, Natal grass	X
Panicum maximum Jacq.	Guinea grass	X
Panicum maximum var. trichoglume Eyles ex Robyns	green panicgrass	X
Saccharum officinarum L.	sugar cane, ko	X
Setaria verticillata (L.) Beauv.	bristly foxtail	X
Sorghum halepense (L.) Pers.	Johnson grass	X

Appendix B
Nagata Survey

EAST KAPOLEI MASTER PLAN

BIOLOGICAL SURVEY

Prepared by: Kenneth M. Nagata
For: PBR Hawaii
17 September 1996

INTRODUCTION

The project site occupies approximately 1300 acres in Honouliuli, Eva District, Oahu. It encompasses the former sugar cane lands mauka of Varona Village from approximately 60' elevation, up to Farrington Highway. Two sections extend mauka to the H-1 Freeway. The west is bordered by the Kapolei development and the east boundary runs through abandoned sugar cane fields.

Ripperton and Hosaka (1942) classified the vegetation of the region as one of lowland shrub with a coastal fringe of kiawe trees (Prosopis pallida). Because of the arid conditions of the region the vegetation cover is generally sparse. Dominant shrubs include klu (Acacia farnesiana), koa-haole (Leucaena leucocephala) and 'ilima (Sida fallax) and the herb layer generally consists of annual grasses such as bristly foxtail (Setaria verticillata), swollen fingergrass (Chloris barbata) and feather fingergrass (Chloris virgata). In the foothills mauka of the flat lowlands where rainfall is more abundant the vegetation is denser and the herb layer includes Spanish needle (Bidens pilosa), false mallow (Malvastrum coromandelianum), cockelbur (Xanthium strumarium) and pili (Heteropogon contortus) in addition to the annual grasses of the lowlands.

Several recent surveys have been conducted in certain portions of the subject property and in the adjacent lands. In 1990 Funk completed a biological survey of the land immediately east and makai of the project site, including the village of Eva (Funk 1990). Among the vegetation types recognized were Sugar Cane Fields, Ruderal Fields and Fallow Fields. These communities were characterized by actively cultivated sugar cane fields, abandoned cane fields, common "weedy" introduced plants and lowland wayside species including those mentioned by Ripperton and Hosaka (1942). Similar vegetation was found in the region immediately east of the subject property where common wayside species including koa-haole, Guinea grass (Panicum maximum) and cultivated and abandoned sugar cane fields were found to be prevalent (Funk 1994). Many of these same species were also present in the area between Varona Village and the golf course just makai of the project site (Nagata 1996) and in Kaloi Gulch (Nagata 1994).

METHODS AND MATERIAL

A walk-through survey was conducted in all plant communities between mid-September and early October, 1996 to determine the floristic compostition of the project site. Transects were established throughout the site and all plants observed were recorded and their relative abundance determined. In conjunction with the plant survey a cursory inventory of animals was also made. All birds and mammals observed along the transects were recorded and listening posts were established at regular intervals. No quantitative analyses was attempted, however, and nests were not investigated.

RESULTS

FLORA

Virtually all of the lowlands and foothills in the Ewa-Honoúliuli region has been altered by the cultivation of sugar cane. In the past several years certain lands have been taken out of sugar and put to other use, eg. diversified agriculture, urbanization, fallowing. Consequently, the vegetation of these lands are entirely secondary and the vegetation in the region is largely determined by the history of cultivation (or disturbance) on each individual parcel of land, ie. how long the cane field has been abandoned, whether the land was recently tilled, etc. Based mostly on these criteria, eight plant communities were recognized. Although these are drawn with discreet boundaries on the vegetation map it must be remembered that such finite boundaries do not exist in nature. Rather, each community exists as a continuum wth one blending into another. Furthermore, the survey was conducted during the dry season. Species composition and vegetational cover will differ somewhat during the rainy season.

Abandoned Cane Fields (ACF)

This is the largest vegetation type in the project site, representing the most recently abandoned sugar cane fields. Here, sugar cane generally accounts for about 50% of the total vegetational cover. In some areas the cane is 15' tall, robust and still very dense. In most areas, however, the cane is senile, less than 7' tall and accounts for as little as 30% of the total vegetational cover. In fields that have been abandoned for a longer period or where growing conditions were not optimal the clumps of cane are mostly dead or dying. Even in these fields these decrepit clumps are still in distinct rows. The vegetation between clumps usually consist of a mixed herb cover of 'ilima, Guinea grass, radiate fingergrass (Chloris radiata), 'uhaloa (Waltheria indica), hoary abutilon (Abutilon incanum), fuzzy rattlepod (Crotalaria incana), peria (Momordica charantia var. abbreviata) and nut grass (Cyperus rotundus). Total vegetational cover is generally about 75-90%; only where the cane is vigorous and dense is the cover up to 100%.

In some areas such as along the Ewa boundary fence the abundance of cane

is very low and the vegetation approaches that of the Fallow Fields. Here the vegetation is more open with more exposed ground. 'Ilima, 'uhaloa, peria, hoary abutilon and little bell (Ipomoea triloba) are abundant.

Fallowed Fields

The Fallowed Fields are those sugar cane fields which have been abandoned for such a long time that almost no living cane remain. Dead and dying clumps generally constitute less than 5% of the total cover. Dead cane stalks may litter the ground and planting furrows may still be evident but these fields are often difficult to recognize as sugar cane fields without close examination. Two Fallowed Fields subcommunities were recognized depending on the relative abundance of grasses.

Fallowed Fields Mixed Herb Association (Fmh)

Typically the vegetation in this community is less than 4' tall and consists of a mixture of 'uhaloa, radiate fingergrass, 'ilima, hoary abutilon, false mallow, buffelgrass (Cenchrus ciliaris), golden crown-beard (Verbesina encelioides) and coat buttons (Tridax procumbens). Small isolated stands of dying cane occur in certain portions of this community. Small patches of Guinea grass and/or radiate fingergrass can also be found. These grasses along with swollen fingergrass (Chloris barbata), sourgrass (Digitaria insularis) and Natal redtop (Rhynchelytrum repens) are especially common in the mauka portions of this community. Along the road delineating the makai boundary the vegetational cover is only about 50%. Pa'uohi'iaka (Jacquemontia ovalifolia) is common in this open area. Several stands of dead or dying cane also occur here.

Fallowed Fields Grassland Association (Fg)

In certain areas the fallowed cane fields are dominated by Guinea grass and/or radiate fingergrass. Almost no standing cane remain although the furrows are still more or less intact and fallen cane stalks are occasional throughout the community. In most areas the grass cover is 100% but small communities and individuals of 'ilima, hoary abutilon and false mallow are scattered through certain portions and swollen fingergrass and sourgrass are common in other areas.

Abandoned Fields (A)

Several former cane fields in the mauka portion along Palehua Road and between Farrington Highway and the H-1 Freeway have been tilled or graded sometime in the past. The ground is quite level with few stones and although some sugar cane is resprouting the planting furrows are gone. These fields were probably planted in some crop in years past but are now overgrown with mostly 'uhaloa, fuzzy rattlepod, nut grass and little bell. In one field mauka of Farrington Highway Guinea grass is abundant but in most of the Abandoned Fields this species is not quite so prevalent. Re-sprouting sugar cane is also common in the mauka portion of this field. Golden crown-beard, peria and hoary abutilon are common in some of the fields.

Cultivated Fields (C)

Cultivated Fields are fields which have been recently plowed, actually planted in a crop (other than sugar cane), or which have been put to some urban use. Of the five fields designated as Cultivated Fields, three have been recently plowed. The vegetation in these consist mostly of seedling little bell, peria, fuzzy rattlepod, 'uhaloa, castor bean (*Ricinus communis*), graceful spurge (*Chamaesyce hypericifolia*) and re-sprouting nut grass. Vegetational cover is about 25-50%. In two fields watermelons (*Citrellus lanatus*) have been planted and along the Ewa boundary fence an approximately two-acre site has been graded and turned into a parking lot. Approximately half of this field has been paved with gravel. Most of the vegetation in this portion consist of *Amaranthus viridis* and nut grass. The vegetation in the ungravelled portion consist of peria, nut grass, 'uhaloa, radiate fingergrass, false mallow and re-sprouting sugar cane.

Grasslands (GR)

Grasslands represent those lands which apparently have not been tilled, graded or planted in any crop including sugar cane. This community exists only on the steepest slopes just makai of the H-1 Freeway and is the smallest of all the vegetation types in the project site. The vegetation is one of Guinea grass 1-2' tall with emergent klu, koa-haole and kiawe. On eroded slopes, 'ilima, false mallow, 'uhaloa, *Beorhavia coccinea*, garden spurge (*Chamaesyce hirta*) and virgate mimosa (*Desmanthus virgatus*) are found in small numbers.

Gulch Association (GU)

Kaloi Gulch together with its tributary Hunehune Gulch represents the only natural drainage system in the project site. The vegetation in the gulches is characterized by extremely dense stands of Guinea grass 5-10' tall. So dense is this layer that very few other species are present. In the makai portion the predominant arborescent species is castor bean which grows to about 15' height. Koa-haole 20-30' tall replaces castor bean as the dominant overstory in the mauka sections of the gulch system. In the mauka portion of Hunehune Gulch ivy gourd (*Coccinea grandis*) is abundant, often completely enshrouding the Guinea grass and koa-haole. Paragrass (*Brachiaria mutica*), wood rose (*Merremia tuberosa*), moon flower (*Ipomoeaalba*) and peria are also found but only in small to moderate numbers.

Roadside Vegetation (R)

Numerous plant species are found along the paved and gravel roads. More species are found in this community than in any other in the project site. Guinea grass and radiate fingergrass are abundant. 'Uhaloa and nut grass are also found in large numbers and many other species including castor bean, fuzzy rattlepod, buffelgrass, graceful spurge, virgate mimosa, peria, lion's ear (*Leonotis nepetifolia*), Australian saltbush (*Atriplex semibaccata*), goosegrass (*Eleusine indica*), Natal redtop (*Rhynchelytrum repens*) and stinkgrass (*Eragrostis cilianensis*) are found in smaller numbers. This is not considered a significant plant community and its total area is very small.

Native Plant Communities

As a result of decades of sugar cultivation, virtually all of the vegetation in the project iste is secondary in nature. Of the 99 plant species recorded two are indigenous ('ilima, pa'uohi'iaka), two are probably indigenous ('uhaloa, hoary abutilon) and one is endemic (ko'oloa'ula, *Abutilon menziesii*). Of these, 'ilima, 'uhaloa and hoary abutilon are dominant or co-dominant in several plant communities and are significant elements in the vegetation in the site as a whole. Pa'uohi'iaka is found in small to moderate numbers in four vegetation types and is common in certain areas in the Fallowed Fields Mixed Herb community. It frequently grows in association with 'ilima, 'uhaloa and hoary abutilon. They do not, however, represent native plant communities. Rather, these native or possibly native species are well adapted to arid lowlands and are able to recolonize disturbed sites.

Except for ko'oloa'ula, all of the native species in the site are common lowland species in Hawaii. Ko'oloa'ula, on the other hand, is a rare and endangered species once endemic to Lanai, Maui, Oahu and Hawaii. It is now extinct on Hawaii.

Endangered Species

At least 38 individuals of the federally listed endangered species ko'oloa'ula were recorded from the site. Most of these (28) were in the Abandoned Cane Fields, six were in the Fallowed Fields Mixed Herb Association and four were in the Fallowed Fields Grassland Association. Approximate locations are indicated on Figure 2. All of these plants were healthy and most were flowering and/or fruiting.

Ko'oloa'ula was first submitted for listing as an endangered species in 1976 (Fed. Reg. 1976). The Endangered Species Act Amendments of 1978 required that the list of candidates for endangered status be withdrawn after two years and in 1979 ko'oloa'ula was withdrawn from consideration (Fed. Reg. 1979). In 1980 it was resubmitted as a top priority Category 1 candidate (Fed. Reg. 1980) and in 1985 the U.S. Fish and Wildlife Service proposed to list it as an endangered species (Fed. Reg. 1985). On Sept. 26, 1986 it was formally listed (Fed. Reg. 1986) and is now protected under the provisions of the Endangered Species Act of 1973, as amended, and the Hawaii State Revised Statutes.

Significant wild populations of ko'oloa'ula are found on Lanai and Maui but its occurrence on Oahu is somewhat of an enigma. It was known from a single plant discovered in an abandoned sugar cane field mauka of Hawaii Raceway Track at Barbers Point in 1981 and more recently from another individual at the Lualualei Naval Magazine (D. Herbst, pers. comm.). Both of these occurrences as well as the current discovery are from highly disturbed environments. The Barbers Point location is approximately four miles from the project site and the Lualualei site is at least 15 miles away. Ko'oloa'ula was not found in any of the prior surveys in the immediate area (Funk 1990, 1994; Nagata 1994, 1996).

FAUNA

Mammals

No mammals were observed in the site. It is probable, however, that field mice (Mus musculus), mongoose (Herpestris auropunctatus) and one or more species of rats (Rattus spp.) are found in the property. In addition, pig trails were observed in several plant communities.

Birds

Seventeen species of birds were observed in the site. To be considered a sighting, the individual must be observed perched or on the ground and not merely flying overhead. In addition, owl pellets were found in the Fallowed Fields Grassland Association community. It is not known, however, whether these are from the barn owl (Tyto alba) or pueo (Asio flammeus). Fifteen species are introduced, one is a common migratory species (Pacific golden-plover) and one is indigenous (Black-crowned night heron).

ARDEIDAE

Cattle egret (Bubulcus ibid)

Eight individuals were observed in the Abandoned Fields mauka of Farrington

Highway. On 4 October the Abandoned Field community immediately makai of the Cultivated Field east of Palehua Road was being plowed. Nearly 100 cattle egrets were seen feeding in the freshly tilled ground.

Black-crowned night heron (Nycticorax nycticorax)

Two young birds were flushed out of Hunehune Gulch near Plantation Road. As there was no water in either Hunehune Gulch or Kaloi Gulch it is not known whether these individuals are residents of the area or whether they are transients. The black-crowned night heron is indigenous to Hawaii.

CHARADRIIDAE

Pacific golden-plover (Pluvialis dominica)

The Pacific golden-plover is a migratory species which commonly spends its winters in Hawaii. Many were observed in the site. Thirty-two were counted in exposed areas in the Abandoned Cane Fields. Most of these were in the open site near the Ewa boundary. Twenty-six were observed in various areas in the Fallowed Fields Mixed Herb Association - six of them from the exposed areas near the makai boundary road. Twenty-six were seen in the Cultivated Areas. Of these, 20 were in the "parking lot" at the Ewa boundary.

COLUMBIDAE

Rock dove (Columba livia)

Three were observed in the exposed sections of the Fallowed Field Mixed Herb Association in the makai portion of the site.

Barred dove (Geopelia striata)

Many were seen in all but two vegetation types. They were most abundant along the paved roads.

Lace-neck dove (Streptopelia chinensis)

This is the most widespread species in the property. It was found in moderate numbers in all vegetation types.

FRINGILLIDAE

Red-crested cardinal (Paroaria coronata)

Three individuals were seen in koa-haole shrubs along Plantation Road.

Kentucky cardinal (Richmondena cardinalis)

One individual was seen in the Fallowed Fields Mixed Herb Association.

PHASIANIDAE

Francolin (Francolinus sp.)

About a dozen were seen in the Abandoned Cane Fields near Kaloi Gulch in the makai portion of the property. These birds ran and hid too quickly for a positive identification to species.

Ring necked pheasant (Phasianus colchicus)

Three pairs were flushed from the Abandoned Cane Fields and one pair was flushed from the Abandoned Fields along Palehua Road.

PLOCEIDAE

House finch (Carpodacus mexicanus)

About 20 were seen in the property, mostly along the roadways.

Orange-cheeked waxbill (Estrilda melpoda)

These were seen in small numbers in the Fallowed Fields Mixed Herb Association, Abandoned Fields and along the roadways.

Black-headed mannikin (Lonchura malacca)

Black-headed mannikins were seen in moderate numbers in the Abandoned Cane Fields, Fallowed Fields communities and along the roadways.

Rice bird (Lonchura punctulata)

Rice birds were seen in moderate to small numbers in all but two plant communities. They were most common along the roadways and in the Fallowed Fields Grassland Association.

PYCNONOTIDAE

Red-vented bulbul (Pycnonotus cafer)

The red-vented bulbul was the second most widespread species in the site. It was found in small to moderate numbers in all vegetation types except the Cultivated Fields.

STURNIDAE

Common mynah (Acridotheres tristis)

Only three were seen in the Abandoned Cane Fields in the makai portion of the property.

ZOSTEROPIDAE

Japanese white-eye (Zosterops japonicus)

Japanese white-eyes were found in small numbers mostly along the roadways.

SUMMARY

The vegetation in the project site consists of sugar cane, lowland shrubs and herbs and grasses. The vast majority of the 99 species recorded from the property is non-native. Only three native species (one endemic, two indigenous) and two possibly indigenous species were encountered but with the exception of the endemic ko'oloa'ula these were present in moderate to large numbers. Native species constitute a rather significant element of the vegetation. However, no native plant communities are present. As a result of decades of sugar cultvation the vegetation is entirely secondary and the native ('ilima, pa'uohi'iaka) or possibly native (hoary abutilon, 'uhaloa) species which are so common in the site are merely recolonizing an already completely altered habitat. According the the U.S. Fish and Wildlife Service the endangered species ko'oloa'ula can also be included as secondary in origin.

The various plant communities in the site serve as an excellent refuge and feeding site for 17 bird species. Fifteen are introduced urban, field or game birds, one is indigenous (black-crowned night heron) and one is a common migratory species (Pacific golden-plover). Many of the birds including the plover are present in moderate to large numbers.

The proposed project will result in the loss of large numbers of 'ilima, pa'uohi'iaka, 'uhaloa and hoary abutilon. These are all common lowland species and theirs is not considered a significant loss to the native flora. The project will also result in the loss of habitat for a large number of Pacific golden-plovers and two black-crowned night herons. At least 38 individuals of the endangered ko'oloa'ula will be affected by the project. The disposition of these will be determined through consultation with the State of Hawaii Division of Forestry and Wildlife as prescribed by the Hawaii Endangered Species Law.

RECOMMENDATIONS

Because of the presence of the federally endangered ko'oloa'ula in the project site, consultation with the Hawaii State Department of Land and Natural Resources Division of Forestry and Wildlife is required under the provisions of the State Endangered Species Law before any grubbing can commence. Similar discussions with the U.S. Fish and Wildlife Service is also recommended. These consultations will essentially determine the fate of the proposed project and what mitigating measures will be required to preserve the ko'oloa'ula.

The plant survey was conducted at 80% coverage and although a more intensive search was conducted in the vicinity of each ko'oloa'ula there is a high probability that more individuals are present in the site. It is therefor recommended that a 100% survey be undertaken in selected areas as indicated in Figure 2.

LITERATURE CITED

Berger, A.J. 1981. Hawaiian Birdlife. 2nd ed. Univ. Press of Hawaii. Honolulu. 260 pp.

Federal Register. 1976. 41 FR 24523; June 16, 1976.

________. 1979. 44 FR 70796; December 10, 1979.

________. 1980. 45 FR 82480; December 15, 1980.

________. 1985. 50 FR 28876; July 16, 1985.

________. 1986. 51 FR 34412; September 26, 1986.

Funk, E. 1990. Biological Resources Survey Report for Ewa Villages Development. Prepared for R.M. Towill Corp. 20 pp.

____. 1994. Biological Resources Survey Report for Schuler Homes East Kapolei Project, East Kapolei, Oahu, Hawaii. Prepared for Schuler Homes, inc. 15 pp.

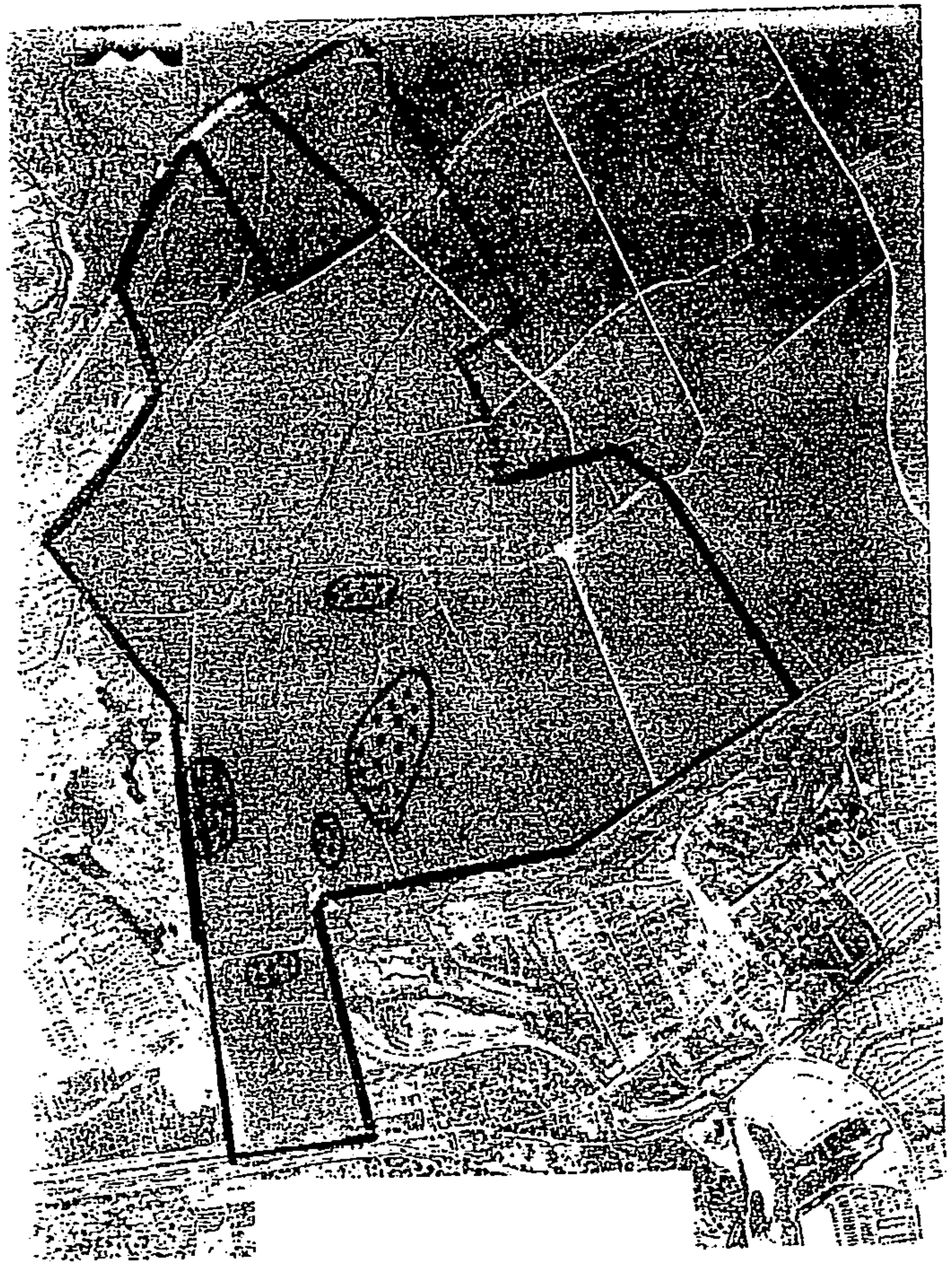
Nagata, K.H. 1994. Kaloi Gulch Vegetation Survey. unpublished. 1 pp.

______. 1996. Varona Village Biological Survey. Prepared for PBR Hawaii. 14 pp.

Neal, M.C. 1965. In Gardens of Hawaii. Bernice P. Bishop Museum Special Publ. 50. Bishop Museum Press. Honolulu. 924 pp.

St. John, H. 1973. List and Summary of the Flowering Plants in the Hawaiian Islands. Pac. Trop. Bot. Gard. Mem. No 1. Lawai. 579 pp.

Wagner, W.L., D.R. Herbst & S.H. Sohmer. 1990. Manual of the Flowering Plant of Hawaii. 2 vols. Univ. of Hawaii Press & Bishop Museum Press. Honolulu. 1853 pp.



PLANT SPECIES CHECKLIST

Families are arranged alphabetically in two groups: Monocotyledons and Dicotyledons. Genera and species are arranged alphabetically within each family. Taxonomy, common names and status follow those of Neal (1965), St. John (1973) or Wagner et. al. (1990). The abundance determinations are relative and are subject to the judgement of the investigator.

EXPLANATION OF SYMBOLS

Species Status:

E - Endemic to the Hawaiian Islands, ie. occurring naturally nowhere else in the world.

I - Indigenous, ie. native to the Hawaiian Islands but also occurring naturally elsewhere.

X - Exotic (alien), ie. plants introduced after the Western discovery of the islands.

P - Polynesian introductions, ie. plants introduced before the Western discovery of the islands.

Relative Abundance Ratings:

A - ABUNDANT, generally the major or dominant species in a given area.

C - COMMON, generally distributed throughout a given area in large numbers.

O - OCCASIONAL, generally distributed through a major portion of a given area, but in small numbers.

U - UNCOMMON, observed uncommonly but more than 10 times in a given area.

R - RARE, observed 2 to 10 times in a given area.

Vegetation Types:

ACF - Abandoned Cane Fields
Fmh - Fallowed Fields Mixed Herb Association
Fg - Fallowed Fields Grassland Association
A - Abandoned Fields
C - Cultivated Fields
GR - Grasslands
GU - Gulch Association
R - Roadside Vegetation

ANIMAL SPECIES CHECKLIST

Families are arranged alphabetically and genera and species are arranged alphabetically within each family. Taxonomy follows that of Berger (1981). Quantitative techniques were not employed and thus only presence is recorded in each vegetation type.

EXPLANATION OF SYMBOLS

Species Status:

- M – Migratory species.
- I – Indigenous, ie. native to the Hawaiian Islands but also occurring naturally elsewhere.
- X – Exotic (alien), ie. animals introduced after the Western discovery of the islands.

Vegetation Types:

- ACF – Abandoned Cane Fields
- Fmh – Fallowed Fields Mixed Herb Association
- Fg – Fallowed Fields Grassland Association
- A – Abandoned Fields
- C – Cultivated Fields
- GR – Grasslands
- GU – Gulch Association
- R – Roadside Vegetation

CHECK LIST OF PLANTS

SCIENTIFIC NAME	COMMON NAME	STATUS	RELATIVE ABUNDANCE ACF	Fmh	Fg	A	C	GR	GU	R
CHECKLIST OF PLANTS										
MONOCOTYLEDONES										
CYPERACEAE										
Cyperus rotundus L.	Nut grass	X	O	C	O	C	C	-	-	C
POACEAE										
Bothriochloa pertusa (L.) A. Camus	Pitted beardgrass	X	U	U	U	-	-	-	-	C
Brachiaria mutica (Forssk.) Stapf	Paragrass	X	U	U	U	R	-	-	U	U
Cenchrus ciliaris L.	Buffelgrass	X	O	C	-	U	R	U	U	U
Chloris barbata (L.) Sw.	Swollen fingergrass	X	U	U	C	U	-	C	-	C
C. radiata (L.) Sw.	Radiate fingergrass	X	C	C	A	U	-	U	-	A
Cynodon dactylon (L.) Pers.	Bermuda grass	X	-	-	-	A	R	-	-	U
Digitaria insularis (L.) Mez ex Ekman	Sourgrass	X	U	U	U	U	-	-	C	R
Echinochloa crus-galli (L.) P. Beauv.	Barnyard grass	X	U	-	-	-	-	-	-	U
Eleusine indica (L.) Gaertn.	Goosegrass	X	U	U	-	U	-	-	-	U
Eragrostis cilianensis (All.) Link	Stinkgrass	X	R	-	-	R	-	-	-	U
E. tenella (L.) P. Beauv. ex Roem. & Schult.	Japanese lovegrass	X	-	-	-	-	-	-	-	U
Leptochloa uninervia (C. Presl) Hitchc.		X	U	-	-	-	-	-	-	-
Panicum maximum Jacq.	Guinea grass	X	C	O	A	C	U	A	A	A
Rhynchelytrum repens (Willd.) Hubb.	Natal redtop	X	U	U	R	R	R	-	R	U
Saccharum officinarum L.	Sugar cane	X	A	U	U	R	-	-	-	R
Setaria verticillata (L.) P. Beauv.	Bristly foxtail	X	-	-	-	R	-	-	R	-
Sorghum halepense (L.) Pers.	Johnson grass	X	-	-	U	C	-	-	-	U
DICOTYLEDONES										
AMARANTHACEAE										
Achyranthes aspera L.		X	U	-	-	-	-	-	-	R
Alternanthera caracasana Kunth	Mat chaff flower	X	-	R	-	-	-	-	-	U
Amaranthus spinosus L.	Spiny amaranth	X	U	U	-	U	A	-	-	R
A. viridis L.		X	U	U	-	U	U	-	-	U
ANACARDIACEAE										
Mangifera indica L.	Mango	X	-	-	-	-	-	-	-	R
Schinus terebinthifolius Raddi	Christmas berry	X	-	-	-	-	-	-	-	R
ASCLEPIADACEAE										
Calotropis gigantea (L.) W.T. Aiton	Crown flower	X	-	R	R	-	-	-	-	-
ASTERACEAE										
Bidens pilosa L.	Spanish needle	X	U	-	-	U	-	-	-	U
B. pilosa var. minor (Bl.) Sherff		X	U	-	-	-	-	-	-	-
Conyza bonariensis (L.) Cronq.	Hairy horseweed	X	U	-	-	-	-	-	-	-
Emilia fosbergii Nicolson	Flora's paintbrush	X	O	-	-	-	U	-	-	R
Flaveria trinervia (Spreng.) C. Mohr		X	-	-	-	-	-	-	-	R
Lactuca serriola L.	Prickly lettuce	X	U	U	-	R	-	-	-	-
Pluchea indica (L.) Less.	Indian fleabane	X	U	U	U	-	-	-	-	U
P. x fosbergii Cooperr. & Galang		X	-	U	R	-	-	-	-	-
P. symphytifolia (Mill.) Gillis	Sourbush	X	U	U	U	-	-	-	-	U
Sonchus asper (L.) J. Hill	Prickly sow thistle	X	R	-	-	-	-	-	-	-

CHECK LIST OF PLANTS

SCIENTIFIC NAME	COMMON NAME	STATUS			ACF	Fab	Fg	A	C	CE	GU	R
ASTERACEAE												
Sonchus oleraceus L.	Sow thistle	A			R	-	-	-	U	-	-	-
Tridax procumbens L.	Coat buttons	A			U	C	U	U	U	-	-	U
Verbesina encelioides (Cav.) Benth. & Hook.	Golden crown-beard	A			U	C	-	U	A	-	-	U
Xanthium strumarium L.	Cocklebur	A			R	-	-	-	R	-	-	U
BIGNONIACEAE												
Spathodea campanulata Beauv.	African tulip	X			R	R	-	-	-	-	-	-
BORAGINACEAE												
Heliotropium procumbens var. depressum (Cham.) Fosb.		X			-	-	-	-	-	U		U
CAPPARACEAE												
Cleome gynandra L.	Wild spider flower	X			-	-	-	-	R	-	-	-
CHENOPODIACEAE												
Atriplex semibaccata R. Br.	Australian saltbush	X			-	-	-	R	-	-	-	U
A. suberecta Verd.		X			U	U	-	-	-	-	-	U
CONVOLVULACEAE												
Convolvulus arvensis L.	Field bindweed	X			U	U	-	-	U	-	-	U
Ipomoea alba L.	Moon flower	A			-	-	-	-	-	-	U	-
I. cairica (L.) Sweet	Koali	A?			-	R	-	-	-	-	-	-
I. obscura (L.) Ker-Gawl		X			U	U	-	-	-	-	-	U
I. triloba L.	Little bell	X			U	U	U	A	A	-	-	U
Jacquemontia ovalifolia (Choisy) H. Hallier	Pa'uohi'iaka	I			U	U	U	-	-	-	-	U
Merremia aegyptia (L.) Urb.	Hairy merremia	A?			U	U	-	U	U	-	-	-
M. tuberosa (L.) Rendle	Wood rose	X			-	-	-	-	-	-	R	-
CUCURBITACEAE												
Citrullus lanatus (Thunb.) Matsum. & Nakai	Watermelon	X			-	-	-	-	U	-	-	-
Coccinea grandis (L.) Voigt	Ivy gourd	X			O	U	U	U	U	R	A	U
Cucumis dipsaceus Ehrenb. ex Spach	Teasel gourd	X			-	R	-	-	-	-	-	-
Momordica charantia L. var. abbreviata	Peria	X			O	O	U	O	C	-	U	O
EUPHORBIACEAE												
Chamaesyce hirta (L.) Millsp.	Garden spurge	X			-	R	R	-	U	U	-	O
C. hypericifolia (L.) Millsp.	Graceful spurge	X			O	U	U	O	O	-	-	O
C. hyssopifolia (L.) Small		X			-	-	R	R	-	-	-	U
Euphorbia cyathophora J.A. Murray	Mexican fire plant	X			-	-	-	-	-	-	-	R
E. heterophylla L.	Kaliko	X			-	-	-	U	U	-	-	-
Ricinus communis L.	Castor bean	X			U	-	U	U	O	-	C	O
FABACEAE												
Acacia farnesiana (L.) Willd.	Klu	X			-	-	R	R	-	U	R	R
Cassia sp.		X			-	U	-	-	-	-	-	-
Chamaecrista nictitans (L.) Moench	Japanese tea	X			-	-	-	-	R	-	-	R
Crotalaria incana L.	Fuzzy rattlepod	X			O	U	O	C	U	U	-	U
C. pallida Aiton	Smooth rattlepod	X			R	R	U	-	-	-	-	U
Desmanthus virgatus (L.) Willd.	Virgate mimosa	X			U	O	U	U	-	U	-	U

CHECK LIST OF PLANTS

SCIENTIFIC NAME	COMMON NAME	STATUS			ACF	Fab	Fg	A	C	CE	GU	R
FABACEAE												
Desmodium tortuosum (Sw.) DC.	Florida beggarweed	X			-	-	-	-	-	-	-	U
Erythrina sp.		X			-	-	-	-	-	-	R	R
Indigofera spicata Forssk.	Creeping indigo	X			-	-	-	-	-	-	-	U
I. suffruticosa Mill.	Indigo	X			U	U	U	R	-	-	-	U
Lablab purpureus (L.) Sweet	Hyacinth bean	X			R	R	-	-	-	-	-	U
Leucaena leucocephala (Lam.) de Wit	Koa-haole	X			U	U	U	U	-	O	A	U
Macroptilium lathyroides (L.) Urban	Cow pea	X			U	U	-	-	U	-	-	R
Pithecellobium dulce (Roxb.) Benth.	'Opiuma	X			R	R	-	-	-	-	-	R
Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	Kiawe	X			-	R	-	-	-	R	-	U
Senna occidentalis (L.) Link	Coffee senna	X			-	R	-	-	-	-	-	-
Vigna sesquipedalis Wight	Long bean	X			R	-	-	-	-	-	-	-
LAMIACEAE												
Leonotis nepetifolia (L.) R. Br.	Lion's ear	X			O	U	R	U	U	U	-	U
MALVACEAE												
Abutilon grandifolium (Willd.) Sweet	Hairy abutilon	X			-	-	-	-	-	U	-	U
A. incanum (Link) Sweet	Hoary abutilon	I?			C	C	C	O	R	U	-	-
A. menziesii Seem.	Ko'oloa'ula	E		ENDANGERED	U	R	-	-	-	-	-	-
Malvastrum coromandelianum (L.) Garcke	False mallow	X			O	C	O	U	C	U	-	O
Sida ciliaris L.		X			-	-	-	-	-	-	-	U
S. fallax Walp.	'Ilima	I			C	A	C	U	-	U	-	R
S. rhombifolia L.	Cuba jute	X			-	U	-	-	-	-	-	U
S. spinosa L.	Prickly sida	X			-	U	-	R	-	U	-	U
MORACEAE												
Morus sp.		X			R	-	-	-	-	-	-	-
NYCTAGINACEAE												
Boerhavia coccinea Mill.		X			O	O	R	U	U	U	-	U
PASSIFLORACEAE												
Passiflora foetida L.	Love-in-a-mist	X			U	-	U	O	R	U	-	U
PORTULACACEAE												
Portulaca oleracea L.	Pigweed	X			U	U	U	R	U	U	-	-
PRIMULACEAE												
Anagallis arvensis L.	Scarlet pimpernel	X			R	-	-	-	-	-	-	-
SOLANACEAE												
Datura stramonium L.	Jimson weed	X			-	-	-	-	-	-	?	-
Lycopersicon pimpinellifolium Mill.	Currant tomato	X			U	R	-	U	U	-	-	U
Nicotiana glauca R.C. Graham	Tree tobacco	X			U	R	R	-	-	-	-	U
STERCULIACEAE												
Waltheria indica L.	'Uhaloa	I?			C	A	O	C	O	U	-	C

CHECK LIST OF PLANTS

SCIENTIFIC NAME	COMMON NAME	STATUS	ACT	FaH	Fa	A	C	CR	CU	R
TILIACEAE										
Triumfetta semitriloba Jacq.	Sacramento bur	I	-	-	-	-	-	-	-	R
ZYGOPHYLLACEAE										
TRIBULUS TERRESTRIS L.	Puncture vine	I	-	R	-	-	R	-	-	O

CHECK LIST OF PLANTS

CHECKLIST OF ANIMALS

SCIENTIFIC NAME	COMMON NAME	STATUS	ACT	FaH	Fa	A	C	CR	CU	R
ARDEIDAE										
Bubulcus ibis	Cattle egret	I	-	-	-	X	X	-	-	-
Nycticorax nycticorax	Black-crowned night heron	I	-	-	-	-	-	-	-	X
CHARADRIIDAE										
Pluvialis dominica	Pacific golden-plover	N	X	X	-	-	X	-	-	-
COLUMBIDAE										
Columba livia	Rock dove	I	-	X	-	-	-	-	-	-
Geopelia striata	Barred dove	I	X	X	X	X	X	-	-	X
Streptopelia chinensis	Lace-neck dove	I	X	X	X	X	X	X	X	X
FRINGILLIDAE										
Paroaria coronata	Red-crested cardinal	I	-	-	-	-	-	-	-	X
Richmondena cardinalis	Kentucky cardinal	I	-	X	-	-	-	-	-	-
PHASIANIDAE										
Francolinus sp.	Francolin	I	X	-	-	-	-	-	-	-
Phasianus colchicus	Ring-necked pheasant	I	X	-	-	X	-	-	-	-
PLOCEIDAE										
Carpodacus mexicanus	House finch	I	X	-	-	-	-	-	-	X
Estrilda melpoda	Orange-cheeked waxbill	I	-	X	-	X	-	-	-	X
Lonchura malacca	Black-headed mannikin	I	X	X	X	-	-	-	-	X
L. punctulata	Rice bird	I	X	X	X	X	-	X	-	X
PYCNONOTIDAE										
Pycnonotus cafer	Red-vented bulbul	I	X	X	X	X	-	X	X	X
STURNIDAE										
Acridotheres tristis	Common mynah	I	X	-	-	-	-	-	-	-
ZOSTEROPIDAE										
Zosterops japonicus	Japanese whiteeye	I	X	X	-	-	-	-	-	X

Appendix C
Char Survey

CHAR & ASSOCIATES
Botanical/Environmental Consultants
4471 Puu Panini Ave.
Honolulu, Hawaii 96816
(808) 734-7828

January 1997

SUMMARY OF FINDINGS
KO'OLOA'ULA ON EAST KAPOLEI PROJECT SITE
'EWA DISTRICT, ISLAND OF O'AHU

INTRODUCTION

The ko'oloa'ula (Abutilon menziesii), a member of the hibiscus or mallow family (Malvaceae), is a much-branched shrub up to 6 to 9 ft. tall, which is covered by velvety, stellate pubescence. The heart-shaped leaves are silvery-green and the attractive flowers are maroon. It is uncommon and occurs in dryland habitats (Wagner et al. 1990). Today, the largest population is found on Lana'i (about 600 plants) in koa haole scrub. Five small populations occur on Maui on 'a'a lava and also on red soils in a large gulch adjacent to sugar cane fields. One population occurs at Puako on the island of Hawai'i. On O'ahu, a single plant was found in abandoned sugar cane fields near the Campbell Industrial Park. Recently, a single plant was found on the Navy's Lualualei facility in kiawe/Guinea grass scrub.

In 1986, the species was federally listed as endangered. All plants on the federal list are automatically added to the state endangered species list. In its natural habitat the ko'oloa'ula plants are threatened by browsing animals (cattle, goats, axis deer), competition from weedy introduced plants, fires, predation by introduced insects, loss of native pollinators, and development (U.S. Fish and Wildlife Service 1994).

Because the plant is attractive and is easy to cultivate (seeds and cuttings), it was once sold by several plant nurseries as "red 'ilima" prior to its listing.

A new populaion of the ko'oloa'ula was recently discovered by Nagata while conducting a survey of the HFDC's East Kapolei project site in September and October 1996. Nagata recorded at least 38 ko'oloa'ula plants from the southwest corner of the project site (Figure 1). Collections of the plants were deposited by Nagata at the Bishop Museum.

A survey to verify and to more accurately inventory and map the plants found by Nagata was conducted in December 1996. This survey followed an unusually heavy rainfall in November 1996 which lasted for about 10 days.

RESULTS

Three colonies of plants were identified in the field and mapped (Figure 2). We could not locate the northern-most colony mapped by Nagata.

Colony A: This colony consists of 6 large, mature (flowering/ budding) plants, 2 to 6 ft. tall, and 2 juvenile (young, immature) plants, 1 to 1.5 ft. tall.

Colony B: This colony is found along the golf course fence. About half (11 plants) are composed of juvenile plants, most of which have probably sprouted and grown since the November rains. The remaining plants (10) are mature individuals.

Colony C: This is the largest colony and is found near the power

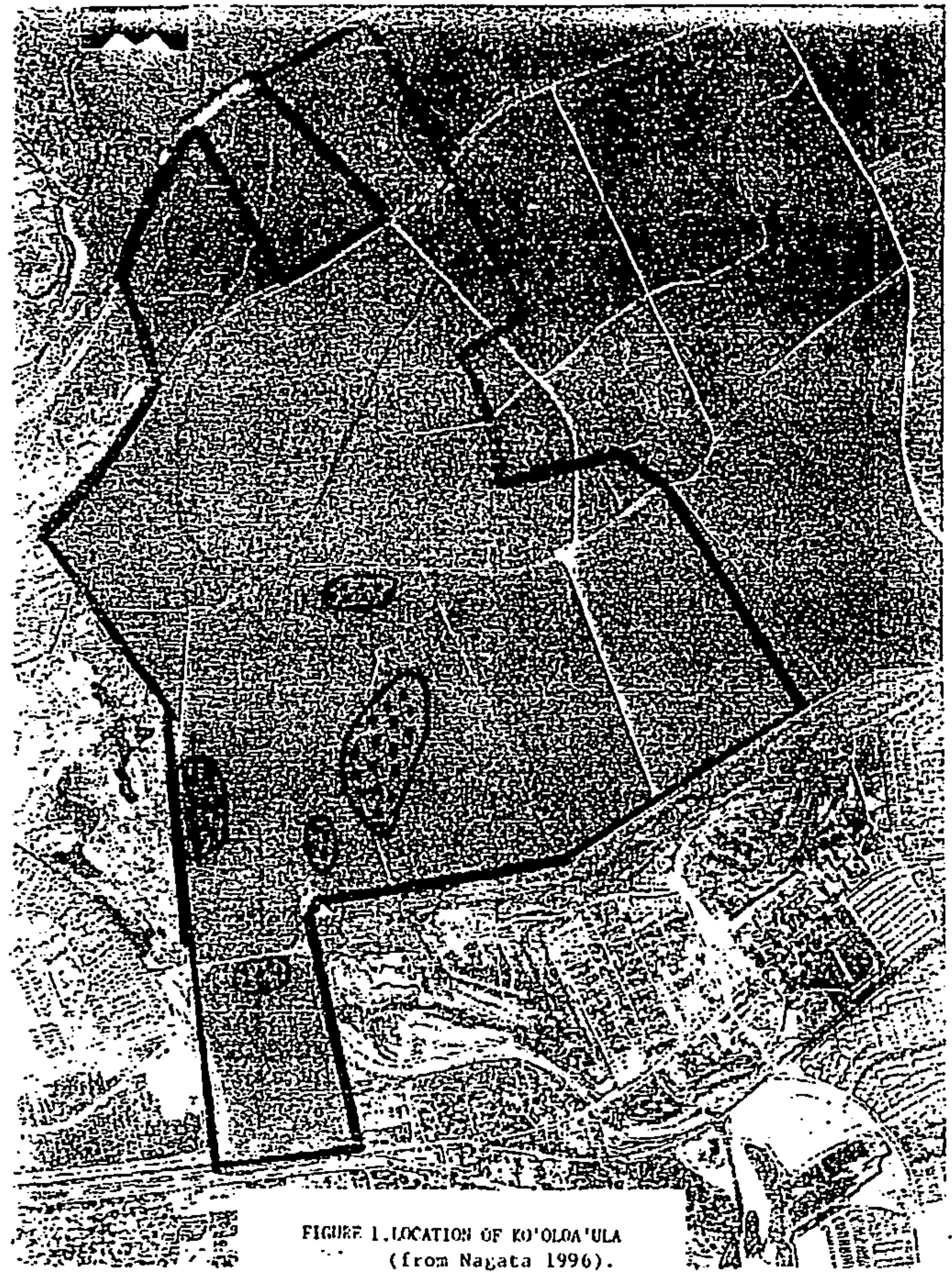


FIGURE 1. LOCATION OF KO'OLOA'ULA (from Nagata 1996).

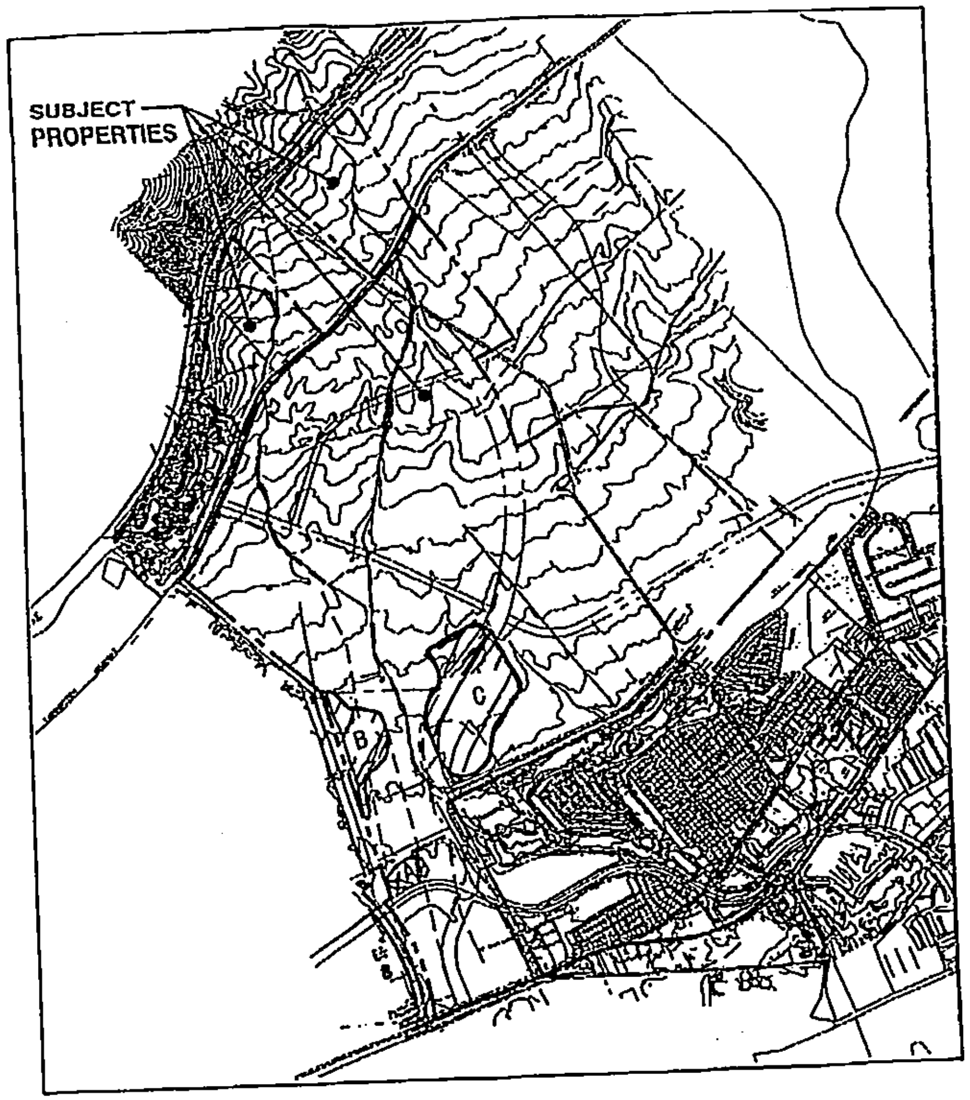


FIGURE 2

LOCATION OF KO'OLOA'ULA DURING THIS SURVEY.

0 1000 2000 FEET February, 1997 PBR

line. Nagata maps it as two separate colonies. But after the more intensive survey, we located plants between the two colonies and have thus lumped them into one larger colony. The majority of the plants are centered around an overgrown, coral-lined cane haul road. A few plants cross under the power line and extend north of the power line for a short distance. The colony consists of 55 large, mature plants (many of them 4 to 6 ft. tall), and 4 juvenile plants.

DISCUSSION AND RECOMMENDATIONS

A total of 88 ko'oloa'ula plants were found during the recent study to flag and inventory the plants on the East Kapolei site. There are a large number of juvenile plants, most of which sprouted and established themselves since the unusually heavy rainfall in November 1996. The number of plants will most likely increase during this rainy season (November 1996 to about February 1997).

It is recommended that a mitigation plan be initiated as soon as possible as the mature plants will continue to set seeds and the colonies will continue to expand in area.

The larger plants can be easily cultivated from seeds and cuttings while the smaller plants can be dug up and transplanted. It is recommended that an area be set aside for the conservation of these plants. An excellent location would be within the power line corridor. A greenway or belt of vegetation with the ko'oloa'ula could be established here. A few plants already occur within this corridor.

References

U.S. Fish and Wildlife Service. 1994. Lana'i plant cluster recovery plan: Abutilon eremitopetalum, Abutilon menziesii, Cyanea macrostegia ssp. gibsonii, Cyrtandra munroi, Gahnia lanaiensis, Phyllostegia glabra var. lanaiensis, Santalum freycinetianum var. lanaiensis, Tetramolopium remyii, and Viola lanaiensis. Portland, Or.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1990. Manual of the flowering plants of Hawai'i. 2 vols. University of Hawai'i Press and B.P. Bishop Museum Press, Honolulu. B.P. Bishop Museum Special Publication 83.

Appendix D
Summary of Proposed Mitigation Measures

SUMMARY OF PROPOSED MITIGATION MEASURES FOR IMPACTS ON ABUTILON MENZIESII AT KAPOLEI

Mitigation Measures	**Cluster C-2 Drainage/Open Space (HFDC)**	**Cluster C-1 North-South Road (DOT)**	**Cluster A Res/Comm'l (HFDC)**	**Cluster B Res / DHHL (HFDC)**	**Cluster D Res / HFDC (HFDC)**	**Cluster C-3 Res / DHHL (HFCD)**
Number of Plants Affected	7	14	10	14	1	40
Nursery Facility (1998-2010)						
Introduce Plants to Nursery	1999 - 2001	N/A	1999 - 2005	1999 - 2005	2001-2005	2005-2008
Duration at Nursery (Approx. Years)	2-3	N/A	1 - 2	1 - 2	1 - 2	1 - 2
Project Phasing						
Interim Management Period (Existing Plants)	Permit period prior to construction	3-4 mos before construction	Permit period prior to construction	Permit period prior to construction	Concurrent with C-3	Permit period prior to construction
Construction Period	Early 1999	Mid 1999	1999-2005	1999-2005	2001-2005	2005-2008
Maintenance Period	Until 2005	3 years	Until 2005	Until 2005	Until 2005	Until 2008
Long Term Maintenance Period	Until recovery goals are met	Until recovery goals are met	Until recovery goals are met	Until recovery goals are met	Until recovery goals are met	Until recovery goals are met
Interim Management Measures (Existing Population)						
Data collection (Baseline)	Completed	Completed	Completed	Completed	Completed	Completed
On-going data collection	Yes	Completed	Yes	Yes	Yes	Yes
Seed collection	On-going after HCP approved	On-going 3-4 mo before construction	On-going after HCP approval	On-going after HCP approval	On-going after HCP approval	On-going after HCP approval
Air-layers	No	On-going during 3-4 mo. period	Begin 1999	Begin 1999	Begin 2001	Begin 2005
Firebreak / Pest Control (as needed)	On-going	On-going during 3-4 mo. period	On-going	On-going	On-going	On-going
Methods of Propagation						
Seed germination (No. Plants)	10	20	15	20	No	60
Air layering (No. Air-layers x plants)	No	56 plants= 4x14	40=4x10	56=4x14	4=4x1	160=4x40
Cuttings (No. Cuttings x plants)	28=4x7	None	40=4x10	56=4x14	None	160=4x40
Re-location of parent plant	7	None	10	14	1	40
Seed banking	As available	As avaialble	As available	As available	As available	As available
Location of Off-Site Nursery						
Honolulu Botanical Gardens	N/A	10 (seed), 28 air layer= 38 plants	N/A	N/A	N/A	N/A
Waimea Arboretum & Botanical Gardens	N/A	10 (seed), 28 (air layer) = 38 plants	N/A	N/A	N/A	N/A
Staffing						
Interim Management Period	PM (ESC)* Researcher	Endangered Species Consultant	PM (ESC) Researcher	PM (ESC) Researcher	PM (ESC) Researcher	PM (ESC) Researcher
Construction Period	PM (ESC) Researcher	N/A	PM (ESC) Researcher	PM (ESC) Researcher	PM (ESC) Researcher	PM (ESC) Researcher
Maintenance Period	PM (ESC) Researcher	N/A	PM (ESC) Researcher	PM (ESC) Researcher	PM (ESC) Researcher	PM (ESC) Researcher
Source of Funding	HFDC	FHWA/SDOT	HFDC	HFDC	HFDC	HFDC
Measurable Goals (Relocate to Open-space Corridor)						
Seeds	50% survival; 25% flowers/fruit	50% survival, 25% flowers/fruit	50% survival; 25% flowers/fruit	50% survival; 25% flowers/fruit	50% survival; 25% flowers/fruit	50% survival; 25% flowers/fruit
Air layers	50% survival, 25% flowers/fruit	50% survival; 25% flowers/fruit	50% survival; 25% flowers/fruit	50% survival; 25%flowers/fruit	50% survival; 25% flowers/fruit	50% survival; 25% flowers/fruit
Cuttings	5% survival	N/A	5% survival	5% survival	5% survival	5% survival
Relocated Mother Plant	5% survival	N/A	5% survival	5% survival	5% survival	5% survival
Reporting Schedule (for Population)						
Interim Management Period (Existing Population)	Annual	End of 3-4 month period	Annual	Annual	Annual	Annual
Construction Period	End construction period	End construction period	End construction period	End construction period	End construction period	End construction period
Maintenance Period	Yr. 1: Semi-annual Yr. 2: Semi-annual Yr. 3+: Annual	Yr. 1: Semi-annual Yr. 2: Semi-annual Yr. 3+: Annual	Yr. 1: Semi-annual Yr. 2: Annual Yr. 3+: Annual	Yr. 1: Annual Yr. 2: Annual Yr. 3+: Annual	Yr. 1: Annual Yr. 2: Annual Yr. 3+: Annual	Yr. 1: Annual Yr. 2: Annual Yr. 3+: Annual

*Project Manager (Endangered Species Consultant)

G. Archaeology

SCIENTIFIC CONSULTANT SERVICES, Inc.
711 Kapiolani Blvd., Suite 777 Honolulu, Hawai'i 96813

11-6-96

Mr. David Hulse
PBR Hawaii
Pacific Tower, Suite 650
1100 Bishop Street
Honolulu, HI 96813

RE: Archaeological Reconnaissance and Assessment of the H.F.D.C- East Kapolei Development Project.

Dear Mr. Hulse;

At your request, Scientific Consultant Services, Inc. (SCS) has undertaken on behalf of PBR Hawaii, a cultural resources review of the subject properties being considered for development at Kapolei (TMK 9-1-16:17)(Figures 1 and 2).

The 1994 letter provided to us by your firm was generated by Don Hibbard of Historic Preservation Division (SHPD) and directed to Dean Uchida of Hawaii Agricultural and Rural Development Program (HARRP). This letter clearly indicates that most of the present project area has been declared to have "no effect" on historic sites due to the many years of commercial sugarcane production on these lands (Attachment A, Doc No. 9408TD01).

In order to be certain that sugarcane plantation operations covered the entire parcel indicated in Figure 2, SCS conducted an on-site inspection of the subject properties on October 23rd, 1996. Under the overall supervision of Robert L. Spear, Ph.D., Senior Archaeologist Jennifer Robins, B.A., and Field Assistant Amy Buffum accessed the northern section of the project area from Farrington Highway (Figures 3 and 4). The purpose of this visual inspection was to confirm that no cultural resources could be located in either the Hunehune and Kaloi Gulches or on the broad agricultural plains. These two gulches are approximately 4 meters wide and 4 meters deep. They appear to be natural gulches that have been modified for cane irrigation.

Given the lack of cultural resources found during the field inspection, and the State of Hawai'i letter referenced above, we concur with the Historic Preservation Division's assessment that future development on these land parcels will have "no effect" on historic sites, and that no further cultural resource work is required.

Sincerely,

Robert L. Spear, Ph.D.
President
Scientific Consultant Services, Inc.

cc. Dr. Tom Dye (SHPD)

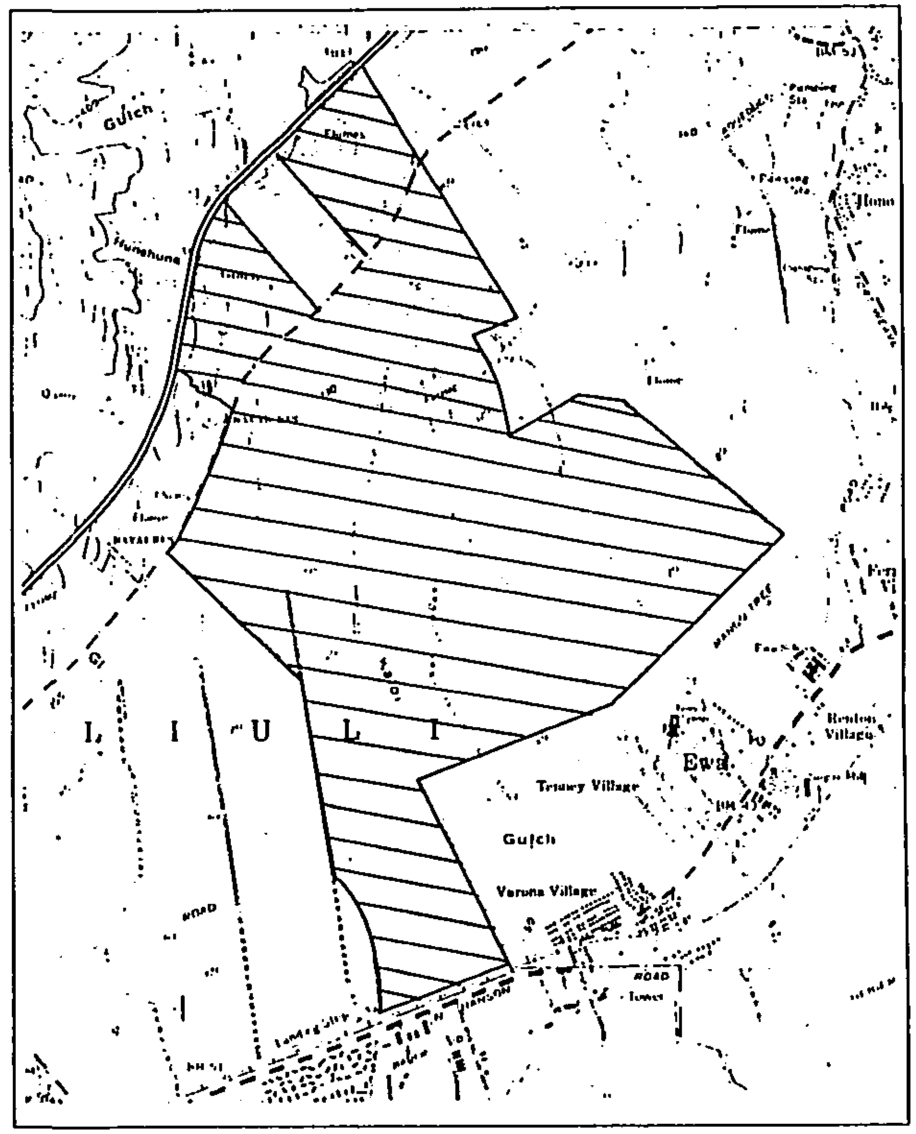


FIGURE 1: USGS EWA QUADRANGLE SHOWING PROJECT AREA.

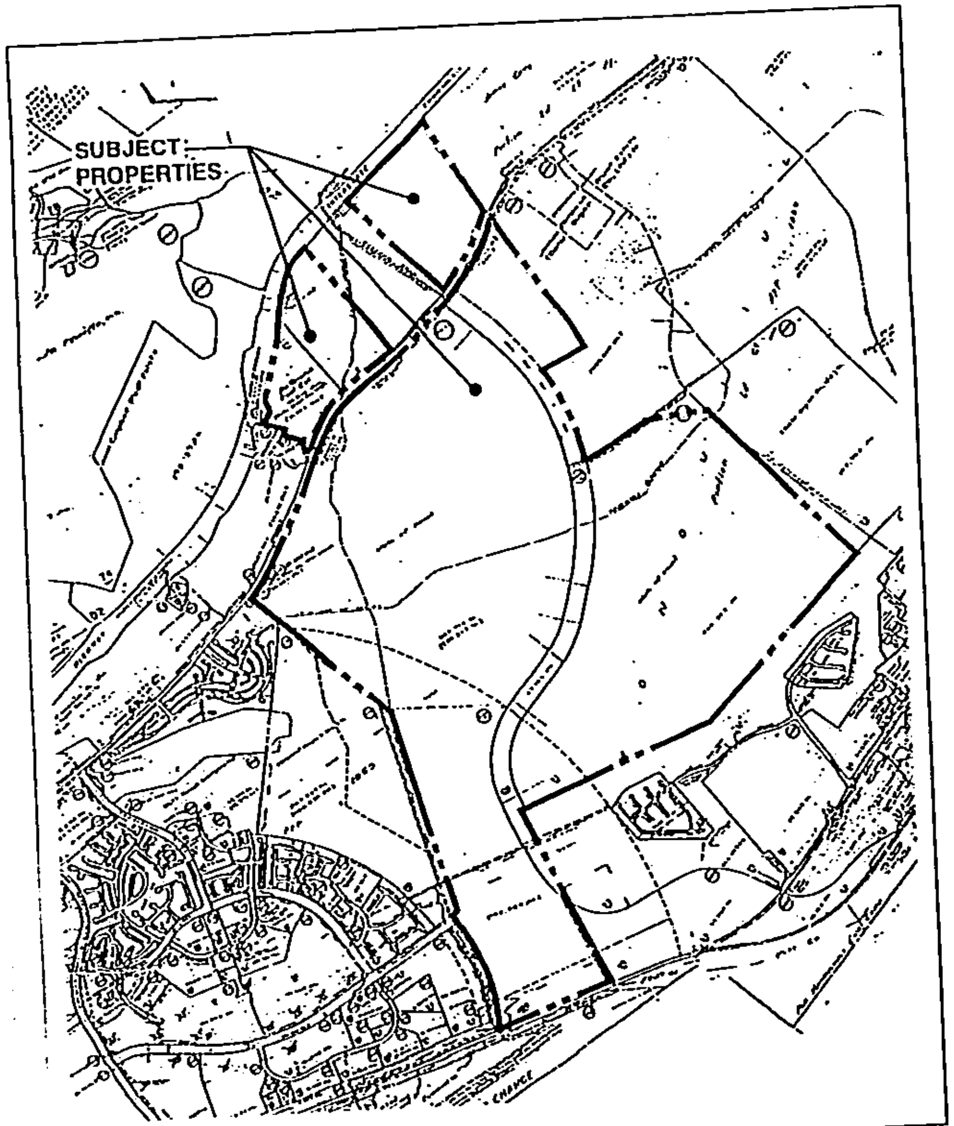


FIGURE 2: TAX MAP KEY 9-1-16: (VARIOUS) SHOWING PROJECT AREA (FROM PBR 1996).

FIGURE 3: GENERAL PROJECT AREA VIEW WITH HUNEHUNE GULCH IN THE DISTANCE. VIEW TO SOUTH.

FIGURE 4: GENERAL PROJECT AREA VIEW ALONG KALOI GULCH. VIEW TO SOUTHWEST.

ATTACHMENT A

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

41712

August 4, 1994

MEMORANDUM

LOG NO: 12352
DOC NO: 9408EJ01

TO: Dean Uchida
Hawaii Agricultural and Rural Development Program (HARRP)

FROM: Don Hibbard, Administrator
Historic Preservation Division

SUBJECT: State Lands at Kapolei, Reclassification from Agriculture to Urban
Honouliuli, 'Ewa, O'ahu
TMK: 9-1-16: por. 25; 9-1-17: por. 4

A review of our records shows that there are no known historic sites on these 1,300 acres of state lands. These lands were used for commercial sugar cane cultivation for many years and this would have destroyed any historic sites that might have been present. We believe that reclassification of these lands and their future development will have "no effect" on historic sites.

DH:jk

H. Traffic Impact Report

▶ East Kapolei Project Traffic Report

▶ Prepared for:

State of Hawaii
Housing Finance and Development Corporation

R. M. Towill Corporation

▶ Prepared by:

Julian Ng, Incorporated
P. O. Box 816
Kaneohe, Hawaii 96744

▶ April, 1998

April 17, 1998 DRAFT

Table of Contents

Traffic Report - East Kapolei Project
Kapolei, Oahu, Hawaii

April 17, 1998 DRAFT

The Housing Finance and Development Corporation (HFDC) of the State of Hawaii has proposed the development of State lands located east of Kapolei, on the Ewa plain of the island of Oahu. The East Kapolei project will include development of a variety of dwelling types in several parcels, designated by the letters "A" through "K" (Exhibit 1).

While not part of this project, a new roadway identified as the "North-South Road" will be constructed through the middle of the development area. A separate traffic study[1] was prepared for the North-South Road; this study considered land uses in the entire Ewa area, addressed future conditions at the major intersections, and provides the baseline from which traffic estimates were made for other major intersections affected by the East Kapolei project. This report includes estimates of weekday peak hour traffic volumes at these intersections. Recommendations for intersection layouts within the project site are based on the estimates made as part of this study.

The regional impacts of the project, including conditions at the proposed H-1 Interchange with the new North-South Road, were addressed as part of the North-South Road study and are not reevaluated herein. The projected volumes entering and leaving the project site are not significantly different and the North-South Road study addresses conditions on off-site facilities and provides recommendations for off-site roadway improvements.

Capacity analyses results reported herein are based on the *Highway Capacity Manual - Third Edition*[2]. For signalized intersections, cycle lengths of 100 seconds were assumed to check if capacities were adequate and to determine the intersection levels of service. At major intersections where peak hour volumes are small and signalization may not be warranted, the unsignalized intersection analysis was applied to determine delays and levels of service for the minor street approaches and the left turns from the major street. Levels of service are described in an attached appendix.

---

1 Parsons Brinckerhoff Quade & Douglas, Inc. *Traffic Study for the North-South Road Project Environmental Assessment*, October 1997.

2 Transportation Research Board, National Research Council, *Highway Capacity Manual (Third Edition)*, Washington, D.C. 1994.

Existing Traffic Conditions

The project site is presently vacant and was formerly used in sugar cane production. The only existing public roadway through the site is Farrington Highway, presently a two-lane highway which provides an alternative to the H-1 Freeway for travel between Kapolei and Kunia Road. The estimated daily traffic on Farrington Highway is between 6,000 and 10,000 vehicles per day.

Most of the existing traffic between Kapolei and Kunia Road is carried on the H-1 Freeway. The State Highways Division has estimated[3] that the segment of the H-1 Freeway between Makakilo Interchange and Kunia Interchange carried an average of 68,040 vehicles per day in 1995. The average volume from seven days of counts west of Kunia Interchange in 1996 was 72,800 vehicles per day. Table 1 summarizes the 1996 traffic counts in the area.

Table 1
1996 TRAFFIC COUNTS

(WB=westbound, EB=eastbound)	24-hour total	AM Peak Hour WB	AM Peak Hour EB	PM Peak Hour WB	PM Peak Hour EB
H-1 Freeway, west of Kunia Interchange *					
February 8-9	74,790	2,456	2,841	2,831	2,863
March 20-21	73,870	2,840	2,937	2,931	2,913
March 21-22	74,680	2,677	2,923	3,030	3,029
May 7	70,800	2,749	3,107	3,050	2,783
May 8	73,380	2,716	3,077	2,993	2,803
May 20-21	70,920	2,641	3,138	2,757	2,658
September 3-4	71,410	2,528	3,077	2,992	2,416
Farrington Highway, east of Kealanani Avenue (westbound only) **					
May 8	5,403	406	--	452	--
Farrington Highway, west of signal at on-ramp to Fort Weaver Road ***					
unstated (1995 or 1996)	--	115	175	330	960

Sources: * State of Hawaii, Department of Transportation, Highways Division. *Traffic Survey Data - Island of Oahu 1996.*

** City and County of Honolulu, Department of Transportation Services.

*** Parsons Brinckerhoff Quade & Douglas, Inc., *North South Road Corridor Study, Draft Environmental Assessment.* April 1997.

---

3 State Department of Transportation, Highways Division. *Traffic Summary, Island of Oahu 1995.*

Future Traffic Conditions

As part of the planning for the North-South Road, land use and economic development in the Ewa area were reviewed along with existing traffic and roadway capacity. Forecasts of transportation demand were made for the future year 2020, including estimates of turning movements at major intersections with ("Build") and without ("No-Build") the proposed North-South Road.

The forecasts shown in Figure 7 of the North-South Road traffic study ("Year 2020 Build Alternative Peak Hour Traffic Projections" were used as a basis for the analyses discussed in this report.

The number of vehicular trips that can be expected to be generated by the proposed East Kapolei project was calculated using the traffic generation rates shown in Table 2. In order to use the per-acre rates, commercial floor area was assumed to be 15,000 square feet per acre of site, parks were assumed to have 5,000 square feet of building area per acre, elementary schools were assumed to have 50 students per acre, and the middle school was assumed to have 45 students per acre. The trip rates and equations are based on data shown in *Trip Generation - 6th Edition*[4], which represents vehicular trips at driveways.

Table 2
TRIP GENERATION RATES

	AM Peak Hour rate	AM Peak Hour %In	PM Peak Hour rate	PM Peak Hour %In
Single Family residential (per dwelling unit)	(1)	25%	(2)	64%
Multifamily residential (per dwelling unit)	(3)	16%	(4)	67%
Commercial site < 4 acres (per 1,000 GSF)	(5)	63%	(6)	50%
Commercial site > 4 acres (per 1,000 GSF)	(5)	61%	(6)	50%
Elementary School (per acre)	14.5	59%	7.5	45%
Middle School (per acre)	23.0	57%	8.0	47%
Park and Ride Lot (per acre)	50.0	80%	50.0	20%
Recreational Center (per acre)	13.2	66%	17.5	34%

Equations from *Trip Generation - 6th Edition* [T = trip ends]:

(1) $(T) = 0.700 * (X) + 9.477$ [X = dwelling units]
(2) $Ln(T) = 0.901 * Ln(X) + 0.527$ [X = dwelling units]
(3) $(T) = 0.497 * (X) + 3.238$ [X = dwelling units]
(4) $(T) = 0.541 * (X) + 18.743$ [X = dwelling units]
(5) $Ln(T) = 0.589 * Ln(X) + 2.378$ [X = 1,000 gross square feet]
(6) $Ln(T) = 0.637 * Ln(X) + 3.553$ [X = 1,000 gross square feet]

[4] Institute of Transportation Engineers, *Trip Generation, 6th Edition*, Washington, D.C. 1997.

The trip generation rates were applied to the low and high range of the land use projections. The distribution of the traffic (inbound or outbound) was adjusted so that the estimates of net traffic generated from the project site for the land use high range were approximately equal to those of the North-South Road study (Tables 3 and 4).

Table 3
PROJECT TRIP ENDS
Low Range Estimates

			AM Peak Hour enter	AM Peak Hour exit	PM Peak Hour enter	PM Peak Hour exit
Area A:	439	single family dwellings	79	238	244	163
	3.0	acres, park	14	6	9	17
Area B:	1,270	single family dwellings	225	673	636	424
	564	multifamily dwellings	65	219	201	123
	8.0	acres, commercial	341	210	376	361
	12.0	acres, elementary school	103	71	48	72
	6.0	acres, park	28	12	18	35
Area C:	792	single family dwellings	141	423	416	277
	321	multifamily dwellings	37	126	119	73
	2.0	acres, commercial	151	92	155	150
	12.0	acres, elementary school	103	71	48	72
	3.0	acres, park	14	6	9	17
Area D:	366	single family dwellings	66	200	207	139
	3.0	acres, park	14	6	9	17
Area E:	55	single family dwellings	12	36	38	25
Area F:	105	multifamily dwellings	13	42	47	29
Area G:	8.0	acres, commercial	341	210	376	361
	2.5	acres, park	12	5	7	15
Area H:	64.3	acres, park	297	127	191	372
Area I:	846	single family dwellings	153	458	467	311
	227	multifamily dwellings	27	89	88	54
	12.0	acres, elementary school	103	71	48	72
	3.0	acres, park	14	6	9	17
Area J:	567	single family dwellings	102	304	308	205
	340	multifamily dwellings	40	132	126	77
	20.0	acres, middle school	236	178	40	120
	15.4	acres, park	71	31	46	89
Area K:	228	multifamily dwellings	27	90	88	54
Area L:	324	multifamily dwellings	38	126	120	74
Total vehicular trip ends			2,867	4,258	4,494	3,815

Table 4
PROJECT TRIP ENDS
High Range Estimates

		AM Peak Hour		PM Peak Hour	
		enter	exit	enter	exit
Area A:	585 single family dwellings	105	314	316	211
	3.0 acres, park	14	6	9	17
Area B:	1,693 single family dwellings	299	896	824	550
	677 multifamily dwellings	78	262	239	146
	8.0 acres, commercial	341	210	376	361
	12.0 acres, elementary school	103	71	48	72
	6.0 acres, park	28	12	18	35
Area C:	1,056 single family dwellings	187	562	539	359
	385 multifamily dwellings	45	150	141	86
	2.0 acres, commercial	151	92	155	150
	12.0 acres, elementary school	103	71	48	72
	3.0 acres, park	14	6	9	17
Area D:	488 single family dwellings	88	263	269	179
	3.0 acres, park	14	6	9	17
Area E:	74 single family dwellings	15	46	49	33
Area F:	126 multifamily dwellings	15	51	54	33
Area G:	8.0 acres, commercial	341	210	376	361
	2.5 acres, park	12	5	7	15
Area H:	64.3 acres, park	297	127	191	372
Area I:	1,129 single family dwellings	202	607	605	403
	272 multifamily dwellings	32	106	103	63
	12.0 acres, elementary school	103	71	48	72
	3.0 acres, park	14	6	9	17
Area J:	756 single family dwellings	135	404	399	265
	408 multifamily dwellings	47	159	148	91
	20.0 acres, middle school	236	178	40	120
	15.4 acres, park	71	31	46	89
Area K:	274 multifamily dwellings	32	107	104	63
Area L:	389 multifamily dwellings	45	152	142	87
Total vehicular trip ends		3,167	5,181	5,321	4,356

The park in Parcel "H" has been described as a sports complex, including a baseball stadium and several practice fields, with a parking lot. This use is not expected to generate significant traffic during the typical weekday peak periods, and the parking lot has been identified as one which would be used as a park-and-ride lot when it is not being used for

the sports complex. The trip generation using park use factors provide reasonable estimates for a park-and-ride lot.

The project trips were assigned to the major street network to conform as closely as possible with the parameters used in the North-South Road study. For the traffic analyses, a single point of access was assumed for Parcels "A", "K", and "L" and multiple points of access were assumed for other areas, as shown in Exhibit 1 (if additional roadway connections are provided, conditions would be better than shown in the analyses). In large parcels with multiple points of access, trips were distributed among the various access points. Exhibit 2 shows the peak hour traffic assignments (high-range of development) at the major intersections.

Summary of Traffic Analyses

Exhibit 3 shows the approach laneage used in the analyses. The typical section of Farrington Highway was assumed to be similar to the section that has been proposed to the west: two lanes in each direction plus a striped median which will become a separate left turn lane at intersections. The typical section of Kapolei Parkway is similar to the section provided through Kapolei to the west: three lanes in each direction separated by a planted median. The North-South Road would also be divided by a planted median. The East-West Road would be a four-lane divided roadway with curbs and sidewalks. In each of these streets, a left turn lane would be placed in the median at intersections. Other roadways were assumed to be standard City streets within 56-foot rights-of-way.

At seven intersections, signalization would be required and peak hour warrants would be satisfied. The *Manual on Uniform Traffic Control Device for Streets and Highways*[5] describes eleven possible warrants, one of which must be satisfied before traffic signals can be installed at an intersection. These warrants include consideration of the street system, school and pedestrian crossings, accident experience, and traffic volumes. The volume warrants include minimum volumes, interruption of continuous traffic on a major street, peak hour volumes, and minimum volumes for four hours. In residential areas, the most likely warrant to be satisfied is the warrant for peak hour volumes.

At the intersection of the collector roadway serving Parcels "K" and "L" with Farrington Highway, peak hour volumes do not satisfy the peak hour warrant for signalization; a review of conditions gives no indication that any of the other warrants would be satisfied. As an unsignalized intersection in which traffic on the collector would be controlled by stop signs, traffic turning left out of the collector or proceeding across the highway would have very long delays, at unacceptable Levels of Service (LOS) E and F.

5 U. S. Department of Transportation, Federal Highway Administration, *Manual on Uniform Traffic Control Devices for Streets and Highways*, Washington, D.C. 1988 and as amended.

Left turns from Farrington Highway to the collector, however, would be at LOS A or B. Table 5 summarizes the findings from the unsignalized intersection analyses.

Table 5
Unsignalized Intersection Analyses

Delay (seconds), LOS	AM Peak Hour		PM Peak Hour	
Road serving Parcels "K" and "L" at Farrington Highway				
southbound right turn	4.6	A	3.7	A
southbound left/through	25.5	D	25.1	D
westbound left turn	3.8	A	4.6	A
eastbound left turn	5.3	B	4.4	A
northbound left turn	48.2	F	35.0	E
northbound through/right	15.3	C	12.7	C

The other intersections were analyzed as signalized intersections with separate phases for left turns. Table 6 summarizes the findings of the signalized intersection analyses. Cycle lengths of 100 seconds (36 cycles per hour) were used in the analyses; for the PM Peak Hour volumes at the intersection of North-South Road and Kapolei Parkway, the cycle length was increased to 160 seconds (22½ cycles per hour) to reduce lost time to increase the capacity. Table 6 presents the findings of average intersection delays and levels of service.

Table 6
Signalized Intersection Analyses

	AM Peak Hour		PM Peak Hour	
	Average delay (sec)	LOS	Average delay (sec)	LOS
Farrington Highway and Road serving Parcels "A" and "B"	19.6	C	21.4	C
North-South Road and East Kapolei Avenue	17.6	C	22.1	C
East-West Road and:				
East Kapolei Avenue	21.9	C	17.3	C
Road serving Parcel "C"	23.9	C	13.3	B
West Road serving Parcels "I" and "J"	22.7	C	21.8	C
East Road serving Parcels "I" and "J"	17.9	C	18.0	C
Kapolei Parkway and:				
Road serving Parcels "F" and "G"	22.8	C	18.3	C
North-South Road	23.4	C	36.3	D

As indicated in Table 6, each of the intersections would operate at an acceptable level of service during both the AM and the PM peak hours. Any additional roadways providing access would lessen the traffic demand, decrease delays, and improve the level of service.

Length of Left Turn Lanes

Left turn lanes should be of sufficient length to prevent the blockage of through traffic by vehicles waiting to turn left into a side street. The storage lengths for left turn lanes are based on the left turn volumes. At unsignalized intersections, the storage length should be adequate to accommodate the number of vehicles expected to arrive in an average 2-minute period within the peak hour, with a minimum length for 2 vehicles, or 75 feet assuming one automobile (25 feet) and one large truck or bus (50 feet). Therefore, at locations where the higher peak hour left turn volume is 60 vehicles per hour or less, the minimum storage length should be provided. At signalized intersections, the storage length provided should be 1½ times the average number of arrivals per cycle, with an average spacing of 20 feet and a minimum storage length of 75 feet.

On City streets, common practice has been to provide the required peak hour storage plus the taper. However, for arterial streets with a speed limit of 35 miles per hour, a minimum total length equal to the deceleration length (315 feet for level conditions) should be provided so that deceleration can occur out of the through lanes under light traffic ("no load") conditions. Tables 7, 8, and 9 summarize the left turn storage lengths for the intersections studied.

Table 7
Recommendations for Storage Lengths
Left Turn Lanes (Farrington Highway)

Farrington Highway to:	Turning Volumes	Left Turn Lane Lengths (ft) Storage	Taper	Total
Road serving Parcel "A" (EB to NB)				
AM Peak Hour	45	75	180	255
PM Peak Hour	130	175	180	355
Road serving Parcel "B" (WB to SB)				
AM Peak Hour	70	100	180	280
PM Peak Hour	100	150	180	330
Road serving Parcel "L" (EB to NB)				
AM Peak Hour	20	75	180	255
PM Peak Hour	115	150	180	330
Road serving Parcel "K" (WB to SB)				
AM Peak Hour	5	75	180	255
PM Peak Hour	10	75	180	315*

recommended minimum length of left turn lane in bold
EB = eastbound, NB = northbound, SB = southbound, WB = westbound
* deceleration distance for no load condition

Table 8
Recommendations for Storage Lengths
Left Turn Lanes (East-West Road)

	Turning	Left Turn Lane Lengths (ft)		
East-West Road to:	Volumes	Storage	Taper	Total
East Kapolei Avenue (EB to NB)				
AM Peak Hour	115	150	180	330
PM Peak Hour	205	275	180	455
East Kapolei Avenue (WB to SB)				
AM Peak Hour	105	150	180	330
PM Peak Hour	35	50	180	230
East Kapolei Avenue (EB to NB)				
AM Peak Hour	115	150	180	330
PM Peak Hour	205	275	180	455
East Kapolei Avenue (WB to SB)				
AM Peak Hour	200	275	180	455
PM Peak Hour	180	250	180	430
Road serving Parcel "C" (WB to SB)				
AM Peak Hour	210	300	180	480
PM Peak Hour	70	100	180	280
West Road serving Parcel "J" (EB to NB)				
AM Peak Hour	190	275	180	455
PM Peak Hour	275	375	180	555
West Road serving Parcel "I" (WB to SB)				
AM Peak Hour	50	75	180	255
PM Peak Hour	95	125	180	315*
East Road serving Parcel "J" (EB to NB)				
AM Peak Hour	125	175	180	355
PM Peak Hour	185	250	180	430
East Road serving Parcel "I" (WB to SB)				
AM Peak Hour	35	50	180	230
PM Peak Hour	65	100	180	335*

recommended minimum length of left turn lane in bold
EB = eastbound, NB = northbound, SB = southbound, WB = westbound
* deceleration distance for no load condition

Table 9
Recommendations for Storage Lengths
Left Turn Lanes (Other Locations)

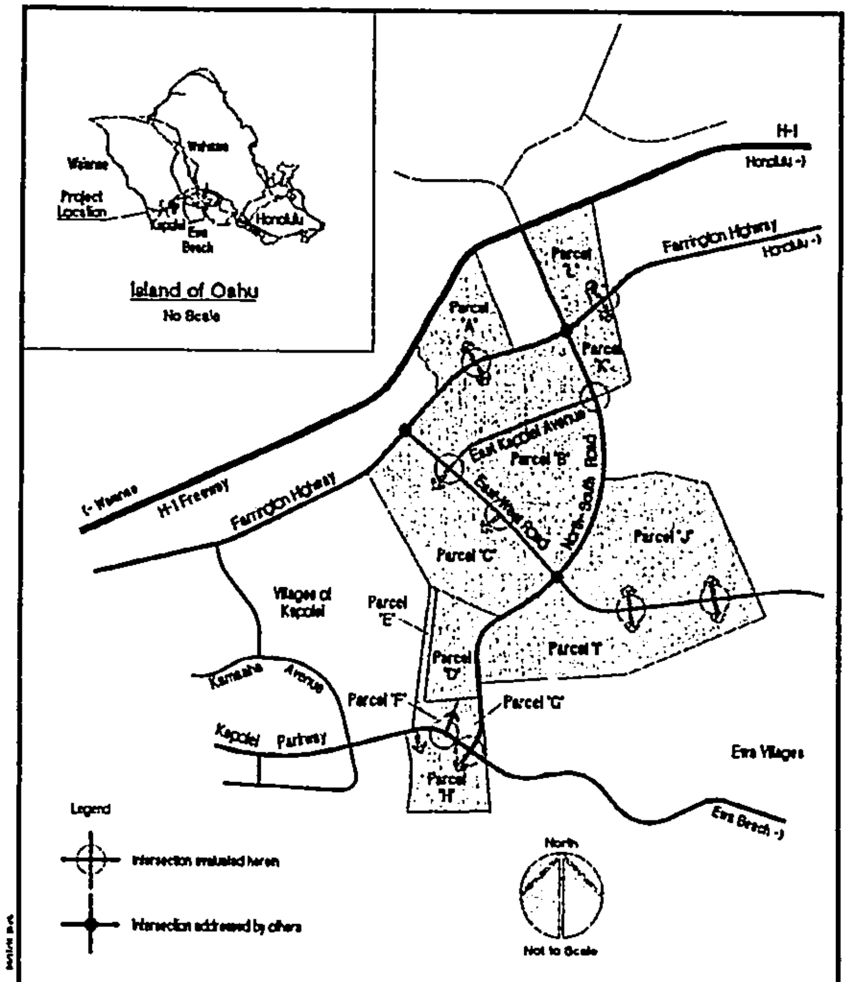
	Turning	Left Turn Lane Lengths (ft)		
	Volumes	Storage	Taper *	Total
North-South Road to:				
East Kapolei Avenue (NB to WB)				
AM Peak Hour	170	225	180	405
PM Peak Hour	430	600	180	780
Kapolei Parkway (SB to EB)				
AM Peak Hour	375	300	180	480
PM Peak Hour	760	575	180	755
Kapolei Parkway (NB to WB)				
AM Peak Hour	65	100	180	280
PM Peak Hour	120	175	180	355
East Kapolei Avenue to:				
North-South Road (EB to NB)				
AM Peak Hour	465	650	180	830
PM Peak Hour	205	275	180	355
Kapolei Parkway to:				
Road serving Parcels "F" & "G" (EB to NB)				
AM Peak Hour	115	150	180	330
PM Peak Hour	195	275	180	455
North-South Road (EB to NB)				
AM Peak Hour	370	275	180	455
PM Peak Hour	705	550	180	730
North-South Road (WB to SB)				
AM Peak Hour	175	250	180	435
PM Peak Hour	60	75	180	255

recommended minimum length of left turn lane in bold
EB = eastbound, NB = northbound, SB = southbound, WB = westbound
* deceleration distance for no load condition
** minimum storage length

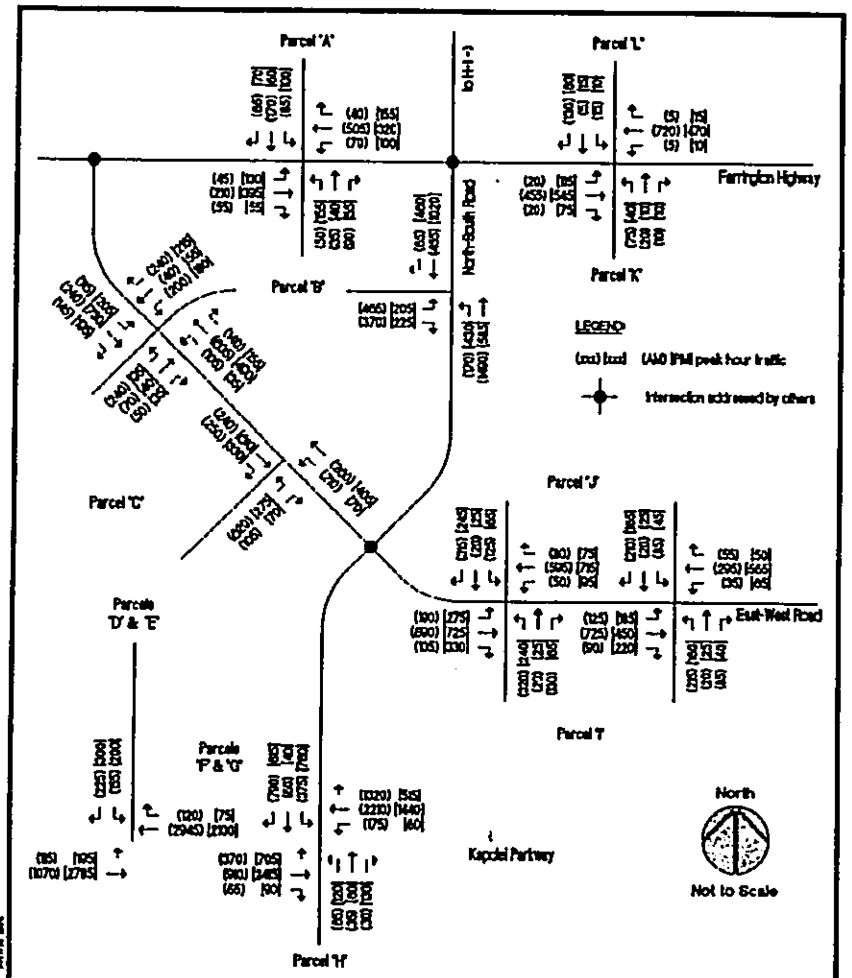
Conclusions

A comprehensive study of future transportation needs for the Ewa region was conducted for the North-South Road project. This study, which used a transportation planning model to estimate future traffic volumes for major roadways in the area, addressed regional issues and identified needed improvements to the roadway system. The East Kapolei project was included in the future land uses for this regional study.

A separate traffic study was conducted for the East Kapolei project to consider the impacts of the development on major roads within the project site and to evaluate conditions at several other major intersections. Intersection approach laneage and signalization have been identified and acceptable conditions are expected at all intersections except one unsignalized intersection, where long delays may occur but traffic signals do not appear warranted. Alternative access patterns may be necessary to mitigate this unacceptable conditions.



Traffic Report East Kapolei Project	Project Site Plan Portion of Kapolei, Oahu prepared by Julian Ng, Incorporated April, 1998	Exhibit 1

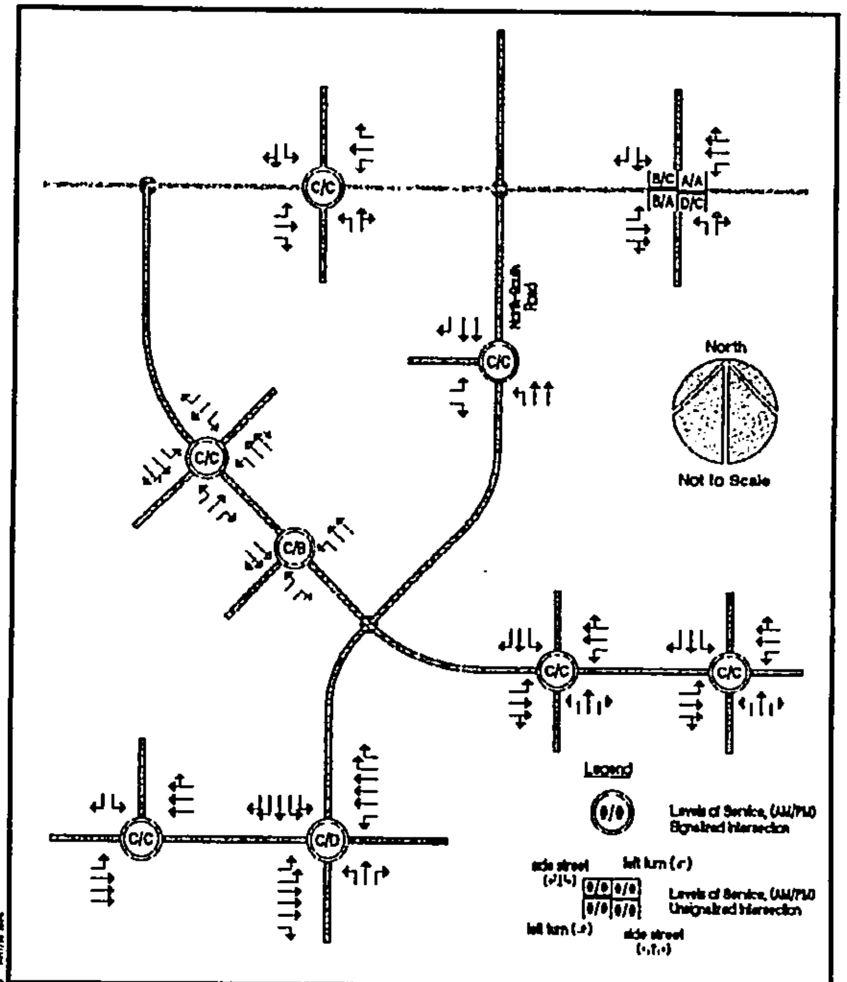


Traffic Report
East Kapolei Project

Traffic Assignments
Year 2020

prepared by Julian Ng, Incorporated — April, 1998

Exhibit
2



Traffic Report
East Kapolei Project

Intersection Laneage
and Levels of Service

prepared by Julian Ng, Incorporated — April, 1998

Exhibit
3

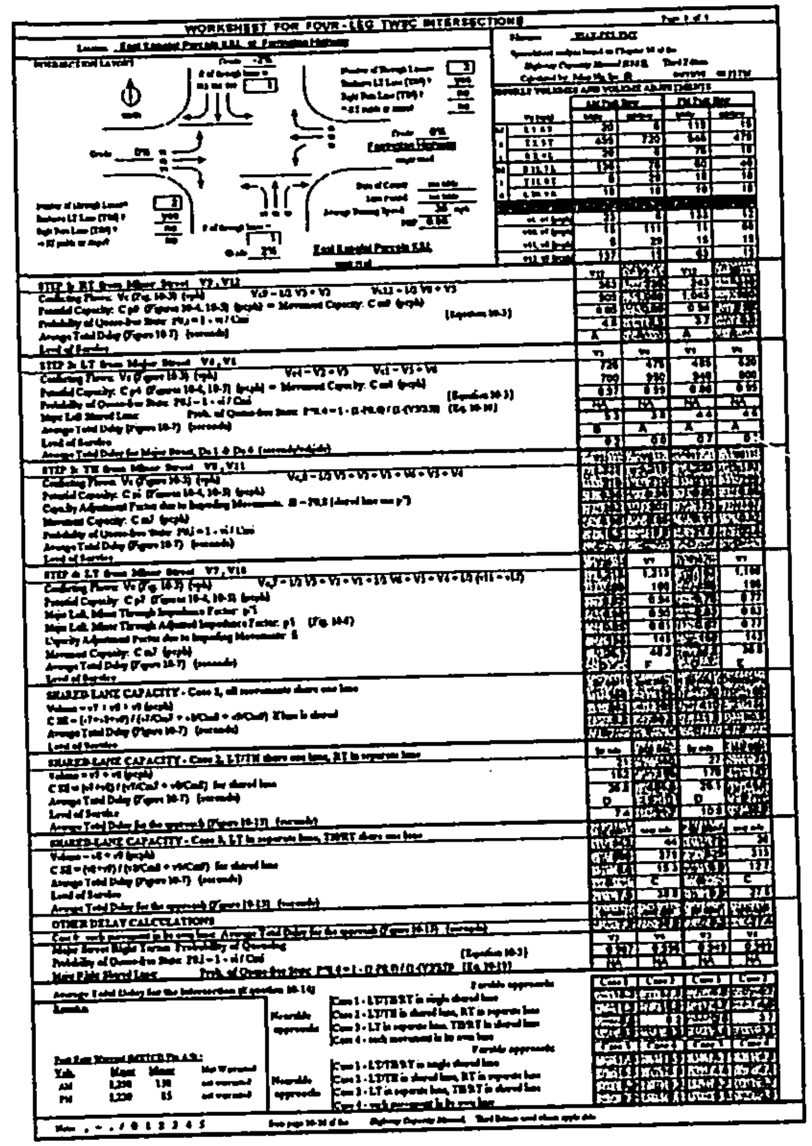
APPENDIX - LEVELS OF SERVICE

A qualitative measure used by traffic engineers to describe traffic operational conditions is the level of service (LOS). Six levels have been defined, from LOS A (best operating condition) to LOS F (worst). The *Highway Capacity Manual* describes analysis procedures for different types of facilities. For uninterrupted flow facilities such as freeways, other divided highways, and two-lane rural highways, factors such as speed and travel time, freedom to maneuver, comfort and safety, and continuity of flow are used to determine levels of service.

Levels of service for signalized intersections and for the controlled movements at unsignalized intersections are based on average delays, which in turn are based on volumes and capacities. For signalized intersections, a planning analysis in which signal timing and capacities are estimated determine these delays for each lane group of each approach. For unsignalized intersections, the procedures from the *Highway Capacity Manual - Third Edition* were used to calculate delays. Criteria for levels of service are:

LOS	General Description of Estimated Delay	Average Delay at Signalized Intersection	Average Delay at Unsignalized Intersection
A	Little or no delay	(≤5 seconds)	(≤5 seconds)
B	Short traffic delays	(>5 and ≤15 seconds)	(>5 and ≤10 seconds)
C	Average traffic delays	(>15 and ≤25 seconds)	(>10 and ≤20 seconds)
D	Long traffic delays	(>25 and ≤40 seconds)	(>20 and ≤30 seconds)
E	Very long traffic delays	(>40 and ≤60 seconds)	(>30 and ≤45 seconds)
F	Very long traffic delays	(>60 seconds)	(>45 seconds)

Reference: Transportation Research Board, National Research Council, *Highway Capacity Manual - Third Edition, Updated 1994*, Special Report 209, Washington, D.C., 1994


WORKSHEET FOR FOUR-LEG TWSC INTERSECTIONS

Planning Analysis (94 HCM) file: HCM3-AB1.FMT.A3=2 printed 05:37 PM 04/13/98 by: Julian Ng, Incorporated page 1 of 1

Intersection of: Farrington Highway and Road serving Parcels A & B — Case: PM Peak Hour (LOS A)
Condition: PM Peak Hour (2020) — Critical Movement Analysis: 789 (under capacity), Xcm = 0.56

A. Volumes, Geometry, and Timing
(PHF= 0.91, T = 3.0%)

	Eastbound left turn	Eastbound through	Eastbound right turn	Westbound left turn	Westbound through	Westbound right turn	Southbound left turn	Southbound through	Southbound right turn	Northbound left turn	Northbound through	Northbound right turn
Volume (vph)	130	395	55	100	320	155	100	60	70	155	40	55
Arrival type (1-6) (3=random)	3	3	3	3	3	3	3	3	3	3	3	3
Initial laneage	1	1	0	1	1	0	1	1	0	1	1	0
Additional lanes (ultimate)			1			1		0			0	
Lanes provided *	1	1	1	1	1	1	1	1	0	1	1	0
Signal Timing												
C =100 seconds	3.5 seconds yellow			1.0 second all-red								
Green Time (seconds)												
Phase 1	15											
Phase 2					38	38						
Phase 3							16					
Phase 4											13	13
Phase 5				11								
Phase 6		42	42									
Phase 7			0							16		
Phase 8								13	13			

Major= 1,155 Minor= 250 warranted by: MUTCD Figure 4-5, 2&1 curve

Capacity Analysis and Level of Service Module

1 (1)	2	3	4	5	6 (3)	7 (6)	8 (2)	9	(4)	(5)	(7)	(8)	(9)	(10)	(11)	(12)
Lane Group Movements	Phase Type	Adj. Flow rate	Adj. Sat. Flow Rate	Flow ratio v/s	Green ratio g/C	Lane Gr. Capacity	Lane Gr v/c ratio	Critical Lane Gr	First Term Delay sec/veh	First Term Delay DF	Second Term Delay m	Second Term Delay sec/veh	Lane Group sec/veh	Lane Group LOS	Approach sec/veh	Approach LOS
EB LT	T	146	1,650	0.090	0.150	248	0.60		30.2	0.85	16	2.8	28.5	D		
EB TH	T	395	1,650	0.239	0.420	693	0.57	**********	16.8	0.85	16	0.8	15.1	C	18.0	C
EB RT	T	63	1,650	0.038	0.420	693	0.09		13.3	0.85	16	0.0	11.3	B		
WB LT	T	114	1,650	0.069	0.110	182	0.63	**********	32.3	0.85	16	4.6	32.1	D		
WB TH	T	320	1,650	0.194	0.380	627	0.51		18.1	0.85	16	0.6	16.0	C	18.4	C
WB RT	T	176	1,650	0.107	0.380	627	0.28		16.4	0.85	16	0.1	14.0	B		
SB LT	T	114	1,650	0.069	0.160	264	0.43		28.8	0.85	16	0.7	25.2	D		
SB TH	T	140	1,650	0.085	0.130	215	0.65	**********	31.4	0.85	16	4.7	31.4	D	28.6	D
NB LT	T	176	1,650	0.107	0.160	264	0.67	**********	30.0	0.85	16	4.4	29.9	D		
NB TH	T	103	1,650	0.062	0.130	215	0.48		30.7	0.85	16	1.3	27.4	D	29.0	D

Cycle length, C = 100 seconds, Lost time per cycle =18.0 seconds Y = Sum (v/s)d = 0.500 Xc =Y * C / (C-L)= 0.610 Overall intersection: 21.4 C

Planning Analysis (94 HCM) file: HCM3-AB1.FMT.A3=1 printed 05:38 PM 04/13/98 by: Julian Ng, Incorporated page 1 of 1

Intersection of: Farrington Highway and Road serving Parcels A & B — Case: AM Peak Hour (LOS A)
Condition: AM Peak Hour (2020) — Critical Movement Analysis: 835 (under capacity), Xcm = 0.60

A. Volumes, Geometry, and Timing
(PHF= 0.91, T = 3.0%)

	Eastbound left turn	Eastbound through	Eastbound right turn	Westbound left turn	Westbound through	Westbound right turn	Southbound left turn	Southbound through	Southbound right turn	Northbound left turn	Northbound through	Northbound right turn
Volume (vph)	45	210	55	70	505	40	85	170	65	50	35	90
Arrival type (1-6) (3=random)	3	3	3	3	3	3	3	3	3	3	3	3
Initial laneage	1	1	0	1	1	0	1	1	0	1	1	0
Additional lanes (ultimate)			1			1		0			0	
Lanes provided *	1	1	1	1	1	1	1	1	0	1	1	0
Signal Timing												
C =100 seconds	3.5 seconds yellow			1.0 second all-red								
Green Time (seconds)												
Phase 1	5											
Phase 2					48	48						
Phase 3							12					
Phase 4											17	17
Phase 5				10								
Phase 6		43	43									
Phase 7			0							6		
Phase 8								23	23			

Major= 925 Minor= 320 warranted by: MUTCD Figure 4-5, 2&1 curve

Capacity Analysis and Level of Service Module

1 (1)	2	3	4	5	6 (3)	7 (6)	8 (2)	9	(4)	(5)	(7)	(8)	(9)	(10)	(11)	(12)
Lane Group Movements	Phase Type	Adj. Flow rate	Adj. Sat. Flow Rate	Flow ratio v/s	Green ratio g/C	Lane Gr. Capacity	Lane Gr. v/c ratio	Critical Lane Gr	First Term Delay sec/veh	First Term Delay DF	Second Term Delay m	Second Term Delay sec/veh	Lane Group sec/veh	Lane Group LOS	Approach sec/veh	Approach LOS
EB LT	T	51	1,650	0.031	0.050	83	0.62	**********	35.4	0.85	16	9.0	39.1	D		
EB TH	T	210	1,650	0.127	0.430	710	0.30		14.1	0.85	16	0.1	12.1	B	16.1	C
EB RT	T	63	1,650	0.038	0.430	710	0.09		12.8	0.85	16	0.0	10.9	B		
WB LT	T	80	1,650	0.048	0.100	165	0.48		32.3	0.85	16	1.8	29.3	D		
WB TH	T	505	1,650	0.306	0.480	792	0.64	**********	14.8	0.85	16	1.2	13.8	B	15.4	C
WB RT	T	48	1,650	0.029	0.480	792	0.06		10.6	0.85	16	0.0	9.0	B		
SB LT	T	97	1,650	0.059	0.120	198	0.49		31.3	0.85	16	1.5	28.1	D		
SB TH	T	244	1,650	0.148	0.230	380	0.64	**********	26.4	0.85	16	2.6	25.0	D	25.9	D
NB LT	T	57	1,650	0.034	0.060	99	0.57	**********	34.8	0.85	16	5.6	35.2	D		
NB TH	T	137	1,650	0.083	0.170	281	0.49		28.6	0.85	16	1.1	25.4	D	28.3	D

Cycle length, C = 100 seconds, Lost time per cycle =18.0 seconds Y = Sum (v/s)d = 0.519 Xc =Y * C / (C-L)= 0.634 Overall intersection: 19.6 C

Planning Analysis (94 HCM) file: HCM3-BK1.FMT.A3=2 printed 03:39 PM 04/19/98 by: Julian Ng, Incorporated page 1 of 1

Intersection of: **East Kapolei Avenue and North-South Road**
Condition: **PM Peak Hour (2020)**

Case: PM Peak Hour (LOS D)
Critical Movement Analysis: 1,145 (under capacity), Xcm = 0.82

A. Volumes, Geometry, and Timing
(PHF= 0.91, T = 3.0%)

	Eastbound left turn	Eastbound through	Eastbound right turn	Westbound left turn	Westbound through	Westbound right turn	Southbound left turn	Southbound through	Southbound right turn	Northbound left turn	Northbound through	Northbound right turn
Volume (vph)	205	0	225	0	0	0	0	1,020	460	430	585	0
Arrival type (1-6) (3=random)	3	3	3	3	3	3	3	3	3	3	3	3
Initial laneage	1	1	1	1	1	0	1	2	0	1	2	0
Additional lanes (ultimate)			0			0			1			
Lanes provided *	1	1	1	1	1	0	1	2	1	1	2	0
Signal Timing												
C = 100 seconds	3.5 seconds yellow			1.0 second all-red								
Green Time (seconds)												
Phase 1	18											
Phase 2					(9)	(9)						
Phase 3												
Phase 4							0					
Phase 5				(9)							73	73
Phase 6		18	18									
Phase 7			32									
Phase 8								37	37	32		

Major= 2,495 Minor= 205 warranted by: MUTCD Figure 4-5, 2&1 curve

Capacity Analysis and Level of Service Module

1 (1) Lane Group Movements	2 Phase Type	3 Adj. Flow rate	4 Adj. Sat. Flow Rate	5 Flow ratio v/s	6 (3) Green ratio g/C	7 (6) Lane Gr. Capacity	8 (2) Lane Gr. v/c ratio	9 Critical Lane Gr	(4) First Term Delay sec/veh	(5) First Term Delay DF	(7) Second Term Delay m	(8) Second Term Delay sec/veh	(9) Lane Group sec/veh	(10) Lane Group LOS	(11) Approach sec/veh	(12) Approach LOS
EB LT	T	233	1,650	0.141	0.180	297	0.79		29.8	0.85	16	8.8	34.1	D		
EB TH	T	0	1,650	0.000	0.180	297	0.00									
EB RT	T	256	1,650	0.155	0.500	825	0.31	********	11.2	0.85	16	0.1	9.6	B	21.3	C
SB TH	T	1,020	3,300	0.309	0.365	1,205	0.85		22.2	0.85	16	4.1	23.0	C		
SB RT	T	524	1,650	0.317	0.365	602	0.87	********	22.4	0.85	16	9.1	28.1	D	24.7	C
NB LT	T	490	1,650	0.297	0.320	528	0.93	********	25.0	0.85	16	16.3	37.6	D		
NB TH	T	585	3,300	0.177	0.730	2,409	0.24		3.4	0.85	16	0.0	2.9	A	18.7	C

Cycle length, C = 100 seconds, Lost time per cycle = 18.0 seconds Y = Sum (v/s)d = 0.789 Xc = Y * C / (C-L) = 0.938 Overall Intersection: **22.1 C**

Planning Analysis (94 HCM) file: HCM3-BK1.FMT.A3=1 printed 03:38 PM 04/19/98 by: Julian Ng, Incorporated page 1 of 1

Intersection of: **East Kapolei Avenue and North-South Road**
Condition: **AM Peak Hour (2020)**

Case: AM Peak Hour (LOS D)
Critical Movement Analysis: 1,210 (NEAR capacity), Xcm = 0.86

A. Volumes, Geometry, and Timing
(PHF= 0.91, T = 3.0%)

	Eastbound left turn	Eastbound through	Eastbound right turn	Westbound left turn	Westbound through	Westbound right turn	Southbound left turn	Southbound through	Southbound right turn	Northbound left turn	Northbound through	Northbound right turn
Volume (vph)	465	0	370	0	0	0	0	455	65	170	1,490	0
Arrival type (1-6) (3=random)	3	3	3	3	3	3	3	3	3	3	3	3
Initial laneage	1	1	1	1	1	0	1	2	0	1	2	0
Additional lanes (ultimate)			0			0			1			
Lanes provided *	1	1	1	1	1	0	1	2	1	1	2	0
Signal Timing												
C = 100 seconds	3.5 seconds yellow			1.0 second all-red								
Green Time (seconds)												
Phase 1	37											
Phase 2					(9)	(9)						
Phase 3												
Phase 4							0					
Phase 5				(9)							54	54
Phase 6		37	37									
Phase 7			19									
Phase 8								31	31	19		

Major= 2,180 Minor= 465 warranted by: MUTCD Figure 4-5, 2&1 curve

Capacity Analysis and Level of Service Module

1 (1) Lane Group Movements	2 Phase Type	3 Adj. Flow rate	4 Adj. Sat. Flow Rate	5 Flow ratio v/s	6 (3) Green ratio g/C	7 (6) Lane Gr. Capacity	8 (2) Lane Gr. v/c ratio	9 Critical Lane Gr	(4) First Term Delay sec/veh	(5) First Term Delay DF	(7) Second Term Delay m	(8) Second Term Delay sec/veh	(9) Lane Group sec/veh	(10) Lane Group LOS	(11) Approach sec/veh	(12) Approach LOS
EB LT	T	525	1,650	0.321	0.370	611	0.87	********	22.2	0.85	16	8.9	27.8	D		
EB TH	T	0	1,650	0.000	0.370	611	0.00									
EB RT	T	421	1,650	0.255	0.560	924	0.48		9.9	0.85	16	0.3	8.7	B	19.3	C
SB TH	T	455	3,300	0.138	0.305	1,007	0.45		21.3	0.85	16	0.2	18.3	C		
SB RT	T	74	1,650	0.045	0.305	503	0.15		19.2	0.85	16	0.0	16.3	C	18.0	C
NB LT	T	194	1,650	0.117	0.190	314	0.62		28.2	0.85	16	2.6	26.6	D		
NB TH	T	1,490	3,300	0.452	0.540	1,782	0.84	********	14.7	0.85	16	2.6	15.1	C	16.4	C

Cycle length, C = 100 seconds, Lost time per cycle = 18.0 seconds Y = Sum (v/s)d = 0.772 Xc = Y * C / (C-L) = 0.942 Overall Intersection: **17.6 C**

Planning Analysis (94 HCM) file: HCM3-BC1.FMT.A3=2 printed 08:40 PM 04/15/98 by: Julian Ng, Incorporated page 1 of 1

Intersection of: **East-West Road and Road Serving Parcels B & C** Case: **PM Peak Hour** (LOS A)
Condition: **PM Peak Hour (2020)** Critical Movement Analysis: **748 (under capacity), Xcm = 0.53**

A. Volumes, Geometry, and Timing
(PHF= 0.91, T = 3.0%)

	Eastbound left turn	Eastbound through	Eastbound right turn	Westbound left turn	Westbound through	Westbound right turn	Southbound left turn	Southbound through	Southbound right turn	Northbound left turn	Northbound through	Northbound right turn
Volume (vph)	205	730	195	35	490	155	180	55	215	95	40	35
Arrival type (1-6) (3=random)	3	3	3	3	3	3	3	3	3	3	3	3
Initial laneage	1	2	0	1	2	0	1	1	1	1	1	1
Additional lanes (ultimate)			0			0		0			0	
Lanes provided *	1	2	0	1	2	0	1	1	1	1	1	1
Signal Timing												
C =100 seconds	3.5 seconds yellow			1.0 second all-red								
Green Time (seconds)												
Phase 1	23											
Phase 2					37	37			23			
Phase 3						17	17					
Phase 4												
Phase 5				5							5	5
Phase 6		55	55									5
Phase 7			12									
Phase 8								10	10	12		

Major= 1,810 Minor= 235 warranted by: MUTCD Figure 4-5, 2&1 curve

Capacity Analysis and Level of Service Module

1 (1) Lane Group Movements	2 Phase Type	3 Adj. Flow rate	4 Adj. Sat. Flow Rate	5 Flow ratio v/s	6 (3) Green ratio g/C	7 (6) Lane Gr. Capacity	8 (2) Lane Gr. v/c ratio	9 Critical Lane Gr	(4) First Term Delay sec/veh	(5) First Term Delay DF	(7) Second Term Delay m	(8) Second Term Delay sec/veh	(9) Lane Group sec/veh	(10) Lane Group LOS	(11) Approach sec/veh	(12) Approach LOS
EB LT	T	233	1,650	0.141	0.230	380	0.61	********	26.2	0.85	16	2.1	24.4	C		
EB TH	T	952	3,300	0.288	0.550	1,815	0.52		10.8	0.85	16	0.2	9.4	B	12.4	B
WB LT	T	40	1,650	0.024	0.050	83	0.48		35.1	0.85	16	3.4	33.2	D		
WB TH	T	668	3,300	0.202	0.370	1,221	0.55	********	18.9	0.85	16	0.4	16.5	C	17.4	C
SB LT	T	205	1,650	0.124	0.170	281	0.73		29.9	0.85	16	6.3	31.7	D		
SB TH	T	55	1,650	0.033	0.100	165	0.33		31.8	0.85	16	0.5	27.5	D		
SB RT	T	245	1,650	0.148	0.330	545	0.45	********	20.0	0.85	16	0.4	17.4	C	24.3	C
NB LT	T	108	1,650	0.066	0.120	198	0.55	********	31.5	0.85	16	2.4	29.2	D		
NB TH	T	40	1,650	0.024	0.050	83	0.48		35.1	0.85	16	3.4	33.2	D		
NB RT	T	40	1,650	0.024	0.100	165	0.24		31.5	0.85	16	0.2	27.0	D	29.6	D

Cycle length, C = 100 seconds, Lost time per cycle =18.0 seconds Y = Sum (v/s)ci = 0.557 Xc =Y * C / (C-L) = 0.680 Overall Intersection: **17.3 C**

Planning Analysis (94 HCM) file: HCM3-BC1.FMT.A3=1 printed 08:40 PM 04/15/98 by: Julian Ng, Incorporated page 1 of 1

Intersection of: **East-West Road and Road Serving Parcels B & C** Case: **AM Peak Hour** (LOS A)
Condition: **AM Peak Hour (2020)** Critical Movement Analysis: **783 (under capacity), Xcm = 0.56**

A. Volumes, Geometry, and Timing
(PHF= 0.91, T = 3.0%)

	Eastbound left turn	Eastbound through	Eastbound right turn	Westbound left turn	Westbound through	Westbound right turn	Southbound left turn	Southbound through	Southbound right turn	Northbound left turn	Northbound through	Northbound right turn
Volume (vph)	115	240	145	105	635	140	200	40	240	240	70	50
Arrival type (1-6) (3=random)	3	3	3	3	3	3	3	3	3	3	3	3
Initial laneage	1	2	0	1	2	0	1	1	1	1	1	1
Additional lanes (ultimate)			0			0		0			0	
Lanes provided *	1	2	0	1	2	0	1	1	1	1	1	1
Signal Timing												
C =100 seconds	3.5 seconds yellow			1.0 second all-red								
Green Time (seconds)												
Phase 1	16											
Phase 2					35	35			16			
Phase 3						23	23					
Phase 4												
Phase 5				14							8	8
Phase 6		37	37									14
Phase 7			23									
Phase 8								8	8	23		

Major= 1,380 Minor= 310 warranted by: MUTCD Figure 4-5, 2&1 curve

Capacity Analysis and Level of Service Module

1 (1) Lane Group Movements	2 Phase Type	3 Adj. Flow rate	4 Adj. Sat. Flow Rate	5 Flow ratio v/s	6 (3) Green ratio g/C	7 (6) Lane Gr. Capacity	8 (2) Lane Gr. v/c ratio	9 Critical Lane Gr	(4) First Term Delay sec/veh	(5) First Term Delay DF	(7) Second Term Delay m	(8) Second Term Delay sec/veh	(9) Lane Group sec/veh	(10) Lane Group LOS	(11) Approach sec/veh	(12) Approach LOS
EB LT	T	131	1,650	0.079	0.160	264	0.50	********	29.1	0.85	16	1.2	25.9	D		
EB TH	T	405	3,300	0.123	0.370	1,221	0.33		17.2	0.85	16	0.1	14.7	B	17.4	C
WB LT	T	120	1,650	0.072	0.140	231	0.52		30.3	0.85	16	1.7	27.5	D		
WB TH	T	794	3,300	0.241	0.350	1,155	0.69	********	21.1	0.85	16	1.2	19.1	C	20.2	C
SB LT	T	228	1,650	0.138	0.230	380	0.60		26.1	0.85	16	1.9	24.1	C		
SB TH	T	40	1,650	0.024	0.080	132	0.30		33.0	0.85	16	0.4	28.5	D		
SB RT	T	273	1,650	0.165	0.240	396	0.69	********	26.3	0.85	16	3.5	25.9	D	25.3	D
NB LT	T	273	1,650	0.165	0.230	380	0.72	********	27.0	0.85	16	4.5	27.5	D		
NB TH	T	70	1,650	0.042	0.080	132	0.53		33.6	0.85	16	3.1	31.7	D		
NB RT	T	57	1,650	0.034	0.220	363	0.16		23.9	0.85	16	0.0	20.3	C	27.2	D

Cycle length, C = 100 seconds, Lost time per cycle =18.0 seconds Y = Sum (v/s)ci = 0.651 Xc =Y * C / (C-L) = 0.794 Overall Intersection: **21.9 C**

Planning Analysis (94 HCM) file: HCM3-BC2.FMT.A3=2 print: 08 41 PM 04/19/98 by: Julian Ng, Incorporated page 1 of 1

Intersection of: **East-West Road and Road Serving Parcel C** Case: **PM Peak Hour** (LOS A)
Condition: **PM Peak Hour (2020)** Critical Movement Analysis: 815 (under capacity), Xcm = 0.58

A. Volumes, Geometry, and Timing
(PHF= 0.91, T = 3.0%)

	Eastbound left turn	Eastbound through	Eastbound right turn	Westbound left turn	Westbound through	Westbound right turn	Southbound left turn	Southbound through	Southbound right turn	Northbound left turn	Northbound through	Northbound right turn
Volume (vph)	0	810	330	70	405	0	0	0	0	275	0	70
Arrival type (1-6) (3=random)	3	3	3	3	3	3	3	3	3	3	3	3
Initial laneage	1	2	0	1	2	0	1	1	1	1	1	1
Additional lanes (ultimate)			0			0		0			0	
Lanes provided *	1	2	0	1	2	0	1	1	1	1	1	1
Signal Timing												
C =100 seconds	3.5 seconds yellow			1.0 second all-red								
Green Time (seconds)												
Phase 1	0.0	0.0	0.0									
Phase 2					65.5	65.5						
Phase 3							0.0					
Phase 4										25.5	25.5	25.5
Phase 5				8.0								
Phase 6	53.0	53.0	53.0									
Phase 7										0.0		
Phase 8								0.0	0.0			

Major= 1,415 Minor= 275 warranted by: MUTCD Figure 4-5, 2&1 curve

Capacity Analysis and Level of Service Module

1 (1) Lane Group Movements	2 Phase Type	3 Adj. Flow rate	4 Adj. Sat. Flow Rate	5 Flow ratio v/s	6 (3) Green ratio g/C	7 (6) Lane Gr. Capacity	8 (2) Lane Gr v/c ratio	9 Critical Lane Gr	(4) First Term Delay sec/veh	(5) First Term Delay DF	(7) Second Term Delay m	(8) Second Term Delay sec/veh	(9) Lane Group sec/veh	(10) Lane Group LOS	(11) Approach sec/veh	(12) Approach LOS
EB TH	T	986	3,300	0.299	0.530	1,749	0.56	**********	12.0	0.85	16	0.3	10.5	B	10.5	B
WB LT	T	80	1,650	0.048	0.080	132	0.60	**********	33.8	0.85	16	5.3	34.0	D		
WB TH	T	405	3,300	0.123	0.655	2,162	0.19		5.2	0.85	16	0.0	4.4	A	9.3	B
NB LT	T	313	1,650	0.190	0.255	421	0.74	**********	26.0	0.85	16	4.8	26.9	D		
NB TH	T	0	1,650	0.000	0.255	421	0.00								25.3	D
NB RT	T	80	1,650	0.048	0.255	421	0.19		22.2	0.85	16	0.0	18.9	C		

Cycle length, C = 100 seconds, Lost time per cycle =9.0 seconds Y = Sum (v/s)d = 0.537 Xc =Y * C / (C-L) = 0.590 Overall intersection: 13.3 B

Planning Analysis (94 HCM) file: HCM3-BC2.FMT.A3=1 print: 08 41 PM 04/19/98 by: Julian Ng, Incorporated page 1 of 1

Intersection of: **East-West Road and Road Serving Parcel C** Case: **AM Peak Hour** (LOS C)
Condition: **AM Peak Hour (2020)** Critical Movement Analysis: 1,075 (under capacity), Xcm = 0.77

A. Volumes, Geometry, and Timing
(PHF= 0.91, T = 3.0%)

	Eastbound left turn	Eastbound through	Eastbound right turn	Westbound left turn	Westbound through	Westbound right turn	Southbound left turn	Southbound through	Southbound right turn	Northbound left turn	Northbound through	Northbound right turn
Volume (vph)	0	240	250	210	260	0	0	0	0	620	0	105
Arrival type (1-6) (3=random)	3	3	3	3	3	3	3	3	3	3	3	3
Initial laneage	1	2	0	1	2	0	1	1	1	1	1	1
Additional lanes (ultimate)			0			0		0			0	
Lanes provided *	1	2	0	1	2	0	1	1	1	1	1	1
Signal Timing												
C =100 seconds	3.5 seconds yellow			1.0 second all-red								
Green Time (seconds)												
Phase 1	0.0	0.0	0.0									
Phase 2					42.5	42.5						
Phase 3							0.0					
Phase 4										48.5	48.5	48.5
Phase 5				18.0								
Phase 6	20.0	20.0	20.0									
Phase 7										0.0		
Phase 8								0.0	0.0			

Major= 960 Minor= 620 warranted by: MUTCD Figure 4-5, 2&1 curve

Capacity Analysis and Level of Service Module

1 (1) Lane Group Movements	2 Phase Type	3 Adj. Flow rate	4 Adj. Sat. Flow Rate	5 Flow ratio v/s	6 (3) Green ratio g/C	7 (6) Lane Gr. Capacity	8 (2) Lane Gr. v/c ratio	9 Critical Lane Gr.	(4) First Term Delay sec/veh	(5) First Term Delay DF	(7) Second Term Delay m	(8) Second Term Delay sec/veh	(9) Lane Group sec/veh	(10) Lane Group LOS	(11) Approach sec/veh	(12) Approach LOS
EB TH	T	525	3,300	0.159	0.200	660	0.79	**********	28.9	0.85	16	4.7	29.3	D	29.3	D
WB LT	T	239	1,650	0.145	0.180	297	0.80	**********	29.9	0.85	16	10.1	35.5	D		
WB TH	T	260	3,300	0.079	0.425	1,403	0.19		13.6	0.85	16	0.0	11.6	B	23.0	C
NB LT	T	706	1,650	0.428	0.485	800	0.88	**********	17.6	0.85	16	8.0	23.0	C		
NB TH	T	0	1,650	0.000	0.485	800	0.00								21.0	C
NB RT	T	120	1,650	0.072	0.485	800	0.15		10.9	0.85	16	0.0	9.3	B		

Cycle length, C = 100 seconds, Lost time per cycle =9.0 seconds Y = Sum (v/s)d = 0.732 Xc =Y * C / (C-L) = 0.804 Overall intersection: 23.9 C

Planning Analysis (94 HCM) file: HCM3-IJ1.FMT.A3=2 printed 08:43 PM 04/19/98 by: Julian Ng, Incorporated page 1 of 1

Intersection of: **East-West Road and First Road: Parcels I and J** Case: **PM Peak Hour** (LOS B)

Condition: **PM Peak Hour (2020)** Critical Movement Analysis: 945 (under capacity), Xcm = 0.68

A. Volumes, Geometry, and Timing (PHF= 0.91, T = 3.0%)

	Eastbound left turn	Eastbound through	Eastbound right turn	Westbound left turn	Westbound through	Westbound right turn	Southbound left turn	Southbound through	Southbound right turn	Northbound left turn	Northbound through	Northbound right turn
Volume (vph)	275	725	330	95	715	95	65	25	245	240	25	65
Arrival type (1-6) (3=random)	3	3	3	3	3	3	3	3	3	3	3	3
Initial laneage	1	2	0	1	2	0	1	1	1	1	1	1
Additional lanes (ultimate)			0			0		0			0	
Lanes provided *	1	2	0	1	2	0	1	1	1	1	1	1

Signal Timing

C =100 seconds 3.5 seconds yellow 1.0 second all-red

Green Time (seconds)	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	SB LT	SB TH	SB RT	NB LT	NB TH	NB RT
Phase 1	25								25			
Phase 2					31	31						
Phase 3						14	14				12	12
Phase 4												10
Phase 5				10								
Phase 6		46	46							23		
Phase 7			23					3	3			
Phase 8												

Major= 2,235 Minor= 265 warranted by: MUTCD Figure 4-5, 2&1 curve

Capacity Analysis and Level of Service Module

1 (1) Lane Group Movements	2 Phase Type	3 Adj. Flow rate	4 Adj. Sat. Flow Rate	5 Flow ratio v/s	6 (3) Green ratio g/C	7 (6) Lane Gr. Capacity	8 (2) Lane Gr v/c ratio	9 Critical Lane Gr	(4) First Term Delay sec/veh	(5) DF	(7) Second Term Delay m	(8) sec/veh	(9) Lane Group sec/veh	(10) LOS	(11) Approach sec/veh	(12) LOS
EB LT	T	313	1,650	0.190	0.250	413	0.76	*****	28.4	0.85	16	5.5	27.9	D	18.1	C
EB TH	T	1,101	3,300	0.334	0.460	1,518	0.73		16.6	0.85	16	1.2	15.3	C		
WB LT	T	108	1,650	0.066	0.100	165	0.66		32.9	0.85	16	6.1	34.1	D	25.1	D
WB TH	T	823	3,300	0.249	0.310	1,023	0.80	*****	24.1	0.85	16	3.4	23.9	C		
SB LT	T	74	1,650	0.045	0.140	231	0.32		29.4	0.85	16	0.3	25.3	D	23.4	C
SB TH	T	25	1,650	0.015	0.030	50	0.51		38.3	0.85	16	6.4	37.3	D		
SB RT	T	279	1,650	0.169	0.280	462	0.60	*****	23.7	0.85	16	1.6	21.7	C		
NB LT	T	273	1,650	0.165	0.230	380	0.72	*****	27.0	0.85	16	4.5	27.5	D	26.0	D
NB TH	T	25	1,650	0.015	0.120	198	0.13		29.9	0.85	16	0.0	25.4	D		
NB RT	T	74	1,650	0.045	0.220	363	0.20		24.2	0.85	16	0.0	20.6	C		

Cycle length, C = 100 seconds, Lost time per cycle =18.0 seconds Y = Sum (V/s)d = 0.774 Xc =Y * C / (C-L) = 0.944 Overall Intersection: 21.8 C

Planning Analysis (94 HCM) file: HCM3-IJ1.FMT.A3=1 printed 08:43 PM 04/19/98 by: Julian Ng, Incorporated page 1 of 1

Intersection of: **East-West Road and First Road: Parcels I and J** Case: **AM Peak Hour** (LOS B)

Condition: **AM Peak Hour (2020)** Critical Movement Analysis: 853 (under capacity), Xcm = 0.61

A. Volumes, Geometry, and Timing (PHF= 0.91, T = 3.0%)

	Eastbound left turn	Eastbound through	Eastbound right turn	Westbound left turn	Westbound through	Westbound right turn	Southbound left turn	Southbound through	Southbound right turn	Northbound left turn	Northbound through	Northbound right turn
Volume (vph)	190	690	135	50	595	50	125	20	315	320	20	130
Arrival type (1-6) (3=random)	3	3	3	3	3	3	3	3	3	3	3	3
Initial laneage	1	2	0	1	2	0	1	1	1	1	1	1
Additional lanes (ultimate)			0			0		0			0	
Lanes provided *	1	2	0	1	2	0	1	1	1	1	1	1

Signal Timing

C =100 seconds 3.5 seconds yellow 1.0 second all-red

Green Time (seconds)	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	SB LT	SB TH	SB RT	NB LT	NB TH	NB RT
Phase 1	21								21			
Phase 2					27	27						
Phase 3						19	19				15	15
Phase 4												6
Phase 5				6								
Phase 6		42	42							28		
Phase 7			28					6	6			
Phase 8												

Major= 1,710 Minor= 340 warranted by MUTCD Figure 4-5, 2&1 curve

Capacity Analysis and Level of Service Module

1 (1) Lane Group Movements	2 Phase Type	3 Adj. Flow rate	4 Adj. Sat. Flow Rate	5 Flow ratio v/s	6 (3) Green ratio g/C	7 (6) Lane Gr. Capacity	8 (2) Lane Gr. v/c ratio	9 Critical Lane Gr	(4) First Term Delay sec/veh	(5) DF	(7) Second Term Delay m	(8) sec/veh	(9) Lane Group sec/veh	(10) LOS	(11) Approach sec/veh	(12) LOS
EB LT	T	216	1,650	0.131	0.210	347	0.62	*****	27.3	0.85	16	2.5	25.7	D	17.3	C
EB TH	T	844	3,300	0.256	0.420	1,386	0.61		17.2	0.85	16	0.6	15.2	C		
WB LT	T	57	1,650	0.034	0.060	99	0.57		34.8	0.85	16	5.6	35.2	D	24.5	C
WB TH	T	652	3,300	0.198	0.270	891	0.73	*****	25.2	0.85	16	2.2	23.6	C		
SB LT	T	142	1,650	0.086	0.190	314	0.45		27.3	0.85	16	0.7	23.9	C	27.7	D
SB TH	T	20	1,650	0.012	0.060	99	0.20		34.0	0.85	16	0.1	29.0	D		
SB RT	T	359	1,650	0.217	0.270	446	0.80	*****	25.9	0.85	16	7.1	29.1	D		
NB LT	T	364	1,650	0.221	0.280	462	0.79	*****	25.3	0.85	16	6.1	27.6	D	26.1	D
NB TH	T	20	1,650	0.012	0.150	248	0.08		27.8	0.85	16	0.0	23.6	C		
NB RT	T	148	1,650	0.090	0.210	347	0.43		26.1	0.85	16	0.5	22.7	C		

Cycle length, C = 100 seconds, Lost time per cycle =18.0 seconds Y = Sum (v/s)d = 0.787 Xc =Y * C / (C-L) = 0.935 Overall Intersection: 22.7 C

Planning Analysis (94 HCM) file: HCM3-U2.FMT.A3=2 printed 02:44 PM 04/19/98 by: Julian Ng, Incorporated page 1 of 1

Intersection of: **East-West Road and Second Road: Parcels I and J** Case: **PM Peak Hour** (LOS A)

Condition: **PM Peak Hour (2020)** Critical Movement Analysis: **678 (under capacity), Xcm = 0.48**

A. Volumes, Geometry, and Timing
(PHF= 0.91, T = 3.0%)

	Eastbound left turn	Eastbound through	Eastbound right turn	Westbound left turn	Westbound through	Westbound right turn	Southbound left turn	Southbound through	Southbound right turn	Northbound left turn	Northbound through	Northbound right turn
Volume (vph)	185	450	220	65	565	50	45	25	165	160	25	40
Arrival type (1-6) (3=random)	3	3	3	3	3	3	3	3	3	3	3	3
Initial laneage	1	2	0	1	2	0	1	1	1	1	1	1
Additional lanes (ultimate)			0			0		0			0	
Lanes provided *	1	2	0	1	2	0	1	1	1	1	1	1
Signal Timing												
C = 100 seconds	3.5 seconds yellow			1.0 second all-red								
Green Time (seconds)												
Phase 1	22								22			
Phase 2					34	34						
Phase 3						13	13					
Phase 4											13	13
Phase 5				8								8
Phase 6		48	48									
Phase 7			22							22		
Phase 8								4	4			

Major= 1,535 Minor= 185 warranted by: MUTCD Figure 4-5, 2&1 curve

Capacity Analysis and Level of Service Module

1 (1)	2	3	4	5	6 (3)	7 (6)	8 (2)	9	(4)	(5)	(7)	(8)	(9)	(10)	(11)	(12)
Lane Group	Phase	Adj. Flow	Adj. Sat.	Flow ratio	Green	Lane Gr.	Lane Gr.	Critical	First Term Delay		Second Term Delay		Lane Group		Approach	
Movements	Type	rate	Flow Rate	v/s	ratio g/C	Capacity	v/c ratio	Lane Gr.	sec/veh	DF	m	sec/veh	sec/veh	LOS	sec/veh	LOS
EB LT	T	211	1,650	0.128	0.220	363	0.58	**********	26.5	0.85	16	1.7	24.2	C		
EB TH	T	700	3,300	0.212	0.480	1,584	0.44		13.0	0.85	16	0.1	11.2	B	14.2	B
WB LT	T	74	1,650	0.045	0.060	132	0.56		33.7	0.85	16	3.9	32.5	D		
WB TH	T	622	3,300	0.188	0.340	1,122	0.55	**********	20.4	0.85	16	0.5	17.8	C	19.4	C
SB LT	T	51	1,650	0.031	0.130	215	0.24		29.7	0.85	16	0.1	25.3	D		
SB TH	T	25	1,650	0.015	0.040	66	0.38		35.6	0.85	16	1.7	32.0	D	22.5	C
SB RT	T	188	1,650	0.114	0.260	429	0.44	**********	23.5	0.85	16	0.5	20.5	C		
NB LT	T	182	1,650	0.110	0.220	363	0.50	**********	26.0	0.85	16	0.9	23.0	C		
NB TH	T	25	1,650	0.015	0.130	215	0.12		29.2	0.85	16	0.0	24.8	C	22.8	C
NB RT	T	46	1,650	0.028	0.210	347	0.13		24.4	0.85	16	0.0	20.7	C		

Cycle length, C = 100 seconds, Lost time per cycle = 18.0 seconds Y = Sum (v/s)d = 0.540 Xc = Y * C / (C-L) = 0.659 Overall Intersection: 17.9 C

Planning Analysis (94 HCM) file: HCM3-U2.FMT.A3=1 printed 02:44 PM 04/19/98 by: Julian Ng, Incorporated page 1 of 1

Intersection of: **East-West Road and Second Road: Parcels I and J** Case: **AM Peak Hour** , (LOS A)

Condition: **AM Peak Hour (2020)** Critical Movement Analysis: **678 (under capacity), Xcm = 0.48**

A. Volumes, Geometry, and Timing
(PHF= 0.91, T = 3.0%)

	Eastbound left turn	Eastbound through	Eastbound right turn	Westbound left turn	Westbound through	Westbound right turn	Southbound left turn	Southbound through	Southbound right turn	Northbound left turn	Northbound through	Northbound right turn
Volume (vph)	125	725	90	35	285	55	85	20	210	215	20	85
Arrival type (1-6) (3=random)	3	3	3	3	3	3	3	3	3	3	3	3
Initial laneage	1	2	0	1	2	0	1	1	1	1	1	1
Additional lanes (ultimate)			0			0		0			0	
Lanes provided *	1	2	0	1	2	0	1	1	1	1	1	1
Signal Timing												
C = 100 seconds	3.5 seconds yellow			1.0 second all-red								
Green Time (seconds)												
Phase 1	27								27			
Phase 2					24	24						
Phase 3						17	17					
Phase 4											14	14
Phase 5				5								5
Phase 6		48	46									
Phase 7			27							27		
Phase 8								4	4			

Major= 1,325 Minor= 235 warranted by: MUTCD Figure 4-5, 2&1 curve

Capacity Analysis and Level of Service Module

1 (1)	2	3	4	5	6 (3)	7 (6)	8 (2)	9	(4)	(5)	(7)	(8)	(9)	(10)	(11)	(12)
Lane Group	Phase	Adj. Flow	Adj. Sat.	Flow ratio	Green	Lane Gr.	Lane Gr.	Critical	First Term Delay		Second Term Delay		Lane Group		Approach	
Movements	Type	rate	Flow Rate	v/s	ratio g/C	Capacity	v/c ratio	Lane Gr.	sec/veh	DF	m	sec/veh	sec/veh	LOS	sec/veh	LOS
EB LT	T	142	1,650	0.086	0.270	446	0.32		22.2	0.85	16	0.1	19.0	C		
EB TH	T	827	3,300	0.251	0.460	1,518	0.55	**********	14.8	0.85	16	0.3	12.9	B	13.8	B
WB LT	T	40	1,650	0.024	0.050	83	0.48	**********	35.1	0.85	16	3.4	33.2	D		
WB TH	T	358	3,300	0.108	0.240	792	0.45		24.6	0.85	16	0.3	21.2	C	22.4	C
SB LT	T	97	1,650	0.059	0.170	281	0.34		27.8	0.85	16	0.3	23.9	C		
SB TH	T	20	1,650	0.012	0.040	66	0.30		35.5	0.85	16	0.8	31.0	D	20.7	C
SB RT	T	239	1,650	0.145	0.310	512	0.47	**********	21.2	0.85	16	0.5	18.5	C		
NB LT	T	245	1,650	0.148	0.270	446	0.55	**********	23.8	0.85	16	1.1	21.3	C		
NB TH	T	20	1,650	0.012	0.140	231	0.09		28.4	0.85	16	0.0	24.1	C	21.8	C
NB RT	T	97	1,650	0.059	0.190	314	0.31		26.5	0.85	16	0.2	22.7	C		

Cycle length, C = 100 seconds, Lost time per cycle = 18.0 seconds Y = Sum (v/s)d = 0.588 Xc = Y * C / (C-L) = 0.693 Overall Intersection: 18.0 C

Planning Analysis (94 HCM) file: HCM3-KNS.FMT.A3=4 printed 10:44 PM 04/19/98 by: Julian Ng, Incorporated page 1 of 1

Intersection of: **Kapolei Parkway and North-South Road** Case: **PM Peak Hour** (LOS E)

Condition: **PM Peak Hour (2000)** Critical Movement Analysis: **1,298 (NEAR capacity), Xcm = 0.93**

A. Volumes, Geometry, and Timing
(PHF= 0.91, T = 3.0%)

	Eastbound			Westbound			Southbound			Northbound		
	left turn	through	right turn	left turn	through	right turn	left turn	through	right turn	left turn	through	right turn
Volume (vph)	695	2,365	90	60	1,440	515	760	40	615	120	70	180
Arrival type (1-6) (3=random)	3	3	3	3	3	3	3	3	3	3	3	3
Lanes provided *	2	3	1	1	3	2	2	1	2	1	1	1
Signal Timing												
C = 120 seconds	3.5 seconds yellow			1.0 second all-red								
Green Time (seconds)												
Phase 1	29								29			
Phase 2					36	36						
Phase 3						32	32					
Phase 4												
Phase 5				6							5	5
Phase 6		59	59									6
Phase 7			14							14		
Phase 8								23	23			

Major= 5,165 Minor= 800 warranted by: MUTCD Figure 4-5, 2&1 curve

Capacity Analysis and Level of Service Module

1 (1) Lane Group Movements	2 Phase Type	3 Adj. Flow rate	4 Adj. Sat. Flow Rate	5 Flow ratio v/s	6 (3) Green ratio g/C	7 (6) Lane Gr. Capacity	8 (2) Lane Gr. v/c ratio	9 Critical Lane Gr	(4) First Term Delay sec/veh	(5) First Term Delay DF	(7) Second Term Delay m	(8) Second Term Delay sec/veh	(9) Lane Group sec/veh	(10) Lane Group LOS	(11) Approach sec/veh	(12) Approach LOS
EB LT	T	791	3,300	0.240	0.242	798	0.99	**********	34.5	0.85	16	22.7	52.0	E		
EB TH	T	2,365	4,950	0.478	0.492	2,434	0.97		22.6	0.85	16	9.2	28.4	D	33.4	D
EB RT	T	102	1,650	0.062	0.608	1,004	0.10		7.5	0.85	16	0.0	8.4	B		
WB LT	T	68	1,650	0.041	0.050	83	0.83		42.9	0.85	16	31.3	67.8	F		
WB TH	T	1,440	4,950	0.291	0.300	1,485	0.97	**********	31.5	0.85	16	12.4	39.2	D	31.6	D
WB RT	T	586	3,300	0.178	0.567	1,870	0.31		10.4	0.85	16	0.0	8.8	B		
SB LT	T	865	3,300	0.262	0.267	880	0.98	**********	33.2	0.85	16	19.7	47.9	E		
SB TH	T	40	1,650	0.024	0.192	316	0.13		30.5	0.85	16	0.0	25.9	D	33.4	D
SB RT	T	700	3,300	0.212	0.433	1,430	0.49		18.6	0.85	16	0.2	16.0	C		
NB LT	T	137	1,650	0.083	0.117	193	0.71		38.8	0.85	16	7.7	40.7	E		
NB TH	T	70	1,650	0.042	0.042	69	1.02		43.7	0.85	16	90.6	127.7	F	190.9	F
NB RT	T	205	1,650	0.124	0.092	151	1.35	**********	41.4	0.85	16	277.5	312.7	F		

Cycle length, C = 120 seconds, Lost time per cycle = 18.0 seconds Y = Sum (v/s)d = 0.917 Xc = Y * C / (C-L) = 1.079 Overall Intersection: **41.7 E**

Planning Analysis (94 HCM) file: HCM3-FH1.FMT.A3=1 printed 08:45 PM 04/19/98 by: Julian Ng, Incorporated page 1 of 1

Intersection of: **Kapolei Parkway and Road Serving Parcels F & G** Case: **AM Peak Hour** (LOS D)

Condition: **AM Peak Hour (2020)** Critical Movement Analysis: **1,252 (NEAR capacity), Xcm = 0.89**

A. Volumes, Geometry, and Timing
(PHF= 0.91, T = 3.0%)

	Eastbound			Westbound			Southbound			Northbound		
	left turn	through	right turn	left turn	through	right turn	left turn	through	right turn	left turn	through	right turn
Volume (vph)	115	1,070	0	0	2,945	120	155	0	225	0	0	0
Arrival type (1-6) (3=random)	3	3	3	3	3	3	3	3	3	3	3	3
Initial laneage	1	3	0	1	3	1	1	1	1	1	1	1
Additional lanes (ultimate)			0			0		0			0	
Lanes provided *	1	3	0	1	3	1	1	1	1	1	1	1
Signal Timing												
C = 100 seconds	3.5 seconds yellow			1.0 second all-red								
Green Time (seconds)												
Phase 1	11.0								11.0			
Phase 2					58.5	58.5						
Phase 3						17.0	17.0	17.0	17.0			
Phase 4												
Phase 5				0.0							-9.0	-9.0
Phase 6		74.0	74.0									0.0
Phase 7			0.0							0.0		
Phase 8												

Major= 4,250 Minor= 155 warranted by: MUTCD Figure 4-5, 2&1 curve

Capacity Analysis and Level of Service Module

1 (1) Lane Group Movements	2 Phase Type	3 Adj. Flow rate	4 Adj. Sat. Flow Rate	5 Flow ratio v/s	6 (3) Green ratio g/C	7 (6) Lane Gr. Capacity	8 (2) Lane Gr. v/c ratio	9 Critical Lane Gr	(4) First Term Delay sec/veh	(5) First Term Delay DF	(7) Second Term Delay m	(8) Second Term Delay sec/veh	(9) Lane Group sec/veh	(10) Lane Group LOS	(11) Approach sec/veh	(12) Approach LOS
EB LT	T	131	1,650	0.079	0.110	182	0.72	**********	32.7	0.85	16	8.7	38.5	D		
EB TH	T	1,070	4,950	0.216	0.740	3,663	0.29		3.3	0.85	16	0.0	2.8	A	6.5	B
WB TH	T	2,945	4,950	0.595	0.585	2,896	1.02	**********	15.8	0.85	16	16.8	30.2	D	29.0	D
WB RT	T	137	1,650	0.083	0.755	1,248	0.11		2.5	0.85	16	0.0	2.1	A		
SB LT	T	176	1,650	0.107	0.170	281	0.63		29.3	0.85	16	3.1	28.0	D		
SB TH	T	0	1,650	0.000	0.170	281	0.00								23.8	C
SB RT	T	256	1,650	0.155	0.280	462	0.55	**********	23.3	0.85	16	1.1	20.9	C		

Cycle length, C = 100 seconds, Lost time per cycle = 18.0 seconds Y = Sum (v/s)d = 0.830 Xc = Y * C / (C-L) = 1.012 Overall Intersection: **22.8 C**

Planning Analysis (94 HCM) file: HCM3-FH2.FMT.A3=2 printed 10:46 PM 04/19/98 by: Julian Ng, Incorporated page 1 of 1

Intersection of: **Kapolei Parkway and Road Serving Parcels F & G** **Case PM Peak Hour** (LOS D)
Condition: **PM Peak Hour (2020)** Critical Movement Analysis: **1,128 (under capacity), Xcm = 0.81**

A. Volumes, Geometry, and Timing
(PHF= 0.91, T = 3.0%)

	Eastbound left turn	Eastbound through	Eastbound right turn	Westbound left turn	Westbound through	Westbound right turn	Southbound left turn	Southbound through	Southbound right turn	Northbound left turn	Northbound through	Northbound right turn
Volume (vph)	195	2,785	0	0	2,100	75	200	0	300	0	0	0
Arrival type (1-6) (3=random)	3	3	3	3	3	3	3	3	3	3	3	3
Initial laneage	1	3	0	1	3	1	1	1	1	1	1	1
Additional lanes (ultimate)			0			0		0			0	
Lanes provided *	1	3	0	1	3	1	1	1	1	1	1	1
Signal Timing												
C =100 seconds	3.5 seconds yellow			1.0 second all-red								
Green Time (seconds)												
Phase 1	18.0								18.0			
Phase 2					43.5	43.5						
Phase 3						25.0	25.0	25.0	25.0			
Phase 4											-9.0	-9.0
Phase 5				0.0								0.0
Phase 6		66.0	66.0									
Phase 7			0.0							0.0		
Phase 8												

Major= 5,155 Minor= 200 warranted by: MUTCD Figure 4-5, 2&1 curve

Capacity Analysis and Level of Service Module

1 (1) Lane Group Movements	2 Phase Type	3 Adj. Flow rate	4 Adj. Sat. Flow Rate	5 Flow ratio v/s	6 (3) Green ratio g/C	7 (6) Lane Gr. Capacity	8 (2) Lane Gr. v/c ratio	9 Critical Lane Gr	(4) First Term Delay sec/veh	(5) First Term Delay DF	(7) Second Term Delay m	(8) Second Term Delay sec/veh	(9) Lane Group sec/veh	(10) Lane Group LOS	(11) Approach sec/veh	(12) Approach LOS
EB LT	T	222	1,650	0.135	0.180	297	0.75		29.5	0.85	16	6.8	31.9	D		
EB TH	T	2,785	4,950	0.563	0.660	3,267	0.85	....	10.0	0.85	16	1.7	10.2	B	11.6	B
WB TH	T	2,100	4,950	0.424	0.435	2,153	0.98		21.1	0.85	16	10.5	28.4	D	27.4	D
WB RT	T	85	1,650	0.052	0.685	1,130	0.08		4.0	0.85	16	0.0	3.4	A		
SB LT	T	228	1,650	0.138	0.250	413	0.56		24.8	0.85	16	1.2	22.3	C		
SB TH	T	0	1,650	0.000	0.250	413	0.00								17.1	C
SB RT	T	342	1,650	0.207	0.430	710	0.48	....	15.6	0.85	16	0.4	13.7	B		

Cycle length, C = 100 seconds, Lost time per cycle =18.0 seconds Y = Sum (v/s)d = 0.770 Xc =Y * C / (C-L) = 0.939 Overall Intersection: 18.3 C

Planning Analysis (94 HCM) file: HCM3-KNS.FMT.A3=1 printed 08:47 PM 04/19/98 by: Julian Ng, Incorporated page 1 of 1

Intersection of: **Kapolei Parkway and North-South Road** **Case: AM Peak Hour** (LOS D)
Condition: **AM Peak Hour (2020)** Critical Movement Analysis: **1,144 (under capacity), Xcm = 0.82**

A. Volumes, Geometry, and Timing
(PHF= 0.91, T = 3.0%)

	Eastbound left turn	Eastbound through	Eastbound right turn	Westbound left turn	Westbound through	Westbound right turn	Southbound left turn	Southbound through	Southbound right turn	Northbound left turn	Northbound through	Northbound right turn
Volume (vph)	370	910	65	175	2,210	1,320	375	60	790	65	35	30
Arrival type (1-6) (3=random)	3	3	3	3	3	3	3	3	3	3	3	3
Initial laneage	2	3	1	1	3	2	2	1	2	1	1	1
Additional lanes (ultimate)			0			0		0			0	
Lanes provided *	2	3	1	1	3	2	2	1	2	1	1	1
Signal Timing												
C =100 seconds	3.5 seconds yellow			1.0 second all-red								
Green Time (seconds)												
Phase 1	15								15			
Phase 2					46	46						
Phase 3						15	15					
Phase 4											6	6
Phase 5				15								15
Phase 6		46	46									
Phase 7			7							7		
Phase 8								14	14			

Major= 5,050 Minor= 435 warranted by: MUTCD Figure 4-5, 2&1 curve

Capacity Analysis and Level of Service Module

1 (1) Lane Group Movements	2 Phase Type	3 Adj. Flow rate	4 Adj. Sat. Flow Rate	5 Flow ratio v/s	6 (3) Green ratio g/C	7 (6) Lane Gr. Capacity	8 (2) Lane Gr. v/c ratio	9 Critical Lane Gr	(4) First Term Delay sec/veh	(5) First Term Delay DF	(7) Second Term Delay m	(8) Second Term Delay sec/veh	(9) Lane Group sec/veh	(10) Lane Group LOS	(11) Approach sec/veh	(12) Approach LOS
EB LT	T	421	3,300	0.128	0.150	495	0.85	....	31.5	0.85	16	9.3	38.1	D		
EB TH	T	910	4,950	0.184	0.460	2,277	0.40		13.6	0.85	16	0.1	11.7	B	18.8	C
EB RT	T	74	1,650	0.045	0.530	875	0.08		8.8	0.85	16	0.0	7.5	B		
WB LT	T	199	1,650	0.121	0.150	248	0.80		31.2	0.85	16	11.8	38.3	D		
WB TH	T	2,210	4,950	0.446	0.460	2,277	0.97		20.0	0.85	16	9.5	26.5	D	20.8	C
WB RT	T	1,503	3,300	0.455	0.610	2,013	0.75	....	10.6	0.85	16	1.1	10.1	B		
SB LT	T	427	3,300	0.129	0.150	495	0.86		31.5	0.85	16	10.1	38.9	D		
SB TH	T	60	1,650	0.036	0.140	231	0.26		29.2	0.85	16	0.1	24.9	C	34.8	D
SB RT	T	899	3,300	0.273	0.290	957	0.94	....	26.3	0.85	16	12.0	34.4	D		
NB LT	T	74	1,650	0.045	0.070	116	0.64	....	34.4	0.85	16	7.6	36.8	D		
NB TH	T	35	1,650	0.021	0.060	99	0.35		34.3	0.85	16	0.9	30.1	D	31.3	D
NB RT	T	34	1,650	0.021	0.210	347	0.10		24.2	0.85	16	0.0	20.6	C		

Cycle length, C = 100 seconds, Lost time per cycle =18.0 seconds Y = Sum (v/s)d = 0.900 Xc =Y * C / (C-L) = 1.098 Overall Intersection: 23.4 C

I. Noise Impact Assessment

D. L. ADAMS ASSOCIATES, LTD.
dba
DARBY & ASSOCIATES
ACOUSTICAL CONSULTANTS

Project No. 96-56

ENVIRONMENTAL NOISE ASSESSMENT STUDY
EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT
KAPOLEI, EWA, OAHU, HAWAII

April, 1998

Prepared for
PBR HAWAII
Honolulu, Hawaii

PALI PALMS PLAZA • 970 NO. KALAHEO AVENUE • SUITE A-311
KAILUA, HAWAII 96734 • (808) 254-3318 • FAX (808) 254-5295

CONTENTS

Table of Contents (Continued)

1.0 SUMMARY

1.1 The East Kapolei Master Plan Development Project involves three parcels of land totaling 1,300 acres of land in Kapolei, Ewa, Oahu, Hawaii. The current development plan entails single-family and multi-family housing, commercial facilities, schools and parks.

1.2 The project area is currently exposed to daytime ambient noise levels of 41 to 46 dBA. The dominant noise sources include traffic, wind in foliage and occasional aircraft flybys or flyovers.

1.3 Nearby noise sensitive areas include the Villages of Kapolei and Ewa Villages which currently experience ambient noise levels of 44 to 47 dBA.

1.4 Traffic noise level increases in 2020 due to the combination of the East Kapolei Master Plan Development Project and other proposed projects in the area will be perceptible by most residents near Farrington Highway. However, the predicted increases due to the East Kapolei Project alone--less than or equal to 2.2 dB--should not be perceptible to the residents near the roadway.

1.5 The dominant noise sources during project construction will probably be earth moving equipment, such as bulldozers and diesel powered trucks unless pile driving is necessary. Noise from construction activities should be relatively short-term, occur only during daytime hours, and must comply with State Department of Health noise regulations.

1.6 Proposed residences along H-1 Freeway, Farrington Highway, North-South Road, East-West Road and Kapolei Parkway may be exposed to future traffic day-night equivalent sound levels, L_{dn}, greater than the HUD recommended limit of 65 dBA, if located too close to the roadways. Noise mitigation should be implemented to conform with HUD noise exposure guidelines for housing.

1.7 The day-night equivalent sound level, L_{dn}, at the project area due to aircraft operations is less than 60 dBA, and thus, compatible with the State Department of Transportation residential guidelines. However, due to the vicinity of the project area to Barbers Point Naval Air Station (BPNAS), aircraft operations associated with the air station as a reliever airport for Honolulu International Airport could impact the nearest proposed residential areas. Noise mitigation is recommended.

1.8 Noise associated with the existing Kapolei Golf Course and Makakilo Quarry, as well as the future Park and Ride Facility and Ballpark could impact the residences nearest to these facilities. Noise mitigation is recommended to avoid future noise complaints.

2.0 PROJECT DESCRIPTION

The East Kapolei Master Plan Development Project involves three parcels of land totaling 1,300 acres of land in Kapolei, Ewa, Oahu, Hawaii. Locations of the parcels are shown in Figure 1. Currently, the project area consists of agricultural and vacant land. Nearby noise sensitive residential areas include Ewa Villages to the south and Villages of Kapolei to the west of the project. The present development plan, as shown in Figure 2, entails single family and multi-family housing, commercial facilities, schools and parks.

3.0 NOISE STANDARDS

Various local and federal agencies have established guidelines and standards for assessing environmental noise impacts and set noise limits as a function of land use. A brief description of common acoustic terminology used in these guidelines and standards is presented in Appendix A.

3.1 State Department of Health - The State Department of Health (DOH) defines three classes of zoning districts and specifies corresponding maximum permissible sound levels due to stationary noise sources such as air-conditioning units, exhaust systems, generators, compressors, pumps, etc., and equipment related agricultural, construction, and industrial activities [Reference 1]. These levels are enforced for any location at or beyond the property line and shall not be exceeded for more than 10% of the time during any 20-minute period. The specified noise limits which apply are a function of the zoning and time of day as shown in Figure 3. DOH also specifies the following with respect to mixed zoning districts.

> "For mixed zoning districts, the primary land use designation shall be used to determine the applicable zoning district class and the maximum permissible sound level."

3.2 City and County of Honolulu Land Use Ordinance - The City's Land Use Ordinance (LUO) specifies maximum allowable levels at the property line [Reference 2]. The LUO criteria differ from those of the DOH in that they use octave band sound levels instead of A-weighted levels and no temporal factor is involved. LUO noise regulations are theoretically enforced by the Building Department, however, since this Department does not have noise measurement capability, noise complaints are usually handled by DOH.

3.3 U.S. Department of Housing and Urban Development - The U.S. Department of Housing and Urban Development (HUD) has established Site Acceptability Standards for interior and exterior noise for housing [Reference 3]. These standards are based on day-night equivalent sound levels, L_{dn}, and identify the need for noise abatement, either at the site property line or in the building construction. HUD Site Acceptability

Criteria rank sites as Acceptable, Normally Unacceptable, or Unacceptable. "Acceptable" sites are those where exterior noise levels do not exceed an L_{dn} of 65 dBA. Housing on Acceptable sites do not require additional noise attenuation other than that provided in customary building techniques. "Normally Unacceptable" sites are those where the L_{dn} is above 65 dBA, but does not exceed 75 dBA. Housing on Normally Unacceptable sites requires some means of noise abatement, either at the property line or in the building construction, to ensure the interior noise levels are acceptable. "Unacceptable" sites are those where the L_{dn} is 75 dBA or higher. The term "unacceptable" does not necessarily mean that housing cannot be built on these sites, but rather that more sophisticated sound attenuation would likely be needed.

3.4 U.S. Federal Highway Administration - The Federal Highway Administration (FHWA) has established design goals for traffic noise exposure [Reference 4]. The FHWA defines four land use categories and assigns corresponding maximum hourly equivalent sound levels, L_{eq}. For example, Category B, defined as picnic and recreation areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals, has a corresponding maximum exterior L_{eq} of 67 dBA and a maximum interior L_{eq} of 52 dBA. These limits are viewed as design goals, and all projects which are developed to meet these limits are deemed in conformance with the FHWA noise standards.

3.5 State Department of Transportation, Highways Division - The State Department of Transportation, Highways Division (DOTH) has adopted FHWA's design goals for traffic noise exposure (Section 3.4) in its noise analysis and abatement policy [Reference 5]. According to the policy, a traffic noise impact occurs when the predicted traffic noise levels "approach" or exceed FHWA's design goals or when the predicted traffic noise levels "substantially exceed the existing noise levels." The policy also states that "approach" means at least 1 dB less than FHWA's design goals and "substantially exceed the existing noise levels" means an increase of at least 15 dB.

3.6 State Department of Transportation, Airports Division - The State Department of Transportation, Airports Division (DOTA) specifies land use compatibility guidelines for aircraft noise exposure [Reference 6]. These guidelines are based on maximum allowable yearly day-night equivalent sound levels, L_{dn}, for various specified land uses. A residential land use, which is specified as single-family homes, apartments, hotels, and resorts, is compatible with an aircraft generated L_{dn} less than or equal to 60 dBA. However, DOTA states,

> "Where the community determines that these uses must be allowed, Noise Level Reduction (NLR) measures to achieve interior levels of 45 L_{dn} or less should be incorporated into building codes and be considered in individual approvals. Normal local construction employing natural ventilation can be expected to provide an average NLR of approximately 9 dB.

Total closure, plus air conditioning, may be required to provide additional outdoor to indoor NLR, and will not eliminate outdoor noise problems."

The DOTA guidelines also specify 60 dBA as the maximum allowable L_{dn} for school, day care center, and church uses without any noise mitigation. Commercial uses such as retail shops, restaurants, shopping centers, etc. are compatible with L_{dn} up to 65 dBA without any noise mitigation. With noise mitigation, such commercial uses are allowed in areas exposed to L_{dn}'s as high as 75 dBA.

3.7 U.S. Environmental Protection Agency - The U.S. Environmental Protection Agency (EPA) has identified a range of yearly day-night equivalent sound levels, L_{dn}, sufficient to protect public health and welfare from the effects of environmental noise [Reference 7]. The EPA has established a goal to reduce exterior environmental noise to an L_{dn} not exceeding 65 dBA and a future goal to further reduce exterior environmental noise to an L_{dn} not exceeding 55 dBA. Additionally, the EPA states that these goals are not intended as regulations as it has no authority to regulate noise levels, but rather they are intended to be viewed as levels below which the general population will not be at risk from any of the identified effects of noise.

4.0 EXISTING ACOUSTICAL ENVIRONMENT

Ambient noise measurements were conducted on December 26, 1996, and on June 17, 1997, to assess the existing acoustical environment. The measurement locations are shown in Figure 4. Noise level measurements were obtained using Larson-Davis Laboratories, Models 700 and 800, Integrating Sound Level Meters. The following results were measured.

Measurement Location	L_{eq} (dBA)	L_{90} (dBA)
1	50	46
2	47	41
3	48	44
4	52	47
5	61	-

L_{eq} is the Equivalent Sound Level and L_{90} is the 90 Percentile Exceedence Level or the level that is exceeded 90% of the time during a measurement period. L_{90} differs from L_{eq} in that L_{90} represents a measure of residual or background noise minimally influenced by nearby discrete events (e.g., aircraft takeoffs) and L_{eq} represents a constant level of sound having the same total acoustic energy as that contained in the

actual time-varying sound measured over a specific time period. Their relationship is shown in Figure A-2 of Appendix A.

Presently, the dominant noise sources at the above locations include traffic, wind, and occasional aircraft flybys. At Location 5, noise measurements were also obtained during blasting operations near Makakilo Quarry. Potential noise impacts on the project, due to quarry operations and associated equipment and vehicles, are assessed in Section 6.3.

5.0 POTENTIAL NOISE IMPACT DUE TO THE PROJECT AND NOISE MITIGATION

5.1 Traffic Noise - Traffic noise level increases, as a result of the project, were calculated using the Federal Highway Administration (FHWA) Traffic Noise Prediction Model [Reference 8] and the traffic data provided [Reference 9]. The future increases with and without the project were predicted along Farrington Highway and H-1 Freeway and are presented in Table 1. As can be seen, a small decrease in traffic noise levels along Farrington Highway between Fort Weaver Road and the future North-South Road was calculated and the predicted maximum traffic noise level increases due to additional traffic generated by the project were determined to be less than or equal to 2.2 dB, which is below the threshold change in noise level that is perceptible to most people with normal hearing. However, the results of Table 1 also indicate significant increases in the year 2020 of 6.4 and 4.1 dB, along Farrington Highway and H-1 Freeway, respectively, due to the East Kapolei Project and other developments. A traffic noise level increase greater than 3 dB would be perceptible by most residents near the roadway. While it's difficult to quantify the average reaction of persons experiencing the predicted noise level increases, using the empirical data of Reference 10, it can be stated that about 9% of the population would be "highly annoyed" if they presently experience traffic noise L_{dn} of 60 dBA, and in the future (2020), about 18% of the people would be "highly annoyed" if they experienced an increase to 66.4 dBA.

5.2 Construction Noise - Development of the East Kapolei Project will involve excavation, grading and the construction of infrastructure and buildings. The various construction phases of the project may generate significant amounts of noise, which may impact nearby residential areas. The actual noise levels produced will be a function of the methods employed during each stage of the construction process. Typical ranges of construction equipment noise are shown in Figure 5. Earthmoving equipment, e.g., bulldozers and diesel-powered trucks, will probably be the loudest equipment used during construction, assuming that pile driving will not be required.

In cases where construction noise exceeds, or is expected to exceed the DOH's "maximum permissible" property line noise levels [Reference 1], a permit must be obtained from the DOH to allow the operation of vehicles, construction equipment, power tools, etc., which emit noise levels in excess of "maximum permissible" levels. Specific permit restrictions for construction activities are:

> "No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels...before 7:00 am and after 6:00 pm of the same day, Monday through Friday."
>
> "No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels...before 9:00 am and after 6:00 pm on Saturday."
>
> "No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels on Sundays and on holidays."

In addition, construction equipment and on-site vehicles or devices whose operations involve the exhausting of gas or air, excluding pile hammers and pneumatic hand tools weighing less than 15 pounds, must be equipped with mufflers, and construction vehicles using trafficway must satisfy the DOH's vehicular noise requirements [Reference 11].

Blasting, if required, could also produce noise impacts. However, blasting at construction sites near populated areas is usually accomplished by using numerous small charges detonated with small time delays. Blast mats can also be used to assist in directing the explosive energy into the rock, controlling flying debris, and muffling the noise. Thus, with the appropriate blast design techniques, the noise from blasting can be controlled within acceptable limits at the closest noise sensitive locations.

6.0 POTENTIAL NOISE IMPACTS ON THE PROJECT AND NOISE MITIGATION

6.1 Traffic Noise - The proposed residential areas of the project could be impacted by traffic noise. The FHWA Traffic Noise Prediction Model was used along with traffic data of Reference 9 to predict future traffic noise levels along H-1 Freeway, Farrington Highway, North-South Road, East-West Road and Kapolei Parkway. Locations of the traffic noise predictions are shown in Figure 6.

The future traffic noise levels were based on the predicted peak-hour traffic volumes with assumptions of truck mix percentage, vehicle speed and roadway characteristics summarized in Table 2. The day-night equivalent sound levels, L_{dn}s, were estimated from the peak-hour equivalent noise levels, L_{eq}, in accordance with the procedures of Reference 4. The results summarized in Table 3 list the minimum setback distances

from the centerline of the roadway for naturally ventilated residences required by HUD traffic noise criteria. It should be noted that the estimated distances of Table 3 are worst cases. Effects of terrain and roadway elevations and any noise shielding afforded by man made structures were not included in the calculations. Detailed analysis of specific building projects may allow smaller setbacks. For example, if portions of specific roadways are elevated above future housing, e.g., along H-1 Freeway, a barrier may effectively shield windows of the second-floor units allowing substantially less setback, if optimum planning, grading and design are incorporated.

In accordance with HUD standards, housing areas exposed to L_{dn} between 65 and 75 dBA require some means of noise reduction, either at the property line or in the building construction in order to meet HUD criteria and, thus, be eligible for HUD/FHA financing. HUD standards for housing areas exposed to L_{dn} between 65 and 70 dBA, require a minimum of 5 dB attenuation in addition to the "attenuation provided by buildings as commonly constructed in the area, and requiring open windows for ventilation." A minimum of 10 dB additional attenuation is required for houses exposed to L_{dn} of 70 to 75 dBA. The standards state, "Emphasis shall be given to noise to sensitive interior spaces, such as bedrooms."

An additional 5 dB of attenuation can usually be achieved by one of the following measures:

a) Constructing a sound barrier at the property line which blocks the line-of-sight to the traffic.

b) Installing carpeting with minimum 40-oz padding, louvered closet doors, and/or absorptive ceiling tiles in the affected bedrooms.

An additional 10 dB of attenuation can usually be achieved by implementing both measures a) and b) above or providing air-conditioning and using standard windows (no jalousies) with good seals in conjunction with normal double wall construction with insulation.

Housing areas exposed to L_{dn} greater than 75 dBA would most often require high sound transmission loss glazing and air-conditioning according to HUD.

6.2 Aircraft Noise - The project area is within approximately 8 miles of Honolulu International Airport (HIA). In accordance with Reference 12, day-night equivalent sound levels, L_{dn}s, due to air traffic associated with HIA will be less 60 dBA at the project site, which is compatible with State DOTA residential guidelines. However, due to the vicinity of the project area to the HIA flight tracks as shown in Figures 7 and 8, aircraft flybys or flyovers may be audible, but should not significantly impact the proposed developments.

Barbers Point Naval Air Station (BPNAS) is located southwest of the project. Even though closure of the air station is anticipated to occur in July 1999, approximately 2147 acres of fee land have been determined to be Government surplus property and are available for disposal under the Defense Base Closure and Realignment Act of 1990. One of the proposed uses involves approximately 1,000 acres of the existing airfield complex at the air station to serve as a general aviation reliever airport for Honolulu International Airport. A draft master plan for the proposed reliever airport use was prepared and aircraft noise contours for various master plan alternatives were developed [Reference 13]. According to these contours, aircraft L_{dn} at the project area will be less than 60 dBA for all alternatives considered. However, due to the vicinity of the air station to the project area, aircraft takeoffs and landings could be audible and could impact the nearest proposed residential areas to the air station. Noise mitigation, if required, could include providing air-conditioning and implementing appropriate sound isolation construction in the design of impacted residences.

6.3 Makakilo Quarry - Makakilo Quarry is located north of the project site and Farrington Highway, as shown in Figure 1. Activities at this site include rock crushing and screening. Blasting operations, however, are conducted north of the site, approximately 300 to 1,200 feet from H-1 Freeway. Noise measurements at Location 5, as shown in Figure 4, were conducted on June 17, 1997, in order to assess the potential noise impacts on the project due to quarry operations and associated equipment and vehicles. During the measurement sessions, it was reported that 2,750 pounds of explosive charge were blasted at 58.5 pounds per delay at about 2,000 feet north of the measurement location [Reference 14]. Based on the measurement results, quarry blast noise is not considered to have significant noise impacts on the proposed project. However, due to the vicinity of the quarry site to the project, noise generated from on-site vehicles and rock crushing and screening equipment could impact the nearest proposed residences. According to DOH noise regulations, the maximum permissible sound level, due to equipment related to agriculture, construction and industrial activities, is 70 dBA during both daytime and nighttime hours at the property line of industrially and agriculturally zoned properties. Thus, consideration should be given to providing noise disclosures in sales documents to alert potential homeowners of the potential noise impacts. Noise mitigation could also be provided by constructing noise barrier walls at the proposed development property line to block line-of-sight between the noise source and the noise receptor and/or by air-conditioning the impacted residences.

6.4 Kapolei Golf Course - The existing Kapolei Golf Course abuts the project area to the west. Equipment associated with ground maintenance activities (e.g., tractors, lawn mowers, leaf blowers, etc.) may impact the proposed nearby residential areas; however, such activities are transient about the golf course and for short periods during the daytime only. Therefore, they should not be objectionable.

6.5 Park and Ride Facility - A park and ride facility is included in the proposed project, as shown in Figure 2. Potential noise sources include parking lot activities, e.g., slamming of doors, starting of engines, etc., and traffic movement of city buses, vans and passenger cars. These activities may impact the proposed, as well as the existing, nearby residential areas, especially in the early morning hours. However, due to the nature of the traffic movements at this facility, minimal noise impact is expected. Noise disclosures could be included in sales documents to alert potential homeowners that sounds from this neighboring activity could be annoying to noise sensitive persons.

6.6 Mechanical Equipment Noise - The present development plan for the project includes commercial facilities and schools. Sounds from stationary equipment at these facilities, e.g., air-conditioning and refrigeration units, exhaust fans and pumps, could impact the proposed adjacent residential areas. Mitigation of noise from such equipment to meet DOH noise regulations includes acoustic enclosures, noise barriers and/or exhaust silencers which should be included in the project design.

6.7 Ballpark - Development of the ballpark, located south of Kapolei Parkway, as shown in Figure 2, could impact nearby existing and future residences if noise from the park is not properly controlled. Potential noise sources include mechanical equipment, a public address system and children, etc. To mitigate the noise impacts, noise barrier walls, acoustical enclosures and/or exhaust silencers for the mechanical equipment should be implemented, any sound system loudspeakers should be oriented so as to not directly impact nearby homes. Additionally, the hours of park use should be limited to avoid noise sensitive times.

REFERENCES:

1. Chapter 46, *Community Noise Control*, Department of Health, State of Hawaii, Administrative Rules, Title 11, September 23, 1996.

2. *Section 3.11 Noise Regulations*, Land Use Ordinance, City and County of Honolulu, Oahu, October 22, 1986.

3. *Department of Housing and Urban Development Environmental Criteria and Standards*, Title 24, CFR, Part 51, 44 FR 40860, July 12, 1979; Amended by 49 FR 880, January 6, 1984.

4. *Department of Transportation, Federal Highway Administration Procedures for Abatement of Highway Traffic Noise*, Title 23, CFR, Chapter 1, Subchapter J, Part 772, 38 FR 15953, June 19, 1973; Revised at 47 FR 29654, July 8, 1982.

5. *Noise Analysis and Abatement Policy*, Department of Transportation, Highways Division, State of Hawaii, June 1997.

6. *Study Recommendations for Local Land Use Compatibility with Yearly Day-Night Average Sound Levels*, Department of Transportation, Airports Division, Received August 1991, Published in Reference 12.

7. *Toward a National Strategy for Noise Control*, U.S. Environmental Protection Agency, April 1977.

8. *FHWA Highway Traffic Noise Prediction Model*, FHWA-RD-77-108; U.S. Department of Transportation, December 1978.

9. Traffic Data Received from Julian Ng, Inc., September 15, 25, and 26, 1997 and from PBR Hawaii, April 21 and 22, 1998.

10. Schultz, T.J., Fidell, S., Green, D. M., *A Theoretical Interpretation of the Prevalence Rates of Noise - Induced Annoyance in Residential Population*, Journal of Acoustical Society of America, 1988.

11. *Chapter 42 - Vehicular Noise Control for Oahu*, Department of Health, State of Hawaii, Administration Rules, Title 11, November 6, 1981.

12. *Honolulu International Airport Master Plan Update & Noise Compatibility Program*, Department of Transportation, Airports Division, Volume 2, October 1989.

13. *Kalaeloa Airport Master Plan*, Department of Transportation, Airports Division, State of Hawaii, June 1996.

14. Notes of telephone conversations between Robert Singlehurst of Grace Pacific and Thao Nguyen of Darby & Associates on May 18 and 20, 1997.

TABLE 1

PROJECTED FUTURE (2020) TRAFFIC NOISE LEVEL (L_{dn} in dBA) INCREASES DURING PEAK TRAFFIC HOURS

	Roadway	
	Farrington Highway (between Fort Weaver and Future North-South Roads)	H-1 Freeway (between Makakilo and Kunia)
Future Increases (dBA Without the Project		
AM	6.8	3.5
PM	1.1	3.3
Future Increases (dBA) with the Project		
AM	6.4	4.1
PM	3.3	3.7
Future Increases (dBA) Due to the Project		
AM	-0.4	0.6
PM	2.2	0.4

Notes:

1. Traffic noise levels were assessed at an arbitrary 100-foot distance from the centerline of the roadway.
2. A negative value indicates a decrease in traffic noise levels.

TABLE 2

ASSUMED TRUCK MIX PERCENTAGES AND ROADWAY CHARACTERISTICS

Roadway	Description	Vehicle Speed (mph)	Truck Mix %	
			MT*	HT**
H-1 Freeway (between Makakilo and Kunia	6-lane roadway with 20-24 ft. median	55	3	2
Farrington Highway (between Makakilo and Kunia)	4-lane roadway with 20-24 ft. median	40	3	2
North-South Road	6-lane roadway with 20-24 ft. planting median	40	2	1
East-West Road	4-lane roadway without median	40	2	1
Kapolei Parkway	6-lane roadway with 20-24 ft. planting median	40	2	1

* MT = Vehicles with 2 axles and 6 wheels
** HT = Vehicles with 3 or more axles

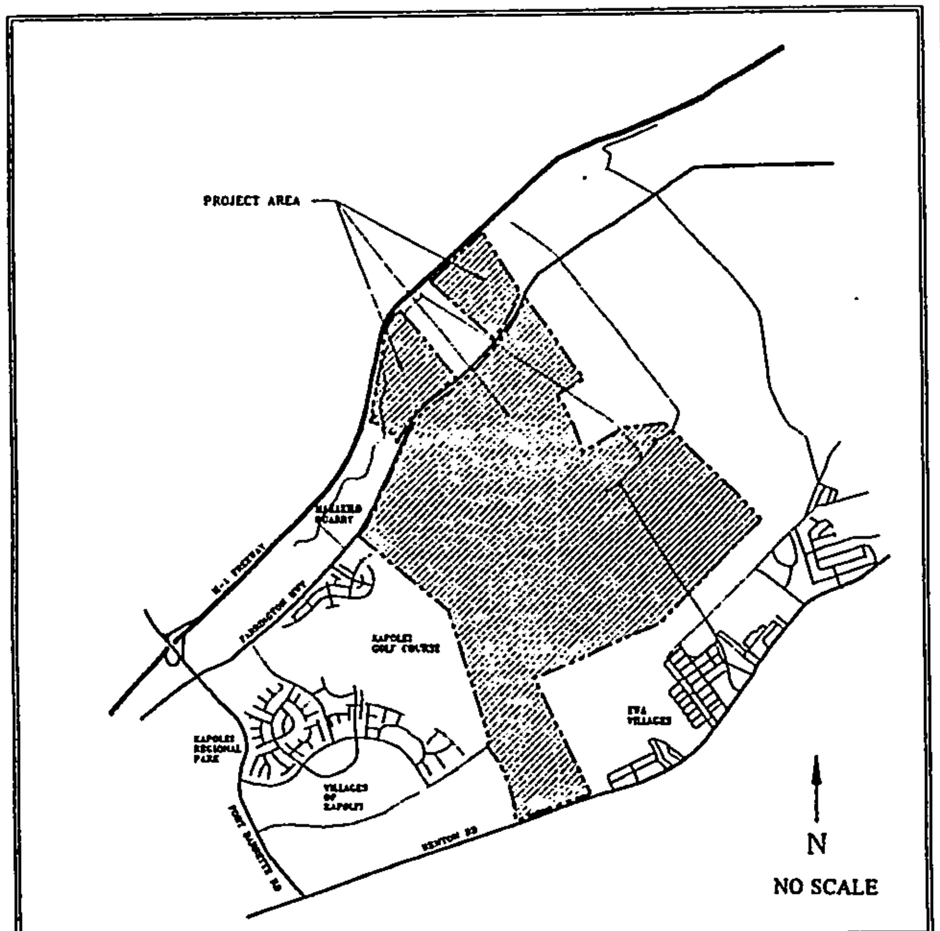
TABLE 3

ESTIMATED MINIMUM SETBACK DISTANCES* (in feet)
FROM ROADWAY CENTERLINE FOR NATURALLY VENTILATED RESIDENCES
AS REQUIRED BY HUD TRAFFIC NOISE CRITERIA

Location** & Roadway	"Acceptable" L_{dn} <65	"Normally Unacceptable"		"Unacceptable" L_{dn} >75
		L_{dn} 65-70	L_{dn} 70-75	
1 - H-1 Freeway	>2761	2761 to 877	877 to 283	<283
2 - Farrington Highway	>133	133 to 51	<51	n/a
3 - Farrington Highway	>157	157 to 54	<54	n/a
4 - North-South Road	>289	289 to 106	<106	n/a
5 - North-South Road	>205	205 to 69	<69	n/a
6 - North-South Road	>249	249 to 84	<84	n/a
7 - East-West Road	>141	141 to 49	<49	n/a
8 - East-West Road	>216	216 to 71	<71	n/a
9 - Kapolei Parkway	>435	435 to 142	<142	n/a

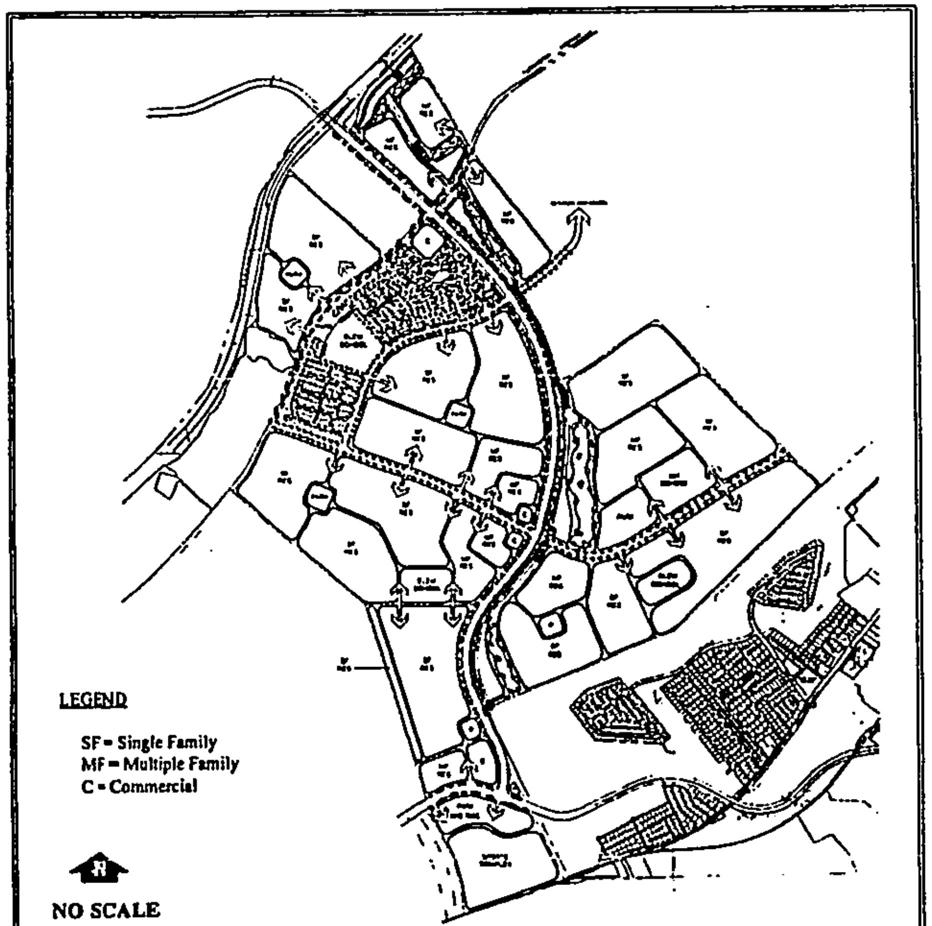
* Effects of terrain and roadway elevations and any noise shielding afforded by man made structures were not included in the calculations.

** See Figure 6.



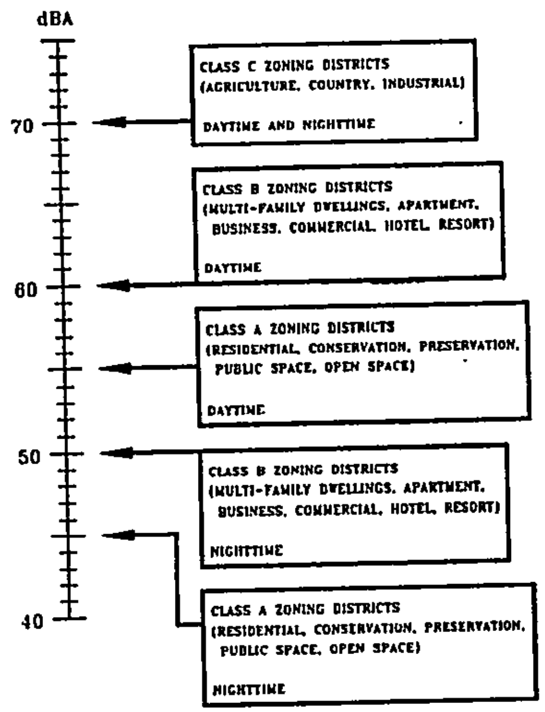
D. L. ADAMS ASSOCIATES, LTD.
dba DARBY & ASSOCIATES
ACOUSTICAL CONSULTANTS

FIGURE 1 - PROJECT AREA AND VICINITY



D. L. ADAMS ASSOCIATES, LTD.
dba DARBY & ASSOCIATES
ACOUSTICAL CONSULTANTS

FIGURE 2 - CONCEPTUAL DEVELOPMENT PLAN

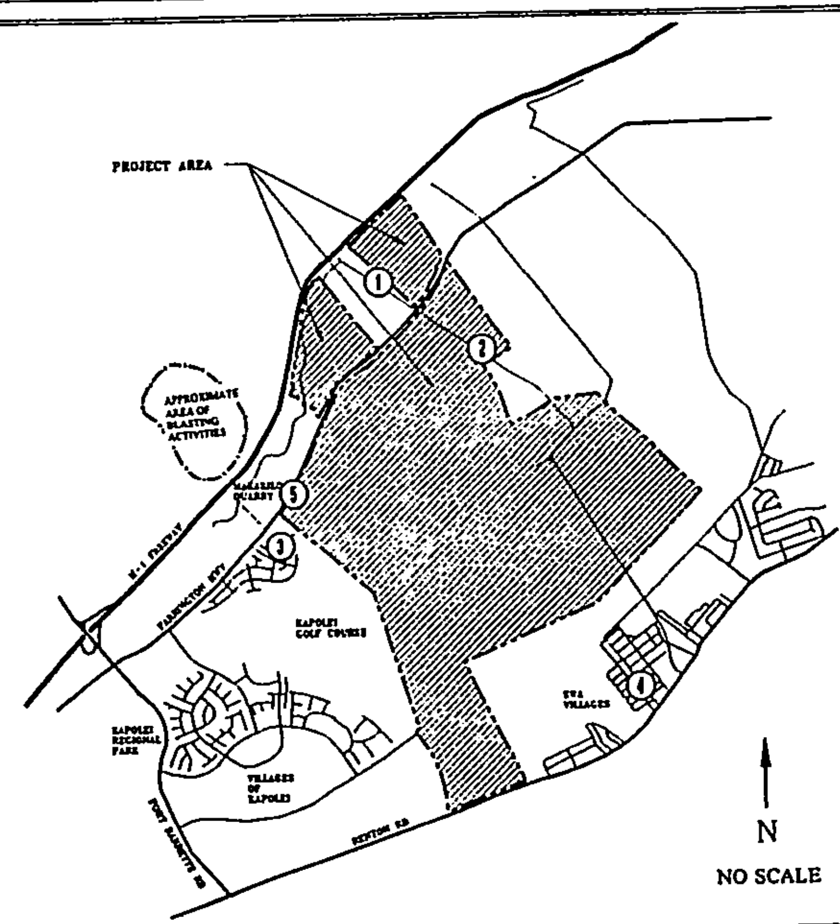


NOTE: SOUND LEVELS INDICATED BY ZONING DISTRICT ARE THE "MAXIMUM PERMISSIBLE" SOUND LEVELS DUE TO EXCESSIVE NOISE SOURCES SUCH AS STATIONARY MECHANICAL EQUIPMENT AND EQUIPMENT RELATED TO AGRICULTURAL, CONSTRUCTION AND INDUSTRIAL ACTIVITIES THAT SHALL NOT BE EXCEEDED FOR MORE THAN 10% OF THE TIME WITHIN ANY 20-MINUTE PERIOD DURING THE TIME PERIOD SHOWN (DAYTIME: 7:00 A.M. TO 10:00 P.M., NIGHTTIME: 10:00 P.M. TO 7:00 A.M.)

D. L. ADAMS ASSOCIATES, LTD.
dba DARBY & ASSOCIATES
ACOUSTICAL CONSULTANTS

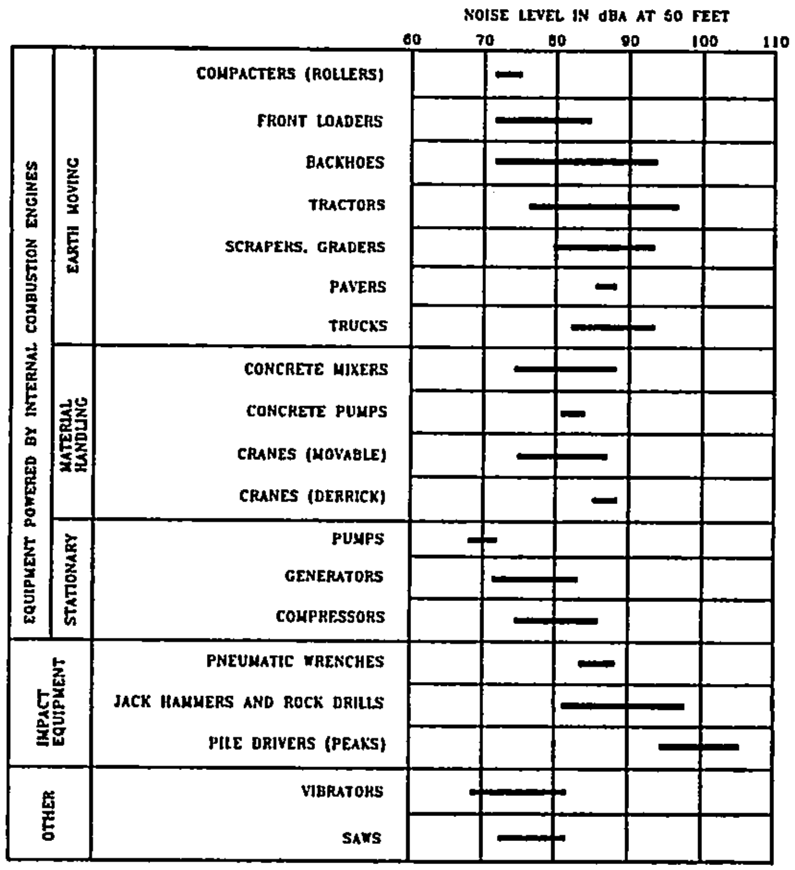
FIGURE 3 - MAXIMUM PERMISSIBLE SOUND LEVELS FOR VARIOUS ZONING DISTRICTS

SOURCE: REFERENCE 1



D. L. ADAMS ASSOCIATES, LTD.
dba DARBY & ASSOCIATES
ACOUSTICAL CONSULTANTS

FIGURE 4 - AMBIENT NOISE MEASUREMENT LOCATIONS

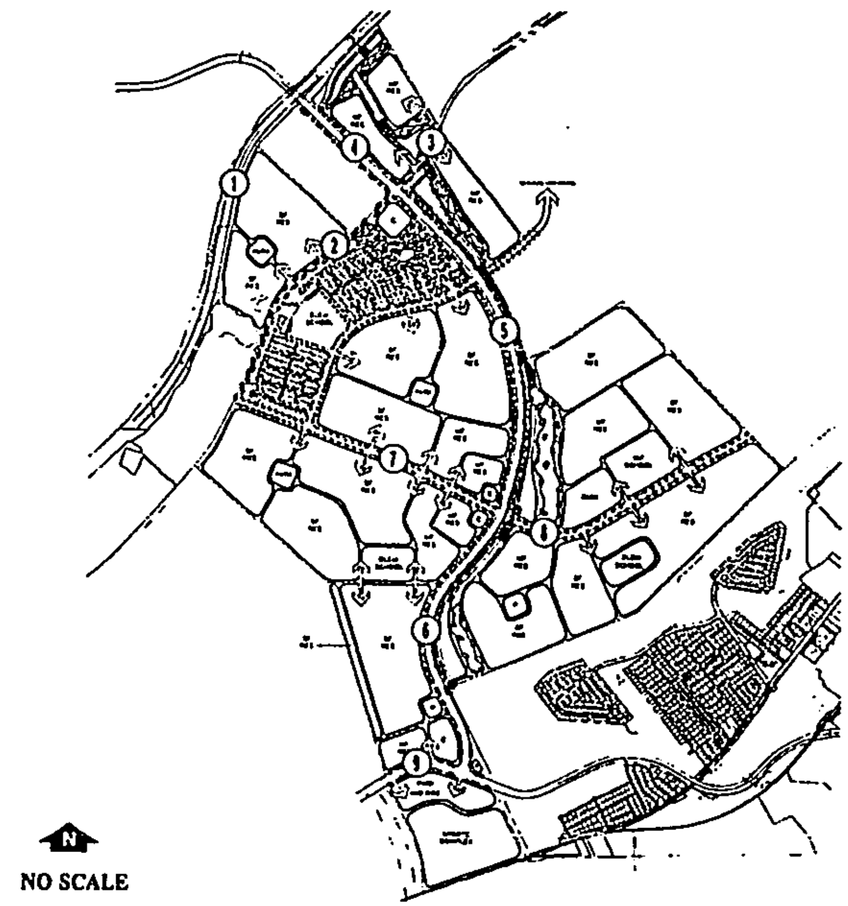


NOTE: BASED ON LIMITED AVAILABLE DATA SAMPLES

D. L. ADAMS ASSOCIATES, LTD.
dba DARBY & ASSOCIATES
ACOUSTICAL CONSULTANTS

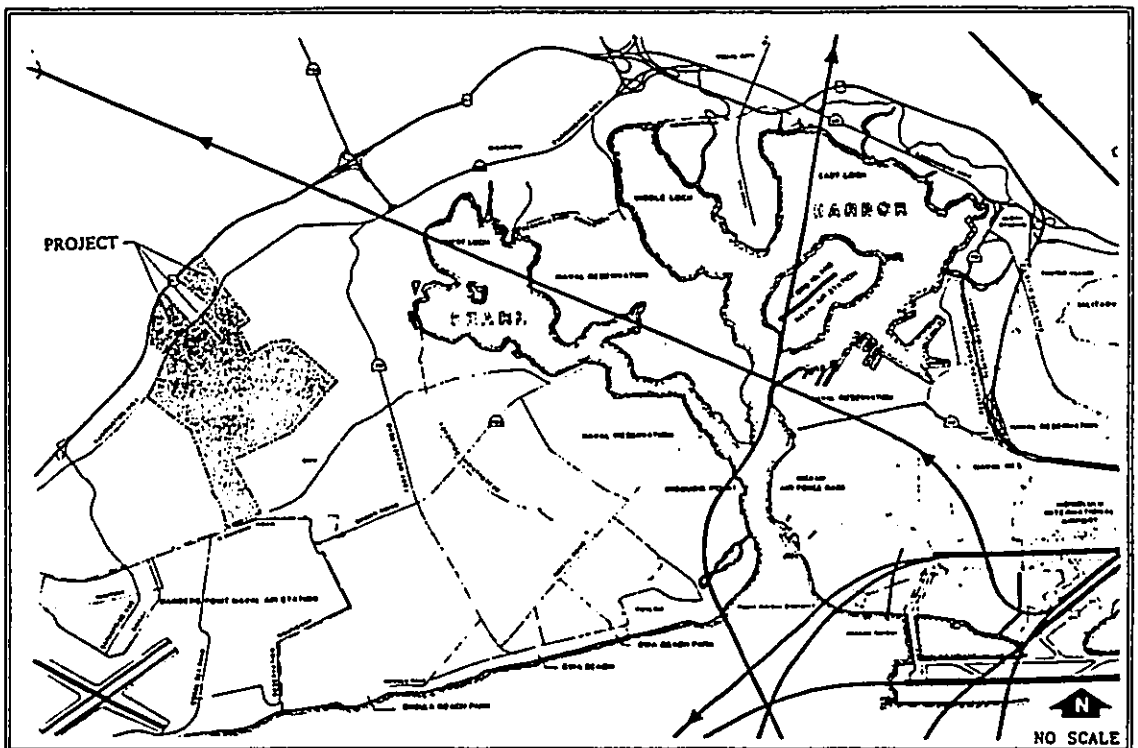
FIGURE 5 - TYPICAL SOUND PRESSURE LEVELS FROM CONSTRUCTION

SOURCE: REFERENCE 7



D. L. ADAMS ASSOCIATES, LTD.
dba DARBY & ASSOCIATES
ACOUSTICAL CONSULTANTS

FIGURE 6 - TRAFFIC NOISE ASSESSMENT LOCATIONS

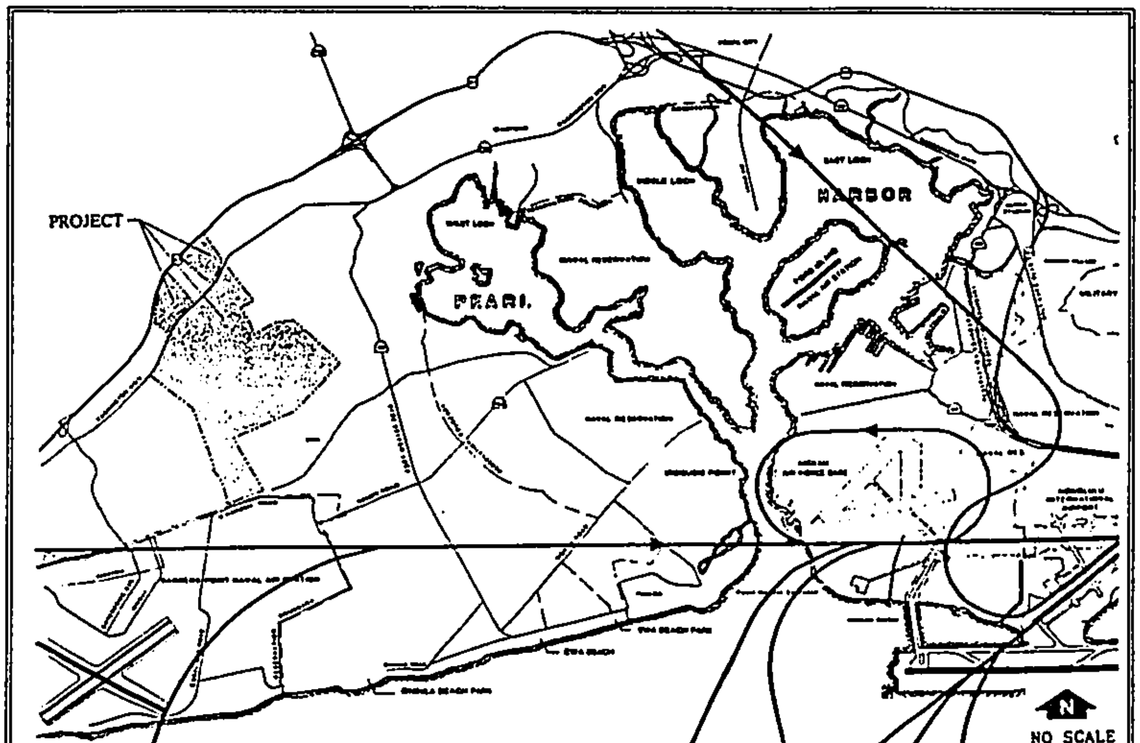


D. L. ADAMS ASSOCIATES, LTD.
dba
DARBY & ASSOCIATES
ACOUSTICAL CONSULTANTS

FIGURE 8 - VICINITY OF HONOLULU INTERNATIONAL AIRPORT
DEPARTURE FLIGHT TRACKS TO PROJECT AREA

SOURCE: REFERENCE 12

PROJECT NO. 96-56



D. L. ADAMS ASSOCIATES, LTD.
dba
DARBY & ASSOCIATES
ACOUSTICAL CONSULTANTS

FIGURE 7 - VICINITY OF HONOLULU INTERNATIONAL AIRPORT
ARRIVAL FLIGHT TRACKS TO PROJECT AREA

SOURCE: REFERENCE 12

APPENDIX A

ACOUSTICAL TERMINOLOGY

Sound Pressure Level

Sound or noise consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. It is measured in terms of decibels (dB) using precision instruments known as sound level meters. Noise is defined as "unwanted" sound.

Technically, sound pressure level (SPL) is defined as:

$$SPL = 20 \log (P/Pref) \text{ dB}$$

where P is the sound pressure fluctuation (above or below atmospheric pressure) and Pref is the reference pressure, 20 micropascals, which is approximately the lowest sound pressure that can be detected by the human ear. For example, if P is 20 micropascals, then SPL = 0 dB, or if P is 200 micropascals, then SPL = 20 dB. The relation between sound pressure in micropascals and sound pressure level in decibels (dB) is shown in Figure A-1.

The sound pressure level that results from a combination of noise sources is not the arithmetic sum of the individual sound levels, but rather the logarithmic sum. For example; two sound levels of 50 dB produce a combined level of 53 dB, not 100 dB; two sound levels of 40 and 50 dB produce a combined level of 50.4 dB.

Human sensitivity to changes in sound pressure level is highly individualized. Sensitivity to sound depends on frequency content, time of occurrence, duration, and psychological factors such as emotions and expectations. However, in general, a change of 1 or 2 dB in the level of a sound is difficult for most people to detect. A 3 dB change is commonly taken as the smallest perceptible change and a 5 dB change corresponds to a noticeable change in loudness. A 10 dB increase or decrease in sound level corresponds to an approximate doubling or halving of loudness, respectively.

A-Weighted Sound Level

The human ear is more sensitive to sound in the frequency range of 250 Hertz (Hz) and higher, than in frequencies below 250 Hz. Due to this type of frequency response, a frequency weighting system, was developed to emulate the frequency response of the human ear. This system expresses sound levels in units of A-weighted decibels (dBA). A-weighted sound levels de-emphasizes the low frequency portion of the spectrum of a signal. The A-weighted level of a sound is a good measure of the loudness of that sound. Different sounds having the same A-weighted sound level are perceived as being about equally loud. Typical values of the A-weighted sound level of various noise sources are shown in Figure A-1.

Statistical Sound Levels

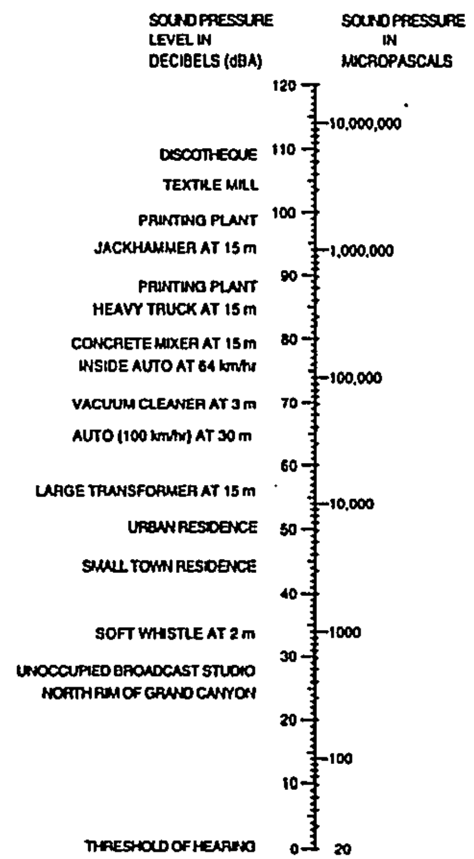
The sound levels of long-term noise producing activities, such as traffic movement, aircraft operations, etc., can vary considerably with time. In order to obtain a single number rating of such a noise source, a statistically-based method of expressing sound or noise levels developed. It is known as the Exceedence Level, L_n. The Exceedence Level, L_n, represents the sound level which is exceeded for n% of the measurement time period. For example, L_{10} = 60 dBA indicates that for the duration at the measurement period, the sound level exceeded 60 dBA 10% of the time. Commonly used Exceedence Levels include L_1, L_{10}, L_{50}, and L_{90}, which are widely used to assess community and environmental noise. Figure A-2 illustrates the relationship between selected statistical noise levels.

Equivalent Sound Level

The Equivalent Sound Level, L_{eq}, represents a constant level of sound having the same total acoustic energy as that contained in the actual time-varying sound being measured over a specific time period. L_{eq} is commonly used to describe community noise, traffic noise, and hearing damage potential. It has units of dBA and is illustrated in Figure A-2.

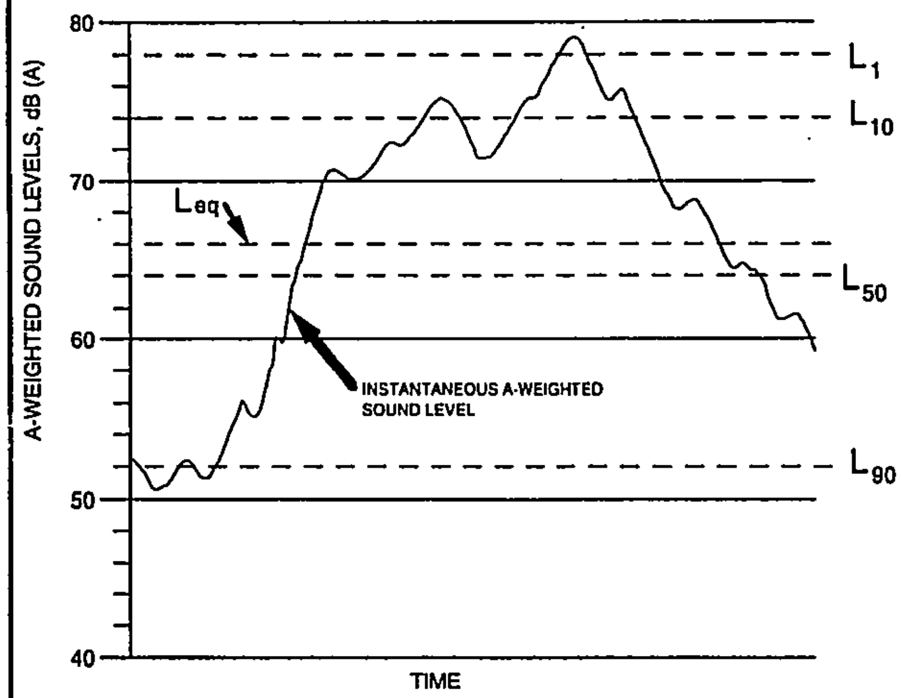
Day-Night Equivalent Sound Level

The Day-Night Equivalent Sound Level, L_{dn}, is the Equivalent Sound Level, L_{eq}, measured over a 24-hour period. However, a 10 dB penalty is added to the noise levels recorded between 10 pm and 7 am to account for people's higher sensitivity to noise at night when the background noise level is typically lower. The L_{dn} is a commonly used noise descriptor in assessing land use compatibility, and is widely used by federal and local agencies and standards organizations. Qualitative descriptions, as well as local examples of L_{dn}, are shown in Figure A-3.



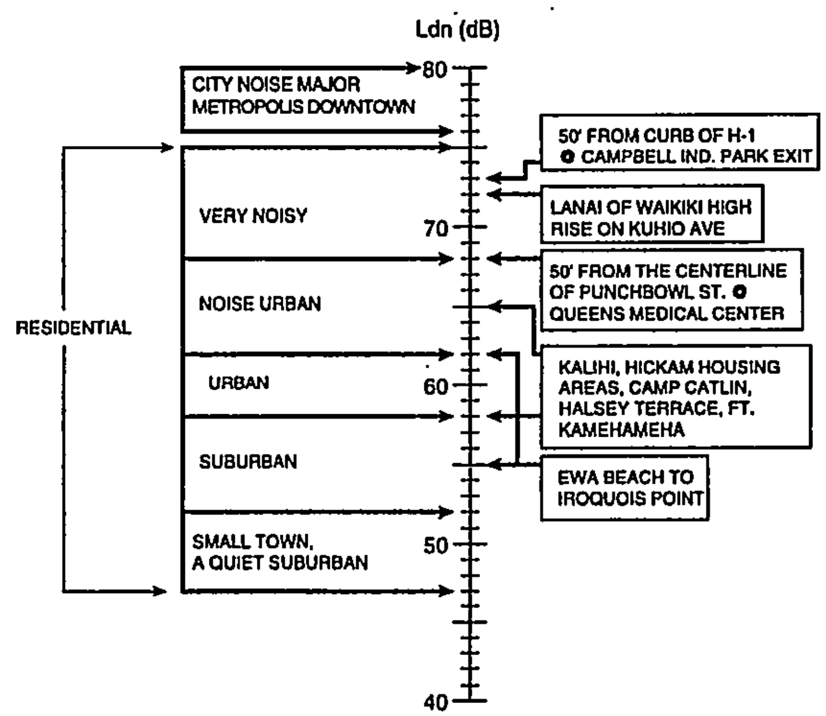
D.L. ADAMS ASSOCIATES, LTD.
dba
DARBY & ASSOCIATES
ACOUSTICAL CONSULTANTS

FIGURE A-1 THE RELATION BETWEEN SOUND PRESSURE, P, AND SOUND PRESSURE LEVEL, SPL. ALSO SHOWN ARE TYPICAL VALUES OF A-WEIGHTED SOUND LEVELS OF VARIOUS NOISE SOURCES.



D.L. ADAMS ASSOCIATES, LTD.
dba
DARBY & ASSOCIATES
ACOUSTICAL CONSULTANTS

FIGURE A-2 COMPARISON OF AN INSTANTANEOUS SOUND LEVEL AND THE CORRESPONDING STATISTICAL SOUND LEVELS



D.L. ADAMS ASSOCIATES, LTD.
dba
DARBY & ASSOCIATES
ACOUSTICAL CONSULTANTS

FIGURE A-3 QUALITATIVE DESCRIPTION OF THE DAY-NIGHT EQUIVALENT SOUND LEVELS (Ldn) AND EXAMPLE Ldn's AT SELECTED LOCATIONS ON OAHU

J. Air Quality

AIR QUALITY STUDY
FOR THE PROPOSED
EAST KAPOLEI PROJECT

EWA, OAHU, HAWAII

Prepared for:

PBR Hawaii

April 1998

B.D. NEAL & ASSOCIATES
*Applied Meteorology * Air Quality * Computer Science*
P.O. BOX [illegible], OCEAN VIEW, HAWAII 96737 * TELEPHONE (808) [illegible] * FAX (808) [illegible]

CONTENTS

TABLES

TABLES (cont.)

1.0 SUMMARY

The State of Hawaii is proposing to develop the East Kapolei Project on approximately 1300 acres of land within the Ewa District on the island of Oahu. The project would be built by private developers beginning in the year 2002 and eventually consist of more than 8000 single and multifamily homes, four schools, commercial shopping areas, parks and recreational areas and a 60-acre sports complex. A new north-south road through the middle of the planned development and an interchange from the nearby H-1 Freeway would be completed before any housing is built. This study examines the potential short- and long-term air quality impacts that could occur as a result of construction and use of the proposed facilities. Mitigative measures to reduce any potential air quality impacts from the project are suggested where possible and appropriate.

Both federal and state standards have been established to maintain ambient air quality. At the present time, seven parameters are regulated including: particulate matter, sulfur dioxide, hydrogen sulfide, nitrogen dioxide, carbon monoxide, ozone and lead. Hawaii state air quality standards are more stringent than the comparable national limits except for sulfur dioxide and the recently revised national particulate matter standard.

Regional and local climate together with the amount and type of human activity generally dictate the air quality of a given location. The climate of the Ewa Plain area is very much affected by its leeward and coastal situation. Winds are predominantly trade winds from the east northeast except for occasional periods when kona storms may generate strong winds from the south or when the trade winds are weak and landbreeze-seabreeze circulations may develop. Wind speeds typically vary between about 5 and 15 miles per hour providing relatively good ventilation much of the time. Temperatures in the leeward Oahu area are generally very moderate with average daily temperatures ranging from about 65°F to 84°F. The extreme minimum temperature recorded at the nearby (former) Ewa Plantation is 47°F, while the extreme maximum temperature is 93°F. This area of Oahu is one of the drier locations in the state with rainfall often highly variable from one year to the next. Monthly rainfall has been measured to vary from as little as a trace to as much as 15 inches. Average annual rainfall amounts to about 21 inches with summer months being the driest.

The present air quality of the project area is relatively good and has probably improved recently with the discontinuation of sugar cane growing in the Ewa Plain area. Air quality data from the nearest monitoring stations operated by the state Department of Health suggest that all national air quality standards are currently being met, although occasional exceedances of the more stringent state standards for ozone and for carbon monoxide may occur.

Presently, air quality in the vicinity of the project is mostly affected by emissions from vehicular, industrial, natural and/or agricultural sources. Fort Weaver Road, situated not far to the east of the project site, is a major arterial roadway that often carries heavy volumes of traffic. Prevailing winds in the area tend to carry emissions from motor vehicles using this roadway toward the project site. Several industrial sources of air pollution are located a few miles to the southwest at Barbers Point, but the prevailing winds carry emissions away from the project site more than 80 percent of the time. Natural sources of

air pollution that may affect the air quality of the site include the ocean, plants, wind-blown dust and distant volcanoes.

If the proposed project is given the necessary approvals to proceed, it is inevitable that some short- and long-term impacts on air quality will occur either directly or indirectly as a consequence of project construction and use. Short-term impacts from fugitive dust will likely occur during the project construction phase. To a lesser extent, exhaust emissions from stationary and mobile construction equipment, from the disruption of traffic, and from workers' vehicles may also affect air quality during the period of construction. State air pollution control regulations require that there be no visible fugitive dust emissions at the property line. Hence, an effective dust control plan must be implemented to ensure compliance with state regulations. Fugitive dust emissions can be controlled to a large extent by watering of active work areas, using wind screens, keeping adjacent paved roads clean, and by covering of open-bodied trucks. Other dust control measures could include limiting the area that can be disturbed at any given time and/or mulching or chemically stabilizing inactive areas that have been worked. Paving and landscaping of project areas early in the construction schedule will also reduce dust emissions. Monitoring dust at the project boundary during the period of construction should be considered as a means to evaluate the effectiveness of the project dust control program. Exhaust emissions can be mitigated by moving construction equipment and workers to and from the project site during off-peak traffic hours.

After construction, long-term impacts on air quality could potentially occur indirectly as a result of emissions emanating from vehicular traffic coming to and from the development. Access

to the project will be accomplished primarily via a new H-1 Freeway interchange and a north-south roadway constructed through the middle of the proposed development. To assess the impact of emissions from these vehicles, an air quality modeling study was undertaken to estimate future maximum ambient concentrations of carbon monoxide along roadways leading to and from the project area. Based on the modeling results, future worst-case carbon monoxide concentrations in the project vicinity would likely exceed the relatively stringent state ambient air quality standards for carbon monoxide near several roadway intersections.
Compliance with the less stringent national 1-hour standard would likely be achieved, but the exceedance of the national 8-hour standard near the high-volume intersection of Kapolei Parkway and the north-south road may potentially occur. It should be mentioned, though, that the allowable state carbon monoxide levels are set so low they are probably currently exceeded at locations near many intersections in the state that have even moderate traffic volumes. Also, due to the prediction methodology involved, estimates of 8-hour concentrations are probably conservatively high and not as reliable as the 1-hour estimates.

Other than making additional roadway improvements to further improve traffic flow and hence reduce traffic-related air pollution emissions, air quality impacts due to project traffic could perhaps be mitigated by reducing traffic through the promotion of bus service, carpooling and alternate business and school hours within the development. Also, although it is beyond the scope of the proposed projet, the state or county at some point in the future may be forced to implement a motor vehicle inspection program, which would likely reduce emissions and improve air quality.

Another potential measure to mitigate traffic-related air quality impacts might be to provide added buffer zones between walkways and roadways where space is available. Technically, however, the public would have to somehow be excluded from the buffer zones. The predicted worst-case concentrations in this report are based on a separation distance of 3 m (10 ft) between walkways and roadways. Doubling this distance to about 6 m (20 ft) would reduce maximum concentrations in some cases by about 10 to 15 percent.

Depending on the demand levels, long-term impacts on air quality are also possible due to indirect emissions associated with a development's electrical power and solid waste disposal requirements. Quantitative estimates of these potential impacts were not made, but based on the relatively low estimated emission rates involved, any impacts are unlikely. Nevertheless, requiring all new construction to incorporate energy conservation design features and promoting conservation and recycling programs within the proposed development could serve to further reduce any impacts.

In evaluating the proposed project, it may be appropriate to consider not only impacts created by the project but also potential impacts on the project from nearby industrial sources. Due to the relatively close proximity of industries located at Campbell Industrial Park, occasional impacts on the project from emissions emanating from these facilities may occur in conjunction with coincidental occurrences of industry malfunctions and kona winds, both of which are relatively infrequent events. This will likely become more of a potential problem for all of the Kapolei area as residential developments encroach closer and closer to the industrial park. Increased scrutiny by the Department of Health, an air quality task force recently mandated by the state legislature and the modernization by some industrial park tenants should help to mitigate future impacts on the proposed project.

2.0 INTRODUCTION AND PROJECT DESCRIPTION

The State of Hawaii is proposing to develop more than 8000 single and multifamily homes and associated educational, commercial and recreational facilities, including a 60-acre sports facility, on approximately 1300 acres of land in the Ewa area on the island of Oahu. The objective of the project is to generate income from state-owned land in support of a new West Oahu Campus for the University of Hawaii while creating more housing, recreational and support facilities for residents in the Ewa Development Plan area. The site of the proposed development, referred to as the East Kapolei Project, is bordered by the H-1 Freeway to the north, the Villages of Kapolei to the west, Ewa Villages to the south and undeveloped land to the east. Traffic will enter and exit the project via a new H-1 Freeway interchange and a new north-south roadway constructed through the project area. Construction of homes will be undertaken by private developers and will not commence until the year 2002 when the freeway interchange and the new roadway have been completed.

The purpose of this study is to describe existing air quality in the project area and to assess the potential short-term and long-term direct and indirect air quality impacts that could result from construction and use of the proposed facilities as planned. Measures to mitigate these impacts are suggested where possible and appropriate.

3.0 AMBIENT AIR QUALITY STANDARDS

Ambient concentrations of air pollution are regulated by both national and state ambient air quality standards (AAQS). National AAQS are specified in Section 40, Part 50 of the Code of Federal Regulations (CFR), while State of Hawaii AAQS are defined in Chapter 11-59 of the Hawaii Administrative Rules. Table 1 summarizes both the national and the state AAQS that are specified in the cited documents. As indicated in the table, national and state AAQS have been established for particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone and lead. The state has also set a standard for hydrogen sulfide. National AAQS are stated in terms of both primary and secondary standards for most of the regulated air pollutants. National primary standards are designed to protect the public health with an "adequate margin of safety". National secondary standards, on the other hand, define levels of air quality necessary to protect the public welfare from "any known or anticipated adverse effects of a pollutant". Secondary public welfare impacts may include such effects as decreased visibility, diminished comfort levels, or other potential injury to the natural or man-made environment, e.g., soiling of materials, damage to vegetation or other economic damage. In contrast to the national AAQS, Hawaii State AAQS are given in terms of a single standard that is designed "to protect public health and welfare and to prevent the significant deterioration of air quality".

Each of the regulated air pollutants has the potential to create or exacerbate some form of adverse health effect or to produce environmental degradation when present in sufficiently high concentration for prolonged periods of time. The AAQS specify a maximum allowable concentration for a given air pollutant for one or more averaging times to prevent harmful effects. Averaging times vary from one hour to one year depending on the pollutant and type of exposure necessary to cause adverse effects. In the case of the short-term (i.e., 1- to 24-hour) AAQS, both national and state standards allow a specified number of exceedances each year.

State of Hawaii AAQS are in some cases considerably more stringent than comparable national AAQS. In particular, the State of Hawaii 1-hour AAQS for carbon monoxide is four times more stringent than the comparable national limit, and the state 1-hour limit for ozone is more than two times as stringent as the national 1-hour standard. The national 1-hour ozone standard will be phased out during the next three years in favor of the new (and more stringent) 8-hour standard.

Hawaii AAQS for sulfur dioxide were relaxed in 1986 to make the state standards essentially the same as the national limits. In 1993, the state also revised its particulate standards to follow those set by the federal government. During 1997, the federal government again revised its standards for particulate. To date, the Hawaii Department of Health has not updated the state particulate standards.

4.0 REGIONAL AND LOCAL CLIMATOLOGY

Regional and local climatology significantly affects the air quality of a given location. Wind, temperature, atmospheric turbulence, mixing height and rainfall all influence air quality. Although the climate of Hawaii is relatively moderate throughout most of the state, significant differences in these parameters may occur from one location to another. Most differences in regional

and local climates within the state are caused by the mountainous topography.

Hawaii lies well within the belt of northeasterly trade winds generated by the semi-permanent Pacific high pressure cell to the north and east. On the island of Oahu, the Koolau and Waianae Mountain Ranges are oriented almost perpendicular to the trade winds, which accounts for much of the variation in the local climatology of the island. The site of the proposed project is located on the broad Ewa Plain leeward of the Koolau Mountains.

The nearest and most representative long-term wind data available for the site were collected at the Barbers Point Naval Air Station located about 3 miles to the west. Data available from the Honolulu International Airport, located about 8 miles to the east, may also be at least semi-representative. Wind frequency data given in Table 2 for Barbers Point show that the annual prevailing wind direction for this area of Oahu is east northeast (the same as at Honolulu International Airport). On an annual basis, 38.1 percent of the time the wind is from this direction, and more than 80 percent of the time the wind is in the northeast quadrant. Winds from the south are infrequent occurring only a few days during the year and mostly in winter in association with kona storms. Wind speeds average about 10 knots (12 mph) and mostly vary between about 5 and 15 knots (6 and 17 mph). Surface winds at the project site are very similar to those recorded at Barbers Point.

Air pollution emissions from motor vehicles, the formation of photochemical smog and smoke plume rise all depend in part on air temperature. Colder temperatures tend to result in higher emissions of contaminants from automobiles but lower concentrations of photochemical smog and ground-level concentrations of air pollution from elevated plumes. In Hawaii, the annual and daily variation of temperature depend to a large degree on elevation above sea level, distance inland and exposure to the trade winds. Average temperatures at locations near sea level generally are warmer than those at higher elevations. Areas exposed to the trade winds tend to have the least temperature variation, while inland and leeward areas often have the most. The project's near coastal, leeward location results in a relatively moderate temperature profile compared to other locations around Oahu and the state. Based on more than 50 years of data collected at Ewa Plantation, average annual daily minimum and maximum temperatures in the project area are 65°F and 84°F, respectively [1]. The extreme minimum temperature on record is 47°F, and the extreme maximum is 93°F.

Small scale, random motions in the atmosphere (turbulence) cause air pollutants to be dispersed as a function of distance or time from the point of emission. Turbulence is caused by both mechanical and thermal forces in the atmosphere. It is oftentimes measured and described in terms of Pasquill-Gifford stability class. Stability class 1 is the most turbulent and class 6 the least. Thus, air pollution dissipates the best during stability class 1 conditions and the worst when stability class 6 prevails. In the Ewa area, stability class 5 or 6 is generally the highest stability class that occurs, developing during clear, calm nighttime or early morning hours when temperature inversions form due to radiational cooling. Stability classes 1 through 4 occur during the daytime, depending mainly on the amount of cloud cover and incoming solar radiation and the onset and extent of the sea breeze.

Mixing height is defined as the height above the surface through which relatively vigorous vertical mixing occurs. Low mixing heights can result in high ground-level air pollution concentrations because contaminants emitted from or near the surface can become trapped within the mixing layer. In Hawaii, minimum mixing heights tend to be high because of mechanical mixing caused by the trade winds and because of the temperature moderating effect of the surrounding ocean. Low mixing heights may sometimes occur, however, at inland locations and even at times along coastal areas early in the morning following a clear, cool, windless night. Coastal areas also may experience low mixing levels during sea breeze conditions when cooler ocean air rushes in over warmer land. Mixing heights in Hawaii typically are above 3000 feet (1000 meters).

Rainfall can have a beneficial affect on the air quality of an area in that it helps to suppress fugitive dust emissions, and it also may "washout" gaseous contaminants that are water soluble. Rainfall in Hawaii is highly variable depending on elevation and on location with respect to the trade wind. The Ewa Plain is one of the driest areas on Oahu due to its leeward and near sea level location. Average annual rainfall amounts to about 21 inches but may vary from about 10 inches during a dry year to more than 40 inches during a wet year [1]. Most of the rainfall usually occurs during the winter months. Monthly rainfall may vary from as little as a trace to as much as 15 inches or more.

5.0 PRESENT AIR QUALITY

Present air quality in the project area is mostly affected by air pollutants from vehicular, industrial, natural and/or agricultural sources. Table 3 presents an air pollutant emission summary for the island of Oahu for calendar year 1993. These emission rates may provide a relative measure with which to assess the proposed project's emissions presented later in this study. The emission rates shown in the table pertain to manmade emissions only, i.e., emissions from natural sources are not included. As suggested in the table, much of the particulate emissions on Oahu originate from area sources, such as the mineral products industry and agriculture. Sulfur oxides are emitted almost exclusively by point sources, such as power plants and refineries. Nitrogen oxides emissions emanate predominantly from industrial point sources, although area sources (mostly motor vehicle traffic) also contribute a significant share. The majority of carbon monoxide emissions occur from area sources (motor vehicle traffic), while hydrocarbons are emitted mainly from point sources. Based on previous emission inventories that have been reported for Oahu, it appears that emissions of particulate and nitrogen oxides have increased during the past ten years, while emissions of sulfur oxides, carbon monoxide and hydrocarbons have declined.

Fort Weaver Road, located about 1 mile to the east of the project site, is a major arterial roadway that presently carries moderate to heavy levels of vehicle traffic during peak traffic hours. Emissions from motor vehicles using this roadway, primarily nitrogen oxides and carbon monoxide, will tend to be carried over the project site by the prevailing winds. Similar emissions emanating from traffic on the H-1 Freeway, running along the

northern boundary of the project, may also impact the site when winds shift slightly to the north.

Several sources of industrial air pollution are located in the Campbell Industrial Park, which is located about 4 miles to the southwest at Barbers Point. Industries currently operating there include the Chevron and BHP refineries, H-Power, Kalaeloa Partners, Applied Energy Services, Hawaiian Cement and others. Hawaiian Electric Company's Kahe Generating Station is located about 5 miles to the west at Kahe Point. These industries emit large amounts of sulfur dioxide, nitrogen oxides, particulate matter, carbon monoxide and other air pollutants. Prevailing winds from the east or northeast will carry these emissions away from the site most of the time.

Until recently, air pollution in the project area originating from agricultural sources could mainly be attributed to sugar cane operations near the project site. Emissions from both the mill and the canefield operations in the area have now been eliminated with the closure of the Oahu Sugar Company and much of the former sugarcane lands are currently being used as pastureland or for diversified agriculture. Long-range uses for the land have not yet been determined.

Natural sources of air pollution emissions that also could affect the project area but cannot be quantified very accurately include the ocean (sea spray), plants (aero-allergens), wind-blown dust, and perhaps distant volcanoes on the island of Hawaii.

The State Department of Health operates a network of air quality monitoring stations at various locations on Oahu. Each station, however, typically does not monitor the full complement of air quality parameters. Table 4 shows an annual summary of air quality measurements that were made nearest to the project site for each of the regulated air pollutants for the period 1989 through 1993. These are the most recent data that are currently available.

During the years 1991 to 1993, sulfur dioxide was monitored by the State Department of Health at an air quality station located at Makaiwa Gulch about 4 miles to the west of the project site. There were no exceedances of the state/national 24-hour AAQS for sulfur dioxide during the 3-year period. Concentrations monitored were consistently low with 24-hour averages ranging from near 0 to 47 $\mu g/m^3$.

The nearest monitoring station for particulate matter less than 10 microns in diameter (PM-10) was located at Kapolei about 3 miles to the southwest. Twenty-four hour average PM-10 concentrations monitored at this location ranged from 8 to 164 $\mu g/m^3$ from 1991 through 1993. Average daily concentrations were approximately 25 $\mu g/m^3$. One exceedance of the state and national AAQS was reported.

The nearest carbon monoxide measurements were made at West Beach, about 4 miles to the west of the project site. During the period, the average daily maximum 1-hour concentration measured at this location was less than 1 mg/m^3. During the most recent year reported, 1993, the daily maximum 1-hour concentration

ranged from 0 to 17.8 mg/m^3, with two exceedances of the state 1-hour AAQS recorded. The national AAQS was not exceeded. During previous years (1991-92), maximum 1-hour concentrations were lower and did not exceed the state AAQS. Daily maximum 8-hour values for 1989-93 have not been reported at this writing, but concentrations for earlier years were less than 5 mg/m^3 and averaged about 1.3 mg/m^3. No exceedances of the state or national 8-hour AAQS have been reported.

The nearest available ozone measurements were obtained at Sand Island (about 10 miles southeast of the project site). The maximum 1-hour concentration for each year from 1990 to 1993 has averaged 118 $\mu g/m^3$ and two to seven exceedances of the state AAQS per year have been recorded. Ozone concentrations were somewhat lower during 1989 when a maximum concentration of 96 $\mu g/m^3$ was measured and no exceedances of the state standard were registered.

The nearest and most recent measurements of ambient lead concentrations that have been reported were made at the downtown Honolulu monitoring station between 1991 and 1993. Lead concentrations at this location have had a downward trend for several years, most probably reflecting the increased use of unleaded gasoline. Average quarterly concentrations were near or below the detection limit, and no exceedances of the state AAQS were recorded. Monitoring for this parameter was discontinued during 1988 and resumed in 1991.

Nitrogen dioxide was not monitored by the Department of Health anywhere in the state during the first four years of the 1989-93 reporting period. In 1993 measurements were taken at Kapolei and the annual mean value reported was 12 $\mu g/m^3$, safely inside the state and national AAQS.

Based on the data and discussion presented above, it appears likely that the Hawaii AAQS for sulfur dioxide, nitrogen dioxide, lead and, with the closing of the Oahu Sugar Company, probably particulate matter are currently being met at the project site. It is likely, however, that the state AAQS for ozone may be exceeded on occasion based on the Sand Island measurements for this parameter. Carbon monoxide readings from West Beach indicate that the state AAQS for carbon monoxide may also be exceeded at a rate of about one to two times per year (although previous exceedances may have been related to sugarcane burning).

6.0 SHORT-TERM IMPACTS OF PROJECT

Short-term direct and indirect impacts on air quality could potentially occur due to project construction. For a project of this nature, there are two potential types of air pollution emissions that could directly result in short-term air quality impacts during project construction: (1) fugitive dust from vehicle movement and soil excavation; and (2) exhaust emissions from on-site construction equipment. Indirectly, there also could be short-term impacts related to slow-moving construction equipment traveling to and from the project site and from a temporary increase in local traffic caused by commuting construction workers.

Fugitive dust emissions may arise from the grading and dirt-moving activities associated with site clearing and preparation work. The emission rate for fugitive dust emissions from construction activities is difficult to estimate accurately because of its

elusive nature of emission and because the potential for its generation varies greatly depending upon the type of soil at the construction site, the amount and type of dirt-disturbing activity taking place, the moisture content of exposed soil in work areas, and the wind speed. The EPA [2] has provided a rough estimate for uncontrolled fugitive dust emissions from construction activity of 1.2 tons per acre per month under conditions of "medium" activity, moderate soil silt content (30%), and precipitation/evaporation (P/E) index of 50. Uncontrolled fugitive dust emissions in the project area would likely be higher because the PE index for the Ewa Plain area is less than 50 due to the relatively dry climate and because the soil silt content in the area is probably greater than 30 percent. In any case, State of Hawaii Air Pollution Control Regulations [3] prohibit visible emissions of fugitive dust from construction activities at the property line. Thus, an effective dust control plan for the project construction phase is essential.

Adequate fugitive dust control can usually be accomplished by the establishment of a frequent watering program to keep bare-dirt surfaces in construction areas from becoming significant sources of dust. In dust-prone or dust-sensitive areas, other control measures such as limiting the area that can be disturbed at any given time, applying chemical soil stabilizers, mulching and/or using wind screens may be necessary. Control regulations further stipulate that open-bodied trucks be covered at all times when in motion if they are transporting materials that could be blown away.

Haul trucks tracking dirt onto paved streets from unpaved areas is oftentimes a significant source of dust in construction areas. Some means to alleviate this problem, such as road cleaning or tire washing, may be appropriate. Paving of parking areas and/or establishment of landscaping as early in the construction schedule as possible can also lower the potential for fugitive dust emissions. Monitoring dust at the project property line could be considered to quantify and document the effectiveness of dust control measures.

On-site mobile and stationary construction equipment also will emit air pollutants from engine exhausts. The largest of this equipment is usually diesel-powered. Nitrogen oxides emissions from diesel engines can be relatively high compared to gasoline-powered equipment, but the standard for nitrogen dioxide is set on an annual basis and is not likely to be violated by short-term construction equipment emissions. Carbon monoxide emissions from diesel engines, on the other hand, are low and should be relatively insignificant compared to vehicular emissions on nearby roadways.

Slow-moving construction vehicles traveling on roadways leading to and from the project site could obstruct the normal flow of traffic to such an extent that overall vehicular emissions are increased, but this impact can be mitigated by moving heavy construction equipment during periods of low traffic volume. Likewise, the schedules of commuting construction workers can be adjusted to avoid peak hours in the project vicinity. Thus, most potential short-term air quality impacts from project construction can be mitigated.

7.0 LONG-TERM IMPACTS OF PROJECT

7.1 Roadway Traffic

After construction is completed, use of the proposed facilities will result in increased motor vehicle traffic in the project area, potentially causing long-term impacts on ambient air quality.

Motor vehicles with gasoline-powered engines are significant sources of carbon monoxide. They also emit nitrogen oxides and other contaminates.

Federal air pollution control regulations require that new motor vehicles be equipped with emission control devices that reduce emissions significantly compared to a few years ago. In 1990, the President signed into law the Clean Air Act Amendments. This legislation requires further emission reductions which have been phased in since 1994. The restrictions on emissions from new motor vehicles will lower average emissions each year as more and more older vehicles leave the state's roadways. Carbon monoxide emissions, for example, will go down by an average of about 10 percent per vehicle during the next 10 years due to the replacement of older vehicles with newer models.

To evaluate the potential long-term indirect ambient air quality impact of increased roadway traffic associated with a project such as this, computerized emission and atmospheric dispersion models can be used to estimate ambient carbon monoxide concentrations along roadways leading to and from the project. Carbon monoxide is selected for modeling because it is both the most stable and the most abundant of the pollutants generated by motor vehicles. Furthermore, carbon monoxide air pollution is generally considered to be a microscale problem that can be addressed locally to some extent, whereas nitrogen oxides air pollution most often is a regional issue that cannot be addressed by a single new development.

To begin the modeling study, critical receptor areas in the vicinity of the project were identified for analysis. Generally speaking, roadway intersections are the primary concern because of traffic congestion and because of the increase in vehicular emissions associated with traffic queuing. For this study, the nine key intersections identified in the traffic study were also selected for air quality analysis. These included the following intersections:

- Farrington Highway at the project access road to areas A and B;
- Farrington Highway at the project access road to areas K and L;
- East Kapolei Avenue at the north-south road; the east-west road at the project access road to areas B and C;
- the east-west road at the project access road to area C;
- the east-west road at the west project access road to areas I and J;
- the east-west road at the east project access road to areas I and J;
- Kapolei Parkway at the north-south road;
- Kapolei Parkway at the project access road to areas F and G.

The traffic impact assessment report for the project [4] describes the projected future traffic conditions and laneage configurations of these intersections in detail.

The main objective of the modeling study was to estimate maximum 1-hour average carbon monoxide concentrations for the future with-project scenario. To evaluate the significance of the estimated concentrations, the predicted values can be compared to the national and state AAQS.

The traffic impact assessment report indicates that traffic volumes generally will be higher during the afternoon peak hour than during the morning peak period. However, to help ensure that worst-case concentrations were identified, both morning and afternoon peak-traffic hours were examined.

The EPA computer model MOBILE5A was used to calculate vehicular carbon monoxide emissions for each year studied. One of the key inputs to MOBILE5A is vehicle mix. Unless very detailed information is available, national average values are typically assumed, which is what was used for the present study. Based on national average vehicle mix figures, the projected vehicle mix in the project area was estimated to be 57.5% light-duty gasoline-powered automobiles, 29.6% light-duty gasoline-powered trucks and vans, 3.4% heavy-duty gasoline-powered vehicles, 0.7% light-duty diesel-powered vehicles, 8.4% heavy-duty diesel-powered trucks and buses, and 0.4% motorcycles.

Other key inputs to the MOBILE5A emission model are the cold/hot start fractions. Motor vehicles operating in a cold- or hot-start mode emit excess air pollution. Typically, motor vehicles reach stabilized operating temperatures after about 4 miles of driving. For traffic operating within the project area, it was assumed that about 21 percent of all vehicles would be operating in the cold-start mode and that about 27 percent would be operating in the hot-start mode. These are typical default (national average) values.

Ambient temperatures of 59 and 68 degrees F were used for weekday morning and afternoon peak-hour emission computations, respectively. These are conservative assumptions since morning/afternoon ambient temperatures will generally be warmer than this, and emission estimates given by MOBILE5A are inversely proportional to the ambient temperature.

After computing vehicular carbon monoxide emissions through the use of MOBILE5A, these data were then input to an atmospheric dispersion model. EPA air quality modeling guidelines [5] currently recommend that the computer model CAL3QHC [6] be used to assess carbon monoxide concentrations at roadway intersections, or in areas where its use has previously been established, CALINE4 [7] may be used. Until recently, CALINE4 was used extensively in Hawaii to assess air quality impacts at roadway intersections. In December 1997, the California Department of Transportation recommended that the intersection mode of CALINE4 no longer be used because it was thought the model has become outdated. Studies have shown that CALINE4 may tend to over-predict maximum concentrations in some situations. Therefore, CAL3QHC was used for the subject analysis.

CAL3QHC was developed for the U.S. EPA to simulate vehicular movement, vehicle queuing and atmospheric dispersion of vehicular emissions near roadway intersections. It is designed to predict 1-hour average pollutant concentrations near roadway intersections based on input traffic and emission data, roadway/receptor geometry and meteorological conditions.

Input peak-hour traffic data were obtained from the traffic study cited previously. This included vehicle approach volumes,

saturation capacity estimates, intersection laneage and signal timings. At signalized intersections, all emission factors that were input to CAL3QHC for free-flow traffic were obtained from MOBILE5A based on an assumed free-flow vehicle speed of 25 mph. At unsignalized intersections, a base free-flow speed of 15 mph was assumed for the stop-controlled approaches, and this was adjusted downward based on the volume/capacity ratio of the approach; a free-flow speed of 25 mph was assumed for the non-stop approaches.

Model roadways were set up to reflect roadway geometry, physical dimensions and operating characteristics. For the future scenario that was studied, it was assumed that sidewalks would exist along all roadways within the project area. Concentrations predicted by air quality models generally are not considered valid within the roadway mixing zone. The roadway mixing zone is usually taken to include 3 meters on either side of the traveled portion of the roadway and the turbulent area within 10 meters of a cross street. Model receptor sites were thus located at the edges of the mixing zones near all intersections that were studied. All receptor heights were placed at 1.8 meters above ground to simulate levels within the normal human breathing zone.

Input meteorological conditions for this study were defined to provide "worst-case" results. One of the key meteorological inputs is atmospheric stability category. For these analyses, atmospheric stability category 5 was assumed for both the morning and the afternoon peak-hour traffic periods. This is the most conservative stability category that is generally used for estimating worst-case pollutant dispersion within suburban areas for these periods. A surface roughness length of 100 cm and a mixing height of 300 meters were used in all cases. Worst-case wind conditions were defined as a wind speed of 1 meter per second with a wind direction resulting in the highest predicted concentration. Concentration estimates were calculated at wind directions of every 5 degrees.

A background carbon monoxide concentration of 1 ppm (1.2 mg/m^3) was assumed for the future (2020) year studied. This is probably conservatively high based on the average concentrations currently measured in urban areas of Oahu.

Predicted Worst-Case 1-Hour Concentrations

Table 5 summarizes the final results of the modeling study in the form of the estimated worst-case 1-hour morning and afternoon ambient carbon monoxide concentrations. These results can be compared directly to the state and the national AAQS (which are noted in the table). Estimated worst-case carbon monoxide concentrations are presented in the table for the 2020 with-project scenario only. The locations of these estimated worst-case 1-hour concentrations all occurred at or very near the indicated intersections.

As indicated in the table, the estimated highest worst-case 1-hour carbon monoxide concentration in the project area in the year 2020 with the project, 21.0 mg/m^3, was predicted to occur during the morning peak hour near the intersection of Kapolei Parkway and the north-south road. The afternoon peak-hour value was estimated to be about 6 percent lower at this location. This intersection is projected to carry nearly 7000 vehicles per hour during peak periods, which is comparable to some of the busiest intersections that currently exist on Oahu. Worst-case concentrations at another location along Kapolei Parkway, Kapolei Parkway at the project

access road to areas F and G, were estimated to be 14.6 mg/m^3 during the morning peak-hour and 13.5 mg/m^3 during the afternoon peak-hour. The estimated worst-case 1-hour concentrations at other locations in the vicinity of the proposed project ranged from 3.1 mg/m^3 during the afternoon peak-hour at the intersection of Farrington Highway and the project access road to areas K and L to 10.8 mg/m^3 during the afternoon peak-hour at the intersection of East Kapolei Avenue and the north-south road.

All estimated worst-case 1-hour carbon monoxide levels were within the national AAQS of 40 mg/m^3. However, future worst-case concentrations with the project were predicted to exceed the more stringent state 1-hour standard of 10 mg/m^3 at five of the nine intersections studied.

Predicted Worst-Case 8-Hour Concentrations

Worst-case 8-hour carbon monoxide concentrations were estimated by multiplying the worst-case 1-hour values by a persistence factor of 0.5. This accounts for two factors: (1) traffic volumes averaged over eight hours are lower than peak 1-hour values, and (2) meteorological dispersion conditions are more variable (and hence more favorable) over an 8-hour period than they are for a single hour. Based on monitoring data, 1-hour to 8-hour persistence factors for most locations generally vary from 0.4 to 0.8 with 0.6 being the most typical. One recent study based on modeling [8] concluded that 1-hour to 8-hour persistence factors could typically be expected to range from 0.4 to 0.5. EPA guidelines [9] recommend using a value of 0.6 to 0.7 unless a locally derived persistence factor is available. Recent monitoring data for Honolulu reported by the Department of Health [10] suggest that this factor may range between about 0.35 and 0.55 depending on location and traffic variability. Considering the location of the project and the probable traffic pattern for the area, a 1-hour to 8-hour persistence factor of 0.5 will likely yield reasonable estimates of worst-case 8-hour concentration.

The resulting estimated worst-case 8-hour concentrations are indicated in Table 6. With the project in the year 2020, the highest estimated worst-case concentration in the project area was 10.5 mg/m^3 and was predicted to occur near the intersection of Kapolei Parkway and the north-south road. A value of 7.3 mg/m^3 was predicted to occur near the intersection of Kapolei Parkway and the project access road to areas F and G. Concentrations at other locations ranged from 1.8 mg/m^3 at the intersection of Farrington Highway and the project access road to areas K and L to 5.4 mg/m^3 at the intersection of East Kapolei Avenue and the north-south road.

Comparing the predicted values to the AAQS, it appears that worst-case 8-hour concentrations could exceed the state AAQS at five of the nine intersections studied and that one location, the intersection of Kapolei Parkway and the north-south road, could potentially exceed the national 8-hour AAQS.

Conservativeness of Estimates

The results of this study reflect several assumptions that were made concerning both traffic movement and worst-case meteorological conditions. One such assumption concerning worst-case meteorological conditions is that a wind speed of 1 meter per second with a steady direction for 1 hour will occur. A steady wind of 1 meter per second blowing from a single direction for an hour is extremely unlikely and may occur only once a year or less. With wind speeds of 2 meters per second, for example, computed carbon monoxide concentrations would be only about half the values given above. The 8-hour estimates are also conservative in that it is unlikely that anyone would occupy the assumed receptor sites (within 3 m of the roadways) for a period of 8 hours.

7.2 Electrical Demand

The proposed project is not expected to create a demand for housing on Oahu, but instead it is expected to help fulfill the future demand. Nevertheless, supplying the project with electrical power will cause indirect air pollution emissions from power generating facilities. The annual electrical demand of the project when fully developed is not expected to exceed about 200 million kilowatt-hours. Electrical power for the project will most probably be provided mainly by oil-fired generating facilities located on Oahu. However, with H-Power and a coal-fired power plant now online at Campbell Industrial Park, some of the project power may well come from sources burning other fuels. In order to meet the electrical power needs of the proposed project, power generating facilities will be required to burn more fuel and hence more air pollution will be emitted at these facilities. Given in Table 7 are estimates of the indirect air pollution emissions that would result from the project electrical demand assuming all power is provided by burning more fuel oil at Oahu's power plants. Based on the 1993 Oahu emission inventory given in Table 3, the estimated indirect emissions from the project electrical demand would result in an increase of about 1 percent or less of the current island-wide emissions on Oahu. If power is supplied instead or in part by coal or solid waste burning facilities, emissions will likely be higher than the estimated values.

7.3 Solid Waste Disposal

Solid waste generated by the project when fully completed is expected to amount to about 170 tons of refuse per day (about 28 6-ton truckloads per day). Most project refuse will likely be hauled away and burned at the H-Power facility at Campbell Industrial Park to generate electricity. Burning of the waste to generate electricity will result in emissions of particulate, carbon monoxide, sulfur dioxide, nitrogen oxides and other contaminants, but these will be offset to some extent by reducing the amount of fuel oil that would be required to generate electricity for the project. Table 8 gives emission estimates assuming all project solid waste is burned at H-Power. With the high level of emission control achieved at H-Power, emission quantities from the burning of project solid waste would be relatively small amounting to much less than 1 percent of the current emission levels on Oahu.

8.0 IMPACTS ON PROJECT FROM CAMPBELL INDUSTRIAL PARK

In addition to assessing the air quality impacts of the project on the surrounding area, the reverse problem of impacts of air pollution sources located in the surrounding area on the residents

of the project is also of concern. For the East Kapolei Project, the issue of primary concern is the Campbell Industrial Park (CIP) located about 4 miles southwest of the project site. Several large industrial sources of air pollution are located at CIP including Applied Energy Systems (AES) Generating Station, Kalaeloa Partners Cogeneration Plant, the Chevron and BHP Refineries, H-Power and Hawaiian Cement. During the past few years, several incidents of acute air pollution levels have occurred in areas within and adjacent to CIP. Some of these incidents have been caused by upset conditions at the BHP and Chevron Refineries, while the source or sources of other incidents have never been identified.

As indicated in Section 4, the trade winds will carry emissions from CIP away from the project site more than 80 percent of the time. Winds from the south or southwest (kona winds), which could carry emissions toward the site, occur less than about 5 percent of the time. While estimating specific air pollution levels at the project site during kona wind conditions is beyond the scope of the present study, it is unlikely that concentrations exceed air quality standards during normal operations. Emissions during normal operations are regulated by the Hawaii Department of Health, and industry operators are required to demonstrate compliance with state and national air quality standards. Perhaps the greatest concern is the coincidence of industry malfunctions and kona winds. Even if industry operators are very diligent in operating and maintaining their facilities, occasional malfunctions that result in air pollution incidents in nearby areas are probably unavoidable.

9.0 CONCLUSIONS AND RECOMMENDATIONS

The major potential short-term air quality impact of the project will occur from the emission of fugitive dust during construction. Uncontrolled fugitive dust emissions from construction activities are estimated to amount to about 1.2 tons per acre per month, depending on rainfall. To control dust, active work areas and any temporary unpaved work roads should be watered at least twice daily on days without rainfall. Use of wind screens and/or limiting the area that is disturbed at any given time will also help to contain fugitive dust emissions. Wind erosion of inactive areas of the site that have been disturbed could be controlled by mulching or by the use of chemical soil stabilizers. Dirt-hauling trucks should be covered when traveling on roadways to prevent windage. A routine road cleaning and/or tire washing program will also help to reduce fugitive dust emissions that may occur as a result of trucks tracking dirt onto paved roadways in the project area. Paving of parking areas and establishment of landscaping early in the construction schedule will also help to control dust. Monitoring dust at the project boundary during the period of construction should be considered as a means to evaluate the effectiveness of the project dust control program and to adjust the program if necessary.

During construction phases, emissions from engine exhausts (primarily consisting of carbon monoxide and nitrogen oxides) will also occur both from on-site construction equipment and from vehicles used by construction workers and from trucks traveling to and from the project. Increased vehicular emissions due to disruption of traffic by construction equipment and/or commuting construction workers can be alleviated by moving equipment and personnel to the site during off-peak traffic hours.

After the project is completed, long-term air pollution impacts from carbon monoxide emitted by motor vehicle traffic associated with the development may cause or contribute to the exceedance of the state 1-hour and 8-hour ambient air quality standards at locations near roadway intersections in the project area. Compliance with the less stringent national 1-hour standard would likely be achieved, but the exceedance of the national 8-hour standard near the high-volume intersection of Kapolei Parkway and the north-south road may potentially occur. It should be mentioned, though, that the allowable state carbon monoxide levels are set so low they are probably currently exceeded at locations near many intersections in the state that have even moderate traffic volumes. Also, due to the prediction methodology involved, estimates of 8-hour concentrations are probably conservatively high and not as reliable as the 1-hour estimates.

Options available to mitigate long-term, traffic-related air pollution are generally to improve roadways, to reduce individual vehicular emissions or to reduce traffic volumes. Improving roadways may not always provide reductions in maximum carbon monoxide concentrations. In some cases, roadway improvements may actually result in higher maximum concentrations when, for example, traffic lanes are added and more traffic becomes concentrated near an intersection. Reduction of emissions from individual vehicles would have to be achieved through the promulgation of local, state or federal air pollution control regulations, which is probably beyond the scope or ability of the proposed project. Currently, the state standards for tailpipe emissions are not commensurate with the stringent state air quality standards. Also, Hawaii currently does not require annual inspections of motor vehicle air pollution control equipment, which would likely provide reduced emissions and improved air quality. Perhaps the only practical way for the proposed project to reduce air quality impacts would be to attempt to reduce project-related traffic during peak traffic hours, although this type of mitigation measure is generally considered only partially successful. Reducing traffic volumes could conceivably be achieved by promoting bus service and car pooling and/or by adjusting local school and business hours to begin and end during off-peak times.

Another potential mitigation measure might be to provide added buffer zones between new walkways and roadways where possible, although technically, the public would have to somehow be excluded from the buffer zones. The predicted worst-case concentrations in this report are based on a separation distance of 3 m (10 ft) between walkways and roadways. Doubling this distance to about 6 m (20 ft) would reduce maximum concentrations by about 10 to 15 percent.

Any long-term impacts on air quality due to indirect emissions from supplying the project with electricity and from the disposal of waste materials generated by the project will likely be insignificant based on the relatively small magnitudes of these emissions. Nevertheless, indirect emissions from project electrical demand could likely be reduced somewhat by incorporating energy-saving features into project design requirements. This might include the use of solar water heaters; designing building space so that window positions maximize indoor light without unduly increasing indoor heat; using landscaping where feasible to provide afternoon shade to cut down on the use of air conditioning; installation of insulation and double-glazed doors to reduce the effects of the sun and heat; providing movable, controlled openings for ventilation at opportune times; and possibly installing automated room occupancy

sensors. Solid waste related air pollution could likely be reduced somewhat by the promotion of conservation and recycling programs within the proposed development. This could reduce solid waste volumes, which would in turn reduce any related air pollution emissions proportionately.

Due to the relatively close proximity of industries located at CIP, occasional impacts on the project from emissions emanating from these facilities will probably be unavoidable. Such impacts may occur in conjunction with the coincidental occurrences of industry malfunctions and kona winds, both of which are relatively infrequent events. This will likely become more of a potential problem for the Kapolei area as residential developments encroach closer and closer to CIP. Because of recent incidents in the area, the Department of Health has begun to scrutinize emissions more closely, and the state legislature has mandated that an air quality task force be organized to assess and monitor emissions in the area. Also, some industries located at CIP, such as Chevron, have recently announced plans to upgrade their facilities in an effort to reduce air pollution incidents that impact nearby areas. All of these measures should help to mitigate future impacts on areas adjacent to CIP.

REFERENCES

1. "Climatic Summary of the United States, Supplement for 1951 through 1960, Hawaii and Pacific", U.S. Department of Commerce, Weather Bureau, Washington, D.C., 1965.

2. Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, Fifth Edition, AP-42, U.S. Environmental Protection Agency, Research Triangle Park, NC, January 1995.

3. State of Hawaii. Hawaii Administrative Rules, Chapter 11-60, Air Pollution Control.

4. Julian Ng, Inc., Traffic Report, East Kapolei Project, Draft, April 17, 1998.

5. Guideline on Air Quality Models (Revised), Including Supplements A and B, EPA-450/2-78-027R, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1986.

6. User's Guide to CAL3QHC Version 2.0: A Modeling Methodology for Predicting Pollutant Concentrations Near Roadway Intersections, U.S. Environmental Protection Agency, November 1992.

7. CALINE4 - A Dispersion Model for Predicting Air Pollutant Concentrations Near Roadways, FHWA/CA/TL-84/15, California State Department of Transportation, November 1984 with June 1989 Revisions.

8. "Persistence Factors for Mobile Source (Roadway) Carbon Monoxide Modeling", C. David Cooper, Journal of the Air & Waste Management Association, Volume 39, Number 5, May 1989.

9. Guideline for Modeling Carbon Monoxide from Roadway Intersections, U.S. Environmental Protection Agency, EPA-454/R-92-005, November 1992.

10. Hawaii Air Quality Data for the Period of January 1988 to December 1993, State of Hawaii Department of Health.

Table 1

SUMMARY OF STATE OF HAWAII AND NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Units	Averaging Time	Maximum Allowable Concentration		
			National Primary	National Secondary	State of Hawaii
Particulate Matter (<10 microns)	µg/m³	Annual 24 Hours	50[a] 150[b]	50[a] 150[b]	50 150[c]
Particulate Matter (<2.5 microns)	µg/m³	Annual 24 Hours	15[a] 65[d]	15[a] 65[d]	- -
Sulfur Dioxide	µg/m³	Annual 24 Hours 3 Hours	80 365[c] -	- - 1300[c]	80 365[c] 1300[c]
Nitrogen Dioxide	µg/m³	Annual	100	100	70
Carbon Monoxide	mg/m³	8 Hours 1 Hour	10[c] 40[c]	- -	5[c] 10[c]
Ozone	µg/m³	8 Hours 1 Hour	157[e] 235[f]	157[e] 235[f]	- 100[c]
Lead	µg/m³	Calendar Quarter	1.5	1.5	1.5
Hydrogen Sulfide	µg/m³	1 Hour	-	-	35[c]

[a] Three-year average of annual arithmetic mean.
[b] 99th percentile value averaged over three years.
[c] Not to be exceeded more than once per year.
[d] 98th percentile value averaged over three years.
[e] Three-year average of fourth-highest daily 8-hour maximum.
[f] Standard is attained when the expected number of exceedances is less than or equal to 1.

Table 2

ANNUAL WIND FREQUENCY FOR BARBERS POINT, OAHU (%)

Wind Direction	Wind Speed (knots) 0-3	4-6	7-10	11-16	17-21	>21	Total
N	0.1	0.4	0.3	0.1	0.0	0.0	0.9
NNE	0.4	1.5	2.3	1.1	0.2	0.0	5.5
NE	1.2	7.9	5.8	2.6	0.2	0.0	17.8
ENE	2.7	16.2	12.0	7.0	0.2	0.0	38.1
E	0.8	6.2	8.3	4.4	0.1	0.0	19.8
ESE	0.2	0.4	1.2	0.7	0.0	0.0	2.5
SE	0.0	0.3	1.2	1.3	0.0	0.0	2.9
SSE	0.0	0.3	1.1	1.0	0.1	0.0	2.5
S	0.1	0.6	1.5	0.7	0.2	0.0	3.1
SSW	0.1	0.3	0.8	0.3	0.0	0.0	1.5
SW	0.0	0.2	0.5	0.3	0.0	0.0	1.1
WSW	0.0	0.1	0.5	0.3	0.0	0.0	1.0
W	0.1	0.2	0.5	0.4	0.0	0.0	1.2
WNW	0.0	0.1	0.4	0.4	0.0	0.0	0.9
NW	0.0	0.1	0.2	0.2	0.0	0.0	0.5
NNW	0.0	0.2	0.1	0.0	0.0	0.0	0.3
CALM	0.4						0.4
TOTAL	6.1	35.0	36.8	20.8	1.2	0.1	100.0

Source: "Monthly and Annual Wind Distribution/Pasquill Stability Classes, STAR Program, Barbers Point Hawaii, 1/72-12/76, 8 Observations/Day" , U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Data Service, National Climatic Center, Asheville, NC.

Table 3

AIR POLLUTION EMISSIONS INVENTORY FOR ISLAND OF OAHU, 1993

Air Pollutant	Point Sources (tons/year)	Area Sources (tons/year)	Total (tons/year)
Particulate	25,891	49,374	75,265
Sulfur Oxides	39,230	nil	39,230
Nitrogen Oxides	92,436	31,141	123,577
Carbon Monoxide	28,757	121,802	150,559
Hydrocarbons	4,160	421	4,581

Source: Final Report, "Review, Revise and Update of the Hawaii Emissions Inventory Systems for the State of Hawaii", prepared for Hawaii Department of Health by J.L. Shoemaker & Associates, Inc., 1996

Table 4

ANNUAL SUMMARIES OF AIR QUALITY MEASUREMENTS
FOR MONITORING STATIONS NEAREST
EAST KAPOLEI PROJECT

Parameter / Location	1989	1990	1991	1992	1993
Sulfur Dioxide / Makaiwa Gulch					
No. of 24-Hr Samples	-	-	329	327	284
Range of 24-Hr Values (µg/m3)	-	-	0-28	0-27	0-47
Average Daily Value (µg/m3)	-	-	3	4	3
No. of State AAQS Exceedances	-	-	0	0	0
PM-10 / Kapolei					
No. of 24-Hr Samples	-	-	39	48	54
Range of 24-Hr Values (µg/m3)	-	-	11-71	8-164	11-60
Average Daily Value (µg/m3)	-	-	24	27	24
No. of State AAQS Exceedances	-	-	0	1	0
Carbon Monoxide / West Beach					
No. of Days of 1-Hr Samples	-	-	183	313	309
Range of Daily Max. 1-Hr Values (mg/m3)	-	-	0.1-8.0	0.0-1.7	0.0-17.8
Avg. Daily Maximum 1-Hr Value (mg/m3)	-	-	0.9	0.4	0.7
No. of State 1-Hr AAQS Exceedances	-	-	0	0	2
Ozone / Sand Island					
No. of Days of 1-Hr Samples	342	340	312	298	290
Range of Daily Max. 1-Hr Values (µg/m3)	0-96	4-114	9-120	9-126	21-111
Avg. Daily Maximum 1-hr Value (µg/m3)	15	36	50	54	48
No. of State AAQS Exceedances	0	2	3	6	7
Lead / Downtown Honolulu					
No. of 24-Hr Samples	-	-	50	44	51
Range of 24-Hr Values (µg/m3)	-	-	0-0.1	0-0.1	0-0.1
Average Quarterly Value (µg/m3)	-	-	0.0	0.0	0.0
No. of State AAQS Exceedances	-	-	0	0	0
Nitrogen Dioxide / Kapolei					
No. of 24-Hr Samples	-	-	-	-	131
Range of 24-Hr Values (µg/m3)	-	-	-	-	4-29
Average Daily Value (µg/m3)	-	-	-	-	12
No. of State AAQS Exceedances	-	-	-	-	0

Source: State of Hawaii Department of Health

Table 5

ESTIMATED WORST-CASE 1-HOUR CARBON MONOXIDE CONCENTRATIONS
ALONG ROADWAYS NEAR EAST KAPOLEI PROJECT
(milligrams per cubic meter)

Roadway Intersection	Year 2020 With Project	
	AM Peak Hour	PM Peak Hour
Farrington Highway at Road to Areas A and B	7.7	9.0
Farrington Highway at Road to Areas K and L	3.6	3.1
East Kapolei Avenue at North-South Road	9.3	10.8
East-West Road at Road to Areas B and C	10.1	10.0
East-West Road at Road to Area C	8.6	8.0
East-West Road at West Road to Areas I and J	9.8	10.4
East-West Road at East Road to Areas I and J	8.6	9.0
Kapolei Parkway at North-South Road	21.0	19.7
Kapolei Parkway at Road to Areas F and G	14.6	13.5

Hawaii State AAQS: 10
National AAQS: 40

Table 4

ANNUAL SUMMARIES OF AIR QUALITY MEASUREMENTS
FOR MONITORING STATIONS NEAREST
EAST KAPOLEI PROJECT

Parameter / Location	1989	1990	1991	1992	1993
Sulfur Dioxide / Makaiwa Gulch					
No. of 24-Hr Samples	-	-	329	327	286
Range of 24-Hr Values (µg/m3)	-	-	0-28	0-27	0-47
Average Daily Value (µg/m3)	-	-	3	4	3
No. of State AAQS Exceedances	-	-	0	0	0
PM-10 / Kapolei					
No. of 24-Hr Samples	-	-	39	48	54
Range of 24-Hr Values (µg/m3)	-	-	11-71	8-164	11-60
Average Daily Value (µg/m3)	-	-	24	27	24
No. of State AAQS Exceedances	-	-	0	1	0
Carbon Monoxide / West Beach					
No. of Days of 1-Hr Samples	-	-	183	313	309
Range of Daily Max. 1-Hr Values (mg/m3)	-	-	0.1-8.0	0.0-1.7	0.0-17.8
Avg. Daily Maximum 1-Hr Value (mg/m3)	-	-	0.9	0.4	0.7
No. of State 1-Hr AAQS Exceedances	-	-	0	0	2
Ozone / Sand Island					
No. of Days of 1-Hr Samples	342	340	312	298	290
Range of Daily Max. 1-Hr Values (µg/m3)	0-96	4-116	9-120	9-126	21-111
Avg. Daily Maximum 1-hr Value (µg/m3)	15	36	50	54	68
No. of State AAQS Exceedances	0	2	3	6	7
Lead / Downtown Honolulu					
No. of 24-Hr Samples	-	-	50	44	51
Range of 24-Hr Values (µg/m3)	-	-	0-0.1	0-0.1	0-0.1
Average Quarterly Value (µg/m3)	-	-	0.0	0.0	0.0
No. of State AAQS Exceedances	-	-	0	0	0
Nitrogen Dioxide / Kapolei					
No. of 24-Hr Samples	-	-	-	-	131
Range of 24-Hr Values (µg/m3)	-	-	-	-	4-29
Average Daily Value (µg/m3)	-	-	-	-	12
No. of State AAQS Exceedances	-	-	-	-	0

Source: State of Hawaii Department of Health

Table 5

ESTIMATED WORST-CASE 1-HOUR CARBON MONOXIDE CONCENTRATIONS
ALONG ROADWAYS NEAR EAST KAPOLEI PROJECT
(milligrams per cubic meter)

Roadway Intersection	Year 2020 With Project	
	AM Peak Hour	PM Peak Hour
Farrington Highway at Road to Areas A and B	7.7	9.0
Farrington Highway at Road to Areas K and L	3.6	3.1
East Kapolei Avenue at North-South Road	9.3	10.8
East-West Road at Road to Areas B and C	10.1	10.0
East-West Road at Road to Area C	8.6	8.0
East-West Road at West Road to Areas I and J	9.8	10.4
East-West Road at East Road to Areas I and J	8.6	9.0
Kapolei Parkway at North-South Road	21.0	19.7
Kapolei Parkway at Road to Areas F and G	14.6	13.5

Hawaii State AAQS: 10
National AAQS: 40

Table 6

ESTIMATED WORST-CASE 8-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR EAST KAPOLEI PROJECT
(milligrams per cubic meter)

Roadway Intersection	Year 2020 With Project
Farrington Highway at Road to Areas A and B	4.5
Farrington Highway at Road to Areas K and L	1.8
East Kapolei Avenue at North-South Road	5.4
East-West Road at Road to Areas B and C	5.0
East-West Road at Road to Area C	4.3
East-West Road at West Road to Areas I and J	5.2
East-West Road at East Road to Areas I and J	4.5
Kapolei Parkway at North-South Road	10.5
Kapolei Parkway at Road to Areas F and G	7.3

Hawaii State AAQS: 5
National AAQS: 10

Table 7

ESTIMATED INDIRECT AIR POLLUTION EMISSIONS FROM EAST KAPOLEI PROJECT ELECTRICAL DEMAND[a]

Air Pollutant	Emission Rate (tons/year)
Particulate	53
Sulfur Dioxide	533
Carbon Monoxide	40
Volatile Organics	<1
Nitrogen Oxides	200

[a]Based on U.S. EPA emission factors for utility boilers [2]. Assumes electrical demand of 200 million kw-hrs per year and low-sulfur oil used to generate power.

Table 8

ESTIMATED INDIRECT AIR POLLUTION EMISSIONS FROM EAST KAPOLEI PROJECT SOLID WASTE DISPOSAL DEMAND[a]

Air Pollutant	Emission Rate (tons/year)
Particulate	<1
Sulfur Dioxide	44
Carbon Monoxide	14
Nitrogen Oxides	110

[a]Based on U.S. EPA emission factors for municipal waste incinerators [2]. Assumes mass burn unit/waterwall combustor with duct sorbent injection/fabric filter and solid waste disposal demand of 170 tons per day.

K. Socio-economic Impact Assessment

SMS

Consulting
Database Marketing
Economic & Social Impact Studies
Research
Training

SMS
1012 Fort Street Mall
Suite 200
Honolulu HI 96813
Ph (808) 537-3356
Fax (808) 537-2686
E-mail info@smshawaii.com
Website www.smshawaii.com

Beyond Information. Intelligence.

SOCIO-ECONOMIC IMPACT ASSESSMENT OF THE EAST KAPOLEI PROJECT

March 1998

Prepared for:

PBR Hawaii
Housing Finance & Development Corporation
Department of Accounting and General Services

SMS affiliations:

Allan Barker Associates
Customer Insight Company
International Survey Research
Simmons Market Research Bureau Inc
Strategic Mapping Inc

EXECUTIVE SUMMARY

The Project

The East Kapolei project includes 1,300 acres alongside the planned North-South Road, in the center of the 'Ewa Plain. Most of the project will be devoted to housing. Additional uses include small commercial areas, parks, schools, and a Sports Complex including a 4,000-seat stadium and practice fields. The State's Housing Finance and Development Corporation (HFDC) plans to provide basic infrastructure and land use permits, and then sell large lots to developers. Income from lot sales will go to pay off development costs, and to pay for much of infrastructure development for the University of Hawai'i West O'ahu (UHWO) campus to be located mauka of the project. The State Department of Hawai'ian Homelands (DHHL) will develop some 200 acres. The Department of Accounting and General Services (DAGS) is taking responsibility for the Sports Complex.

Project construction could begin in 1998. The Sports Complex could open in 2000. The first homes on DHHL parcels could be built as soon as 2000. On other parcels, the first homes might be built by 2002, but construction will likely stretch over a period of 15 to 20 years.

Housing will likely include a mix of single-family and multi-family units, priced to sell to island residents. HFDC will not impose detailed restrictions on developers as it did for the Villages of Kapolei, allowing them to develop housing as the market permits. (However, City and County rules demanding that 30% of all units be affordably priced will be in effect.)

The Sports Complex will be developed as a site for professional sports activities, notably Japanese baseball teams' spring practice. In order to cover operating costs, the operator will have to market the site strongly to professional teams, amateur adult groups, and sports federations, both in Japan and on the North American Mainland. After an early development period, the Sports Complex could bring in revenues amounting to about $0.5 million for the operator, and taxes on cash flows associated with visitor spending amounting to another $0.5 million. This income will offset the operating costs of the Sports Center.

While the Sports Complex will be marketed to islandwide and international users, some fields at the facility will be made available to community groups when demand from outside groups is low.

The Surroundings

Kapolei, on the 'Ewa Plain, has been identified by the State and City as O'ahu's "Second city," a site for rapid urban growth. New homes have been built in the thousands along Fort Weaver Road and in the Villages of Kapolei. The region is home to about 50,000 residents in a mix of new suburbs, older plantation communities, and military housing. By 2020, the population is targeted for growth to a level above 120,000.

Job growth has occurred, for instance in the Kapolei Shopping Center, but not kept pace with housing development. 'Ewa includes O'ahu's only heavy industrial area, at James Campbell Industrial Park, but planned job creation at 'Ewa Marina and Ko 'Olina is behind schedule. The 1999 closing of Naval Air Station Barbers Point will mean the loss of both military and civilian jobs in the short run, although redevelopment could eventually bring civilian jobs in greater numbers than in the past.

Currently, there is little to unify the various communities of the 'Ewa Plain. Roadways linking the east and west sides of the district are few. A lead community organization, the Neighborhood Board, recently split into two boards in recognition of the different concerns and outlooks of the two sides of the area.

Demographic Impacts

At buildout, the project could be home to some 20,950 to 27,050 persons in about 6,500 to 8,400 housing units. Housing will be for O'ahu residents. Activities at the Sports Center could, however, will contribute an estimated 21,000 visitors days to O'ahu annually.

Economic Impacts

Development at East Kapolei will involve construction jobs over a period of some 20 to 25 years, generating a total of 7,200 to 7,750 person-years of work on construction. It will support another 11,125 to 12,000 person-years of indirect and induced jobs in the Hawaii economy. (From 1998 through 2022, the average construction employment will be about 300 jobs annually, supporting an additional 450 or more jobs statewide.)

On-site employment will grow to about 1,250 to 1,375 permanent jobs. Some 1,100 to 1,250 additional jobs in the Hawaii economy -- indirect or induced jobs generated by project spending – will come to exist. The payroll for direct

operations jobs will exceed $25 million (1997 dollars) by 2022, while wages for indirect and induced jobs will come to total more than $30 million.

In 'Ewa, continuing jobs will number about 1,350 to 1,500 when the project is fully built.

Development of the East Kapolei project will provide the City and County of Honolulu with significant new tax revenues. If rates remained at current levels, the new taxes will grow to about $6.3 million to $7.5 million (1997 dollars) annually. Costs to the City and County will be very small in relation to this income.

The State of Hawaii will incur major costs as developer, but also gain significant revenues from the project. Development costs are estimated as about $95 million for infrastructure and $27.5 million for the Sports Complex. (DHHL construction costs and interest are not included here.) Revenues include receipts from land sales, taxes on construction-related cash flows, operating revenues for the Sports Complex and new income associated with visitor spending due to the Sports Complex.

HFDC will be able to cover its development costs and supply the University of Hawai'i West O'ahu (UHWO) with funds for infrastructure soon after major land sales occur. Overall, the proposed development on the East Kapolei site will result in continuing cash flows for the State over and beyond State costs. By 2022, the net balance of revenues over costs of the project as a whole is estimated as $193 million to $245 million (constant 1997 dollars). The net present value of HFDC cash flows is estimated as well over $60 million (with a discount rate of 8%). The net present value of HFDC and State general fund spending and income associated with the project (not including DHHL investment) is estimated as about $90 million to $120 million through 2022.

To cover its obligations, HFDC will have to develop and sell some 650 to 690 acres of residential land. The project includes 733.4 residential acres to be sold to developers plus 18 acres of commercial land. Eventually, after the UHWO funds transfer, HFDC is expected to net some $34 million to $54 million (constant 1997 dollars).

Community Concerns

When SMS staff interviewed members of the 'Ewa community about the project in mid-1997, several expressed concern that the project could add traffic on congested roads and demand for such public facilities as schools and play areas. They stressed the importance of building public infrastructure and facilities in a timely manner. At that time, the Sports Complex was not part of the proposed project. Since then, the "Ball Field at Kapolei" has been proposed by the State to local groups, which received it with interest and support.

Social Impacts

The East Kapolei project will provide land for housing, helping to assure continuing expansion of O'ahu's housing stock. Increases in the number of homes for middle-income families will help to relieve the imbalance between supply and demand for moderate- and middle-income housing on O'ahu. The Sports Complex will help to bring new visitors to the island, diversifying Hawai'i's appeal.

The project will have complex regional impacts in 'Ewa. In its early years, it could add to problems of traffic congestion. Construction noise and dust could be local irritants, especially for residents within the East Kapolei project. Over time, it will help to knit together the region as a whole, both by making urban development continuous from Kapolei to 'Ewa Beach. Also, the Sports Complex will become a focus for regional interest and attention, providing a site shared by residents from the two sides of 'Ewa along with people from outside the area. By supporting development of UHWO, the project will help to create a local job center and local source of pride.

The project is first and foremost a housing development. As such, it will continue 'Ewa's imbalance between housing, on the one side, and jobs and community facilities on the other.

Mitigation of Adverse Impacts

Adverse impacts anticipated by the community can be minimized, largely through planning and cooperation among community groups. Residents' lead concern – traffic – will be most affected by a development not included in the project, the new North-South Road and an interchange linking both the new road and a new Makakilo access route to the H-1 highway. Public facilities needs can partly be met through development of parks (included in the project) and community centers. The latter may be provided by private developers, for their subdivisions.

CONTENTS

EXHIBITS

1. INTRODUCTION

1.1 PROJECT DESCRIPTION

The East Kapolei Master Plan Development is being planned by the State Housing Finance and Development Corporation (HFDC). It will occupy approximately 1,300 acres of land in 'Ewa District, O'ahu. The site lies makai and south of H-1 and Farrington Highways, east of the Villages of Kapolei and Kapolei Golf Course, and north of the 'Ewa Villages area along Renton Road. It is bordered on the east by undeveloped agricultural land. The proposed North-South road will pass through the project and have its own entrance to H-1. (Exhibit 1-A shows the site in relation to the Development Plan Areas of the City and County of Honolulu.)

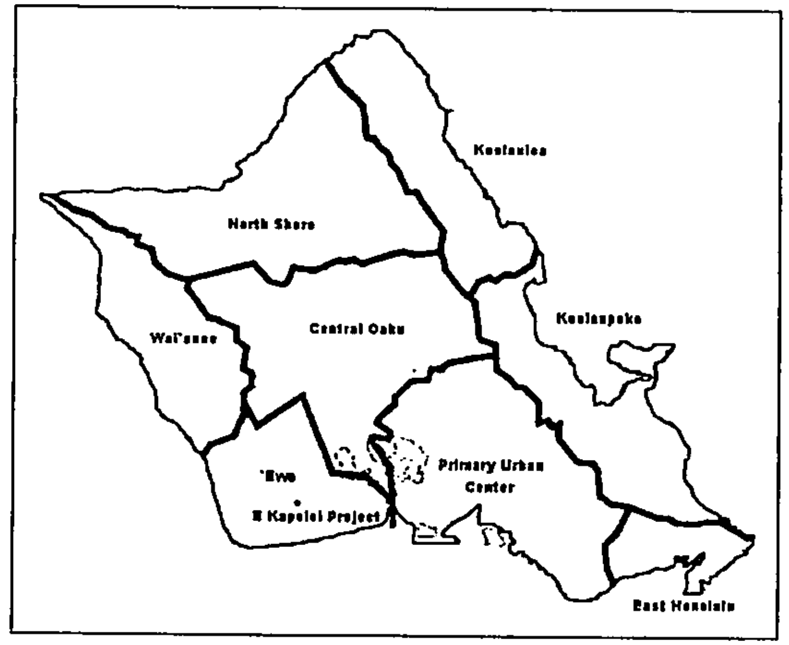
The HFDC plans to develop basic infrastructure for the site. It will then sell development rights for large housing areas. Once development costs are covered, proceeds of the land sales would go to finance construction of the University of Hawai'i West O'ahu campus. Other parts of the project will be developed by the Department of Hawai'ian Homelands (DHHL), the Department of Accounting and General Services (DAGS) and the Department of Education (DOE). DHHL has entitlement rights to 200 acres at the project site and is considering a mix of housing for its beneficiaries.

The project was announced in March 1997. Since then, it has changed in one major respect – a baseball-oriented sports complex is now part of the project.

The Sports Complex was proposed at the beginning of the 1990s. Site selection, design and environmental studies have already been done for DAGS (Mitsunaga 1990; 1992). The idea of a baseball complex was supported by the Barbers Point Redevelopment Commission, which allocated space for it about half a mile south of the site under consideration in this report. Moreover, funds for design and construction of an 'Ewa baseball complex were allocated by the Hawaii State Legislature in 1997. However, HFDC plans for East Kapolei did not at first include a sports complex. (The community interviews discussed later in this report hence do not deal with the complex.) This sports complex will be discussed in greater detail in Chapter 3.

Apart from the Sports Complex, the proposed development would consist of housing with supporting infrastructure and public facilities. The residential portion of the project will probably include:

Exhibit 1-A: LOCATION MAP



- For the general resident market, between 5,197 and 6,680 units of housing, including multi-family and single-family units. A mix of market and affordable homes would be built.
- For Native Hawai'ians, from 1,247 to 1,631 units of housing on DHHL land. The proposed housing could be a mix of single- and multi-family housing. Parcels A, D and I-2 on Exhibit 1-B have been allocated for DHHL use.
- Land for three elementary and one intermediate schools.
- About 36 acres dedicated to park use, in addition to acreage designated for the proposed sports complex. One district park would occupy about 15 acres, while the other parks would be smaller.

- About 192 acres in open space, including a "linear park" along the North-South Road. While much of this area would be designed for drainage control, it could also be put to some recreational uses, such as jogging.
- About 18 acres of land for neighborhood commercial development. This acreage is divided into separate lots to serve smaller neighborhoods.

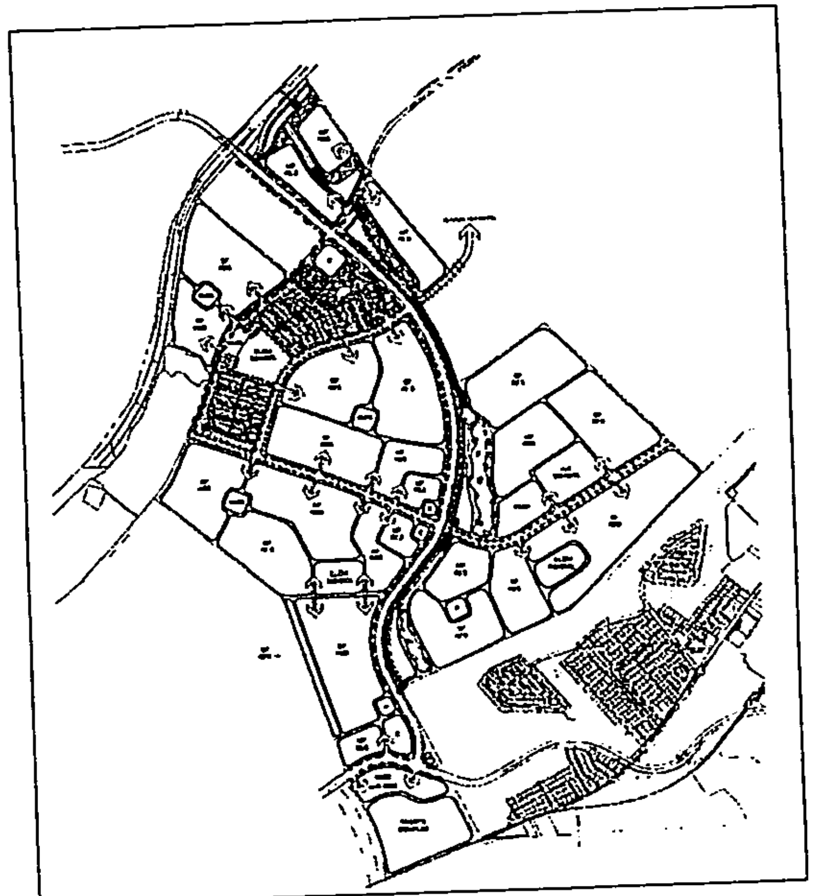
A theme park has also been proposed for part of the project site (*The Honolulu Advertiser*, May 1, 1997, p. B-1). However, that is not under consideration in this socio-economic impact assessment.

Access to the project site will be from H-1, Farrington Highway, and the to-be-constructed North-South Road. The project site will be bisected by the North-South Road which is currently scheduled to break ground in late 1998 and would take at least a year to complete (Personal Communication: Ron Suzuki, State Department of Transportation, June 1997). While the North-South Road will be necessary to reach some areas of the project, the first phases of development could have access from Farrington Highway. Sales of land to developers could occur before the completion of the North-South Road.

Transfer of land to DHHL could occur in 1998, and developers working for DHHL could have some housing built in 2000. Initial land sales to developers could begin around 1999 (The Prudential Locations, Inc., 1997). Consequently, housing for the general public could begin to be built by 2001.

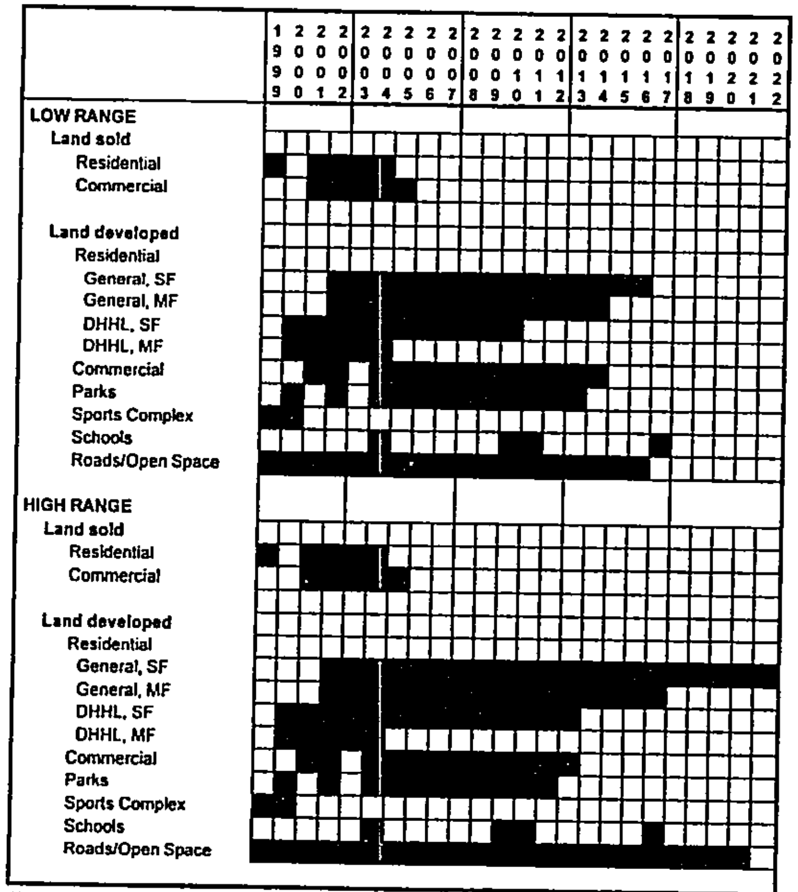
Based on plans by the various agencies involved in the project and the market study by Prudential Locations, Inc. (1997), two development scenarios, with high and low densities of housing on-site, have been sketched out by SMS Research for the purposes of environmental impact studies. Exhibit 1-C provides a sense of the duration of major development activities, while Exhibit 1-D shows the extent of construction and land development in selected years. (Development will be accomplished by many parties, not just HFDC.)

Exhibit 1-B: PRELIMINARY CONCEPT PLAN



SOURCE: PBR Hawaii

Exhibit 1-C: DEVELOPMENT TIMETABLE



NOTES: Timing assumptions based on market report (Prudential Locations, Inc., 1997) and developer plans.

Exhibit 1-D: LAND DEVELOPMENT OVER TIME

	2002	2007	2012	2017	2022
Low Range					
Land sold					
Residential					
Annual	-	48.0	48.0	-	-
Cumulative	400.0	448.0	688.0	749.5	749.5
Commercial (Cumulative)	2.0	11.0	16.0	18.0	18.0
Land developed (Cumulative)					
Residential					
General, SF	22.2	209.7	397.2	561.3	561.3
General, MF	8.8	83.8	158.8	188.2	188.2
DHHL, SF	50.0	133.3	168.3	168.3	168.3
DHHL, MF	15.0	22.7	22.7	22.7	22.7
Commercial	2.0	10.0	15.0	18.0	18.0
Parks	69.0	85.0	99.0	100.2	100.2
Schools	-	12.0	44.0	56.0	56.0
Roads/Open Space (1)	33.5	102.2	157.5	185.3	185.3
TOTAL	200.5	658.7	1,062.5	1,300.0	1,300.0
High Range					
Land sold					
Residential					
Annual	-	-	48.0	48.0	-
Cumulative	400.0	400.0	544.0	736.0	749.5
Commercial (Cumulative)	2.0	11.0	18.0	18.0	18.0
Land developed (Cumulative)					
Residential					
General, SF	16.6	157.3	297.9	438.5	561.3
General, MF	7.3	69.8	132.3	188.2	188.2
DHHL, SF	37.5	100.0	162.5	168.3	168.3
DHHL, MF	12.5	22.7	22.7	22.7	22.7
Commercial	2.0	10.0	17.0	18.0	18.0
Parks	69.0	86.0	100.2	100.2	100.2
Schools	-	12.0	44.0	56.0	56.0
Roads/Open Space (1)	22.6	79.4	130.4	166.6	185.3
TOTAL	167.5	537.2	907.0	1,158.5	1,300.0

NOTES: Buildout estimated on basis of (a) residential buildout according to market report assumptions of fixed annual absorption; (b) commercial and parks development in proportion to residential unit counts, and (c) preliminary plans for timing of remainder of project. Commercial and parks built on working assumption that they could be supported by development of 20,000 persons on-site. These assumptions are meant to approximate fairly speedy development. They are not meant as proscriptive.

(1) Category includes Sports Complex.

1.2 PURPOSE AND SCOPE OF THIS REPORT

This report assesses the socio-economic impacts of the proposed project. It takes into account both existing conditions and likely future trends in the area surrounding the project. This report is intended to serve as an appendix to an Environmental Impact Statement being prepared by PBR Hawai'i.

The report is written to identify and disclose information that may be of use to decision makers and members of the general public as they evaluate the implications of the project. Discussions of the likely points of compatibility of the project with surrounding land uses, of potential impacts, and of steps which might mitigate unwanted impacts are intended to help in the EIS process and to contribute to community planning over the long term. This report also includes a discussion of the more recently proposed sports complex which would be located within the project site.

The sections of this report deal with the following:

- Existing conditions and emerging trends in the area surrounding the project;
- The sports complex;
- Economic and demographic impacts of the project;
- The likely fit of the project with the surrounding communities;
- Other social impacts; and
- Potential mitigation measures and processes that would appropriately respond to adverse impacts of project development.

2. EXISTING AND EMERGING CONDITIONS IN THE SURROUNDING COMMUNITY

2.1 STUDY AREA

The East Kapolei Project will be located on the 'Ewa Plain. To the west of the project are the Villages of Kapolei housing areas and golf course; to the north, H-1, Farrington Highway, and Makakilo; to the south, 'Ewa Villages and the new municipal golf course; and to the east, undeveloped agricultural lands, previously planted in sugar cane.

The project is situated in the State's 'Ewa District and the 'Ewa Development Plan Area (DPA) of the City and County of Honolulu (See Exhibit 1-A). This area of O'ahu has been designated as the secondary urban center for the island and has been the focus of residential development over the last 20 to 30 years, with more intense development taking place since the mid- to late-1980s. The housing to be built on the project site responds to existing and anticipated demand from all areas of the island of O'ahu. It will compete for buyers with other projects in 'Ewa and Central O'ahu

For this report, the 'Ewa DPA is the Primary Study Area. Because the project could have impacts on residents and housing projects in the DPAs adjoining 'Ewa, the Wai'anae and Central O'ahu DPAs are considered Secondary Study Areas in this report. (The State's 'Ewa Judicial District is much larger, with boundaries running from Halawa in the east to Barbers Point in the west. That region is not considered a useful unit for the purposes of this report.)

2.2. EMERGING CONDITIONS

Development on the 'Ewa Plain has included industrial and commercial areas, as well as housing. In the southwest corner of the DPA, Campbell Industrial Park is the state's only heavy industrial park. It has over 300 tenants. It is also home to some of the state's leading companies. Next to Campbell Industrial Park is Barbers Point Harbor, the state's newest and second busiest harbor.

Some of the components of a developing secondary urban center have begun to emerge in Kapolei. A shopping center and entertainment complex have been in existence for several years and new businesses have begun to locate there. Bank of Hawaii has moved some of its operations into its own office complex in Kapolei and smaller companies have taken space in the James Campbell and

Kapolei Buildings. A day care center for children located next to the regional park opened and new retail centers are currently under construction or consideration. Construction of a state office building is well underway. A new City and County district police station and civic center is planned.

The Ko 'Olina resort complex is located in the southwest corner of 'Ewa. So far the complex includes a hotel, golf course and a 280-townhouse community.

Overall, job creation in 'Ewa has not kept pace with the development of new residential communities. Consequently, current and future homebuyers in 'Ewa will likely have to continue to commute to their jobs, which, for the most part, will be located outside of 'Ewa. This means that the transit corridor between 'Ewa and downtown Honolulu will continue to be heavily congested with eastbound traffic in the morning and with westbound traffic in the afternoon and early evening. Construction of the proposed project will add to this traffic situation.

2.3 PRIMARY STUDY AREA

2.3.1 Historical Context of the Region

Geography

The project site is in the 'ahupua'a of Honouliuli. The two major land forms in the 'Ewa region are the 'Ewa Plain and Makakilo upland. H-1 Freeway and Farrington Highway are the general boundaries of the two land areas.

'Ewa Plain is an elevated coral reef covered by alluvium. Elevations vary from about 50 feet above mean sea level (MSL) near the southern boundary at NAS Barbers Point, to 2,300 feet MSL at Pu'u Manawahua, the highest peak in the 'Ewa region.

The climate is relatively dry in 'Ewa. However, the land was arable in earlier times. There were once large terrace areas near West Loch, referred to as 'Ewa taro lands. Hawai'ians used the holes and pits in the coral for planting.

History

'Ewa means "crooked" or "ill-fitting." It is said that the gods Kane and Kanaloa once walked around O'ahu and threw stones to determine district boundaries. Wherever the stone landed would become the boundary. However, when they came to present day 'Ewa they could not find the stone they threw and called that

district "'Ewa." The story concludes that the stray stone was later found at Pili o Kahe, a place at the present-day boundary of Wai'anae and 'Ewa in Nanakuli.

Kamehameha III awarded the 'ahupua'a of Honouliuli to Chief Miriam Ke'ahikuni Kekau'onohi in 1848. She in turn leased it to ranchers. James Campbell bought Honouliuli from a rancher in 1878 and had the first artesian well drilled on his ranch in 1879. He followed by developing a well system which allowed the cultivation of sugar cane in Honouliuli. Campbell leased about 2,000 acres of land to Castle and Cooke in 1890 to raise cane under the incorporation of 'Ewa Plantation Company. A plantation settlement was established around the mill site on Renton Road and 'Ewa became a plantation community.

'Ewa Plantation merged with O'ahu Sugar Company (OSCo) in 1970. Cane cultivation continued but processing was done at OSCo's Waipahu mill. During the late 1980's and early 1990's the economic viability of sugar cane cultivation came under increasing scrutiny. In the early 1990's OSCo began the process of closing down its operations, and by the time its lease with Campbell Estates expired in 1995, OSCo had ceased sugar cane operations completely.

'Ewa's sugar lands continued to be replaced by urban development. Recent years have witnessed residential growth and modest retail development. However, plans call for a complete city, not a set of suburbs. The Kapolei Area Long Range Master Plan contains designs for a city similar in layout to Honolulu — a commercial and government center, surrounded by homes, with a resort area six miles from the urban center, and a commercial harbor in close proximity.

2.3.2 Recent and Current Conditions

'Ewa is made up of many different and distinct communities. Old and new settlements have distinctive identities and stand in contrast to each other. US Census data from 1990 showed:

- 'Ewa Villages and 'Ewa Beach, two older and major communities, were largely Filipino in 1990;
- While Caucasians were the largest single group in the 'Ewa DPA, Filipinos comprised the largest ethnic group;
- The 'Ewa DPA had a large proportion of young adults, aged 18 to 34 years;
- Some 21% of home owners in the 'Ewa DPA paid 35% or more of their income for housing expenses, while the island-wide average was only 15%.

- Due to the presence of the Naval Air Station Barbers Point (NASBP) and the Iroquois Point housing area, the number of persons employed in the military was double that of Honolulu County. The number of men and women working in the civilian labor force was slightly higher than the island-wide population. (See Appendix A-5).

In 1990, the mean household income for the City and County of Honolulu was $49,959. Given the cost of housing elsewhere on O'ahu, it is likely that many of the new homeowners in the 'Ewa DPA are first time buyers with less disposable income than average. The mean household income in 1990 for those living in 'Ewa was $44,759. As the area builds out and these families mature, they will have more disposable income.

Population

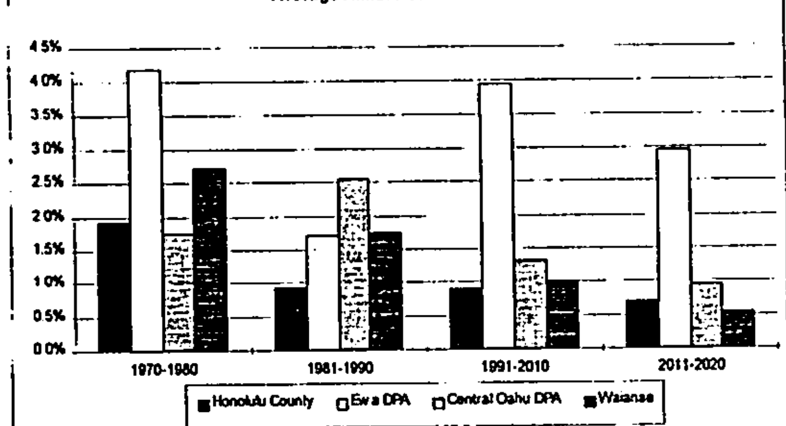
Exhibit 2-A below shows recent and projected population figures, along with the average annual growth rates, for the City and County of Honolulu as well as for the 'Ewa, Central Oahu, and Wai'anae Development Plan Areas from 1970 to 1990. The population for each of these areas has increased over time, although at different rates of growth. Growth rates for the 'Ewa and Central Oahu DPAs in large part correspond with stepped up residential construction in those areas which began during the 1970's.

In 1977, as part of the new General Plan, the Kapolei area in 'Ewa was designated as the focal point for a secondary urban center on the island. This center was to be the focus of major economic activity and housing development, and a center for government services. Residential development in the area has progressed more rapidly than has development of additional employment opportunities. Regional population projections indicate that 'Ewa's population will more than double by 2010 and triple by 2020. That represents an average annual growth rate of approximately 3.6 percent. For the same period, Central Oahu, Wai'anae and the City and County of Honolulu are expected to grow only at an average of 1 percent per year.

The share of the island population living in each of the Development Plan Areas between 1970 and 1990 is shown in Exhibit 2-B. As can be seen, the share that each area has of the island's population has remained relatively stable through 1990. The General Plan calls for 'Ewa and Central Oahu to increase their share of the island population. The anticipated population growth follows from the development of major new subdivisions. In the 20-year period from 1990 to 2010, 'Ewa's housing stock is expected to increase by nearly 24,136 units, almost triple the 1990 stock.

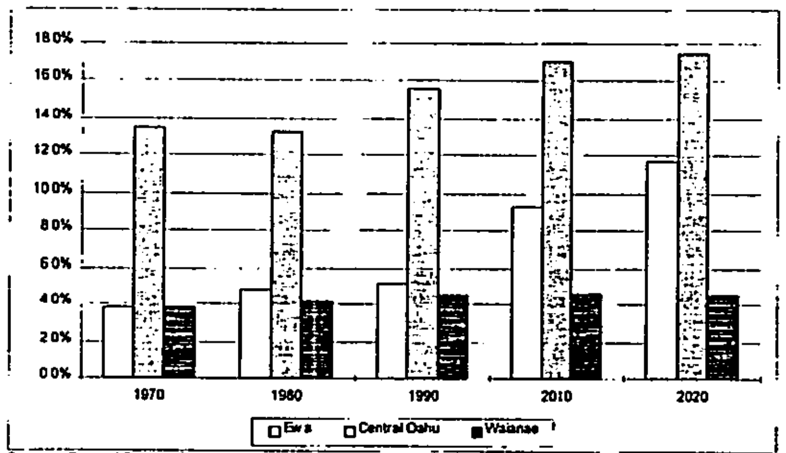
Exhibit 2-A: POPULATION AND AVERAGE GROWTH RATES FOR PRIMARY AND SECONDARY STUDY AREAS

	Historical			Projected	
	1970	1980	1990	2010	2020
Honolulu County	630,528	762,565	836,231	999,500	1,071,226
Ewa DPA	24,087	36,234	42,931	93,112	124,775
Central Oahu DPA	85,317	101,494	130,526	169,815	186,629
Walanae	24,077	31,487	37,411	45,654	48,155



Source: City and County of Honolulu, Planning Department, *Forecast of Population, Housing and Employment on O'ahu by Small Area 1990 - 2010*, 1993; unpublished forecast, 1997

Exhibit 2-B: PERCENT OF ISLAND POPULATION FOR SELECTED DEVELOPMENT PLAN AREAS



Source: City and County of Honolulu, Planning Department, *Forecast of Population, Housing and Employment on O'ahu by Small Area 1990 - 2010*, 1993; unpublished forecast, 1997.

Employment

With continued urbanization, 'Ewa's regional jobcount is projected to reach 56,772 jobs in 2020, nearly four times the 1990 figure. However, the speed of job-creation at Ko 'Olina and at NASBP (after the base closes in 1999) is uncertain. Kapolei is projected to become the major employment center of the region, dependent on continued business development in the City of Kapolei. Campbell Industrial Park and Barbers Point Deep Draft Harbor will function as industrial and maritime employment centers.

Agriculture

The project site has been planted in sugar cane for most of this century. After the closing of Oahu Sugar Company (OSCo) in 1995, the landowners, The Estate of James Campbell, negotiated two leases with truck farmers to continue agricultural use of the land. The project site lands have been conveyed to the State of Hawai'i. A certain portion of the land covered by these agricultural leases (approximately 142 acres) are contained within the project site. Lease terms, though, permit withdrawal of these lands from agricultural use. Further upland,

much Estate land is under pasture lease. Some of that land could be urbanized as plans for the University of Hawai'i West O'ahu are realized.

Major Communities

SMS Research compiled 1990 Census data for five 'Ewa residential areas ('Ewa Villages, 'Ewa Beach, 'Ewa by Gentry, NAS Barbers Point, and Makakilo). Kapolei and West Loch are also notable developments as of 1994. These are discussed here in order of age:

- **'Ewa Villages.** Sugar mill construction commenced in 1891, and plantation villages sprouted up around the mill site over the next 60 years. The number of residential units amounted to over 1,200 during that era. The 'Ewa Sugar Company built most of the villages, and at one time there were eight villages, housing immigrant plantation workers from Portugal, Spain, Korea, Japan, and the Philippines. Four of the newer villages — Renton, Tenney, Varona, and Fernandez — are still standing.

  Renton Village is the historic core of the Villages. It was built between 1913 and 1938. Much of the community's infrastructure and facilities were constructed during George F. Renton's tenure as plantation manager. Improvements to the area included construction of most of the mill structures, a system of roads, installation of street lighting, water mains, service lines and plumbing, fire equipment, theaters, clubhouses, playgrounds, tennis courts, a swimming pool, administration building, and a hospital.

  The 'Ewa Villages population was 3,780 in 1990 (See Appendix A-1, Demographic Characteristics). Residents were

  - Primarily Filipino (67%);
  - The median age was 32.4 years;
  - Most of the Villages residents were born in Hawai'i , while one-third were born in another country;
  - About half of the residents were living in houses that were more than twenty years old, while about 23% had lived in their homes from 6 to 20 years;
  - Two-thirds of the households were owner-occupants, while one-third were renters;
  - The average household size — 4.19 persons per household in 1990 — was very high for O'ahu;

- Almost half of the Villages' households received Social Security income, and one-third received retirement income (See Appendix A-4);
- Few Village residents (1%) lived in poverty, and the median household income was just above the island median.

There has been no construction of new villages since the 1950s. Fernandez Village was redeveloped in the late '70s to early '80s.

The City Department of Housing and Community Development (DHCD) has more recently been engaged in a revitalization project in the Villages in order to preserve the plantation character and heritage of the mill area. The original project called for 515 affordable homes in Lincoln, Tenney, and Renton villages. Of those, 113 homes were built in Lincoln Village and all were sold after going to market in 1995. By the beginning of March, 1997, all but 50 of 170 homes built in Tenney and Renton villages had been sold. The remaining homes have not yet been build. Also, part of the project included construction of gap group housing (those whose income is between 120 percent and 140 percent of median income) as well as a city-built and operated golf course which would act as a drainage basin to help prevent flooding. About 45 of the gap group homes have been built and the golf course has been completed and is operating.

The development and sale of 282 lots in a subdivision known as Green View Villas was to have subsidized the 'Ewa Villages project. In early 1997, the developer of Green View Villas pulled out of the project, and as of late 1997, only one home had been sold of the four that had been build. It appears that the original 'Ewa Villages project will be abandoned. The City Council has recently approved a city administration proposal to provide three nonprofit agencies (Unity House, Inc.; Self-Help Housing Corp.; and EV Community Development Corp.) with federal funding to develop sale and rental homes for low-income families, the elderly and people with permanent illnesses. It is likely that the affordable single- and multi-family housing units would compete with the HFDC East Kapolei project.

- **'Ewa Beach.** 'Ewa Beach began as a weekend recreational area in the 1940s and eventually became a permanent residential community. There were 3,426 housing units reported in the 1990 Census.

There were 14,315 people residing in 'Ewa Beach in 1990 and residents were largely Filipino. The median age was 28.6 years (Appendix A-7). Households are very large, with an average size of 4.26 persons. People

in 'Ewa Beach were much more likely to be receiving public assistance for income than the other major communities in 'Ewa (Appendix A-10).

- **Naval Air Station Barbers Point (NASBP).** Known as Kalaeloa in Hawai'ian, this area in the south-central portion of Honouliuli was renamed Barbers Point after Captain Henry Barber wrecked his ship on a coral shoal in 1795. NASBP was established during World War II as a major U.S. Navy aviation facility. The station comprises 3,700 acres and operates on a 24-hour basis. There are three 8,000-foot runways which allow operation of fixed-winged and rotary-winged aircraft.

According to the 1990 Census, the air station had 2,218 residents. (In addition, the Iroquois Point military housing area, on the eastern side of 'Ewa houses about 5,000 persons.)

Military personnel stationed on-base at NASBP numbered 4,146 in 1990, while 1,619 civilians were employed there (according to Census runs for transportation analysis, for Traffic Advisory Zone 251). NASBP is scheduled to shut down in mid-1999 as part of the national Base Realignment and Closure initiative. A Draft Environmental Impact Statement (DEIS) has been completed and should be available for public review by April 1, 1998. The DEIS addresses the impact of the base closure and proposed reuse plans. The Navy will retain housing and recreation areas after the Naval aviation facility closes.

In comparison to other 'Ewa communities, in 1990, Barbers Point residents were young with a median age of 24.7. Due to the low military wage structure, there was less difference between rich and poor at Barbers Point than in 'Ewa Beach or Honolulu County as a whole (as shown by the interquartile income range, in Appendix A-10).

After the closure of NASBP in mid-1999, the demographics of residents of the area will change as the result of redevelopment. Depending on the redevelopment alternative finally approved, the number of additional housing units could range from 1,281 to 1,900. The units would be for homeless, low-income and Native Hawai'ian groups.

- **Makakilo.** Makakilo opened for occupancy in 1962, with single- and multi-family, mid-priced homes. Finance Realty is the major developer at Makakilo, which encompasses 1,202 acres. Development is more than halfway through and there will be approximately 6,200 homes at full build-out.

Makakilo had 9,828 residents in 1990. (See Appendix A-7) Nearly half were Caucasian. Although people have lived in Makakilo since 1962, over two-thirds of the population were recent arrivals in 1990 — 64% had moved into their homes within the five years preceding the Census (Appendix A-8).

Makakilo had higher household income levels than the other communities shown in Appendix 10. However, costs were also high in Makakilo. Some 24% of homeowners spent 35% or more of their incomes on housing costs, while 46% of renters spent similarly large shares of their income on housing.

- **'Ewa by Gentry.** The first residents began moving into Soda Creek, the development's first subdivision, in 1988. The population of 'Ewa by Gentry was nearly 2,000 in 1990 (Appendix A-7). One-third of the residents were Caucasian, and about another third were Filipino. The median age was 28.4 years. Similar to Makakilo, almost 90% of 'Ewa Gentry residents had earned a high school diploma and 40% had a college degree.

  In 1990, there were 752 houses in 'Ewa by Gentry. Eighty percent of the homes were owner-occupied. Owners and renters alike in this development paid the most for housing costs, compared to the other 'Ewa communities studied. Almost 40% of homeowners, and 78% of renters, paid more than 35% of their income for housing costs (Appendix A-10).

  Gentry Development Company plans to build about 8,000 homes over approximately 1,000 acres of land in Honouliuli. By mid-1997, just under half of the units had been completed. Another 479 units are expected to be completed by mid-1998. The remainder of units are scheduled to be built through 2006. The Holomua Elementary School, located in the 'Ewa by Gentry development opened in 1997.

  The Geiger Community Park has come on line and will used mainly for playing fields. Because it is a community park, recreational facilities are planned for the area; however, the timetable for providing these facilities remains uncertain at this time. The 'Ewa Mahiko park still has not been dedicated. Once this happens, it will remain largely undeveloped due to limited funding. Land for another community park is currently being used by the developer as a drainage area. There are talks underway regarding a substitute park to be used until such time that the drainage problems are resolved.

- **West Loch.** This DHCD project is situated on 491 acres in Honouliuli on the western edge of Pearl Harbor's West Loch. The development consists of approximately 1,600 single- and multi-family homes; 60% are affordable and 40% are in the market range. The community currently includes the Asing Community Park, an 18-hole municipal golf course, and a 40-acre shoreline park. Phase I development of the park for two playing fields and a recreational building are currently in the design stages.

- **Kapolei.** Kapolei, which was not even counted as a Census Defined Place in 1990, is to be the regional center for 'Ewa and nearby areas.

  Campbell Estate has been involved in master planning its extensive property in the 'Ewa region since 1955 when Harland Bartholomew and Associates prepared the first 'Ewa master plan. The plan was revised in the early 1960s, and updated in 1974, at which time the concept of a self-contained city evolved. In 1986, Campbell Estate proposed a detailed implementation plan for a city center, bordered by Makakilo, Campbell Industrial Park, and NAS Barbers Point, and renamed it Kapolei. The city center concept accorded with General Plan policies to develop a secondary urban center in west O'ahu.

  The Kapolei Area Long Range Master Plan defines the second city as consisting of the Villages of Kapolei, Kapolei Town Center, Kapolei Regional Park, Kapolei Shopping Center, Ko 'Olina resort, James Campbell Industrial Park, Barbers Point Harbor, and Makakilo. Finance Realty plans to develop Kapolei Knolls mauka of Kapolei Villages. The East Kapolei project lies to the east of Kapolei.

  The State Housing, Finance, and Development Corporation (HFDC) is developing the Villages of Kapolei. The first homes were completed in 1990. As of mid-1997, approximately half of the total units had been built. Housing in the Villages consists of single- and multi-family housing units in Kapolei and at buildout there will be about 4,700 residential units.

  Non-residential development at Kapolei also includes:

  - Offices at Campbell Square, which currently house 32 businesses;
  - Kapolei Shopping Center with more than 30 businesses, ranging from grocery markets, service outlets, specialty shops, and fast food eateries;
  - A new elementary school;

- Bank of Hawaii building with capacity to house 1,200 employees involved in the bank's back office support functions;
- A 16-screen movie theater;
- The Seagull School child-care center has been operating for over two years and can accommodate 240 children, from two to five years old. The school has been enlarged to incorporate an intergenerational day care for seniors and infants/toddlers.
- State Office Building, currently under construction, which will house approximately 1,000 government employees;
- The Kapolei Regional Park;
- The Kapolei Business Park, a light industrial park. The Park is the home for the new Kapolei fire station, as well as the site for the Hawai'i operations of Allegiance Healthcare Corporation and a service/distribution center for the Nieman Marcus store currently under construction at Ala Moana Shopping Center;
- Kapolei Park Square. Located next to Seagull School, this retail project is nearly complete and available for leasing.
- Additional planned components include: Kapolei Medical Park, a new district police station and a City and County civic center in which up to 640 city employees are to be housed by the year 2000.

<u>Non-Residential Developments</u>

Major employment centers, in addition to NASBP, are James Campbell Industrial Park, Barbers Point Harbor, and the Ko 'Olina Resort:

- **James Campbell Industrial Park (JCIP).** Campbell Estate developed this park as a heavy industrial complex in 1959. The entire complex encompasses 1,367 acres. Major tenants include two oil refineries, a concrete manufacturing plant, cattle feed lot operation, large building material supply yards, numerous light industrial businesses, and the City's H-POWER plant. About 75% of the park is owned in fee by its tenants.

- **Barbers Point Harbor (BPH).** The new State-owned harbor is located at the northwestern edge of the Campbell Industrial Park. Campbell Estate dedicated 89 acres to the State for the harbor. Both BPH and Campbell Industrial Park are extensions of Foreign Trade Zone No. 9. The first increment of the development was completed in 1990, and ships now make regular calls at BPH. Facilities include 1,600 feet of pier and 30 acres of paved back-up area and related infrastructure. In addition, a bulk cargo ship unloader went into use in 1992.

When harbor development is completed in the next 15 or 20 years, there will be a total of 237 acres of developed area surrounding the basin. BPH is being planned to accommodate O'ahu's shipping needs for the next 50 years.

- **Ko 'Olina.** Ko 'Olina is a planned resort complex at the southwest edge of the 'Ewa region. Developer West Beach Estates has planned and created beaches and lagoons for a 1,000-acre complex. To date, one hotel and a golf course have been developed. The Fairways at Ko 'Olina, a 280-townhouse community bordering the golf course, has been completed and all units have been sold. Eventually , a maximum of 8,700 housing units could be built, and about 9,000 people employed at West Beach. Additional medium-rise apartment-condominiums, low-density apartments would be constructed near the golf course. Further development of the marina is currently on hold and further hotel development is on hold at this time. (Personal communication: Ken Williams, West Beach Estates, June 1997; February 1998)

2.3.3 Future Trends and Conditions

The 'Ewa DPA has been the location for extensive residential development and some commercial development. Both are continuing to grow. By the year 2000, 'Ewa DPA will continue to be largely a suburban residential area with residents commuting to jobs elsewhere.

It is anticipated that between the State and the City and County, approximately 1,600 jobs will be relocated to Kapolei. If these plans come to pass, it will help in the further development of a Second City with multiple land uses.

There will be some additional jobs created in areas which support residential developments, but nothing on a scale that would significantly alter the job situation in 'Ewa.

Population and Housing. In 1990, 42,960 people, or 5% of the island's population, lived in 'Ewa. As growth is directed away from the Primary Urban Center towards the Second City in leeward O'ahu, planning officials predict that 'Ewa's population will more than double over the next 10 years.

'Ewa experienced a boom in housing development through 1995. Residential construction projects began in the mid-1980s with the first phases of 'Ewa by Gentry, the Villages of Kapolei, and West Loch. In 1995, there were approximately 15,123 housing units. Residential construction is projected to continue well into the next century. Major developments planned for the late 1990s to 2005 are:

PROJECT	UNITS
'Ewa by Gentry	3,200
'Ewa Marina	1,250
'Ewa Villages	1,275
Kapolei	3,500

In 'Ewa there are about 22,325 housing units either proposed or committed by various developers through 2015. In line with predictions for the growing population, housing should increase four times faster than for all of O'ahu.

Employment. City planners hope for a high rate of growth in jobs for 'Ewa in the next 15 years. Kapolei would become the focal point of the region, with its town center, shopping center, and regional park. Campbell Industrial Park will continue as one of O'ahu's major industrial parks, and will be complemented by the development of the Kapolei Light Industrial Park. The deep draft harbor at Barbers Point should be completed in the next 15-20 years and will be the second seaport along O'ahu's leeward coast, becoming the focal point of maritime activity for 'Ewa and west leeward communities.

While the region's military facilities, tourism plant, and industrial area have provided a basis for jobs in the region in the past, uncertainties loom over several projects in the area, which may affect 'Ewa's employment growth projections:

- **Kapolei Civic Center.** The first Kapolei State office building is under construction and is scheduled for occupancy in 1998. The City is also planning a civic center and a regional police station for Kapolei. It was originally expected that construction would begin in late 1997 or early 1998. As of February 1998, construction on either facility had not started. Past forecasts have indicated that many of the 9,800 jobs projected for the Kapolei urban core would be comprised of civil service positions. However, current plans account for relocating only approximately 1,600 civil service jobs to Kapolei.

- **The Naval Air Station at Barbers Point** is scheduled to close in mid-1999. The Navy plans to retain housing and some recreation areas after base closure. The installation's closing will result in the loss of most civilian jobs in support of existing military operations. In 1990, NAS at Barbers Point provided a substantial number of the jobs in the 'Ewa DP area. In its new role, it will provide significantly less jobs for 'Ewa.

  The state-approved plan for reuse of NASBP include a reliever airport, recreational areas, sports tourism, and housing for the homeless.

  Employment is expected to be at a low around the year 2000, then climb slowly. On-site employment will not reach current or recent levels even by the year 2020. However, civilian employment will exceed current civilian employment when proposed uses are developed.

- **Ko 'Olina** is planned as a major resort complex. Projections indicate that Ko 'Olina would provide a substantial percentage of the jobs in the 'Ewa DP Area. At build-out, it is anticipated that the resort will employ approximately 9,000 people.

  Development, though, has lagged behind initial plans, and no firm dates are available for construction of additional hotels or most of the proposed residential stock. Consequently, Ko 'Olina is unlikely to be a major employer in the region in the near term.

- **'Ewa Marina** (now known as Ocean Pointe) is a master-planned residential/recreational/visitor complex on 1,100 acres with one mile of ocean frontage near One'ula Beach Park. It is to include a 1,400-slip marina and comprise a mix of: residential units, visitor units, specialty hotels, a 27-hole golf course, health and fitness center, and community-scale commercial center. Developer HASEKO ('Ewa), Inc. received designation of the property for urban use by the City and County and State Land Use Commission in 1993. Haseko (Hawai'i), Inc. is starting construction on 11 model residences of the first phase of Ke Aina Kai at Ocean Pointe. Approximately 2,500 residential units are scheduled to be built by 2010, and about 2,250 more units between 2010 and 2020. At build-out, there will be approximately 4,800 residential units and almost 1,000 visitor units. The earliest that construction could begin on the marina would be in the year 2000.

  This timetable suggests that 'Ewa Marina will generate many construction jobs during the late 1990s and into the next decade, but few on-site operational jobs.

Until the Kapolei Civic Center, Ko 'Olina, and 'Ewa Marina are substantially built out and occupied, the ratio of jobs to housing in 'Ewa will be low.

2.3.4 'Ewa 2010 to 2020

Between 2000 and 2010, Kapolei will have become increasingly urbanized with more jobs and housing. The 'Ewa Marina project should be well underway and redevelopment of NASBP should be progressing. Both of these projects will provide ocean-based recreational opportunities for area and island-wide residents as well as for visitors. These will also provide additional area employment opportunities.

This urbanization of the 'Ewa Plain will have the affect of opening up what were once the more isolated areas of the 'Ewa Plain. This might have the effect of bringing the various communities together to work more cooperatively with each other for the benefit of the region as a whole. Currently, the 'Ewa plain is divided along Fort Weaver Road for such activities as sports. And, based on conversations with various community members, there is currently little interaction between the many communities which compose the 'Ewa DPA..

Population and Housing. Current City and County projections put the population for 'Ewa in 2010 at 93,112, 9.3% of the island's population.

There have been delays in the start of many of the housing developments. Hence, housing starts could be greater from 2000 to 2010 than in the 1990s. Planned projects that will contribute significant increments of housing during the first decade of the 21st century are:

PROJECT	UNITS
'Ewa by Gentry	2,600
'Ewa Marina	2,250
'Ewa Fairways	1,400
Villages of Kapolei	1,250
City of Kapolei — Makai	1,000
Makaiwa Hills	1,000

From 2011 to 2020, an additional 11,350 housing units are currently planned.

Employment. City and County Planning Department projections are very optimistic regarding the rate of job growth in 'Ewa by the year 2020. However, there have been no substantial job relocations or new employment opportunities in 'Ewa since 1990, when there were an estimated 13,000 - 15,000 jobs.

Other Regional Forces for Change. Two additional factors may affect the character of the region after 2000:

- **University of Hawai'i West O'ahu (UHWO).** Planning and design money must be approved by the legislature by 2006 and construction started by 2011 to meet the transfer agreement between the State and the Estate of James Campbell.

- **Department of Hawaiian Home Lands (DHHL).** By and large, O'ahu residential acreage held by DHHL and which can be inexpensively developed will have been placed in use by the year 2000. Plans which would most directly affect the proposed East Kapolei project are for

approximately 320-380 housing units planned for Village 6 of the Villages of Kapolei. This is being planned in two phases. Phase I will consist of approximately 150-175 single family units and ground breaking should take place in 1998. It is anticipated that Phase II of the project will include some multi-family housing units. All units in both phases should be quickly absorbed by current DHHL beneficiaries. (Personal communication with Ray Soon, DHHL Land Management Division Administrator, May 1997, February 1998).

Within the proposed East Kapolei project, DHHL has entitlement to 200 acres. The location of the acreage has been determined and agreed to. One of the parcels is located along Farrington Highway and DHHL is prepared to build quickly. DHHL expects to bear its fair share of infrastructure costs.

2.4 SECONDARY STUDY AREAS

2.4.1 Central O'ahu Development Plan Area

Central O'ahu contains both established communities that have long served as plantation towns — Waipahu and Wahiawa — and new developments. Of the new developments, Mililani Town is a planned community, with homes, a technology park, and a major shopping center; and Waikele includes both extensive residential areas and a major shopping center. It is located between Waipahu and other subdivisions, not as a separate community. While Central O'ahu is much more populous than the 'Ewa DPA, the two areas' populations are very similar.

Central Oahu had more than 130,000 residents in 1990 (as shown in Appendix A-1). The age structure was very similar to that of 'Ewa. As in 'Ewa, about a quarter of the population was of Filipino ancestry. Caucasians formed the largest single group, but amounted to only 30% of the population (vs. 40% in 'Ewa). Household incomes were slightly higher than for 'Ewa households (as shown in Appendix A-4). The average household size — 3.49 persons per household — was slightly less than the 'Ewa average, but still much higher than the islandwide average of 3.02 persons (Appendix A-3).

The Central O'ahu DPA follows 'Ewa as one of the leading growth areas on the island. The year 2010 population is forecast as above 169,000, or about 17% of the island's population.

Major growth areas are located near Mililani and on the mauka side of Waipahu. Near Mililani, Mililani Mauka is planned to include 6,213 units of which just over half had been built by mid-1997. Another 320 units are either currently under construction of are expected to be completed by mid-1998. In Launani Valley, over 500 units had been built, of a planned total of 1,028. The nearby Mililani Technology Park is still being developed.

Near Waipahu, Waikele has permits to build nearly 3,000 homes (of which approximately 2,300 are now standing). The Royal Kunia project (Phase I and II) is planned to include 4,000 units, if permits are gained for both phases. As of mid-1997, just over one third of Phase I had been completed. At Waiawa Ridge, the Gentry Corporation proposes building some 2,675 units beginning in 2000.

AMFAC/JMB is developing a light industrial park as well as commercial and community facilities near the O'ahu Sugar Mill site in Waipahu. These developments will likely bring more jobs to the area than operation at OSCo recently provided.

2.4.2 Wai'anae Development Plan Area

Wai'anae is relatively isolated, with one major roadway linking the region to the rest of O'ahu. (A second road connection through the Wai'anae Range has been proposed.) Major land uses include military uses (at Lualualei and Mākua Valley), Hawai'ian Homelands areas (in Nanakuli, Lualualei, and Wai'anae) and a golf course in Makaha.

The region is known for a distinctive "country" lifestyle based in the Native Hawai'ian culture of many residents. Households are larger than in nearby regions. In 1990, the average household size in Wai'anae was 3.93 persons.

In 1990, Native Hawai'ians made up 41% of the DPA population. About three-quarters of the population was born in Hawai'i. The community was young, with a median age of 26.3 years. (For demographic characteristics, see Appendix A-1)

Incomes tended to be low in the Wai'anae DPA. About a fifth of the population had incomes below the poverty line (Appendix A-4). Many renters (44%) paid a very large part of their incomes for housing costs. However, only 14% of homeowners paid over 35% of their incomes for housing, in contrast with the other DPAs under study. Unemployment was about twice as high as the islandwide average, and workers typically commuted 36 minutes to work (as shown in Appendix A-5).

Wai'anae. Wai'anae's growth is forecast by the City as modest in comparison to 'Ewa and Central O'ahu. By 2010, Wai'anae is expected to have about 5% of the island's population, with over 45,000 people. In 2020, the population is projected to be just over 48,000, or 4.5% of the population on O'ahu. While this is a "country" area, new housing projects will house much of the regional population growth:

- **Mā'ile Kai.** Schuler Homes has zoning approvals to build nearly 1,400 homes in Mā'ile (of which just over one-quarter had been build by mid- 1997).

- **Village Pōkaī Bay.** A total of about 507 single-family homes are planned for this Wai'anae 'ahupua'a project. As of mid-1997, this project was 70% completed.

The City's forecasts for Wai'anae do not fully allow for historic patterns of natural increase and large households seen there in recent decades. Two other issues add to uncertainty in forecasting:

- **Department of Hawaiian Homelands (DHHL).** On the island of O'ahu the majority of land held by DHHL is in Wai'anae. As of mid-1997, the City and County of Honolulu Planning Office's Development Plan Annual Report shows that in Wai'anae approximately 185 housing units are to be built in 1998 and 1999. Another 3,255 would be built after 2001. The actual number of housing units developed after 2001 could be significantly less than is suggested in the Planning Department's report, due in large part to the difficulty in developing large portions of the DHHL acreage in Nanakuli.

- **Jobs at Ko 'Olina.** It is uncertain when the bulk of this project, at the entry to the Wai'anae Coast, will be developed. The 9,000 jobs anticipated there are a significant resource for Wai'anae DPA residents as well as 'Ewa. If resort development does not proceed, no major new job center will be closer to Wai'anae than to the housing areas of 'Ewa.

2.5 COMMUNITY ISSUES AND CONCERNS

The residents of the 'Ewa Development Plan Area have largely accepted the area's location for the island's Secondary Urban Center and the development that will occur as a result. Of particular concern, though, to many area residents is that developers and/or public officials fail to adequately address existing traffic problems and the timely development of infrastructure.

Because job creation in the area has not kept pace with residential development, traffic out of and into the 'Ewa area will continue to be a major complaint. So far, it only gets worse with each new development. Developing alternatives which address traffic problems and other infrastructure issues, such as schools and recreation facilities, needs to be done early in the development process. Many feel that these issues are addressed reactively instead of proactively.

Community Contacts

As part of the process of assessing the community's concerns regarding the proposed project, SMS Research has turned toward minutes of the 'Ewa and Makakilo/Kapolei/Honokai Hale Neighborhood Boards to get a sense of what issues are being discussed at the community level. In addition, interviews with key community members were undertaken in 1997. The purpose of both was to develop a sense of what was important to the community. This is important for assessing what the potential impacts of the proposed project might be.

Neighborhood Boards

On O'ahu, neighborhood boards provide an arena where citizens discuss a wide range of issues and local leaders express views clearly when they vote on proposals.

SMS Research reviewed the minutes of the 'Ewa and Makakilo/Kapolei/Honokai Hale Neighborhood Boards for the period from mid-1994 through the end of 1996 to identify recurring concerns in 'Ewa communities.[1] Major concerns expressed by members of these boards and others in the community included:

- **Development.** Development in the 'Ewa DPA has generally been accepted by many residents. However, support has often been tempered by community concerns regarding potential impacts of projects, particularly relating to parking and traffic issues.
- **Public Infrastructure and facilities.**
  - **Traffic:** Residents cite congestion getting on and off H-1 and traffic along Farrington Highway and Fort Weaver Road, as a significant problem. Among the responses discussed at Neighborhood Board meetings, construction of the North South Highway, additional traffic signals, and road widening were

[1] The 'Ewa Neighborhood Board represented the entire 'Ewa Development Plan area until The Makakilo/Kapolei/Honokai Hale Neighborhood Board #34 was formed. The first available minutes for the latter board are for June, 1995.

generally treated as important contributions to improved traffic flow. Increasing the speed limit along Fort Weaver Road, an H-1 contra-flow lane, improvement of the 'Ewa/Kunia exit, and an additional off-ramp at Makakilo were also viewed by some residents as helpful.

- **Schools:** Residents want the state to provide adequate educational facilities in a timely manner, particularly the long-promised Kapolei High School and Kapolei Intermediate School.
- **Waste Management:** A proposal to locate a medical waste incinerator in Waipahu was challenged by residents, who questioned its necessity. They were concerned that potentially adverse health and environmental impacts had not been adequately addressed.

  A proposed sludge recycling project aroused Kapolei residents' and business owners' fears about potential health risks. Pollution control measures to reduce or eliminate odors and dust, and transportation of waste materials from the Honouliuli Waste Treatment Plant to the treatment site in Campbell Industrial Park were of particular concern. While noting these concerns, the board supported construction and operation of this facility.

- **Air Quality.** Incidents where pollutants were accidentally released into the air and reached neighborhoods surrounding Campbell Industrial Park raised community fears regarding the dangers of industrial pollution as well as of the adequacy of emission monitoring at the park. Community residents and political leaders called for a coordinated response to such incidents in the future as well as establishing an information clearinghouse to counter the problem of misinformation during such situations.
- **Parks.** Kapolei Community Park, located in the Villages of Kapole,i has not yet been accepted by the City and County of Honolulu, although it is doing some of the maintenance. Board members recommended accepting the park only after lighting had been installed. Funding for development of planned neighborhood parks was of concern to 'Ewa Neighborhood Board and community members. Furthermore, community residents are concerned with the regular up-keep and maintenance of community parks in both Neighborhood Board areas.
- **Water.** The demise of sugar cane cultivation in 'Ewa has added to the controversy about the disposition of water flowing through the Waiahole Ditch from the Windward Stream. Competing viewpoints include retaining all water on the Windward side or continuing diversion of water to Leeward O'ahu. Both boards were approached by public and private

interests to support an equitable retention of Waiahole Ditch water. Both boards passed resolutions supporting retention of an equitable share of Waiahole Ditch water which would be necessary for further development of diversified agriculture and the future growth of the area.

- **Crime.** While there were some community concerns regarding the level of staffing in the district, and Kapolei in particular, speeding, graffiti and youth gangs were singled out for discussion in meetings.

- **Naval Air Station Barbers Point.** The future of the station concerns community residents. Many residents continue to oppose the State plans to convert the area into an airport. Proposals to site a minimum or medium security correctional facility at NAS Barbers Point were found unacceptable in discussions before the Boards. The Makakilo/Kapolei/Honokai Hale Neighborhood Board has voted against the state's proposals to use the station as a temporary minimum or medium security correctional or general aviation facility. Furthermore, it has voted in support of the city's proposal for a sports and recreation center at the station. (The Barbers Point Redevelopment Commission removed prison facilities from the plan for reuse of the base.)

Key Contact Interviews

SMS Research conducted interviews of community leaders and other representatives in April 1997, to understand what issues and concerns were most pressing to them. For the most part, the interviewees' concerns tended to center on traffic and parks/recreation facilities:

- **Traffic.** This issue was raised by every individual contacted. All felt that the project would add to the current traffic congestion that already plagues the major transit arteries into and out of the 'Ewa area. Many saw the North South Road as chiefly serving the proposed project and residents in the Kapolei area, not those who currently live in 'Ewa and 'Ewa Beach.

  Many felt, though, that construction of the much discussed North/South Road would help to alleviate some of the traffic congestion in the area. Better timing of existing and planned traffic signals, widening Farrington Highway from Kapolei to Waipahu to four lanes, make the North South Road a six-lane road and be certain that it connects with H-1 were among the other suggestions for addressing this issue. Among those interviewed, there was substantial agreement that the issue of traffic and development of the infrastructure to handle the added traffic needed to be addressed before the project was started, not after.

- **Public Facilities.** Individuals interviewed consistently raised concerns about the timing of the construction of public facilities which would serve the project as well as of these facilities contained in the project plans. The concerns related particularly to:

  - Park facilities. Those interviewed, by and large, agreed on the need for open green spaces. Some felt that the open spaces contained in the plans were adequate. Many, though, felt that there should be more and felt that recreational facilities such as soccer fields, basketball courts and tennis courts should be included. There were some who felt that including a gym would be of benefit. Some also felt that including some of these parks/recreational spaces as part of the schools would allow greater utilization of such facilities, by the schools as well as the larger community. (At the time of the interviews, a district park was not part of the East Kapolei project proposal. Subsequent to that time, a 15-acre district park has been included within the project site. As a district park, it is expected that it will include recreational facilities, although it is not known at this time who will provide the funding for such facilities.)

  - Schools. There was substantial concern expressed whether existing schools were adequate to meet the educational needs of the residents of the project. The delay in building of an intermediate and high school in Kapolei was frequently cited as a reason for concern in evaluating a residential development that would bring more children to the area.

  In discussions of the development of parks and schools as part of the project, it was very often suggested that these facilities should be built early on in the project development.

- **Jobs.** Several of those interviewed wondered about where the occupants of the homes built in the project would work. Adding more homes without an increase in the availability of jobs in the area would serve to increase the amount of traffic by those commuting to jobs outside the area. In effect, it just becomes another bedroom community.

Other issues and concerns raised by those interviewed included:

- **Water.** Residents wanted to know where water will come from to support development of this project.

- **Housing Market.** Given the current state of the housing market, several residents questioned whether the East Kapolei homes would sell.

- **Youth.** With another development, there is increased need to plan for more organized activities and services for youth in the development.
- **Waste Treatment.** Some informants wanted assurance that Honouliuli Sewage Treatment Plant would be capable of handling the waste water treatment needs of the proposed development.

3. SPORTS COMPLEX

3.1 OVERVIEW

3.1.1 Project Description

The Sports Complex was proposed at the beginning of the 1990s. Site selection, design and environmental studies have already been done (Mitsunaga 1990; 1992). The idea of a baseball complex was supported by the Barbers Point Redevelopment Commission, which allocated space for it about half a mile south of the site under consideration in this report. However, Housing Finance and Development Corporation plans for East Kapolei did not at first include a regional sports complex. (The community interviews discussed later in this report hence do not deal with the complex.)

The current Sports Complex proposal was presented to community groups in 'Ewa in mid-1997 as a facility that would be designed to encourage professional teams to come to Hawai'i for spring training (Bakutis, 1997; Kosaki, 1997). The complex would also be available for exhibition games and, when not in use by professionals, to the surrounding community. The Makakilo-Kapolei-Honokai Hale Neighborhood Board voted in support of the plan. The plan was also incorporated in the 'Ewa Development Plan, and was part of the plan accepted by the Honolulu City Council in 1997.

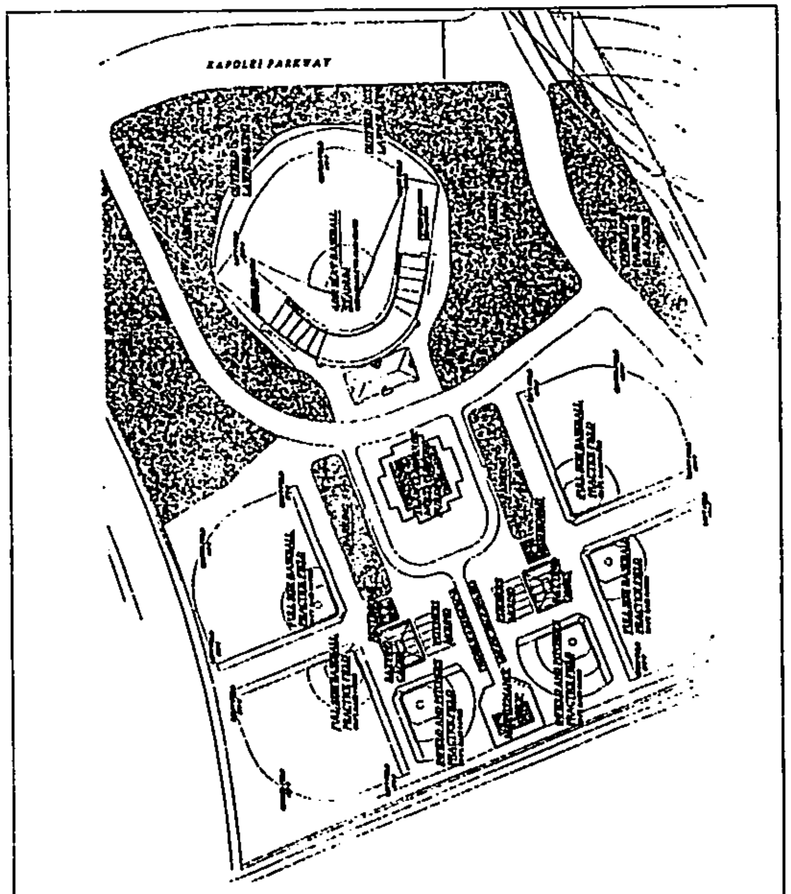
The proposal includes:

- A stadium, built to seat about 4,000 people, but capable of being expanded to serve about 10,000;
- Baseball fields;
- Areas that can be used for soccer and softball (either fields devoted to these sports or ones that could be converted from baseball use to other sports)
- A separate multipurpose building with classrooms and offices;
- Ample parking for the stadium; and
- Ancillary facilities (including bull pens and rest rooms).

The mix of facilities points to different ways the complex might be used: professional athletics, tournament-level play, and community sports activities. Potential users are expected to include professional baseball teams from outside Hawai'i; the Hawai'i Winter Baseball League; and community groups. All of these would likely seek both practice areas and a field where games can be held before spectators. Also, parking lots would be used by commuters who work in Kapolei's government center.

The conceptual design used during the course of this study included three baseball fields and three softball fields. Exhibit 3-A shows one of the conceptual designs under review. (Designs varied notably in the size and routing of the North-South Road.)

Exhibit 3-A: PRELIMINARY CONCEPTUAL DESIGN FOR SPORTS COMPLEX



Source: Masunaga & Associates, Inc.

3.1.2 Scope of Research on the Sports Complex

SMS Research was contracted to conduct research on feasibility of the Sports Complex, to estimate operating costs and revenues, and to identify economic and social impacts of inclusion of the complex in the East Kapolei project area. To meet these aims, SMS collected information concerning earlier work on the sports complex, the ongoing effort to attract teams and events to Hawai'i, interest in the complex among Japanese and other Asian professional teams, and operations at Mainland venues for spring training.

For design issues, discussions with Japanese team managers and a study assessing Rainbow Stadium in terms of minor league baseball design standards were useful. The feasibility analysis draws mostly on information from Mainland sports complexes.

3.1.3 Operations Concepts

The East Kapolei Sports Complex could be operated in different ways. In planning the concept, State officials have emphasized that a public-private partnership would be encouraged. That phrase can cover many different levels of private-sector involvement and investment. The choice of an operating concept affects field and stadium design and revenues. Two alternative concepts were investigated:

1. **Public facility,** charged to earn income, and to support community recreation in a modest way, e.g., by making fields available to community groups at cost and/or by supplying revenue needed to support public parks in the region. Such a facility would likely support the range of user groups listed above, but would charge for the use of facilities in proportion to actual costs, and would actively encourage rentals and corporate participation in order to cover the costs of operations.

2. **Private operator,** committed by lease to allow some public participation: A private operator would be charged to make some fields available to community groups for low fees but would be free to use most of the facility as it deems profitable. The operator could run training camps, tournaments for visiting groups, or other activities.

Major implications of the concepts are summarized in Exhibit 3-B. The choice among the concepts involves trade-offs:

- A public facility aggressively pursuing revenues would provide for community play (on fields and, to a limited extent, in the stadium) and could be attractive to out-of-state users, but would still need public support. That support could, however, be justified as largely offset by State revenues from spending by visitors attracted by the facility.

- A private operator would be appealing as minimizing the State's financial obligations. However, the surrounding community would get very little or no use of the facility. Moreover, the risk that an operator would not be able to succeed at the site is high.

In this chapter, impacts of both concepts are discussed. Elsewhere in the report, attention focuses on the first concept, inasmuch as (a) it involves maximal assumptions about State costs and (b) costs and social impacts of a privately operated facility are far less certain, since no potential operator has made a detailed proposal for the facility.

3.1.4 Design Features

The various components of the complex could be used under both concepts. The stadium and classroom/office building would be used differently:

- A facility pursuing revenues would need to attract professional teams with a high quality play surface, and facilities for training and sports medicine. Expenditures in this area might also be justifiable if linked to a sponsor's activities.

- A private operator might be expected to pay for specialized facilities needed for for-profit activities, and would likely prefer the facility to be easily adapted to many different uses. Hence a private operator would likely want a facility much like a community-oriented one. However, a private operator would need large-scale food services on-site.

Exhibit 3-B: OPERATIONS CONCEPTS STUDIED FOR THIS REPORT

	A. PUBLIC Revenue emphasis	B. PRIVATE OPERATOR
Implications of Concept for Usage	Encourage visitor use and corporate sponsors	Multiple uses, emphasis on adaptability
Design		
Stadium	seat backs, sky boxes; team facilities include large weight and training rooms	Heavy usage for paying events
Building	Offices for visiting teams; media facility; sports medicine; possible wellness center	classrooms, may need large area for indoor sports; will want to have and run cafeteria
Fields	not yet clear	emphasize ease of conversion; timing depends on sales
Cost-Revenue Profile		
Construction Costs	higher	midrange
Operating Costs	high event costs; maintenance costs variable	no cost to State
Revenues	norm is up to 50% of operating costs. Project could do better with strong sponsor tie-ins	Rental and a share of revenues
Est. Ann. Balance		*If viable --*
Direct	- $500K	$100K to $350K
Total	- $20K	$300K to $800K
Economic Impact on State	Return covers ops costs	Positive but (a) high risk and (b) might not support HWB or Asian professionals.
Social Impacts	Limited community play. Local charities can raise funds as volunteers.	Little or no community play. No charity tie-ins.

3.1.5 Findings on Feasibility

SMS Research learned from Mainland research that

- Mainland spring training venues do not cover their operating costs with revenues from fields and stadiums;
- Commonly, Major League Baseball spring training revenues make up about half the total annual revenues of stadium and field operators;
- The remaining revenues come from a wide range of sources, and operators must be quite resourceful in finding revenue-generating sources; and
- Mainland venues commonly justify their stadium operating costs in terms of (a) general economic benefit of attracting tourist spending and (b) community benefit from the use of the facilities. Studies of the amount and impact of sports tourist spending are suggestive, but far from definitive.

Mainland stadiums were built and refurbished in the last decade or two either because of a broad policy decision – e.g., Florida's dedication of a major tax to sports promotion, to be spent by the counties -- or to keep up with competitors. They did not recoup operating costs, much less initial investments, through direct revenues.

SMS explored private-sector sports tourism at some length with one Florida operator and discussed with others involved in sports a range of activities that might be staged by private or public-sector operators. It appears possible that a private operator might be able to pay the state for use of the complex, but: (a) much more information is needed about operations and operators before a decision is taken to rely on an operator; (b) such an operator would have to grow the market for tournaments and other events, not just claim a share for Hawai'i of an existing market; and (c) the risk is increased by competition from public sector operators. While a successful private operation would likely offer a better return to the state than a public operator, that success is far from certain.

Private sports operators aim at both adult and youth sports markets. Operators of fixed facilities typically provide activities – clinics, camps, and tournaments – for several different sports, in order to make full use of their facilities. Others specialize in a particular activity (e.g., youth soccer camps) and may run these at locations such as university and community fields during the summer. A private operator for the East Kapolei Sports Complex would need to market the facility

both to Westbound and Eastbound markets, and would be open to use of the site for a range of paying activities.

3.1.6 Findings on Economic and Social Impacts

Economic and social impacts of the sports complex are discussed further in later chapters, in the context of the East Kapolei project as a whole. The key impacts of the complex can be summarized here.

Construction costs for the Sports Complex have been estimated as in the range of $27.5 million (not including off-site costs). That figure would cover a 4,000-seat stadium, the multipurpose building, and parking for about 800 cars. Construction costs borne by the State for a private venue could be lower. Public operation of the facility would involve expenditures of about $1.0 million per year, supporting some 15 on-site jobs and additional part-time work for large events. A private operator would probably support a larger staff, with many of the on-site jobs being filled by part-time workers.

The total economic impact of the Sports Complex concepts discussed here is estimated as:

Public operator: Increased visitor spending, growing to some $7.5 million (1997 dollars) annually attributable to the sports complex, resulting in State revenues (from operations and from taxes on cash flows from visitor spending) of about $1.0 million annually. Costs would likely be greater than revenues until a strong program attracting visitors has been developed.

Private operator: Any contract between the state and a private operator would demand that the operator cover operating costs and provide the state with a minimal rental. State revenues could then be in the range of $0.3 to $0.8 million, but the State would not incur operating costs, so the net balance is positive. State revenues would come from (a) rents and the State's share of facility revenues; and (b) visitor spending. Visitor spending associated with the private operator concept is estimated as capable of reaching about $6.7 million. (Should a private operator succeed in developing an amateur tournament program for eastbound visitors similar to that found on the mainland for residents of Northern states, visitor spending and associated state revenues could be higher.)

Social Impacts depend on the reception of a sports facility that will help increase 'Ewa's visibility on O'ahu and to visitors, but will provide only limited community play. The economic activity will support jobs, both on-site and in West Beach hotels. However, residents of the region have stressed the need for playing fields for local use. Some have questioned whether new facilities should be built when local government is not maintaining existing parks well. Community criticism is hence likely unless the Sports Complex generates revenues to support construction and operation of recreation facilities for the general public.

Two possible changes in concept might mitigate the potential adverse economic and social impacts noted here. These are:

- Developing training and sports medicine facilities that could (a) attract significant sponsorship and/or lease rents in the multipurpose building; (b) be part of the State's effort to develop "health tourism" from Japan and Asia; and (c) provide special amenities for Kapolei residents and commuters; and/or

- Seeking an operator capable both of setting up long-term relationships with Japanese or Asian teams and of marketing the Sports Center to Westbound adult amateurs, increasing the operator's return and State revenues associated with the project.

3.2 CURRENT AND LIKELY FUTURE CONTEXT

3.2.1 Similar Facilities in Hawai'i

Currently, O'ahu has no facility fully comparable to the proposed East Kapolei Sports Complex. One such facility could be built in the near future. Existing facilities include:

- The University of Hawai'i has fields and a stadium highly suited to play by minor league teams and training by visiting professionals. Rainbow Stadium is respected as a high-quality college baseball stadium. It substantially meets Major League Baseball requirements for a Class A stadium (Gould Evans Associates, 1993). However, University teams and activities have priority over other users. Hawai'i Winter League Baseball has been able to use Rainbow Stadium from October through December. It is not available to non-University teams from January through May. Also, no consumption of alcoholic beverages is allowed on the grounds of the University.

- Hans L'Orange Park in Waipahu has been used by Hawai'i Winter League. Currently, the outfield is cramped, but it will increase in size as land donated by Amfac/JMB Hawai'i is incorporated in the playing area.

High schools and City and County parks have baseball diamonds, but these lack the seating and other facilities proposed at the East Kapolei Sports Center. Hawai'i Winter League Baseball is also played on Maui and the Big Island.

A major new baseball facility has been proposed as part of the Waiola Regional Park and Sports Complex, between Waipahu and Mililani. The park plans are still being refined. A conceptual master plan dated January 16, 1998 includes:

- A 6,000-seat baseball stadium;
- Five baseball fields;
- Four youth baseball and four softball fields;
- A field house and training center;
- A total of 2,400 parking stalls; as well as
- Facilities for soccer and football, basketball, beach volleyball, tennis, boxcar racing, and in-line hockey.

The Waiola complex would provide baseball facilities very similar to those of the East Kapolei facility. It could compete as a venue. By the same token, the two facilities could work together to support play by more than one team, encouraging different teams to come and play each other in Hawai'i. The Honolulu City Council has failed to date to vote funds for construction at Waiola. As a result, the baseball stadium seems not likely to be built in the near future. However, eventual development of the park with a strong emphasis on recreation seems sure to happen.

Additional planned O'ahu facilities include a soccer complex on the Waipi'o peninsula, with some 24 fields and a stadium planned, and new developments in what is now the Barbers Point Naval Air Station. At the time of base closure in 1999, some 500 acres in Barbers Point are expected to be transferred to the City and County Parks Department. Most of that area consists of the shoreline and camping areas nearby. However, eventual development of some 200 acres has bee proposed for (a) a training center for world-class athletes, and (b) a baseball complex (Helber Hastert & Fee, Planners, 1997).

There is no evidence that the City and County will be able to build major sports facilities at Barbers Point in the near future. Hence it is very unlikely that the baseball complex originally proposed would be built. Instead, playing fields will likely be open for community use.

Maui recently succeeded in gaining the Hula Bowl, and then increased seating at War Memorial Stadium to 20,000 seats. This signals the fact that the Neighbor Island counties could create ball parks with bleacher seating on short notice.

In sum, while there is only one facility in Hawai'i now comparable to the proposed baseball complex, several facilities could be built or expanded after the year 2000. These would likely not offer baseball practice and play areas fully comparable to those planned for East Kapolei, but could well compete with East Kapolei as a venue for games, lowering the fees that any one operator could charge. The East Kapolei Sports Complex will need to be more than a place to play baseball in order to assure demand from paying customers for its facilities.

3.2.2. Markets for the Sports Complex

Sports tourism has been the subject of extensive analysis (Don Smith Consultants, Inc., 1989; Hill and Knowlton, 1991; KPMG Peat Marwick, 1991). It is widely acknowledged that events such as the Honolulu Marathon contribute greatly to the economy, and that the State will benefit from increased sports activity and publicity. New investigations by SMS added to our knowledge about sports tourism, but did not change the critical factors:

1. Hawai'i's climate and scenery make sports in Hawai'i very appealing and exciting – so much so that television coverage of events is thought to attract other visitors in large numbers.
2. Transportation costs to and from Hawai'i are so high that few people come here simply to watch or play in a particular event.

These facts mean that sports tourism makes sense within a larger tourism process:

a) Sports as tourism promotion, bringing more people to Hawai'i than those who attend a given event;

b) Encouraging people to come to Hawai'i for sports as well as other activities, not just one event; and

c) Encouraging groups to come to Hawai'i, some of whom are sports-oriented, while others may want beaches, relaxation, and or cultural tourism.

The State of Hawai'i and others have tracked the number of visitors coming to attend or participate in events such as the Honolulu Marathon or Pro Bowl (e.g., Hawai'i State Department of Business, Economic Development and Tourism, 1991). Data are not available on the number of people attracted by reports of events such as the Hawai'ian Open, even though it is generally believed that such events provide important publicity for Hawai'i.

For this report, SMS Research made contact with several US Mainland stadium operators. (See list in Exhibit 3-C.) Most had facilities used for spring training by Major League Baseball. They discussed a range of markets and activities, including:

Major League Baseball Spring Training. This has become a valued source of tourism for Florida and Arizona communities. The stadiums and local communities often see about $300,000 annually in facility revenues from a 15-home-game season of spring training. The communities estimate that additional spending by teams and visitors attracted by spring training amounts to many millions.

The cost of hosting spring training has increased markedly during the 1990s. Florida made available to its counties tax funds for sports and cultural facilities. New stadiums built to meet Major League Baseball expectations have drawn some teams from older facilities. Renovation and construction of new ball parks in Arizona has followed, as Arizona moved to retain the teams that form the Cactus League.

New stadiums, seating more than 10,000 spectators, have been built in both states to accommodate Major League Baseball. The cost of new construction has ranged up to $1,800 per seat. Construction has been supported by dedicated state and county taxes, local community initiatives, and long-term contracts with professional teams.

Major League spring training is not a viable option for East Kapolei, since it demands the presence of several teams, with a schedule of games to attract visitors. For that matter, the investment cost in a stadium that would meet current Major League standards could not be justified in terms of use by other markets over most of the year.

US Minor League Baseball. Stadium operators saw minor league baseball as a way to keep their facilities in use, but not a major source of revenue. Attendance is commonly less than a thousand spectators. No operator mentioned minor league baseball as attracting tourists. (One economic impact study conducted in Florida deals with both spring training and minor league operations. Concession and operations spending for the minor league teams was estimated as less than 5% of the total estimated direct economic impact of professional baseball in Palm Beach County (PMG Associates, Inc., 1993).

Honolulu had a minor league team, the Islanders. Transportation costs made it difficult to operate a single professional team in the state. This condition seems likely to continue.

Exhibit 3-C: EXPERTS ON US STADIUM OPERATIONS INTERVIEWED FOR THIS REPORT

NAME	TITLE	TEAM/FIELD	LOCATION
HAWAII			
Glenn Nakaya	Stadium Manager	Rainbow Stadium	
Dick Walsh	General Manager	Hawaii Convention Center	
ARIZONA			
Chris Baier	Director of Sports Promotion, State		Phoenix
Dave Dunn	Stadium Manager	HoHoKam Park	Mesa
Robert Brinton	Mesa VCB, Director		Mesa
Rob Harman	Parks Dept	Phoenix Muni and Maryvale	Phoenix
Ron Pies	City of Tempe; Pres. AZ Bball Commission	Diablo Stadium	Tempe
Will Gorman	Stadium Coordinator	Diablo Stadium	Tempe
Dana Braccia		Scottsdale Stadium	Scottsdale
Antonia Flores	City of Yuma	Desert Sun Stadium	Yuma
Mary Cordery	Caballeros de Yuma		Yuma
FLORIDA			
Giles Malone	Vice President	Cocoa Expo	Cocoa Beach
Albie Scoggins	General Manager	NY Mets/Thomas J. White Stadium	Port St. Lucie
Don Miers		Houston Astros/Osceola County Stadium	Kissimmee
Rob Rabenecker	General Manager	Sports Complex	Jupiter
Grant Griesser	GM, Vero Beach Dodgers, Stadium Operations	LA Dodgers/Holman Stadium, Dodgertown	Vero Beach
Caroline Ginn	Cty Commissioner, Indian River County	LA Dodgers/Holman Stadium, Dodgertown	Vero Beach
Milt Thomas	Dir of Economic Development, Indian River County	LA Dodgers/Holman Stadium, Dodgertown	Vero Beach
Marney Brown	Asst Stadium Mgr.	Cincinnati Reds /Ed Smith Stadium	Sarasota
Patrick Calhoon	Sports Facilities Director	Cincinnati Reds /Ed Smith Stadium	Sarasota
Pete Schneider	Deputy City Administrator	Cincinnati Reds /Ed Smith Stadium	Sarasota

Instructional League Baseball. The Hawai'i Winter League (HWL), like the Arizona Fall Instructional League, has provided minor league professional players from the United States, Japan and Korea with an off-season opportunity to play baseball. League operations are supported in

part by the professional teams that send players to the league. Attendance at games is modest, so stadium operations revenues would come from rental and expenses, with little more from concessions and parking.

Hawai'i Winter League officials contacted for this study expressed interest in locating a team at the East Kapolei stadium, since the league has plans to expand (personal communications, Duane Kurisu and Frank Kudo, Hawai'i Winter Baseball, January 1998). However, in February 1998, HWL announced that efforts to renegotiate the league's contract with Major League Baseball had failed, and the 1998 season would be canceled (Arnett, 1998). The initial contract called for HWL to receive no support from the US teams as of 1999; HWL needed a partial subsidy for US players in order to continue operations.

For this report, SMS has assumed that HWL or the like could resume operations in time to use the East Kapolei Sports Complex.

International Exhibition Games. The idea of international exhibition games or an international world series has been raised in the past in Hawai'i. A major series of games would need a large stadium as a venue. One or two smaller games could be held at the East Kapolei sports complex. These might involve higher ticket prices than instruction league games, but attendance must be assumed to be modest.

Japanese and Asian Professional Spring Training. Mainland operators had enjoyed working with Japanese teams, and saw spring training as a source of revenue for the surrounding community (from visitor spending by the teams and media). The Yakult Swallows have trained in Yuma for many years. Other Arizona sites have been visited by Japanese and Korean teams, but no longer host these. There does not appear to be a strong marketing effort from the Mainland states to regain this market.

The operator's revenues from this market would include basic facility rental fees and expenses for the training period, and revenues from one or two exhibition games. The State might have to share some of those revenues, in order to bid competitively with other spring training sites.

Celebrity Sports Events. These are usually organized for charities. The amount of interest generated will depend on the participants and whether the event has been held regularly.

Adult Amateur Tournaments. These are well established in the Phoenix area, which hosts tournaments by teams from the East Coast. Stadium revenues are modest, but visitor spending in the area is considerable.

Similar tournaments could be established in Hawai'i, given the cooperation of league and tournament operators from the teams' home states.

Youth Tournaments. Local youth tournaments would involve minimal rentals, fees and other revenues for the operator. Some could be scheduled, but these would involve greater cost than the revenues accruing to an operator.

Non-local youth tournaments involve little in the way of stadium rentals. For major tournaments, incentives and concessions are typically offered by a host city to attract a tournament attended by many visitors (Hill and Knowlton, 1991).

One operator contacted in the course of the study maintains a busy schedule of tournaments and spring training activities, especially for out-of-state college teams. Major revenue sources for the operation include lodging, food sales, and tournament operations. This operation involves a full-time staff in marketing and organizing tournaments in several sports.

Clinics and Sports Camps. These range from one- or two-day events for children to week-long adult events. The former are usually held on public facilities, and pay low rentals. Camps led by well-known trainers or sports figures may attract adults willing to pay well for the experience.

Fantasy Camps. These are more elaborate versions of adult sports camps. Campers are suited up in authentic gear, and taught by well-known sports figures. Camps may be affiliated with a particular major league team.

Non-Sports Uses. Baseball stadiums in Florida and Arizona stand empty for much of the time. Some periods of low use are necessary for field maintenance. Others arise for lack of a market. Managers actively seeking stadium uses have sought new uses energetically:

- *Corporate rentals*: Stadiums and fields may be used for corporate meetings and shows (e.g., of new cars to be sold by the salesmen in the audience);
- *Concerts*: A venue such as the East Kapolei Sports Complex could book concerts with a draw comparable to that of the Waikīkī Shell. Revenues from attendance, concessions and parking make this a potentially attractive source of revenue. However, the stadium will be near to residential areas, and access to the facility runs between

residential areas. Consequently, noise restrictions will need to be established and enforced.

- *Commercial shoots*. Commercials are shot at stadiums throughout the country. Competition holds down the charges that an operator can expect from this source.
- *Advertising*: Wall and scoreboard advertising can yield as much as $100,000 for a stadium with well-attended events and a Jumbotron scoreboard. Without Major League spring training in Hawai'i, potential revenues would be much smaller.
- *RV Sales*: Mainland stadium operators will rent out their parking lots for days at a time to firms selling campers and other recreational vehicles, gaining stadium rentals in return. This particular revenue source cannot be replicated in Hawai'i, since RVs are illegal, but boat and car shows could provide occasional revenues.
- *Parking for Commuters and for Events Elsewhere*. Municipal stadiums often provide parking for events at other City facilities at little or no cost. At East Kapolei, the Sports Complex parking area could be needed when major events are held at venues elsewhere in Kapolei, including planned recreational areas in what is now Barbers Point Naval Air Station.

Sponsorship deserves mention as a major source of revenue for new facilities. In Arizona, a full-size Major League stadium is being sponsored by a bank, while the new Tucson spring training field is sponsored by the local electric company. Sponsorship fees can vary greatly depending on the exposure gained.

Finally, a trend is appearing in Florida, where stadiums and practice fields are integrated into larger resort complexes. A new stadium is part of the Disneyworld complex. Baseball operations in such a site may be viable as one of many attractions. Disneyworld and the older Dodgertown complex are simply not comparable to the East Kapolei site, with its limited land area and lack of on-site hotel facilities.

Mainland stadium operators take pride in attracting paying events to their sites. However, they succeed in using their facilities, not in turning a profit. Stadium earnings probably covered from 20% to 60% of annual operating costs, not including payments for initial construction. (In some cases, the operating costs were paid by several sources, and could not be summed up.)

3.2.3 Potential for Japanese and Asian Use

SMS Research finds that a new baseball facility will probably be able to attract a professional team for spring training, but that retention of a team or teams year after year may demand concerted effort.

An 'Ewa baseball complex has been sought for years as a site for Japanese teams to train. Japanese and Korean teams have trained in Hawai'i in the past. In mid-1997, letters from officials of four Japanese teams and one Taiwan team expressed support for construction, and eventual interest in use, of the East Kapolei baseball complex. An official of the San Diego Padres wrote to suggest that an exhibition series, involving American and Japanese professional teams, could be held in Hawai'i, if a large baseball complex were available. (It is not clear whether the East Kapolei site would be the sole venue, or whether the major games would occur in Aloha Stadium.)

Concern has been expressed that the recent Asian financial crisis may rule out spring training in Hawaii. SMS Research called teams in Japan to learn more about their current spring training activities and interest in a Hawai'i facility in the future. Phone interviews were held with officials from six teams (listed in Exhibit 3-D). Of these, one currently trains on Saipan, and one part-time on Okinawa. The rest go to southern Japan for spring training.

The officials were familiar with Hawai'i, and most teams had trained in the United States in the past. At least one was very familiar with the 'Ewa proposal from past discussions.

Exhibit 3-D: JAPANESE BASEBALL OFFICIALS INTERVIEWED FOR THIS REPORT

NAME	TITLE	TEAM
Ikoma Yoshio	President/GM	Kintetsu Buffaloes
Chitomi Takahashi	General Manager	Hiroshima Carp
Mr. Kuzutani		Fukuoka Daiei Hawks
Mr. Tanaka		Seibu Lions
Yuji Hiromoto	Public Relations	Chiba Lotte Marines
Mr. Iijima	Asst. Director, Administration	Yomiuri Giants

Most expressed polite interest in training in Hawai'i, but could say little more about their teams' interest until a facility is actually built. Moreover, most seemed satisfied (at least in January, just before spring training) with their current sites. Training in Japan allows team management to travel easily between the training site and the home office. Japanese sites are familiar. City and prefecture governments have sought to cooperate with the teams.

In sum, a new Hawai'i site will face serious competition from sites nearer Japan and Korea. Points that could favor development of spring training in Hawai'i include:

- **Quality of facilities and amenities:** Mainland US baseball complexes offer Japan teams stadiums, clubhouses, and other facilities built to standards set by the Major Leagues. Japan and Okinawa host sites are eager to work with the ball teams to meet their needs. A competing Hawai'i facility will need to combine American facilities with the understanding of Japanese teams' needs and willingness to work with the teams found nearer home.

  In the interviews, it seemed clear that Japan training areas provide little or no facilities for training with weights or for sports medicine. A Hawai'i facility could stand out if equipped for serious training based on American research.

- **Ties to Japanese Interests in Hawai'i:** The teams training in Hawai'i in the past include the Seibu Lions, who stayed at Seibu Railways' Maui Prince Hotel while training. Hawai'i ties of the teams' owners may influence the choice of training site, but do not determine the choice – the Lions are training elsewhere this year.

- **Teams' interest in trying something new:** A few teams have returned to the same spring training site for decades. Most have been moving from site to site, trying to find an advantage to serve them through the season. Consequently, it may not be difficult to find a team interested in trying out Hawai'i as their next spring training site. Retaining a team year after year many be more difficult.

- **Development of a Hawai'i spring exhibition season:** Over the long term, Hawai'i can hope to keep Japanese and Asian professional teams and their fans by attracting more than one team, and providing venues for exhibition games. Florida and Arizona communities have benefited from development of the Grapefruit and Cactus Leagues. Major League teams have moved from field to field, but they are committed to playing other teams in these venues. The result is an attraction for repeat visitors. (One Florida poll found that 55% of spectators at a Braves / Expos game were from out of state [Sports Management Research Institute, 1996].)

With at least two Hawai'i sites planned to attract professional baseball for spring training, there is a good chance of attracting more than one team, and of scheduling exhibition games in Hawai'i. With only a handful of teams visiting, Hawai'i cannot expect to host a full-blown league. Still, a recognized exhibition game season will attract repeat visitors and media attention, making teams' return to Hawai'i increasingly likely.

3.2.4 Implications for Management and Feasibility

The data reviewed here suggest that the East Kapolei sports complex will find many users. At the same time, the complex will only be able to schedule events that pay more than nominal fees with a serious marketing effort. That effort would involve outreach to potential users overseas, cooperation with hotel operators, collaboration with other field and stadium operators, notably the City and County Parks Department, to provide fields for practice and play at reasonable rates.

The stadium and field users discussed above vary greatly in their ability to pay for facility use and their overall spending in Hawai'i. Economic success of the facility will depend on effective recruitment of several segments. (See Exhibit 3-E for a listing of segments.

Stadium revenues, of greatest concern to a private operator, are perhaps highest at special events such as concerts and exhibition games involving professionals. Hawai'i Winter Baseball would be of concern to an operator as a multi-event source of rentals and income from the operator's share of tickets, concessions and parking. The operator would likely seek to maximize play by adult amateurs (in tournaments, fantasy camps, and clinics). Recruitment of eastbound amateurs will likely be crucial in this effort.

Concerts that would fill the proposed stadium would not attract out of state visitors, and hence would offer little additional benefit to the state through taxation. Similarly, westbound and local youth activities, which would keep the stadium occupied, generate little new income for the state. Consequently, the mix of markets that a private operator would target might be somewhat different from those promising the highest overall return to the state.

Exhibit 3-E: MARKET SEGMENTS

MARKET SEGMENT	STADIUM REVENUES	OFF-SITE VISITOR SPENDING
Eastbound		
Professional teams	Reasonable fees but few spectators	Considerable spending by teams, media, fans
Adult amateurs (1)	Reasonable fees but no spectators	Considerable spending by participants
Westbound		
Professional teams	Reasonable fees and gate; rare	Considerable spending by teams
Adult amateurs	Reasonable fees but no spectators	Moderate spending by participants
Youth groups	Low fees; spectators not spend much	Low spending by visitors
Hawaii-based		
Hawaii Winter Baseball	Reasonable fees; moderate attendance	None due to stadium
Youth groups	Low fees	None
Corporate	Rent, fees	None
Concerts	Rent, fees, share of attendance	None

NOTE: (1) Feasibility of developing this market has not been established.

3.3 PROGRAM

A sports complex intended to attract professional players and other markets will need to be designed to Major League Baseball standards for Class A teams (with a 4,000-seat stadium) and to provide amenities needed to distinguish the complex from community facilities.

Costs of construction have been estimated as amounting to $27.5 million. That figure includes planning and design, on-site infrastructure, and construction of a 4,000-seat stadium, the multipurpose building, the practice fields and parking lots (Mitsunaga and Associates, Inc., January 1998). Off-site infrastructure costs are not included in that figure.

Operating costs are shown in Exhibit 3-F. The estimates are adapted from detailed budgets of comparable facilities with Major League spring training events.

(The key cases on which SMS relied in developing cost and revenue estimates are discussed in Appendix B.) Costs have been reduced somewhat from Mainland US costs in light of the size of the stadium.

Projected sports complex revenues from a facility marketed to a wide range of users are shown in Exhibit 3-G Total state revenues associated with the program shown in Exhibit 3-G are shown in Exhibit 3-H. All values are calculated in current (1997) dollars.

Such a program of activities yields the state a minimal positive annual balance, when taxes derived from visitor spending are combined with operational income (as shown in Exhibit 3-H). That balance includes revenues from visitors attending events at the stadium. Presumably, additional visitors would be motivated to come to Hawai'i after media coverage of events at the sports complex.

Sponsor contributions account for a major share of revenues. As noted in Exhibit 3-G, corporate sponsorship of a government-owned facility is not known in Hawai'i. In Arizona, Tucson Electric Stadium and Bank One Stadium, home of the Phoenix Major League expansion team, are being built with major corporate sponsorship.

The exhibits show costs and revenues for the facility after its marketing program has succeeded in recruiting not only repeat professional users but also a variety of amateurs (including amateur adult activities and at least one interstate regional youth tournament annually). This level of activity could only be achieved after a development period of perhaps five years. The specific mix of activities developed at the site will depend on marketing and opportunities arising in the future; the detailed listing of activities in Exhibit 3-G should be seen as provisional.

Both Eastbound and Westbound marketing will be needed for the Sports Complex. SMS knows of no baseball facility of similar size that has developed stable domestic and international market segments. Consequently, the time needed to reach a stable level of usage is not well established. Even when the facility is well known both to US mainland and Eastbound groups, active marketing will be needed to secure major youth tournaments and retain other events.

Exhibit 3-F: ESTIMATED ANNUAL OPERATING COSTS

	FTE	Wages per FTE	Fringe, Taxes	Subtotal	Annual Total
Staff					
Management	2.5	$ 34,800	$ 9,744	$ 111,360	
Grounds/ Maintenance	8.5	$ 22,500	$ 6,300	$ 244,800	
Mechanical	1.5	$ 25,000	$ 7,000	$ 48,000	
Parking (FTE)	5	$ 12,500	$ 3,500	$ 66,000	
Ticket Office	1.5	$ 16,000	$ 4,480	$ 28,480	
					$ 498,640
Contract services		*Range per event*			
Stadium clean up		$ 300	$ 600		$ 24,000
Event-related (ushers, security)		$ 250	$ 1,000		$ 35,000
Trash pick up					$ 42,000
Repair services					$ 45,000
Grounds					$ 100,000
Equipment/Repair					$ 25,000
Utilities					
water/sewer					$ 100,000
electric					$ 100,000
other					$ 20,000
Promotion					$ 5,000
Insurance					$ -
Off-Site Management					$ -
TOTAL					$ 994,640

NOTE Estimated from costs of comparable US Mainland facilities.

Exhibit 3-G: ESTIMATED ANNUAL OPERATING REVENUES

		Potential Operator Revenues Per Event	Annually, HI
PROFESSIONAL SPORTS (1)			
Major League Baseball Spring Training		$ 22,000	NA
Minor League Baseball	(1)	$ 3,088	NA
Instructional Leagues	(1)	$ 3,088	$ 46,313
International Exhibition Games	(1)	$ 6,150	$ 12,300
Asian Spring Training: practice		$ 1,500	$ 42,000
Asian Spring Training: games	(1)	$ 4,250	$ 17,000
OTHER SPORTS EVENTS			
Celebrity Events	(1)	$ 7,400	$ 14,800
Adult Amateur Tournaments	(1)	$ 2,200	$ 22,000
Youth Tournaments	(1)	$ 1,200	$ 12,000
Clinics, Sports Camps		$ 1,200	$ 9,600
Fantasy Camps		$ 1,800	$ 18,000
OTHER STADIUM USES			
Corporate Rentals		$ 1,500	$ 12,000
Concerts	(2)	$ 16,600	$ 99,600
Commercials		$ 1,800	$ 10,800
Advertising (with scoreboard)			$ 25,000
ADDITIONAL REVENUE SOURCES			
RV Sales		$ 2,500	NA
Boat or Car Shows		$ 1,000	$ 4,000
Parking for Commuters (3)		$ 1,200	NA
Parking for Events at other Facilities		$ 1,600	$ 24,000
Sponsorship (4)		$ 150,000	$ 150,000
			$ 519,413

NOTES: All calculations are for 4,000-seat stadium, with 800 parking spaces for events. Estimated stadium rentals include charges for utilities and services. "Per event" column shows revenues per event or per day.

(1) Revenue estimate includes stadium rental, 50% of admissions, 25% of concession sales, and all parking revenues.

(2) Estimate includes 50% of admissions and all parking revenues.

(3) State employees commuting to Kapolei offices are presumed to be parking in lots developed with money from a revolving fund, with revenues from parking going toward the fund. The Sports Complex would have revenues from these stalls in times other than the work week.

(4) Not based on Hawaii experience. Sponsor would likely gain rights to advertising, stadium boxes, and multipurpose building space.

Exhibit 3-H: ESTIMATED TOTAL ANNUAL STATE REVENUES ASSOCIATED WITH OPERATIONS: STATE AS OPERATOR

	Operator Revenues	State Share of Cash Flow	Total State Share
PROFESSIONAL SPORTS			
Major League Baseball Spring Training	NA		
Minor League Baseball	NA		
Instructional Leagues	$ 46,313		
International Exhibition Games	$ 12,300	$ 91,957	$ 104,257
Asian Spring Training: practice	$ 42,000	$ 107,284	$ 149,284
Asian Spring Training: games	$ 17,000	$ 137,936	$ 154,936
OTHER SPORTS EVENTS			
Celebrity Events	$ 14,800	$ 20,946	$ 35,746
Adult Amateur Tournaments	$ 22,000	$ 29,886	$ 51,886
Youth Tournaments	$ 12,000	$ 70,245	$ 82,245
Clinics, Sports Camps	$ 9,600	$ 8,302	$ 17,902
Fantasy Camps	$ 18,000	$ 11,648	$ 29,648
OTHER STADIUM USES			
Corporate Rentals	$ 12,000		
Concerts	$ 99,600		
Commercials	$ 10,800		
Advertising (with scoreboard)	$ 25,000		
ADDITIONAL REVENUE SOURCES			
RV Sales	NA		
Boat or Car Shows	$ 4,000		
Parking for Commuters (3)	NA		
Parking for Events at other Facilities	$ 24,000		
Sponsorship (4)	$ 150,000		
	$ 519,413	$ 478,203	$ 997,616

NOTES: All calculations are for 4,000-seat stadium, with 800 parking spaces for events. Estimates of visitor spending based on current average spending and length of stay for US Mainland and Japanese visitors. State share adapted from DBEDT estimate of local government revenues from cash flows derived from visitor spending (82.6% allocated to State, in proportion to overall tax revenues.)

4. ECONOMIC IMPACTS

4.1 OVERVIEW

This section provides calculations of demographic and economic impacts of project development. First, a brief discussion of the application of the concept of "impact" provides a basis for distinguishing quantifiable aspects or implications of the project from its impacts on the island or State.

The project will build out over many years, as demand arises from Oahu's growing population. It will include about 6,500 to 8,400 housing units, supporting facilities (including parks and neighborhood commercial areas) and a major Sports Complex attracting users from all over Oahu and off-island.

Project buildout has been estimated by adapting the housing market study prepared by The Prudential Locations, Inc. (1997) to the acreages and density assumptions suggested by the master developers, HFDC and DHHL. (See Exhibit 4-A for key development assumptions.) SMS Research & Marketing Services, Inc. has studied the feasibility of the Sports Center, as discussed in the last chapter.

Because the project involves thousands of housing units, built by several developers, the number of units to be built could only be estimated as a range, not a single figure. Accordingly, low- and high-range calculations are used throughout this chapter. If housing is built at lower densities, the project could be completed by 2017 (as shown in Exhibit 4-B). At higher densities, completion would come in 2022.

Population. The project will come to house some 20,950 to 27,050 persons at buildout. At these levels, the project residents would amount to about 17% to 21% of the anticipated 2020 'Ewa Development Plan Area population, and about 2% of the island population.

Employment and Incomes. Over the construction period, the project would generate a total of 7,200 to 7,750 person-years of work on construction, and it would support another 11,125 to 12,000 person-years of indirect and induced jobs in the Hawai'i economy.

Permanent employment on-site would grow to about 1,250 to 1,375 jobs. Additional jobs in the Hawai'i economy would be indirect or induced jobs generated by project spending. The payroll for direct operations jobs would exceed $25 million (1997 dollars) by 2022, while wages for indirect and induced jobs associated with the project would amount at least to an additional $30 million.

Exhibit 4-A: DEVELOPMENT ASSUMPTIONS

	Share	Low Range	High Range
Assumptions affecting			
Numbers of units			
Units/acre SF		6	8
Units/acre MF		10	12
SF Acreage			
General		561.3	561.3
DHHL		168.3	168.3
MF Acreage			
General		188.2	188 2
DHHL		22.7	22.7
Unit count			
SF			
General		3,368	4,490
DHHL		1,010	1,346
MF			
General		1,882	2,258
DHHL		227	272
Sales Price Basis			
Affordable (General)	30% (1)		
MF		1,575	2,025
Market (General)	70%		
SF		3,368	4,490
MF		307	234
Self-help (DHHL)	20% (2)		
SF		247	324
Contractor-built (DHHL)	80% (2)		
SF		762	1,023
MF		227	272

NOTES: Assumptions developed by SMS Research based on market study, EIS preparation notice, and discussions with HFDC, DHHL and project planners.
(1) Per City and County of Honolulu regulation.
(2) Assumption from SMS Research. DHHL is trying out different ways to make housing available to beneficiaries in a wide range of circumstances. Self-help housing is one of several approaches that may be taken. It is singled out here because it involves different costs than construction by professionals. The standard DHHL practice, of leasing lots on which recipients build homes, could fall under either of the two categories listed here, depending on whether lessees use sweat equity or professional builders.

Exhibit 4-B: HOUSING CONSTRUCTION AND OCCUPANCY, EAST KAPOLEI PROJECT

	2002	2007	2012	2017	2022
Units built in year (1)					
Low Range (2)	671	475	375	85	-
High Range (3)	671	475	475	295	82
Units built, cumulative					
Low Range	671	3,123	5,208	6,487	6,487
High Range	671	3,168	5,543	7,385	8,368
Units occupied (end of year) (4)					
Low Range					
SF: General	126	1,195	2,264	3,199	3,199
SF: DHHL	285	760	959	959	959
MF: General	84	796	1,509	1,788	1,788
MF: DHHL	143	259	259	259	259
TOTAL	638	3,010	4,991	6,205	6,205
High Range					
SF: General	126	1,195	2,264	3,333	4,266
SF: DHHL	285	760	1,235	1,279	1,279
MF: General	84	796	1,509	2,145	2,145
MF: DHHL	143	259	259	259	259
TOTAL	638	3,010	5,267	7,016	7,949

NOTES: DHHL: Department of Hawaiian Homelands acreage. General: other housing areas in project. SF: single-family; MF: multi-family housing

(1) Buildout based on market report assumptions (a) that about half a year's product would be delivered in the first year (2002) and (b) the housing market would absorb, on average, 225 single-family and 150 multi-family units from the project annually. Demand from DHHL beneficiaries for housing on Oahu is strong, so this has been estimated as demand for an additional 100 single-family units and 50 multi-family units annually, until the DHHL area (200 acres) is fully built out

(2) Housing densities assumed to be 6/acre (SF) and 10/acre (MF).

(3) Housing densities assumed to be 8/acre (SF) and 12/acre (MF).

(4) Occupancy estimated as 95% of units built.

SOURCES: The Prudential Locations, Inc., 1997; estimates of DHHL buildout by SMS Research, after discussions with DHHL staff.

Government Costs and Revenues. Project development will result in increased property taxes for the City and County of Honolulu. The cumulative impact amounts to some $84 to $86 million (1997 dollars) through the year 2022. At buildout, City and County property tax revenues would stabilize at about $6.3 million to $7.5 million annually from the project.

The State of Hawai'i will incur major costs, but also gain significant revenues from the project. Development costs are estimated as about $95 million for

infrastructure and $27.5 million for the Sports Complex. (DHHL construction costs and interest are not included here.) Revenues include receipts from land sales, taxes on construction-related cash flows, operating revenues for the Sports Complex and new income associated with visitor spending due to the Sports Complex. It appears that HFDC will be able to cover its development costs and supply the University of Hawai'i, West O'ahu with funds for infrastructure soon after major land sales occur. Overall, the proposed development on the East Kapolei site will result in continuing cash flows for the State over and beyond State costs. By 2022, the net balance of revenues over costs of the project is estimated as $200 million to $213 million(1997 dollars). The net present value of HFDC cash flows is estimated as approximately $74 million (with a discount rate of 8%). The net present value of HFDC and State general fund spending and income associated with the project (not including DHHL investment) is estimated as about $100 million through 2022.

Assumptions used to Estimate Values. Exhibit 4-C itemizes assumptions concerning development and construction costs used in the analysis. It expands the difference between the low and high range estimates by including different estimates of land value. The high range estimates of land value come from the Locations, Inc. market study (1997), using that study's assumptions about cost per acre of land, converted to constant 1997 dollars. Recognizing that real estate values have generally fallen in recent years, the values for the low range estimate are reduced (from $347,000 to $300,000 per acre for residential land, and from $1,300,000 to $1,000,000 for commercial land). This reduction is not based on extensive research: large lot sales comparable to those involved in the East Kapolei project are too few, and involve too few parties, to establish solid market trends that could be projected into the next decade.

Next, it was assumed, after discussion with HFDC staff, that land sales would occur on an accelerated time scale based on interest by more than one developer. All land sales are concluded by 2005, as shown in Exhibit 1-C.

4.2 APPLICATION OF THE CONCEPT OF "IMPACT" TO THE PROJECT

In socio-economic impact analysis, **an impact is the difference between two possible futures, with and without the proposed project**, rather than the difference between present conditions and future ones with the project. Yet, for members of the surrounding community, the difference between the current situation and the future can profoundly affect perceptions of any project. Again, perceptions are often shaped by experience with recent projects, which may have little to do with the proposed action.

Exhibit 4-C: CONSTRUCTION COST ASSUMPTIONS

All values are in $1,000s of 1997 dollars	Low Range	High Range
Cost/acre (1997 $1,000s)		
Residential	$ 300	$ 347
Commercial	$ 1,000	$ 1,301
Infrastructure cost/acre		
All Resid, Comm	$ 93	$ 93
Infrastructure cost/unit		
SF	$ 16	$ 12
MF	$ 9	$ 8
Purchase price/unit		
SF (General)	$ 250	$ 250
MF (General, market)	$ 125	$ 125
Construction cost/unit (including infrastructure)		
SF (General)	$ 177	$ 213
MF (General)	$ 106	$ 106
SF (DHHL)		
Developed	$ 112	$ 108
Self-help	$ 76	$ 72
MF (DHHL)	$ 79	$ 75
Commercial (acre)	$ 2,218	$ 2,218
Schools		
Elementary	$ 20,000	$ 20,000
Intermediate	$ 40,000	$ 40,000
Parks (acre)	$ 98	$ 98
Open Space (acre)	$ 65	$ 65
Sports Complex	$ 27,750	$ 27,750

NOTES: Assumptions formulated by SMS Research from market study, EIS preparation notice, and discussions with HFDC, DHHL and project planners.

Impacts must be assessed in relation to context. A change brought by a project may be highly significant at a local level, yet small on a regional or county scale. It is useful to distinguish locational impacts from absolute ones. An absolute impact is a change that will occur with a project, but would not occur otherwise; a locational impact will occur, but would not occur at the site of a project, or would perhaps be dispersed over a large area, without the project.

From an economic perspective, industries such as tourism bring new inputs into the island economy which might otherwise go outside Hawai'i; these are primary causes of change. With an economy supported by such primary industries, people may be housed in various ways, in different places — but they must be housed. The impact of a major residential project has to do with where people are housed, not whether there will be economic and population growth.

Economic impacts of the East Kapolei project are largely locational. Still, without the project, there is no certainty that housing production would reach the same level, and crowding could be more frequent. A larger housing stock and less crowding are absolute impacts of project development.

The Sports Complex is designed to attract new visitors to Hawai'i. Arguably, sports teams and their supporters would come in response to invitations from other Hawai'i venues – but the East Kapolei complex is designed specifically to attract out-of-state teams and users. Hence, the impacts of additional visitor spending are viewed here as absolute – unlikely to occur without the development of the sports complex – and not just locational.

4.3 EMPLOYMENT AND INCOMES

The project involves short-term jobs related to construction and long-term jobs associated with continuing operations. Employment associated with both construction and operations falls into three broad types:

- Direct jobs are immediately involved with construction of a project or with its operations. Direct jobs are not necessarily on-site: construction supports construction company personnel in offices and base yards, as well as on site.
- Indirect jobs are created as businesses directly involved with a project purchase goods and services in the local economy.
- Induced jobs are created as workers spend their income for goods and services.

Indirect and induced employment in Hawai'i can be estimated using multipliers from the model of input-output relations in Hawai'i's economy maintained by State Department of Business, Economic Development and Tourism researchers.

Direct jobs are not necessarily located at the site of a project. As a rule of thumb, some 20% of direct construction jobs are off-site (in baseyards, offices, and the like). Indirect and induced jobs are measured on a statewide basis. These are likely to be concentrated in commercial and/or industrial centers, rather than near a job site.

4.3.1 Construction Employment

Construction employment can be estimated based on construction spending. Exhibit 4-C shows some of the assumptions used to estimate total construction spending. Exhibit 4-D then estimates direct, indirect, and induced jobs associated with construction of the various elements of the East Kapolei project (including construction by private developers).

Exhibit 4-D: CONSTRUCTION-RELATED EMPLOYMENT AND INCOMES

	1998-2002	2003-2007	2008-2012	2013-2017	2018-2022
Construction spending (in1,000,000s, 1997 $s)					
Low Range	$ 186.3	$ 304.2	$ 328.1	$ 207.1	$ -
High Range	$ 189.7	$ 310.1	$ 362.3	$ 266.5	$ 163.2
Construction-related employment (FTE jobs/year)					
Low Range					
Direct jobs	1,332	2,175	2,346	1,481	-
Indirect and induced jobs	2,065	3,372	3,636	2,295	-
TOTAL JOBS	3,398	5,547	5,982	3,776	-
High Range					
Direct jobs	1,356	2,217	2,590	1,906	1,167
Indirect and induced jobs	2,102	3,437	4,016	2,954	1,809
TOTAL JOBS	3,459	5,654	6,606	4,859	2,977
Construction-related income (in1,000,000s, 1997 $s)					
Low Range					
Direct jobs	$ 58.7	$ 95.8	$ 103.4	$ 65.2	$ -
Indirect and induced jobs	$ 56.5	$ 92.3	$ 99.5	$ 62.8	$ -
TOTAL INCOME	$ 115.2	$ 188.1	$ 202.8	$ 128.0	$ -
High Range					
Direct jobs	$ 59.8	$ 97.7	$ 114.1	$ 84.0	$ 51.4
Indirect and induced jobs	$ 57.5	$ 94.0	$ 109.9	$ 80.8	$ 49.5
TOTAL INCOME	$ 117.3	$ 191.7	$ 224.0	$ 164.8	$ 100.9

NOTES: Construction cost from assumptions in Exhibit 4-C.. Jobs estimated from 1996 ratio of construction jobs per million dollars in GET construction spending (7.15). Indirect and induced jobs from SMS ImplanPro model of 1992 State Input-Output Model (based on DBEDT version) -- average multiplier for construction: 2.55. Incomes from average construction industry and covered employment incomes, 1996.

SOURCES: Hawaii State Department of Business, Economic Development and Tourism, 1997a; Department of Labor and Industrial Relations, 1997

Direct construction employment is estimated as about 7,350 to 8,050 person-years of work over 25 years' time, for an average annual employment of about 290 to 320 construction workers annually over that time. (These averages are based on annualized data, as are the five-year totals shown in Exhibits 4-D and

4-E.) Total direct, indirect and induced employment is projected as about 18,700 to 20,600 person-years of employment over the entire period.

Direct construction workers' wages would peak at about $30 million annually in mid-project. Total construction-related wages would come to a high point of about $60 million per year in mid-project (1997 dollars). (These peak levels are not sustained from year to year. The totals shown in Exhibit 4-D show that average wages are below peak wages, even for five-year periods.)

Operations Employment

On-site jobs would be created in the course of development. Except for the jobs at the Sports Center, these jobs are locational impacts, likely to be created as the residents' needs for shelter are satisfied. At build out, direct jobs at East Kapolei would number about 1,250 to nearly 1,400 jobs. (See Exhibit 4-E.)

The total direct, indirect and induced jobs associated with the project's operations would be in the range of 2,350 to 2,625 jobs after buildout (as shown in Exhibit 4-F). Of those jobs, some 1,350 to 1,500 jobs would be located in the Ewa DP Area.

Exhibit 4-G shows that incomes associated with project operations (including indirect and induced jobs) would amount to some $55.3 million to $62.8 million (1997 dollars) annually at buildout.

4.3.2 Labor Force Impacts

Since 1991, the construction industry jobcount has declined in Hawai'i by 30% to 23,450 in 1996. The average annual direct construction workforce would amount to about 1% of the construction workforce statewide

The operations workers associated with the project form a very small part of Hawai'i's overall workforce. Within the 'Ewa DPA, jobs associated with project operations would amount to about 2.5% of the total employment projected for 2020 – still, a small part of the larger regional economy. As a result, the project's impact on the labor force is likely to be small.

Exhibit 4-E: DIRECT OPERATIONS EMPLOYMENT

	2002	2007	2012	2017	2022
Low Range					
Direct Jobs by Land Use					
Home sales	7	23	23	9	-
Property management and maintenance	10	57	102	131	131
Commercial	90	450	675	810	810
Schools	31	132	213	261	261
Parks	4	17	28	34	34
Sports Complex	19	19	19	19	19
TOTAL	161	698	1,060	1,264	1,255
High Range					
Direct Jobs by Land Use					
Home sales	7	23	23	20	9
Property management and maintenance	10	58	103	146	166
Commercial	90	450	765	810	810
Schools	31	134	231	300	337
Parks	4	18	30	39	44
Sports Complex	19	19	19	19	19
TOTAL	161	701	1,171	1,335	1,385

NOTES: Employment is for on-site work, except in the case of schools and parks. For the latter, employment is estimated on the basis of historical ratios of employment per resident (parks) and per DOE student (schools) Presumably the bulk of parks and school jobs will be on-site or near the project site. Employment ratios:

Home Sales	3 per 100 homes built last year + this yrear
Property mgmt.	3 per 100 MF units sold
	2 per 100 SF units sold
Commercial	3 per 1,000 sf of commercial space built (GLA)
	45 per acre (@ 15,000 GLA/ac)
Schools	8.3 per 100 students
	8.2 per 100 students
	8.5 per 100 students
Parks	1.6 per 1,000 residents

SOURCES: Hawaii State Department of Education, 1995; City and County of Honolulu, 1996.

Exhibit 4-F: INDUSTRY CLASSIFICATION OF DIRECT OPERATIONS JOBS

	2002	2007	2012	2017	2022
Low Range					
Direct Jobs by Industry					
Agriculture (Landscaping)	9	46	79	100	100
Amusement Services	19	19	19	19	19
Auto Repair	9	45	68	81	81
Eating and Drinking	27	135	203	243	243
Education	31	132	213	261	261
Real Estate	12	51	74	75	65
Retail Trade	54	270	405	486	486
Subtotal. Direct Jobs	161	698	1,060	1,264	1,255
Indirect and Induced Jobs Associated with –					
Agriculture (Landscaping)	7	33	58	73	73
Amusement Services	16	16	16	16	16
Auto Repair	9	44	66	80	80
Eating and Drinking	23	117	175	210	210
Education	22	94	152	187	187
Real Estate	31	139	200	202	177
Retail Trade	40	199	299	358	358
Subtotal: Indirect and Induced Jobs	148	642	966	1,126	1,101
TOTAL: Direct, Indirect and Induced Jobs	309	1,340	2,025	2,390	2,355
High Range					
Direct Jobs by Industry					
Agriculture (Landscaping)	9	47	82	113	127
Amusement Services	19	19	19	19	19
Auto Repair	9	45	77	81	81
Eating and Drinking	27	135	230	243	243
Education	31	134	231	300	337
Real Estate	12	52	74	93	92
Retail Trade	54	270	459	486	486
Subtotal Direct Jobs	161	701	1,171	1,335	1,385
Indirect and Induced Jobs Associated with --					
Agriculture (Landscaping)	7	34	60	82	93
Amusement Services	16	16	16	16	18
Auto Repair	9	44	75	80	80
Eating and Drinking	23	117	199	210	210
Education	22	96	165	215	241
Real Estate	31	140	201	253	250
Retail Trade	40	199	338	358	358
Subtotal: Indirect and Induced Jobs	148	646	1,054	1,214	1,248
TOTAL: Direct, Indirect and Induced Jobs	309	1,348	2,225	2,549	2,633
Ewa Share of Operations Jobs					
Low Range					
Direct	161	698	1,060	1,264	1,255
Indirect and Induced	8	43	76	102	107
TOTAL	169	741	1,136	1,366	1,362
High Range					
Direct	161	701	1,171	1,335	1,385
Indirect and Induced	8	43	83	110	121
TOTAL	169	745	1,254	1,445	1,507

NOTES: Industry classifications are as used in the State's Input-Output model. Employment multipliers are from the SMS version of the 1992 model (based on the DBEDT version, but on ImplanPro software. 'Ewa share of jobs estimated on the assumptions that all direct operations jobs are in 'Ewa and the 'Ewa share of indirect and induced jobs is the same as the area's share of all civilian jobs islandwide (increasing from 2.7% in 1990 to 9.7% in 2020.)

SOURCES: State Department of Business, Economic Development and Tourism, 1997b; and City and County of Honolulu Planning Department regional allocation of forecast population and employment to 2020.

Exhibit 4-G: INCOME FROM OPERATIONS-RELATED JOBS

Amounts are in $1,000s of 1997 dollars	2002	2007	2012	2017	2022
Low Range					
Direct Jobs					
Agriculture (Landscaping)	$ 216	$ 1,096	$ 1,889	$ 2,380	$ 2,380
Amusement Services	$ 402	$ 402	$ 402	$ 402	$ 402
Auto Repair	$ 196	$ 980	$ 1,470	$ 1,764	$ 1,764
Eating and Drinking	$ 354	$ 1,768	$ 2,652	$ 3,183	$ 3,183
Education	$ 871	$ 3,662	$ 5,923	$ 7,252	$ 7,252
Real Estate	$ 325	$ 1,440	$ 2,075	$ 2,104	$ 1,842
Retail Trade	$ 926	$ 4,632	$ 6,948	$ 8,337	$ 8,337
Subtotal	$ 3,290	$ 13,981	$ 21,359	$ 25,423	$ 25,161
Indirect and Induced Jobs	$ 4,047	$ 17,568	$ 26,421	$ 30,803	$ 30,113
TOTAL	$ 7,337	$ 31,549	$ 47,780	$ 56,226	$ 55,274
High Range					
Direct Jobs					
Agriculture (Landscaping)	$ 216	$ 1,119	$ 1,961	$ 2,689	$ 3,039
Amusement Services	$ 402	$ 402	$ 402	$ 402	$ 402
Auto Repair	$ 196	$ 980	$ 1,666	$ 1,764	$ 1,764
Eating and Drinking	$ 354	$ 1,768	$ 3,006	$ 3,183	$ 3,183
Education	$ 871	$ 3,722	$ 6,412	$ 8,348	$ 9,369
Real Estate	$ 325	$ 1,459	$ 2,094	$ 2,627	$ 2,597
Retail Trade	$ 926	$ 4,632	$ 7,874	$ 8,337	$ 8,337
Subtotal	$ 3,290	$ 14,083	$ 23,415	$ 27,350	$ 28,691
Indirect and Induced Jobs	$ 4,047	$ 17,680	$ 28,848	$ 33,208	$ 34,140
TOTAL	$ 7,337	$ 31,763	$ 52,263	$ 60,559	$ 62,832

NOTES: Wages estimated from 1996 averages, adjusted to 1997 in proportion with average growth in personal income per job. For direct jobs, City and County of Honolulu average wages used. For indirect and induced jobs, average statewide wage for covered employment used.

SOURCE: Hawaii State Department of Labor and Industrial Relations, 1997.

4.4 POPULATION AND HOUSING IMPACTS

4.4.1 Residential Population

The East Kapolei project will build out over time. In light of demand for O'ahu housing among Native Hawai'ian beneficiaries, DHHL expects to be able to develop its part of the project quickly. Demand for housing for the general public will lead to eventual development, with a total on-site population in the range from 20,950 to 27,050 residents.

Exhibit 4-H: RESIDENT POPULATION, EAST KAPOLEI PROJECT

		2002	2007	2012	2017	2022
Occupied units	(1)					
Low Range		638	3,010	4,991	6,205	6,205
High Range		638	3,010	5,267	7,016	7,949
Resident Population						
Annual New Residents						
Low Range						
General	(2)	664	1,126	1,126	255	-
DHHL	(3)	618	428	-	-	-
TOTAL		1,281	1,554	1,126	255	-
High Range						
General	(2)	664	1,126	1,126	887	247
DHHL	(3)	618	428	428	-	-
TOTAL		1,281	1,554	1,554	887	247
Cumulative Population						
Low Range		2,516	10,576	17,103	20,943	20,943
High Range		2,516	10,749	18,516	24,106	27,054

NOTES:
(1) Unit count as shown in Exhibit 3-*.
(2) Household size for general public estimated as 3.16 persons per unit. This is the estimated average household size for the 'Ewa DPA in 2020, according to recent City Planning Department forecasts. In earlier years, families in a new development are likely to be somewhat smaller, in comparison to regional averages, than after the development (and families) mature, so the 2020 average is taken as applying to the entire development period.
(3) For the DHHL units, average sizes of 4.0 persons per unit in MF units, and 4.5 persons per unit in SF homes are used. These are based on recent survey data but also depend on generous estimates of space available in future DHHL units. Accordingly, these tend to maximize population estimates. Household sizes estimated by SMS Research after conversations with DHHL.

SOURCES: Unpublished forecasts, Honolulu Planning Department, SMS Research, 1995

Project residents will largely already be residents of Hawai'i. No new residents are likely to be attracted to O'ahu by the housing areas or by the Sports Complex.

4.4.2 Net Impact on Regional Population and Housing

The housing impact of the project is not simply the number of houses added to the islandwide housing supply, for two reasons:

- Two hundred acres will be used for Native Hawai'ian homes, responding to strong demand from a group that has a high incidence of crowding and other housing problems (Urban Institute, 1995).

- The total impact is less than the total number of houses, to the extent that development of the project permits some island residents to form new households. In other words, the project creates demand for housing (to a limited extent) as well as supplying housing. Such demand arguably arises when persons with permanent jobs due to the project start their own households. Exhibit 4-I shows the population and households supported by operations-related jobs, while Exhibit 4-J goes on to estimate new household formation. Housing costs and other factors affect the speed at which young families create their own households, so new household formation can only be estimated by a range. After buildout, the total new household demand associated with the project comes to about 270 to 450 units, of which some 140 to 260 units might well be in 'Ewa.

Exhibit 4-I: POPULATION AND HOUSEHOLDS SUPPORTED BY OPERATIONS JOBS

	2002	2007	2012	2017	2022
Employment					
Low Range					
Direct Jobs	161	701	1,171	1,335	1,385
Indirect and Induced Jobs	148	646	1,054	1,214	1,248
'Ewa Jobs	169	741	1,136	1,366	1,362
High Range					
Direct Jobs	161	701	1,171	1,335	1,385
Indirect and Induced Jobs	148	646	1,054	1,214	1,248
'Ewa Jobs	169	745	1,254	1,445	1,507
Population Supported by Operations Jobs (including workforce)					
Low Range					
Statewide	615	2,634	4,266	4,790	4,889
'Ewa	401	1,712	2,560	3,001	2,946
High Range					
Statewide	615	2,634	4,266	4,790	4,889
'Ewa	401	1,722	2,827	3,175	3,259
Workforce Households					
Low Range					
Statewide	212	923	1,524	1,746	1,804
'Ewa	116	507	778	935	933
High Range					
Statewide	212	923	1,524	1,746	1,804
'Ewa	116	510	859	989	1,032

NOTES: Population calculated on the basis of 1990 O'ahu ratio of workers per household (1.46) and forecast future household sizes for O'ahu and for 'Ewa DP area

Exhibit 4-J: NEW HOUSEHOLD FORMATION BY PROJECT OPERATIONS-RELATED WORKFORCE

	2002	2007	2012	2017	2022
Low Range/Low Scenario					
Statewide	32	138	229	262	271
'Ewa	17	76	117	140	140
High Range/High Scenario					
Statewide	53	231	381	436	451
'Ewa	29	128	215	247	258

NOTES: Over time, workers with project-related operations jobs will form their own households. With slow growth in the population, multiple jobs/household, and the high cost of housing in Hawaii, employees are likely not to form separate households quickly (and some will simply replace their parents as heads in a continuing household). Based on earlier studies of resort workers, the number of new households eventually formed by workers is estimated as ranging from 15% (the "low scenario") to 25% of the number of operations jobs. (In other studies, a high scenario of 30% was used. That high factor applied to a resort workforce with many immigrants, and is inappropriate here.)

SOURCES: Community Resources, Inc. 1987a, 1987b

Exhibit 4-K: POTENTIAL IMPACT OF PROJECT EMPLOYMENT ON REGIONAL HOUSING SUPPLY

	2002	2007	2012	2017	2022
Units in Project					
Low Range	671	3,123	5,208	6,487	6,487
High Range	671	3,168	5,543	7,385	8,368
Housing Demand, 'Ewa, from Project-Related Workforce					
Low Range/Low Scenario	17	76	117	140	140
High Range/High Scenario	29	128	215	247	258
Difference between Supply and Workforce Demand					
Low Estimate	654	3,047	5,091	6,346	6,347
High Estimate	642	3,041	5,329	7,138	8,110

SOURCES: Exhibits 4-B and 4-J.

4.4.3 Visitor Population

Of the various components of the East Kapolei project, only the Sports Complex will attract visitors to Hawai'i. These would come for particular events, once those events have been marketed and publicized overseas. The program described in Chapter 3 for active marketing of the stadium would result in attracting about 2,500 visitors to Hawai'i (including professional players, team officials, media representatives, fans, amateur players, and participants in camps, Clinics and special events) who would stay for a total of 21,000 visitor days each year. The average daily impact would come to fewer than 60 visitors per day. Most of those visitors would not spend most of their time in Hawai'i on-site, so the on-site impact would be modest.

4.5 FISCAL IMPACTS

4.5.1 Impacts on the City and County of Honolulu

Revenues

The project's major impact on the City and County of Honolulu comes from the creation of property subject to real property taxes. Previously, the site was used for agriculture, and hence taxed on the basis of artificially low values. Currently, the land is in State hands and not taxed. With development, taxes on land and improvements on the site will grow to some $6.3 to $7.5 million annually. By the end of 2022, the cumulative additional property tax revenue for the City and County of Honolulu would come to some $84 million to $86 million. (The figures in Exhibits 4-L and 4-M are in 1997 dollars, and are calculated on the assumption that tax rates will stay at historical levels. Rates are expected to rise significantly this year, so the tax estimates are conservative.)

Costs

The Sports Complex will help to bring visitors to Hawai'i. Once its program is well developed, over 21,000 visitor-days per year will be attributable to this complex. Averaged out over the year, the impact comes to an estimated 58 visitors each day. When City and County expenditures are treated as delivered to the entire resident or resident-plus-visitor population (as in Exhibit 4-N), the impact of each visitor on City and County spending can be estimated. (Again, this is a conservative approach, since the impact of marginal change – each additional visitor or resident – is in most conditions smaller than the average impact.) Exhibit

4-O goes on to show the estimated cost of Sports Center visitors – about $40,000 (1997 dollars) annually for the City and County.

In recent years, concern has been expressed that the creation of new developments may force local governments to provide services to wider and wider areas, increasing the cost of service delivery. Research by Decision Analysts Hawai'i (1995) and by SMS Research suggests the opposite, at least for large-scale development in Leeward O'ahu. Key factors limiting the exposure of the City and County of Honolulu include (a) developer payments to offset the cost of needed infrastructure improvements and (b) lower service, maintenance and replacement costs for new infrastructure.

As more people move from older urban areas to new suburbs, the pressure on aging infrastructure decreases, allowing the City and County more time to replace or repair its facilities. Similarly, while new housing areas mean the Fire Department will be responsible for a larger urban area, construction according to current fire and building codes involves less risk of fires or other calls for Fire Department services, lessening the impact of a greater service area.

Balance

Annual project-related revenues for the City and County will come to some $6.3 million to $7.6 million annually, and a cumulative total, through 2022, of some $83.7 million to $85.6 million in net revenues (1997 dollars).

Exhibit 4-L: PROPERTY TAX IMPACTS FOR THE CITY AND COUNTY OF HONOLULU – LOW RANGE

	2002	2007	2012	2017	2022
A. AREAS (ACRES) – LOW RANGE					
ACREAGE TO BE DEVELOPED (1)					
Agricultural (2)	298.6	-	-	-	-
Unimproved Res. (3)	451.8	501.4	238.9	7.0	0.0
Commercial	9.0	10.0	4.0	-	-
NEWLY DEVELOPED ACREAGE (ANN.)					
Improved Residential (3)	-	37.5	37.5	37.5	-
Apartment (3)	-	15.0	15.0	-	-
Commercial	1.0	1.0	1.0	-	-
CUMULATIVE DEVELOPED:					
Improved Residential	-	172.2	359.7	547.2	554.2
Apartment	-	68.8	143.8	188.2	188.2
Commercial	1.0	8.0	14.0	18.0	18.0
TOTAL TAXABLE AREA	1.0	249.0	517.5	753.4	760.4
B. VALUES ($1,000s)					
ACREAGE TO BE DEVELOPED (2)					
Agricultural (2)	$80,622	$0	$0	$0	$0
Unimproved Res	$121,986	$135,387	$64,512	$1,899	$0
Commercial	$2,700	$3,000	$1,200	$0	$0
ANNUAL NEW DEVELOPED LAND VALUE					
Improved Residential	$0	$11,250	$11,250	$11,250	$0
Apartment	$0	$4,500	$4,500	$0	$0
Commercial	$1,000	$1,000	$1,000	$0	$0
CUMULATIVE DEVELOPED LAND VALUE:					
Improved Residential	$0	$51,650	$107,900	$164,150	$166,260
Apartment	$0	$20,640	$43,140	$56,460	$56,460
Commercial	$1,000	$8,000	$14,000	$18,000	$18,000
ANNUAL NEW IMPROVED VALUE					
Improved Residential	$0	$56,250	$56,250	$56,250	$0
Apartment	$0	$18,750	$18,750	$0	$0
Commercial	$2,218	$2,218	$2,218	$0	$0
CUMULATIVE IMPROVED VALUE					
Improved Residential	$0	$258,250	$539,500	$820,750	$831,300
Apartment	$0	$86,000	$179,750	$235,250	$235,250
Commercial	$2,218	$17,744	$31,052	$39,924	$39,924
TOTAL VALUE (LAND + IMPROVED)	$208,526	$580,671	$981,054	$1,336,433	$1,347,194

(Continued)

Exhibit 4-L, Cont.

	2002	2007	2012	2017	2022
C. ADJUSTMENT FOR OWNER-OCCUPANT EXEMPTION (4)					
VALUE OF EXEMPTIONS (3)					
Improved Residential	$0	$41,320	$86,320	$131,320	$133,008
Apartment	$0	$27,520	$57,520	$75,280	$75,280
AFFECTED TAXABLE VALUES (AFTER EXEMPTION)					
Residential -- Improvement Value	$0	$216,930	$453,180	$689,430	$698,292
Apartment Improvement Value	$0	$58,480	$122,230	$159,970	$159,970
D. TAXES ($1,000s) (5)					
ACREAGE TO BE DEVELOPED (2)					
Agricultural (2)	NA	NA	NA	NA	NA
Unimproved Res	$2	$2	$1	$0	$0
Commercial	$0	$0	$0	$0	$0
DEVELOPED LAND VALUE					
Improved Residential	$0	$161	$337	$512	$519
Apartment	$0	$727	$1,519	$1,987	$1,987
Commercial	$9	$68	$119	$153	$153
IMPROVED VALUE					
Improved Residential	$0	$850	$1,776	$2,703	$2,737
Apartment	$0	$206	$430	$563	$563
Commercial	$19	$151	$264	$340	$340
TOTAL TAXES	$29	$2,165	$4,446	$6,258	$6,299
E. INCREASE IN TAX REVENUES					
(1,000s)					
TAX REVENUES BEFORE DEVELOPMENT (5)	$0				
DIFFERENCE IN TAX REVENUES					
TOTAL TAXES:					
Annual	$29	$2,165	$4,446	$6,258	$6,299
Cumulative	$29	$6,182	$23,905	$52,237	$83,734

NOTES: All figures in thousands of dollars, except Areas (in acres).

(1) Acreage "to be developed" is taxable area, excluding schools, parks, public facilities, open space, roads. Analysis based on increase in value from time of land use permit applications. Timing of classification based on land sales projections. Until transferred to developers, State land is not taxed, so actual value is not at issue.

(2) Land owned by State not taxed. Land sold for development taxed under urban classifications.

(3) DHHL land and improvements are excluded from these calculations as not taxed

(4) Standard homeowner's exemption ($40,000) assumed for all units Homeowner's exemption applied to improved value.

(5) Taxes calculated at current (1997-1998) rates.

Exhibit 4-M: PROPERTY TAX IMPACTS FOR THE CITY AND COUNTY OF HONOLULU – HIGH RANGE

	2002	2007	2012	2017	2022
A. AREAS (ACRES) –HIGH RANGE					
ACREAGE TO BE DEVELOPED (1)					
Agricultural (2)	298.6	0.0	0.0	-	-
Unimproved Res. (3)	451.8	555.9	352.8	149.7	3.2
Commercial	10.0	18.0	18.0	18.0	18.0
NEWLY DEVELOPED ACREAGE (ANN.)					
Improved Residential (3)	-	28.1	28.1	28.1	28.1
Apartment (3)	-	12.5	12.5	12.5	-
Commercial	-	-	-	-	-
CUMULATIVE DEVELOPED:					
Improved Residential	-	129.1	269.8	410.4	551.0
Apartment	-	57.3	119.8	182.3	188.2
Commercial	-	-	-	-	-
TOTAL TAXABLE AREA	-	186.5	389.6	592.7	739.2
B. VALUES ($1,000s)					
ACREAGE TO BE DEVELOPED (2)					
Agricultural (2)	$80,622	$0	$0	$0	$0
Unimproved Res	$141,097	$173,621	$110,185	$46,749	$999
Commercial	$3,470	$6,246	$6,246	$6,246	$6,246
ANNUAL NEW DEVELOPED LAND VALUE					
Improved Residential	$0	$9,759	$9,759	$9,759	$9,759
Apartment	$0	$4,338	$4,338	$4,338	$0
Commercial	$0	$0	$0	$0	$0
CUMULATIVE DEVELOPED LAND VALUE:					
Improved Residential	$0	$44,806	$93,603	$142,400	$191,197
Apartment	$0	$19,895	$41,582	$63,270	$65,305
Commercial	$0	$0	$0	$0	$0
ANNUAL NEW IMPROVED VALUE					
Improved Residential	$0	$56,250	$56,250	$56,250	$56,250
Apartment	$0	$18,750	$18,750	$18,750	$0
Commercial	$2,218	$2,218	$2,218	$0	$0
CUMULATIVE IMPROVED VALUE					
Improved Residential	$0	$258,250	$539,500	$820,750	$1,102,000
Apartment	$0	$86,000	$179,750	$273,500	$282,300
Commercial	$2,218	$17,744	$33,270	$39,924	$39,924
TOTAL VALUE (LAND + IMPROVED)	$227,407	$606,562	$1,004,136	$1,392,838	$1,687,972

(Continued)

Exhibit 4-M, Cont.

	2002	2007	2012	2017	2022
C. ADJUSTMENT FOR OWNER-OCCUPANT EXEMPTION (4)					
VALUE OF EXEMPTIONS (3)					
Improved Residential	$0	$41,320	$86,320	$131,320	$176,320
Apartment	$0	$27,520	$57,520	$87,520	$90,336
AFFECTED TAXABLE VALUES (AFTER EXEMPTION)					
Residential – Improvement Value	$0	$216,930	$453,180	$689,430	$925,680
Apartment Improvement Value	$0	$58,480	$122,230	$185,980	$191,964
D. TAXES ($1,000s) (5)					
ACREAGE TO BE DEVELOPED (2)					
Agricultural (2)	NA	NA	NA	NA	NA
Unimproved Res	$2	$2	$1	$1	$0
Commercial	$0	$0	$0	$0	$0
DEVELOPED LAND VALUE					
Improved Residential	$0	$140	$292	$444	$597
Apartment	$0	$700	$1,464	$2,227	$2,299
Commercial	$0	$0	$0	$0	$0
IMPROVED VALUE					
Improved Residential	$0	$850	$1,776	$2,703	$3,629
Apartment	$0	$206	$430	$655	$676
Commercial	$19	$151	$283	$340	$340
TOTAL TAXES	$21	$2,050	$4,247	$6,369	$7,540
E. INCREASE IN TAX REVENUES					
(1,000s)					
TAX REVENUES BEFORE DEVELOPMENT (5)	$0				
DIFFERENCE IN TAX REVENUES					
TOTAL TAXES:					
Annual	$21	$2,050	$4,247	$6,369	$7,540
Cumulative	$21	$5,836	$22,695	$50,391	$85,933

NOTES: All figures in thousands of dollars, except Areas (in acres).

(1) Acreage "to be developed" is taxable area, excluding schools, parks, public facilities, open space, roads. Analysis based on increase in value from time of land use permit applications. Timing of classification based on land sales projections. Until transferred to developers, State land is not taxed, so actual value is not at issue.
(2) Land owned by State not taxed. Land sold for development taxed under urban classifications.
(3) DHHL land and improvements are excluded from these calculations as not taxed.
(4) Standard homeowner's exemption ($40,000) assumed for all units. Homeowner's exemption applied to improved value.
(5) Taxes calculated at current (1997-1998) rates.

Exhibit 4-N: AVERAGE PER CAPITA COST OF SERVICES, CITY AND COUNTY OF HONOLULU

Operating Expenditures, by Function	FY 1994 Total Expenditure (In $1,000s)	Cost Per – Resident	Cost Per – Visitor
General government			
Control	$6,963.0	$7.56	$7.56
Staff	$83,181.0	$95.70	$0.00
Public safety			
Police and fire	$156,210.1	$169.70	$169.70
Other	$20,574.1	$22.35	$22.35
Highways	$28,413.1	$30.87	$30.87
Health and sanitation	$101,092.5	$109.82	$109.82
Recreation	$55,149.2	$59.91	$59.91
Interest	$72,323.7	$83.20	$0.00
Bond redemption	$87,225.0	$100.35	$0.00
Retirement and pension	$70,860.3	$81.52	$0.00
Economic and urban development	$27,926.4	$32.13	$0.00
Mass Transit	$82,943.5	$95.42	$95.42
Cash capital improvements	$17,705.4	$20.37	$0.00
Miscellaneous	$63,265.8	$72.78	$0.00
Total	$873,833.4	$976.36	$586.01
adjusted to 1997 $s	$927,881.8	$1,036.75	$622.25

NOTE: The City and County is currently reorganizing to cut costs. Costs per resident or visitor could in future be smaller than shown here.

SOURCES: DBEDT, 1997, 1998.

Exhibit 4-O: BALANCE OF REVENUES AND COSTS ASSOCIATED WITH PROJECT, CITY AND COUNTY OF HONOLULU

(in million 1997 $s)	2002	2007	2012	2017	2022
Revenues					
Real Property Taxes from Project					
Low Range	$ 29.2	$2,165.0	$ 4,446.3	$ 6,258.2	$ 6,299.5
High Range	$ 20.7	$2,049.6	$ 4,247.1	$ 6,369.1	$ 7,539.6
Costs					
Costs due to Increased Visitor Count					
Average Visitor Count	35	58	58	58	58
Costs	$ 0.02	$ 0.04	$ 0.04	$ 0.04	$ 0.04
Annual Balance					
Low Range	$ 29.2	$2,165.0	$ 4,446.3	$ 6,258.2	$ 6,299.5
High Range	$ 20.7	$2,049.6	$ 4,247.1	$ 6,369.1	$ 7,539.6
Cumulative Balance					
Low Range	$ 29.2	$6,181.7	$23,905.3	$52,236.7	$83,734.0
High Range	$ 20.7	$5,835.6	$22,695.0	$50,390.9	$85,933.2

SOURCES: Exhibits 4-L, 4-M, and 4-N.

4.5.2 Impacts on the State of Hawai'i

Fiscal impacts for the State of Hawai'i are more complex than for the City and County, inasmuch as the State is landowner and developer of infrastructure for the project as well as recipient of taxes. As developer, the Housing Finance and Development Corporation (HFDC) will incur construction costs, but will also be able to profit from selling land with urban classification, access and utilities. The State's plan is to gain enough income from land sales to cover costs and set aside moneys to begin building the University of Hawai'i West Oahu campus well before its scheduled 2011 opening. HFDC could recoup enough from land sales to add to its revolving funds.

The State will further act as developer and, presumably, operator of the Sports Complex. Operating costs and revenues were discussed in Chapter 3 and are incorporated in exhibits in this section. Construction costs have been estimated by Mitsunaga and Associates, Inc. for the Department of Accounting and General Services. For this report, SMS Research has assumed the cost of bond financing for the project to be comparable to that of the HFDC project, but paid off over a 20-year term.

The State will gain new tax revenues associated with construction on-site. Excise taxes on construction spending will be fairly modest, since much of the project will be tax-exempt. Taxes on workers' incomes and spending will reflect the large scope of the project and its workforce. (Construction-related spending is treated as a source of new taxes – new impacts on State revenues – since residents arguably could live in existing housing, not the East Kapolei project. Operations jobs and spending would arguably be created whether or not the project is built, and hence are not counted as generating revenue impacts.)

(DHHL expenditures and revenues are excluded from the discussion because DHHL draws on its own funds, not the General Fund. Also, DHHL has yet to make decisions concerning the mix of units and the extent of its investment in building them at East Kapolei. Accordingly, it is treated as equivalent to a private developer for the purposes of this analysis.)

Revenues from Land Sales

As noted earlier, different assumptions about sale prices are incorporated into the low and high ranges. The total revenue from land sales (excluding transfers to State agencies) is estimated as ranging from $241 million to $281 million (1997 dollars).

Revenues associated with Construction

Exhibit 4-P summarizes construction-related revenues for the State. Total revenues returning to the State after construction will come to some $48.5 to $59.7 million.

Revenues associated with Operations

The Sports Complex can be treated as a new operation that would not exist apart from the project; other operational jobs and cash flows are supported by the resident population and could exist apart from the project. Sports Complex revenues are estimated as stabilizing at about $1 million annually, of which about half would be revenues to the State as stadium operator, and half would be revenues associated with cash flows from visitor spending.

Exhibit 4-P: STATE TAX REVENUES DERIVED FROM CONSTRUCTION

(in $1,000,000s)	1998-2002	2003-2007	2008-2012	2013-2017	2018-2022
Low Range					
Cash Flows					
Const. spending	$ 185.4	$ 357.9	$ 320.3	$ 201.3	$ -
Const.-related wages	$ 114.6	$ 221.3	$ 198.0	$ 124.5	$ -
Excise Taxes					
Const. spending (1)	$ 1.1	$ -	$ -	$ -	$ -
Const.-related wages (2)	$ 3.5	$ 6.7	$ 6.0	$ 3.8	$ -
Income Taxes					
Corporate (3)	$ 0.5	$ 0.9	$ 0.8	$ 0.5	$ -
Personal (4)	$ 4.6	$ 8.9	$ 8.0	$ 5.0	$ -
TOTAL	$ 9.7	$ 16.6	$ 14.8	$ 9.3	$ -
CUMULATIVE (5)	$ 9.7	$ 24.3	$ 39.2	$ 48.5	$ 48.5
High Range					
Cash Flows					
Const. spending	$ 161.2	$ 367.8	$ 416.5	$ 260.9	$ 159.8
Const.-related wages	$ 99.7	$ 227.4	$ 257.5	$ 161.3	$ 98.8
Excise Taxes					
Const. spending (1)	$ 1.1	$ -	$ -	$ -	$ -
Const.-related wages (2)	$ 3.0	$ 6.9	$ 7.8	$ 4.9	$ 3.0
Income Taxes					
Corporate (3)	$ 0.4	$ 0.9	$ 1.0	$ 0.7	$ 0.4
Personal (4)	$ 4.0	$ 9.2	$ 10.4	$ 6.5	$ 4.0
TOTAL	$ 8.6	$ 17.0	$ 19.3	$ 12.1	$ 7.4
CUMULATIVE (5)	$ 8.6	$ 23.7	$ 40.2	$ 52.3	$ 59.7

NOTES: All dollar figures are 1997 dollars. Costs and revenues are for the entire construction period.

(1) Calculated at 4% of direct construction spending, but only for Sports Center (as housing areas presumed exempt from tax).

(2) Calculated at 4% of workforce income spent on taxable items. Taxable share estimated from 1992-93 US Bureau of Labor Statistics study.

(3) Calculated as 0.25% of construction spending, from 1989-90 data on business receipts and corporate income tax collections.

(4) Calculated as 5.7% of workforce income, based on 1992 data on individual tax liability and gross income.

(5) Cumulative as of last year of period.

SOURCES: DBEDT, 1996; Hawaii State Department of Taxation, 1991.

Costs

Development costs include construction costs paid by HFDC and DAGS and interest on loans to cover those costs, as shown in Exhibits 4-Q and 4-R. Interest has been estimated on the assumptions that (a) HFDC will minimize costs be repaying as quickly as possible, while DAGS, with a facility that does not generate revenues quickly, will take a long-term strategy. Operations costs cover use and maintenance of the Sports Complex. (Since the project does not attract new pupils to Hawai'i, Department of Education operating costs are not attributable to the project.)

Balance of Revenues and Costs

Exhibits 4-Q and 4-R show positive balances of revenues over costs both for HFDC and for the project as a whole. (The transfer of funds from HFDC to UHWO is discussed separately below.)

Exhibit 4-Q: BALANCE OF REVENUES AND COSTS FOR THE STATE OF HAWAI'I: LOW RANGE

In millions of 1997 $s	1998-2002	2003-2007	2008-2012	2013-2017	2018-2022
REVENUES					
Land Sales	$ 216.2	$ 24.6	$ -	$ -	$ -
State Revenues Associated with Construction	$ 10.0	$ 14.1	$ 15.2	$ 9.2	$ -
Revenues associated with Operations					
State Taxes on Operations Workforce Income	$ 0.9	$ 7.6	$ 14.7	$ 19.4	$ 19.5
Sports Center Operating Revenues	$ 0.6	$ 2.5	$ 2.6	$ 2.6	$ 2.6
Revenues from Visitor Spending Cash Flows	$ 0.6	$ 2.3	$ 2.4	$ 2.4	$ 2.4
Annual Total (end of period)	$ 73.7	$ 6.0	$ 6.7	$ 6.2	$ 4.9
Cumulative Total (end of period)	$ 228.2	$ 279.2	$ 314.0	$ 347.6	$ 372.1
COSTS					
Construction					
HFDC	$ 94.8	$ -	$ -	$ -	$ -
DAGS	$ 27.8	$ -	$ -	$ -	$ -
Other Development Costs	$ 7.7	$ -	$ -	$ -	$ -
Lending					
HFDC	$ 27.4	$ -	$ -	$ -	$ -
DAGS	$ (17.9)	$ 12.1	$ 12.1	$ 12.1	$ 2.4
Costs due to Increased Visitor Count	$ 0.1	$ 0.2	$ 0.2	$ 0.2	$ 0.2
Annual Total (end of period)	$ 7.4	$ 2.5	$ 2.5	$ 2.5	$ 0.0
Cumulative Total (end of period)	$ 139.8	$ 152.1	$ 164.4	$ 176.7	$ 179.3
BALANCE					
HFDC					
Annual Total (end of period)	$ 65.6	$ -	$ -	$ -	$ -
Cumulative Total (end of period)	$ 94.0	$ 118.5	$ 118.5	$ 118.5	$ 118.5
All State Revenues and Costs					
Annual Total (end of period)	$ 68.3	$ 3.6	$ 4.2	$ 3.7	$ 4.9
Cumulative Total (end of period)	$ 88.3	$ 127.1	$ 149.6	$ 170.9	$ 192.8

NOTES: Estimates and calculations summarize most State spending and revenues, not including transfers between agencies. Thus, HFDC costs of infrastructure development and DAGS construction costs are shown, but timing and amount of repayment by DHHL or DAGS to HFDC is not shown. Again, DHHL charges against its revolving fund are not estimated, since the type of units and construction to be put in place are still being determined. "Lending" payments for HFDC equal interest paid (a) to its revolving fund, then (b) as payments on a balloon note, at 6.25%. For DAGS, a 20-year bond at the same rate is assumed, so the row includes payments on the bond, minus the principal (in 1999).

Exhibit 4-R: BALANCE OF REVENUES AND COSTS FOR THE STATE OF HAWAI'I: HIGH RANGE

In millions of 1997 $s	1998-2002	2003-2007	2008-2012	2013-2017	2018-2022
REVENUES					
Land Sales	$ 251.5	$ 29.6	$ -	$ -	$ -
State Revenues Associated with Construction	$ 10.1	$ 14.3	$ 16.7	$ 12.3	$ 7.1
Revenues associated with Operations					
State Taxes on Operations Workforce Income	$ 0.9	$ 7.6	$ 14.7	$ 19.4	$ 19.5
Sports Center Operating Revenues	$ 0.6	$ 2.5	$ 2.6	$ 2.6	$ 2.6
Revenues from Visitor Spending Cash Flows	$ 0.6	$ 2.3	$ 2.4	$ 2.4	$ 2.4
Annual Total (end of period)	$ 84.8	$ 6.1	$ 7.2	$ 7.9	$ 5.1
Cumulative Total (end of period)	$ 263.6	$ 319.9	$ 356.3	$ 392.9	$ 424.6
COSTS					
Construction					
HFDC	$ 94.8	$ -	$ -	$ -	$ -
DAGS	$ 27.8	$ -	$ -	$ -	$ -
Other Development Costs	$ 7.7	$ -	$ -	$ -	$ -
Lending					
HFDC	$ 27.4	$ -	$ -	$ -	$ -
DAGS	$ (17.9)	$ 12.1	$ 12.1	$ 12.1	$ 2.4
Costs due to Increased Visitor Count	$ 0.1	$ 0.2	$ 0.2	$ 0.2	$ 0.2
Annual Total (end of period)	$ 7.4	$ 2.5	$ 2.5	$ 2.5	$ 0.0
Cumulative Total (end of period)	$ 139.8	$ 152.1	$ 164.4	$ 176.7	$ 179.3
BALANCE					
HFDC					
Annual Total (end of period)	$ 76.7	$ -	$ -	$ -	$ -
Cumulative Total (end of period)	$ 129.3	$ 158.8	$ 158.8	$ 158.8	$ 158.8
All State Revenues and Costs					
Annual Total (end of period)	$ 77.3	$ 3.6	$ 4.7	$ 5.4	$ 5.1
Cumulative Total (end of period)	$ 123.8	$ 167.8	$ 191.9	$ 216.3	$ 245.3

NOTES: Estimates and calculations summarize most State spending and revenues, not including transfers between agencies. Thus, HFDC costs of infrastructure development and DAGS construction costs are shown, but timing and amount of repayment by DHHL or DAGS to HFDC is not shown. Again, DHHL charges against its revolving fund are not estimated, since the type of units and construction to be put in place are still being determined. "Lending" payments for HFDC equal interest paid (a) to its revolving fund, then (b) as payments on a balloon note, at 6.25%. For DAGS, a 20-year bond at the same rate is assumed, so the row includes payments on the bond, minus the principal (in 1999).

The constant-dollar figures used in the preceding tables help to assess changing cash flows over time. To estimate the overall results, recognizing that the value of returns on investments diminishes as time elapses between investment and return, net present value calculations can be made. These can be used to treat the entire cash flow associated with the project as a single value, as shown in Exhibit 4-S.

Exhibit 4-S shows that the entire net positive cash flow for the State will reach values equivalent to $90 million up to nearly $120 million in hand at present. The positive balance achieved by HFDC has a net present value in the range of $70 million to nearly $100 million.

Exhibit 4-S: NET PRESENT VALUE OF STATE INVESTMENTS

In millions of 1997 $s	NPV
Low Range	
HFDC	$68.58
TOTAL	$89.07
High Range	
HFDC	$96.73
TOTAL	$119.98

NOTES: Net present value calculation of balance of revenues over costs from 1998 to 2022 for HFDC and for all the State revenues and costs included in Exhibits 4-Q and 4-R. Discount rate: 8%.

Transfer of Funds to University of Hawai'i, West O'ahu

So far, the analysis has focused on transactions between the State as a whole, and other parties. Interagency transactions have been minimized, since the initial concern, for the purpose of an environmental impact statement, was to identify costs and revenues for the State as a unit. In effect, HFDC has been treated as assuming costs on behalf of the State as a whole, while payments from other agencies for infrastructure and land have not been reflected in the analysis.

Special attention is needed to the transactions that are at the root of the whole project. The East Kapolei development was planned in order to raise funds for infrastructure for University of Hawai'i, West O'ahu. HFDC will provide the University of Hawai'i with funds associated with the net revenues from developing 500 acres of the 1,300 acres in the project. It will be important for UHWO to have the funds in time for development in 2006 and subsequent years. HFDC's ability to retire debt, and then to go on to provide capital for the University of Hawai'i West Oahu, will depend on the timing of land sales. Currently, the developer expects these to occur in the years 2001 - 2005.

The cumulative balances for HFDC shown in Exhibits 4-Q and 4-R show well over $100 million in hand as of 2007, indicating that the project is expected to generate the needed funds. Exhibit 4-T deals more directly with the transfer, by estimating

the costs and revenues involved. (Actual numbers will vary depending on land sale prices.)

According to the estimate in Exhibit 4-T, HFDC will need to sell a total of 654 to 690 acres of land in order to cover all its costs and make planned payments to UHWO.

The exhibit further shows a net profit for HFDC of $34 million to $54 million (1997 dollars).

Exhibit 4-T: ESTIMATED IMPACT OF UHWO TRANSFER ON HFDC

	Gross Acres	Net Acres	Valuation (Million 1997 $s) Low	High
A. Land sale proceeds on 500 acres				
Developable acreage				
SF Residential		722.5	$216.75	$250.71
MF Residential		210.9	$63.27	$73.18
Commercial		18.0	$18.00	$23.42
	1,235.7	951.4	$ 298.0	$ 347.3
Developable portion per gross acre		77.0%		
Excluding: DHHL area	200.0	191.0	$ 57.3	$ 66.3
Total realizable from Land Sales			$ 240.7	$ 281.0
B. Costs of Infrastructure on 500 acres				
Total Cost			$ 94.8	$ 94.8
Calculation of pro rata share of cost				
Residential and Commercial acreage		951.4		
Sports Complex		64.3		
Total		1,015.7		
Cost per developable acre			$ 0.1	$ 0.1
Average developable area, 500 gross ac.		385.0	$ 35.9	$ 35.9
C. Amount due to UHWO				
UHWO share of land sales (500 ac. of gross area for development (1235.7 ac.))			$120.6	$140.5
minus share of infrastructure			$35.9	$35.9
			$84.7	$104.6
D. Amount needed to cover costs				
Infrastructure cost			$ 94.8	$ 94.8
Interest			$ 27.4	$ 27.4
UHWO			$ 84.7	$ 104.6
Total			$ 206.9	$ 226.8
Total expressed in acreage to be sold to cover costs (residential acres)			689.6	653.6
E. Balance				
Land Sales			$ 240.7	$ 281.0
Costs			$ 206.9	$ 226.8
Difference (cushion for HFDC)			$ 33.9	$ 54.2

NOTES: Calculated by SMS based on land and usage assumptions of project, as shown above and in preceding exhibits.

5. FIT OF PROJECT WITH SURROUNDING COMMUNITIES

This section discusses the "fit" between the State Housing Finance and Development Corporation's (HFDC) proposed East Kapolei project with its neighbors. It draws extensively on the views of key informants knowledgeable about the concerns of people in 'Ewa. In Section 6, we go on to provide an independent consultant's assessment of impacts on social life.

Community members offered several suggestions for improving the project or benefiting the community. We mention some of these in this section and discuss mitigations of project impacts in Section 7.

5.1 APPROACH

5.1.1 "Fit" or Compatibility

How well a project fits into or is compatible with existing 'Ewa communities is neither fully predictable nor guaranteed. Objective and subjective factors combine to make a project fit with its surroundings. Judgments about whether the project is in harmony with community character are based on personal viewpoints, people's definition of community character, and their own concept of what makes a project compatible with its surroundings. Also, residents' concerns change over time and new ones will likely emerge.

5.1.2 Sources

Community interviews provided the major source for learning about concerns of the area communities. During April 1997, SMS Research staff conducted interviews of community leaders, organizational representatives, and private citizens who were likely to know about issues and concerns of importance to various groups in 'Ewa. The interview process included residents of 'Ewa, 'Ewa Beach, Kapolei and Makakilo as well as other interested stakeholders who do not live in the area. (See Appendix C for a list of interviewees.)

Interviewees were given a handout with project description and map (Appendix D). The interviews provided an occasion for people to discuss their concerns, opinions about regional growth, perceptions of potential impacts associated with the project, and possible mitigations. Appendix E displays a list of major concerns and issues that surfaced during the interviews.

At the time of the interviews, the Sports Complex was not then a part of the proposed East Kapolei project. Discussions with interviewees did not include this feature of the project. In mid-1997, after our interviews, the Sports Complex proposal was presented to community groups in 'Ewa as a facility that would be designed to encourage professional teams to come to Hawai'i for spring training. The complex would also be available for exhibition games, and when not in use by professionals, to the surrounding community. The Makakilo-Kapolei-Honokai Hale Neighborhood Board voted in support of the plan.

5.2 COMPATIBILITY

During the community interviews, several factors emerged which have bearing on residents' assessments of the project's compatibility with surrounding areas and activities. Residents were concerned that the project avoid problems they saw with other development.

Informants tended to evaluate the project, first in terms of the likelihood that it will add to or alleviate 'Ewa's current traffic problem. Next, they asked whether the project would provide adequate open space and park areas. Several wanted to be sure the schools included in the project would be developed in a timely manner.

5.2.1 Views of Community Character

Residents recognize that 'Ewa is in transformation. Most have accepted that development and urbanization is inevitable. However, some question the timing of development of additional residential housing, particularly when there has been difficulty in selling new housing. Others question the continued development of housing without a commensurate increase in jobs in the region. Nearly all would appreciate timely development of the infrastructure for the project. It is important for them that parks and schools, along with the North-South Road and other road improvements are built during the early stages of development.

Many see the 'Ewa Plain to consist of several, self-contained communities with little interaction with each other. Several interviewees noted perceptions of division between existing communities. For example, some interviewees mentioned that Makakilo was distinctive from other 'Ewa communities and went on to distinguish between "lower" and "upper" Makakilo neighborhoods. In the 'Ewa Plain, the 'Ewa Beach community tends to see itself as different from the other communities.

5.2.2 Factors Shaping Community Views of Project Compatibility

Traffic and Roadways. Residents expressed concern that the project would add to the region's traffic congestion, and recommended that development of the North-South Road should precede the development of homes at the project site. Some wanted assurances that the North-South Road would have its own connection to H-1, and would not add to traffic on Farrington Highway.

Comment: At first, the project will be reached from Farrington Highway and Kapolei Parkway. The North-South Road will be necessary to reach other areas of the project site and will, in time, be the major point of entry to the project. That road will have an H-1 interchange and a connection to Farrington Highway. Hence it will tend to lower the traffic volume on Farrington Highway and Fort Weaver Road by providing a new road into and out of the region.

Need for Community Facilities. Community informants emphasized recreation and religious facilities:

- **Park Space and Recreational Facilities.** Development reduces green space and open vistas. Residents feel particularly affected by a lack of park space and recreational facilities. This is a major issue for 'Ewa residents. In the past, developers of new communities have been criticized for not providing parks with adequate facilities in a timely manner, and the City Parks Department has been criticized for not maintaining the parks satisfactorily.

  The original East Kapolei proposal allocated space for several neighborhood parks as well as a "linear park." Many of the interviewees voiced concern that there were no recreational facilities planned for these park areas. With the anticipated influx of families with children, those interviewed felt it was important that such facilities be available in the park spaces.

  Comment: Recreation would be possible in the parks. Hiking trails and exercise stations could be located in the long "linear park" open space.

  Changes have been made to the original proposal for the East Kapolei project. A 15.4-acre district park has been added to the East Kapolei project site. As a district park, it is expected that it will include recreational facilities for park users. Next, it is possible that the proposed Sports Complex would be available to the community when not in use by professionals.

- **Space for Churches.** Several interviewees remarked that the planned development does not provide space on which religious organizations can establish their churches. Interviewees pointed out the importance of having local places of worship; in their eyes, churches provide important community services.

  Comment: There are no provisions for church facilities within the proposed project, but there are churches of different religious denominations in the nearby 'Ewa Plain and Makakilo communities.

Need for the Timely Development of Schools. Many interviewees were concerned that the schools planned for the project would not be built in a timely fashion. Their experiences with past projects has been that schools are not developed and built in anticipation of needs. Given the fact that the project encourages home ownership by families with children, interviewees thought it was reasonable to expect schools be built early in the development cycle.

Comment: The Department of Education (DOE) has developed a tentative schedule for construction of additional school facilities as the project is built. The pace of the build out as well as state legislative funding will affect this schedule.

Support of University Development. Several interviewees thought that the East Kapolei project would be compatible with the future University of Hawai'i West O'ahu (UHWO) now proposed for a site mauka of the H-1. Some expressed regrets that the site for the future campus had been changed from its original location.

Comment: The sale of parcels to private developers will help in financing the development of the West O'ahu campus.

Regional Balance of Jobs and Housing. A number of interviewees cautioned that the project could end up as another bedroom community if Kapolei falls short of becoming a major employment center for the region. Additional efforts, they felt should be made to develop job opportunities to permit people to work in close proximity to their homes.

Comment: The East Kapolei project will support operational jobs in its neighborhood commercial areas. Residents will likely shop at Kapolei commercial areas as well. Additionally, some businesses have relocated in whole or in part to Kapolei. The City and County of Honolulu and the State

are also working to relocate some offices and personnel to Kapolei in the near future. Presumably, many Kapolei workers will live in the East Kapolei project, as in nearby communities.

5.3 DEVELOPMENT OF "FIT"

Any large new project stands out simply by being new. Over time, it becomes a recognized, if not necessarily loved, part of its region. The proposed project will affect the region in different ways over time. The importance of different compatibility issues will also change.

The buildout of the proposed East Kapolei project will take place over approximately 20 to 25 years. The state will install major infrastructure on the property and it is projected that land sales could begin as early as 1999 with completed housing units available as early as 2001.

The Farrington-Kapolei Parkway segment of the long-anticipated North-South Road is currently scheduled to break ground in September 1998. Construction of this roadway includes development of a drainage way to assist in flood control in the area. Although no timetable has been established, construction of the North-South Road and drainage way should take at least one year to complete. Project plans call for development of a "linear park" along the route of the North-South Road.

Initial project development will occur along Farrington Highway. Hence traffic on Farrington highway will be heavier because of the construction work. As development progresses, traffic along the newly constructed North-South Road will also increase as a result of construction traffic. Traffic will be affected as homes are sold. Currently, it is not known when the North-South Road will be extended to H-1; hence new residents will also be using Farrington Highway to commute to work. The North-South Road is not part of the East Kapolei project. Nonetheless, it is clear that development of a new H-1 interchange and link to Farrington Highway will lessen congestion on Farrington Highway and lessen friction between East Kapolei residents and others in traffic.

The design of the East Kapolei project will affect 'Ewa residents' views of their communities. The villages of Kapolei are subject to detailed design guidelines. Developers in East Kapolei will not be so constrained; consequently, the project could include a greater variety of units and designs than in nearby areas.

5.4 COMPATIBILITY OF THE SPORTS COMPLEX

The 1997 interviews did not deal with the Sports Complex. In public meetings, community representatives welcomed it as a contribution to the region. It can be widely accepted as a regional amenity if it provides visibility for 'Ewa and Kapolei, if it supports local sports activity (through access to fields and/or funding of play fields elsewhere), and if events at the Sports Complex are appropriate, given its location at one end of a residential zone.

6. SOCIAL IMPACTS

6.1 OVERVIEW

This section describes potential impacts on lifestyle, family life, and community organization. It is an independent consultant's assessment, based on research conducted for this study, interviews with 'Ewa residents and business leaders, and SMS Research's experience of communities and projects throughout Hawai'i.

Social impacts are rarely automatic results of development. They are shaped by planning and design decisions, by interactions with the surrounding community, and by outside forces and events. The assessment of social impacts hence deals with tendencies, dangers, and opportunities, not inevitable consequences. Potential unwanted impacts and problems of compatibility can often be reduced or avoided. Section 7 discusses measures for mitigating potential adverse impacts.

Social Impacts. Major social impacts of the project are summarized as:

- Provision of needed housing for O'ahu;
- Enhancement of Kapolei's customer base;
- Development of a new community focus, at the Sports Center;
- Increase in traffic and congestion;
- Possible impacts on social life due to construction noise or dust;
- Competition for community resources and facilities, namely parks and schools;
- Continued transformation of 'Ewa into a bedroom community; and
- Financing for development of the University of Hawai'i West O'ahu.

Community Issues and Concerns. Most of the potential social impacts cited by 'Ewa residents during community interviews were tied to regional concerns over the adequacy of infrastructure and public facilities. Residents' experience with regional change has repercussions for the proposed East Kapolei project. Residents seemed to have lumped together perceptions of the East Kapolei project with the other residential developments. Consequently, impacts of the project were invariably voiced in terms of potential cumulative impacts on the region.

Based on the types of issues and concerns raised by the interviewees, some broad themes emerge around which the potential impacts can be grouped:

- **Quality of Life** — primarily infrastructure and other engineering issues which affect the quality of people's lives in a community.
- **Community Character** — elements of design, configuration, timing and coordination of the development, and community consultation processes which affect the project's compatibility with surrounding communities and land uses, and resident perceptions of whether the project is an asset to the region.
- **Community Involvement** — an expressed need for informational and cooperative problem-solving interactions between developer and community representatives, who seek pro-active steps to mitigate anticipated project impacts.

6.2 ISLANDWIDE IMPACTS

Both the provision of housing and the creation of a Sports Complex will have island-level impacts.

For decades, O'ahu has experienced housing problems, including inadequate supply and high prices both for rentals and owner-occupied housing. O'ahu housing prices are among the highest in the nation. HFDC and other housing initiatives during the last decade have helped to address the problem, and the sluggish economy has further worked to limit housing prices. Still, it is likely that pent-up demand for housing will continue – the O'ahu Effective Demand model in the most recent projection of future housing needs indicates a deficit of some 16,300 units over the period 1997-2016 (SMS Research & Marketing Services, Inc., and Locations, Inc., 1997).

Housing will be largely aimed at moderate- and middle-income families. The increase in the housing stock will help families throughout O'ahu to find new homes and, in many cases, to become homeowners. As these families leave existing housing, demand for older housing will be somewhat lower than it would otherwise, helping to limit price increases for low- and moderate-income housing.

The pace of housing production will be largely in response to market demand. As a result, the impact of the new housing stock on the market as a whole will be gradual.

The Sports Complex will provide a site tailored for spring training by professional teams. It will also be available for exhibition games not likely to draw enough

spectators to justify use of Aloha Stadium. With the new facility, more events will be possible, and facilities management can be more efficiently accomplished. To the extent that the site encourages new professional baseball activity on O'ahu, it will further help to increase islandwide revenues from tourism spending.

6.3 REGIONAL IMPACTS

6.3.1 Phasing

The proposed East Kapolei project is among the largest residential communities in the region. Consequently, it may result in substantial impacts to the region. The impacts are discussed in relation to the stages of project development. Years are approximate. Actual development timing will depend on market demand.

- **Early Construction (1998- 2005)** — Off-site construction begins in late 1998 with road work to widen Farrington Highway from Fort Barrette Road to the Kapolei Golf Course entry road as well as beginning construction of the new North-South Road. Additionally, installation of major infrastructure should begin on-site, which will be followed by the sale of parcels to and subsequent housing construction by private developers. The first housing units should become available by 2001. Potential impacts related to this phase of development include:
  - Increased construction work traffic along Farrington Road, both that of the construction workers traveling to and from work as well as of heavy construction vehicles.
  - Construction noise and/or dust.
  - Opening of the Sports Center.
  - Linkage of 'Ewa Villages to Kapolei.
- **Mid-development (2006 - 2016)** — Housing construction should be well underway during this time. Infrastructure work continues on-site. Over 75% of the proposed units are projected to have been built and occupied by the end of the period. Potential impacts related to this phase of development include:
  - Continuation of construction traffic and noise and/or dust, largely within the project site.
  - The larger residential population will intensify the need for schools, park space, and community amenities.

    - Loss of historical identity in 'Ewa — more of the former cane land will have been transformed into housing. Much of the Plain area will have become urbanized, and existing pockets of plantation life may be dwarfed by the new developments, including the East Kapolei project.
    - Increased population will intensify the need for early childhood education and care in the region. (Situated in Kapolei, Seagull Schools is the major child care and education facility in the region.)
- **Final development to build-out (2017-2022)** — Housing construction will continue. The average rate of growth of the general and school-age populations will have decreased substantially. Potential impacts related to this phase of development include:
    - Continued construction traffic and noise and/or dust, largely within the project site.
    - Increased population should have lessened impact on schools, park space and community amenities if these have been built as anticipated.

Potential increased demand for infrastructure, facilities, and services can mean greater competition for limited resources in the short term. In the long term, the larger the regional population, the more justification will exist for locating social service providers and other government services in the proposed Kapolei Civic Center, and for commercial outlets nearby.

The East Kapolei project was designed to provide financing, after initial infrastructure costs were met, for the construction of the University of Hawai'i West O'ahu campus. The new campus could potentially serve as a source of community pride for the 'Ewa region, as well as provide employment for residents of the area. Also, UHWO sports teams may eventually be users of the Sports Complex.

6.3.2 Regional Identity

Over time, the project will contribute strongly to development of a sense of 'Ewa as a region, rather than as a jumble of separated communities. The East Kapolei project will bring developments along Fort Weaver Road and Fort Barrette Road closer to each other both by providing additional roadways and by extending the urban area between the two areas now developed. Within the project, the Sports Complex will be a focus of regional interest.

6.3.3 Regional Facilities

Interviewees commented extensively on traffic, recreation facilities, and schools. The first is the topic of a technical study for the EIS. Traffic is mentioned later in this chapter in order to specify the particular issues that may affect people in one community or another. Recreation and schools are discussed in this section as regional issues.

The project will respond to regional needs for recreation by supplying park space and, at the Sports Complex, a venue for professional games and other activities. In the long run, the region could have a greater variety and range of recreation areas than elsewhere on O'ahu, with development of the Barbers Point recreation areas. The Sports Complex could supply a focus for regional and islandwide competitions.

The East Kapolei project will supply students for both public and private schools in the region. Public school enrollments are projected as reaching a total of 3,150 to 4,050 pupils, as shown in Exhibit 6-A. The bulk of these would attend schools within the project site, at three elementary schools and one intermediate school.

Currently, Campbell High School in 'Ewa Beach serves the 'Ewa Plain communities. A new Kapolei High School is planned. With the development of the entire 'Ewa Plain, either major expansion of these schools or a third 'Ewa high school may be needed.

It should be stressed that the impact of the East Kapolei project is strictly locational: it does not attract new students to the Hawai'i public schools, but draws them from other areas to 'Ewa. Some, coming from the Honolulu area, may now attend schools that are at or below capacity. Others, coming from Pearl City, Waipahu, Wai'anae, or East Honolulu, could well already attend schools that now have limited facilities. Consequently, the overall impact, if measured in terms of the number of students in crowded schools who otherwise would not be in such facilities, is much less than the total enrollment (or the total high school enrollment) shown in Exhibit 6-A.

Exhibit 6-A: ESTIMATED PUBLIC SCHOOL ENROLLMENTS OF EAST KAPOLEI RESIDENTS

	2002	2007	2012	2017	2022
Total Population (1)					
Low Range	2,516	10,576	17,103	20,943	20,943
High Range	2,516	10,749	18,516	24,106	27,054
Public School Enrollment (2)					
Low Range					
Elementary	214	899	1,454	1,780	1,780
Intermediate	55	233	376	461	461
High School	108	455	735	901	901
High Range					
Elementary	214	914	1,574	2,049	2,300
Intermediate	55	236	407	530	595
High School	108	462	796	1,037	1,163

NOTES: (1) From Exhibit 4-H.
(2) Public school enrollments estimated on the basis of historical share of population in school age cohorts and in public schools. Factors used here -- 8.5% of total population in public elementary school; 2.2% in public intermediate schools, and 4.3% in public high schools -- are derived from 1994 statewide data on school attendance and population, and on a review of 1990 census data on public school attendance in selected 'Ewa communities.

6.4 IMPACTS ON SPECIFIC AREAS AND LAND USES

6.4.1 Project Site

The project will take 20 or more years to build. The people most affected by construction and occupation of the site are the residents of the project site itself. Residents will move in as housing is completed and construction will continue until buildout.

Impacts:

- **Quality of Life.** The project will provide new housing for thousands of O'ahu residents. For many, this will be a first chance of home ownership. After years of interviews with Hawai'i social service professionals, SMS Research finds that the provision of housing (and hence less crowding in existing neighborhoods) is strongly associated with lower stress and family problems. However, new homeowners typically pay a large share of their income to cover housing costs. Homeownership does not relieve people of economic and social

challenges so much as increase the benefits of meeting these challenges.

- **Community Character.** The project will alter the visual character of the region. What were once fields planted in sugar cane will be replaced by another housing subdivision.

  Facilities that support social interaction and activities — social halls, churches, and parks — contribute to the vitality of neighborhood and community life. Limited availability of such spaces can minimize residents' involvement in community life.

- **Health and Safety.** Construction noise and dust are potential irritants or health hazards to project residents. Sites near completed homes will be under construction and barriers such as shrubbery or landscaping may either be freshly or incompletely planted. In extreme cases, chronic exposure to construction conditions can have cumulative impacts on residents' health.

6.4.2 Communities in Close Proximity to Project

The 'Ewa Plain communities which could be most directly affected by the proposed East Kapolei project include 'Ewa Villages and Kapolei.

'Ewa Villages. 'Ewa Villages lie southeast of the East Kapolei project site.

Residents' Issues and Concerns. Infrastructure issues — drainage, traffic, school, and parks — were mentioned most frequently.

Impacts:

- **Health and Safety.** Housing construction at the project site nearest to 'Ewa Villages will more than likely not take place immediately. Construction will initially begin along the Farrington Highway portion of the project site. Impacts from construction dust from both housing and North-South Road construction work will likely be minimal, if at all. The 'Ewa Villages golf course will separate the Villages from construction sites.

  Potential project impacts on drainage — and hence on the flooding that occurs in 'Ewa Villages apart from the project — are being addressed with construction of the North-South Road. This road and adjacent parks are specifically designed to serve as a drainage way during times of flooding.

- **Community Character.** The larger scale of the proposed East Kapolei project could add to the potential to overwhelm the historic atmosphere of the rehabilitated 'Ewa Villages. The addition of these units to the region may lessen residents' sense of historic place and identity in 'Ewa. This incongruity may become magnified because 'Ewa Villages will be situated between two large-scale housing developments, East Kapolei and 'Ewa by Gentry. It is also quite likely that those traveling from the eastern area of 'Ewa to Kapolei will do so by way of 'Ewa Villages.
- **Quality of Life.** Construction of community facilities can take a number of years, depending on various factors, including the availability of funds. If parks included in East Kapolei project are not developed as planned, park spaces in 'Ewa Villages could become over burdened.

Kapolei. Kapolei and the Villages of Kapolei lie to the west of the East Kapolei project site.

Residents' Issues and Concerns: Again, for those interviewed from Kapolei, infrastructure issues — traffic, schools, and community facilities — were mentioned most frequently. One resident mentioned that sometimes there is some unhappiness among those who have lived in the area longer and the perception that the newcomers are getting what they've been requesting for years.

Impacts:

- **Health and Safety.** Impacts from construction dust will likely be few. The major portion of the Villages of Kapolei will be separated from the East Kapolei project construction site by the Kapolei Golf Course.

  Construction traffic and residential traffic along Farrington Highway will increase as the project is built out, resulting, perhaps, in longer commute times for residents of Kapolei.
- **Quality of Life.** Construction of school facilities can take a number of years, depending on various factors, including the availability of State funds. Kapolei Elementary school could be adversely affected if elementary schools planned for East Kapolei are not completed as currently scheduled. The greatest average annual rate of increase of elementary-age school students occurs between 2001 and 2006 and decreases substantially after that through project buildout. A similar situation exists for intermediate and high school student populations. If schools are not built as anticipated, there could be overcrowding at existing schools.

The project will add to the customer base for Kapolei commercial areas.

6.4.3 Other 'Ewa Communities.

Residents' Issues and Concerns. Residents from the West Loch, Gentry, and 'Ewa Beach communities were concerned that the proposed East Kapolei project might exacerbate existing regional conditions. They were most apprehensive about the development adding to what they feel are already terrible traffic conditions.

Impacts:

- **Quality of Life.** During construction of the North-South Road and improvements to Farrington Highway, increased construction traffic will have an impact on local traffic into and out of the 'Ewa area. As homes are sold, local traffic will likely increase along Farrington Highway between the project site and the Farrington Highway and Kunia Road intersection above West Loch as well as between the project site and the intersection of Farrington Highway and Fort Barrette Road.

6.4.4 Makakilo

Residents' Issues and Concerns. Residents of Makakilo felt that their community would be most affected by increased freeway traffic from the project.

Impacts: While some felt that the project residents would add to freeway traffic, others felt that the traffic situation would always present a problem, regardless of the degree to which employment opportunities were available in the area.

6.5 REGIONAL IMPACTS OF PLANNED LAND USES

6.5.1 East Kapolei Sports Complex

Development of the proposed sports complex will increase 'Ewa's visibility on O'ahu and to visitors. However, it will provide only limited community play. The economic activity generated by the sports complex will support jobs, on-site and in Ko 'Olina hotels.

Residents of the region have stressed the need for playing fields for local use. Some have questioned whether new facilities should be built when local government is not maintaining existing parks well. Community criticism is hence likely unless the Sports Complex generates revenues to support construction and operation of recreational facilities for the general public.

6.5.2 University of Hawai'i West O'ahu (UHWO)

Once development costs are covered, proceeds of the land sales at the proposed project site would go to finance construction of the University of Hawai'i West O'ahu campus.

Residents' Issues and Concerns. Community interviewees were generally in favor of locating UHWO in the region. However, some were disappointed that the site for the campus had been changed.

Impacts:

- **Quality of Life.** When UHWO is open, the project will provide housing and neighborhood commercial areas serving students, faculty, and staff. Additionally, once the campus is open, it should provide additional employment opportunities. The university might also serve as a unifying force for the region, particularly if it includes a sports program.

6.5.3 DHHL Communities within the East Kapolei Project

Within the proposed project site, DHHL has entitlement to 200 acres. Development by DHHL will create more housing for Hawai'ian families and will extend the Hawai'ian presence in the 'Ewa urban area. (Village VI of the Villages of Kapolei is currently being designed for DHHL. It will include about 300 housing units.)

6.6 IMPACTS ON SECONDARY STUDY AREA

6.6.1 Wai'anae DPA

Most Wai'anae residents commute to Honolulu or to other areas of the island for work. Farrington Highway and the H-1 Freeway are the only thoroughfares out of the region. The project will affect residents by adding traffic to the freeway. Furthermore, the increase in population in 'Ewa as a result of the East Kapolei project will also bring greater competition for Leeward O'ahu jobs.

6.6.2 Central O'ahu DPA

The project will compete with Central O'ahu housing developments as well as with 'Ewa subdivisions for the resident housing market. As a result, it will tend to slow the build out of those developments, and hence tend to slow the pace of growth in Central O'ahu.

7. MITIGATION MEASURES

In this section, SMS Research identifies ways to mitigate possible adverse socio-economic impacts of the project. This is an independent consultant's assessment, implying no commitment on the part of the Housing Finance and Development Corporation, to undertake any of the steps mentioned. We further note possible community benefits, without implying in any way that provision of these benefits is necessary or obligatory.

Many adverse impacts are by no means inevitable and necessary consequences of development. Many can be avoided through planning and community action. Hence the listing of impacts in this chapter must be understood as part of the process of mitigation, not as counts against the project.

To the extent that impacts affect people's sense of their lifestyles and community, mitigation of those impacts depends on whether they see proposed solutions as appropriate. Community involvement in decision-making can be crucial to implementing mitigation measures that effectively respond to residents' needs and concerns. Accordingly, consultant recommendations are suggestions for further review by the project developer, residents and community leaders, not prescriptions.

7.1 MITIGATION MEASURES

The project helps to meeting the islandwide need for housing. It fits in with government policy encouraging growth in 'Ewa. As a result, it contributes to the regional problem of coordinating development so that infrastructure, housing, and services are all provided efficiently. It can also contribute to the solution.

Potential adverse impacts of the project fall under three general headings, as shown in Exhibit 7-A on the next page.

- **Quality of Life.** Potential adverse impacts are inadequate regional physical and social infrastructure; limited community facilities on site for residents, and irritation due to traffic congestion.

  The problems of limited <u>regional</u> Infrastructure and facilities (discussed in Section 6) can be addressed through:

Exhibit 7-A: POSSIBLE MITIGATION MEASURES

POTENTIAL ADVERSE IMPACTS	MITIGATION MEASURES
Quality of Life	
Regional physical and social infrastructure for growing community	• Develop infrastructure for project in coordination with other public agencies • Work with community groups to plan for regional facilities
On-site: lack of childcare, limited community space	• Work with developers to provide community facilities or support community associations' use of park space • Work with developers to allow family care homes in CC&Rs
On-site and in Kapolei Villages near Sports Complex: Irritation due to traffic congestion	• Work for development of the North-South Road interchange with H-1
Possible disruptions of residential life due to events at Sports Complex	• Noise restrictions
Health and Safety	
Construction dust and noise	• Follow City and State regulations governing construction • Plan construction timing to limit duration of impact on adjoining areas • Anticipate, respond to resident complaints
Community Character	
Preservation of the character of nearby 'Ewa Villages	• Encourage designs sensitive to 'Ewa Villages (in areas near the Villages)

- *Coordinated regional planning for infrastructure development.* In 1998 the State Department of Transportation is scheduled to break ground on the new North South Road. Additionally, HFDC will begin improvements along Farrington Highway between Fort Barrette Road and the new North-South Road. The City and County of Honolulu will also work on Farrington Highway improvements from Fort Weaver Road and the New North-South Road; however, no timetable has been established for that work at this time. Additionally, development of the North-South Road H-1 interchange should be accomplished as quickly as possible.

- *Work with community associations, landowners and interest groups to plan for regional facilities.* Beyond infrastructure planning, 'Ewa landowners and communities may seek to cooperate in identifying needed services in government centers to be developed in Kapolei. Again, cooperation will be needed to insure that regional park plans — in existing developments and at Barbers Point NAS — respond to local needs and are developed in a timely manner.
- *Encourage public agencies to develop facilities when needed.* While government policy supports new development in 'Ewa, budgets are tight. Agencies and legislators may understandably delay construction of needed facilities in "Ewa.

- The East Kapolei project consists at the moment of little more than a conceptual plan. As a result, provision of community facilities on site is only indicated by the allocation of park space. Two potential adverse impacts are visible:

  - *Community facilities and spaces.* Project plans include parks and schools as sites for neighborhood and community life, but no other community facility spaces have as yet been identified. While community halls may often not be well used, it is doubtful that open space in the parks will suffice by itself to support an active and varied community life. Potential mitigations include (a) providing space for additional community or neighborhood social facilities and (b) supporting community groups to organize and use available park or school space.
  - *Child care needs.* While Kapolei will have a large child care center, project residents are likely to need additional services. In Hawai'i, most working parents prefer to find child care in family home settings — with relatives, friends, or other providers — for children younger than three years old. Because of the distance between 'Ewa and older urban areas, many families may find it impossible or impractical to take young children to relatives on a daily basis, and may need child care facilities nearby. Their needs can be met by skilled private providers in the project area so long as (a) the individual development CC&Rs allow family care homes and (b) child care providers and support services such as Traveling Preschools are allowed to use community parks.
  - Activities at the Sports Complex run the risk of irritating nearby residents due to noise or spectators' behavior before or after

events. Noise restrictions based on the distance between the stadium and residential areas will need to be developed.

In the near term, project contributions to regional traffic congestion will affect the quality of life of residents depending on Farrington Highway and the Fort Weaver Road, and the Fort Barrette and Farrington Highway interchanges. The most effective mitigation strategy would be to work to encourage development of the North-South road interchange with H-1, as quickly as possible.

- **Health and Safety.** Two separate potential impacts are of concern:

  Construction impacts are recognized irritants on the dry 'Ewa Plain. The project can work to minimize construction dust and noise by (a) following government regulations and (b) planning the timing of construction so that adjoining properties are affected by project construction only for a limited period of time. Construction adjoining 'Ewa Villages and the Villages of Kapolei can be planned to limit the length of time that construction occurs near any particular village.

  In addition, HFDC may consider establishing a hotline for complaints about construction impacts and delegating employees to respond to these. While this action is a form of community response, it also can help in monitoring the performance of construction crews, insuring that they meet standards needed to minimize construction impacts.

  Aside from construction irritants at the project site, another potential impact involves the safety of residents living at the project site as build out continues. Construction equipment will use Farrington Highway and the North-South Road to access construction areas. Individual developer parcels will be completed prior to selling individual homes. Consequently, construction will not be taking place in within the parcels and should not pose any additional danger to residents.

- **Community Character.** 'Ewa is being urbanized, and the project cannot be held accountable for that fact. However, areas of the project are situated next to 'Ewa Villages, where an attempt is being made to preserve a plantation community and a "country" ambiance through restoration and design of new homes. In order to support this effort, some attention may be necessary to coordinate the design of the areas near 'Ewa Villages with the Villages.

7.2 COMMUNITY OUTREACH AND BENEFITS

Community involvement is advisable to increase the fit of the project with surrounding areas, to encourage regional cooperation in planning, and to identify effective mitigations for local-level impacts. Such involvement, by HFDC, the individual private developers and by resident community groups, can further help to counter the regional trend toward a split between old and new communities. HFDC may want to consider encouraging the private developers as parcels are sold to involve the community through presentations to community groups and close communication with recognized community leaders.

Further steps toward cooperation and interaction could include:

- Planning paths, roads, and bikeways that link neighboring communities; and
- Encouraging inter-community activities through community associations, sports leagues, and regional events.

APPENDIX A

Detailed Exhibits on Existing Conditions

Appendix A

1. DEMOGRAPHIC CHARACTERISTICS, SELECTED DP AREAS, 1990

	Honolulu County	SELECTED DP AREAS		
		Ewa (1)	Central (1)	Waianae
POPULATION	836,231	42,960	130,474	37,411
ETHNICITY				
Caucasian	32%	40%	30%	23%
Japanese	23%	9%	20%	6%
Filipino	14%	28%	24%	16%
Hawaiian	11%	10%	8%	41%
Other	20%	13%	18%	15%
AGE				
Less than 5 years	7%	10%	10%	10%
5 to 17 years	17%	21%	20%	26%
18 to 34 years	31%	35%	34%	27%
35 to 64 years	34%	29%	29%	30%
65 or more years	11%	5%	6%	7%
Median age (years)	32.2	N/A	N/A	26.3
EDUCATION OF PERSONS AGED 25 & OVER (2)				
High School Diploma (3)	81%	80%	82%	69%
College Degree (4)	33%	25%	29%	15%
PERSONS AGED 5 & OVER WHO SPEAK A LANGUAGE OTHER THAN ENGLISH AT HOME (2)	26%	24%	26%	19%
PERSONS WITH MOBILITY OR SELF-CARE LIMITATIONS (2)				
% of persons aged 16 to 64	4%	5%	4%	6%
% of persons aged 65 or more	18%	20%	20%	26%

NOTES: (1) See Appendix A-6 for a detailed list of equivalent Census regions for these Development Plan Areas.
(2) Based on 15% sample; hence, figures represent estimates only.
(3) All persons with a high school diploma, including those with college education.
(4) Includes Associate, Bachelor's, and graduate degrees.

SOURCES: U.S. Bureau of the Census, 1992, 1991.

Appendix A

2. GEOGRAPHIC MOBILITY, SELECTED DP AREAS, 1990 (1)

	Honolulu County	SELECTED DP AREAS		
		Ewa	Central	Waianae
PERSONS (2)				
PLACE OF BIRTH				
Born in Hawaii	54%	46%	51%	74%
Other U.S.-born (3)	30%	38%	35%	18%
Foreign-born	16%	16%	15%	8%
RESIDENCE 5 YEARS PREVIOUS FOR PERSONS AGED 5 & OVER				
Same house	50%	38%	43%	55%
Same county, different house	26%	29%	27%	33%
Same state, different county	1%	1%	1%	1%
Different state	17%	26%	24%	9%
Lived abroad	5%	6%	6%	2%
HOUSEHOLDERS (2)				
WHEN HOUSEHOLDER MOVED INTO UNIT				
In the last 5 years	53%	66%	62%	52%
6 to 20 years ago	29%	26%	26%	35%
21 to 30 years ago	10%	6%	8%	7%
31 years ago or more	8%	3%	4%	6%

NOTES: (1) Based on 15% sample; hence, figures represent estimates only.
(2) Base figures used in calculating these data may be different than in 100% count.
(3) Includes persons born in U.S. territories, and persons born abroad or at sea to American parents.

SOURCE: U.S. Bureau of the Census, 1992.

Appendix A
3. HOUSING CHARACTERISTICS, SELECTED DP AREAS, 1990

	Honolulu County	SELECTED DP AREAS		
		Ewa	Central	Walanae
HOUSING UNITS	281,683	11,734	36,260	10,680
TOTAL VACANT UNITS	6%	3%	2%	12%
Seasonal/recreational	2%	0%	0%	4%
AGE OF STRUCTURE (1)				
1 year	2%	7%	3%	1%
2 to 10 to years	14%	15%	28%	13%
11 to 20 years	30%	29%	29%	42%
21 years or more	54%	48%	40%	44%
UNITS IN STRUCTURE				
1 unit	55%	80%	65%	70%
2 to 4 units	7%	7%	9%	5%
5 or more units	36%	11%	24%	23%
Trailer, other	1%	1%	1%	2%
NOT COMPLETE PLUMBING (1)	1%	0%	0%	1%
HOUSEHOLDS	265,304	11,434	35,443	9,417
HOUSEHOLD TYPE				
1 or more non-relatives	12%	12%	10%	15%
No non-relatives	88%	88%	90%	85%
TENURE				
Owner-occupied	52%	53%	55%	52%
Renter-occupied	48%	47%	45%	48%
PERSONS PER HOUSEHOLD	3 02	3 66	3.49	3 93
CROWDED HOUSEHOLDS				
Mildly crowded (2)	8%	11%	10%	16%
Very crowded (3)	8%	9%	8%	18%
MEAN VALUE (4)	$312,624	$232,270	$265,169	$168,784

NOTES. (1) Based on 15% sample, hence, figures represent estimates only
(2) Indicated by households with 1 00 to 1.50 persons per room.
(3) Indicated by households with 1.51 or more persons per room
(4) For owner-occupied, non-condominium housing units.

SOURCES: U S Bureau of the Census, 1992, 1991.

Appendix A
4. INCOME CHARACTERISTICS, SELECTED DP AREAS, 1990 (1)

	Honolulu County	SELECTED DP AREAS		
		Ewa	Central	Walanae
HOUSEHOLDS (2)				
INCOME LEVEL				
Lowest (3)	13%	9%	11%	22%
Highest (4)	17%	12%	15%	9%
Mean Income (5)	$49,959	$44,759	$47,540	$38,310
Interquartile Range (6)	$43,154	$36,073	$39,908	$35,239
WITH SELECTED INCOME SOURCES				
Social Security Income	24%	15%	17%	23%
Retirement Income	20%	17%	17%	21%
Public Assistance Income	6%	6%	8%	22%
OWNER HOUSING COSTS (7)				
35% or more of Household Income	15%	21%	20%	14%
Mean Monthly Costs	$909	$968	$1,041	$607
RENTER HOUSING COSTS (8)				
35% or more of Household Income	34%	36%	37%	44%
Mean Gross Rent	$711	$810	$717	$617
Mean Contract Rent (9)	$655	$738	$652	$551
POPULATION (2)				
PERSONS BELOW POVERTY LEVEL	7%	5%	7%	19%
% of persons aged 18 to 64	6%	4%	5%	15%
% of persons aged 65 or more	8%	4%	9%	14%
% of related children aged less than 18	10%	5%	10%	26%
% of unrelated individuals	19%	17%	18%	33%

NOTES. (1) Based on 15% sample (except "Mean Contract Rent"), hence, figures represent estimates only.
(2) Base figures used in calculating this data may be different than in 100% count.
(3) Incomes of less than $15,000 (based on lowest 14 8% of incomes statewide).
(4) Incomes of $75,000 or more (based on highest 15 8% of incomes statewide).
(5) In 1989 dollars
(6) A smaller range means less difference between rich and poor, while a larger range means a greater difference between rich and poor.
(7) Owner costs include (but are not limited to) mortgage, real property tax, property insurance, utilities, and fuels.
(8) Renter costs include (but are not limited to) rent, utilities, and fuels.
(9) Monthly cash rent only. Does not include other costs.

SOURCES: U S. Bureau of the Census, 1992, 1991.

Appendix A
5. LABOR FORCE CHARACTERISTICS, SELECTED DP AREAS, 1990 (1)

	Honolulu County	SELECTED DP AREAS		
		Ewa	Central	Waianae
POPULATION AGED 16 & OVER	651,920	30,768	94,346	24,973
In Armed Forces	8%	17%	16%	2%
POTENTIAL CIVILIAN LABOR FORCE	598,371	25,556	78,949	24,377
In Civilian Labor Force	69%	71%	72%	62%
CIVILIAN LABOR FORCE	410,023	18,081	57,071	15,107
MALE				
Labor force participation (2)	75%	79%	79%	71%
Unemployed	4%	5%	4%	8%
FEMALE				
Labor force participation (2)	63%	64%	67%	53%
Unemployed	3%	5%	4%	8%
EMPLOYED CIVILIAN LABOR FORCE	395,811	17,120	54,571	13,901
BY SELECTED INDUSTRY				
Agriculture, forestry, fisheries, mining	2%	2%	2%	4%
Construction	7%	8%	8%	12%
Manufacturing	6%	9%	8%	8%
Transportation	7%	7%	7%	7%
Retail trade	19%	20%	19%	17%
Finance, Insurance, real estate	8%	7%	7%	4%
Personal, entertainment, recreation	8%	6%	7%	7%
Health, education, professional	22%	17%	19%	19%
Public administration	9%	11%	12%	9%
BY OCCUPATION				
Managerial, professional	28%	18%	23%	17%
Technical, sales, support	35%	35%	35%	27%
Service	17%	18%	17%	18%
Farming, forestry, fishing	2%	2%	2%	4%
Precision, craft, repair	10%	13%	12%	14%
Operators, cleaners, laborers	9%	14%	11%	20%
COMMUTE TO WORK				
More than 45 minutes	16%	21%	20%	40%
Mean travel time (minutes)	25	N/A	N/A	36

NOTES: (1) Based on 15% sample; hence, figures represent estimates only.
(2) Calculated by dividing "Civilian Labor Force" by "Potential Civilian Labor Force."

SOURCE: U.S. Bureau of the Census, 1992.

Appendix A
6. 'EWA AND CENTRAL DP AREAS IN CENSUS TERMS

Region	1990 Population
'EWA DP AREA	42,983
APPROXIMATE CENSUS AREAS	42,960
Tract 83 01	5,786
Tract 83 02	6,699
Tract 87.98 (BG 9 only)	826
Tract 84	9,677
Tract 85	4,529
Tract 86 03 (all except BG 1)	5,907
Tract 86 04	4,015
Tract 86 98	5,521
DIFFERENCE	23
CENTRAL DP AREA	130,474
APPROXIMATE CENSUS AREAS	130,474
Tract 82	0
Tract 86 03 (BG 1 only)	602
Tract 87.01	7,598
Tract 87.02	4,161
Tract 87.98 (all except BG 9)	3,645
Tract 88	6,172
Tract 89 01	8,064
Tract 89 04	5,183
Tract 89 05	7,561
Tract 89 06	4,025
Tract 89 07	4,560
Tract 89 08	6,688
Tract 89.09	3,779
Tract 89.10	10,444
Tract 89.11	11,893
Tract 89.12	2,193
Wahiawa Division (1)	43,886
DIFFERENCE	0

NOTE: (1) Comprised of Tracts 90, 91, 92, 93, 94, 95.01, 95 02, 95 03, 95 04, and 95.05

SOURCES: U.S. Bureau of the Census, 1992.
Steve Young, City & County Planning Department ('Ewa DP — 2/13/92, Central DP — 8/8/94).

Appendix A
7. DEMOGRAPHIC CHARACTERISTICS, SELECTED `EWA AREAS, 1990

	Honolulu County	Barber's Point	`Ewa Beach	`Ewa Villages	Makakilo	`Ewa Gentry
POPULATION	836,231	2,218	14,315	3,780	9,828	1,992
ETHNICITY						
Caucasian	32%	76%	23%	8%	47%	31%
Japanese	23%	1%	9%	14%	10%	18%
Filipino	14%	6%	39%	67%	18%	28%
Hawaiian	11%	1%	17%	5%	13%	7%
Other	20%	15%	12%	5%	14%	15%
AGE						
Less than 5 years	7%	19%	7%	7%	8%	10%
5 to 17 years	17%	10%	23%	21%	19%	15%
18 to 34 years	31%	61%	30%	27%	34%	46%
35 to 64 years	34%	8%	33%	30%	36%	27%
65 or more years	11%	0%	7%	15%	3%	3%
Median age (years)	32.2	24.7	28.8	32.4	29.8	28.4
EDUCATION OF PERSONS AGED 25 & OVER (1)						
High School Diploma (2)	81%	90%	71%	55%	90%	88%
College Degree (3)	33%	15%	17%	12%	37%	37%
PERSONS AGED 5 & OVER WHO SPEAK A LANGUAGE OTHER THAN ENGLISH AT HOME (1)	26%	15%	29%	46%	16%	24%
PERSONS WITH MOBILITY OR SELF-CARE LIMITATIONS (1)						
% of persons aged 18 to 64	4%	2%	6%	4%	5%	3%
% of persons aged 65 or more	18%	0%	18%	22%	15%	0%

NOTES
(1) Based on 15% sample; hence, figures represent estimates only
(2) All persons with a high school diploma, including those with college education
(3) Includes Associate, Bachelor's, and graduate degrees

SOURCES U.S. Bureau of the Census, 1992, 1991

Appendix A
8. GEOGRAPHIC MOBILITY, SELECTED `EWA AREAS, 1990 (1)

	Honolulu County	Barber's Point	`Ewa Beach	`Ewa Villages	Makakilo	`Ewa Gentry
PERSONS (2)						
PLACE OF BIRTH						
Born in Hawaii	54%	13%	63%	62%	45%	52%
Other U.S.-born (3)	30%	78%	18%	5%	43%	31%
Foreign-born	16%	9%	20%	33%	12%	17%
RESIDENCE 5 YEARS PREVIOUS FOR PERSONS AGED 5 & OVER						
Same house	50%	2%	61%	43%	47%	2%
Same county, different house	26%	5%	29%	50%	29%	78%
Same state, different county	1%	0%	1%	1%	1%	2%
Different state	17%	79%	6%	3%	25%	16%
Lived abroad	6%	14%	3%	4%	8%	3%
HOUSEHOLDERS (2)						
WHEN HOUSEHOLDER MOVED INTO UNIT						
In the last 5 years	53%	99%	39%	56%	64%	100%
6 to 20 years ago	29%	1%	49%	23%	26%	0%
21 to 30 years ago	10%	0%	8%	3%	10%	0%
31 years ago or more	8%	0%	3%	18%	0%	0%

NOTES:
(1) Based on 15% sample; hence, figures represent estimates only
(2) Base figures used in calculating these data may be different than in 100% count
(3) Includes persons born in U.S. territories, and persons born abroad or at sea to American parents

SOURCE: U.S. Bureau of the Census, 1992

Appendix A
9. HOUSING CHARACTERISTICS, SELECTED 'EWA AREAS, 1990

	Honolulu County	Barber's Point	'Ewa Beach	'Ewa Villages	Makakilo	'Ewa Gentry
HOUSING UNITS	281,683	866	3,426	939	3,050	752
TOTAL VACANT UNITS	6%	1%	2%	4%	2%	6%
Seasonal/recreational	2%	0%	0%	0%	0%	0%
AGE OF STRUCTURE (1)						
1 year	2%	1%	1%	5%	1%	71%
2 to 10 to years	14%	1%	7%	43%	28%	29%
11 to 20 years	30%	5%	41%	1%	44%	0%
21 years or more	54%	93%	52%	51%	27%	0%
UNITS IN STRUCTURE						
1 unit	55%	49%	86%	95%	79%	50%
2 to 4 units	7%	19%	4%	2%	7%	5%
5 or more units	36%	30%	9%	1%	13%	44%
Trailer, other	1%	2%	1%	3%	1%	1%
NOT COMPLETE PLUMBING (1)	1%	0%	1%	0%	0%	0%
HOUSEHOLDS	265,304	854	3,355	902	2,978	708
HOUSEHOLD TYPE						
1 or more non-relatives	12%	2%	15%	8%	16%	17%
No non-relatives	88%	98%	85%	92%	84%	83%
TENURE						
Owner-occupied	52%	0%	69%	66%	74%	80%
Renter-occupied	48%	100%	31%	34%	26%	20%
PERSONS PER HOUSEHOLD	3 02	2 52	4 26	4.19	3 30	2 81
CROWDED HOUSEHOLDS						
Mildly crowded (2)	8%	4%	17%	21%	7%	10%
Very crowded (3)	8%	1%	15%	21%	5%	7%
MEDIAN VALUE (4)	$283,800	$275,000	$218,900	$118,500	$248,600	$277,600

NOTES
(1) Based on 15% sample, hence, figures represent estimates only
(2) Indicated by households with 1 00 to 1 50 persons per room
(3) Indicated by households with 1 51 or more persons per room
(4) For owner-occupied, non-condominium housing units

SOURCES U S Bureau of the Census, 1992, 1991.

Appendix A
10. INCOME CHARACTERISTICS, SELECTED 'EWA AREAS, 1990 (1)

	Honolulu County	Barber's Point	'Ewa Beach	'Ewa Villages	Makakilo	'Ewa Gentry
HOUSEHOLDS (2)						
INCOME LEVEL						
Lowest (3)	13%	14%	11%	13%	3%	5%
Highest (4)	17%	1%	16%	8%	20%	8%
Median Income (5)	$40,581	$23,908	$45,184	$40,924	$50,284	$45,824
Interquartile Range (6)	$43,154	$13,490	$37,672	$37,023	$34,317	$33,156
WITH SELECTED INCOME SOURCES						
Social Security Income	24%	3%	23%	47%	10%	7%
Retirement Income	20%	3%	28%	32%	17%	8%
Public Assistance Income	6%	1%	14%	5%	3%	3%
OWNER HOUSING COSTS (7)						
35% or more of Household Income	15%	N/A	16%	12%	24%	38%
Median Monthly Costs	$1,121	N/A	$910	$710	$1,268	$1,393
RENTER HOUSING COSTS (8)						
35% or more of Household Income	34%	15%	31%	5%	46%	78%
Median Gross Rent	$683	$664	$755	$127	$971	$923
Median Contract Rent (9)	$615	$644	$701	$99	$960	$907
POPULATION (2)						
PERSONS BELOW POVERTY LEVEL	7%	1%	7%	1%	3%	6%
% of persons aged 18 to 64	6%	1%	6%	1%	3%	4%
% of persons aged 65 or more	8%	0%	4%	3%	4%	0%
% of related children aged less than 18	10%	2%	7%	1%	4%	8%
% of unrelated individuals	19%	0%	29%	20%	6%	8%

NOTES
(1) Based on 15% sample (except "Median Contract Rent"), hence, figures represent estimates only
(2) Base figures used in calculating this data may be different than in 100% count
(3) Incomes of less than $15,000 (based on lowest 14 8% of incomes statewide)
(4) Incomes of $75 000 or more (based on highest 15 6% of incomes statewide)
(5) In 1989 dollars
(6) A smaller range means less difference between rich and poor, while a larger range means a greater difference between nc
(7) Owner costs include (but are not limited to) mortgage, real property tax, property insurance, utilities, and fuels
(8) Renter costs include (but are not limited to) rent, utilities, and fuels
(9) Monthly cash rent only Does not include other costs

SOURCES U S Bureau of the Census, 1992, 1991

Appendix A
11. LABOR FORCE CHARACTERISTICS, SELECTED 'EWA AREAS, 1990 (1)

	Honolulu County	Barbor's Point	'Ewa Beach	'Ewa Villages	Makakilo	'Ewa Gentry
POPULATION AGED 16 & OVER	651,920	1,681	10,499	2,855	7,296	1,634
In Armed Forces	8%	52%	3%	1%	13%	12%
POTENTIAL CIVILIAN LABOR FORCE	598,371	802	10,221	2,831	6,306	1,443
In Civilian Labor Force	69%	73%	70%	67%	76%	87%
CIVILIAN LABOR FORCE	410,023	589	7,129	1,899	4,768	1,255
MALE						
Labor force participation (2)	75%	82%	76%	72%	84%	94%
Unemployed	4%	21%	6%	5%	5%	1%
FEMALE						
Labor force participation (2)	63%	71%	63%	62%	67%	81%
Unemployed	3%	21%	4%	5%	4%	1%
EMPLOYED CIVILIAN LABOR FORCE	395,811	466	6,773	1,608	4,541	1,243
BY SELECTED INDUSTRY						
Agriculture, forestry, fisheries, mining	2%	1%	1%	11%	1%	0%
Construction	7%	9%	8%	6%	8%	7%
Manufacturing	6%	3%	8%	13%	9%	10%
Transportation	7%	4%	7%	7%	8%	7%
Retail trade	19%	29%	24%	20%	16%	16%
Finance, insurance, real estate	8%	7%	7%	5%	6%	11%
Personal, entertainment, recreation	8%	4%	7%	8%	4%	7%
Health, education, professional	22%	20%	15%	10%	20%	16%
Public administration	9%	19%	7%	9%	15%	15%
BY OCCUPATION						
Managerial, professional	28%	15%	12%	9%	26%	26%
Technical, sales, support	35%	39%	34%	27%	36%	36%
Service	17%	28%	22%	20%	13%	14%
Farming, forestry, fishing	2%	0%	1%	8%	1%	0%
Precision, craft, repair	10%	13%	14%	13%	13%	11%
Operators, cleaners, laborers	9%	5%	17%	23%	10%	12%
COMMUTE TO WORK						
More than 45 minutes	18%	5%	31%	22%	19%	30%
Mean travel time (minutes)	25	13	34	29	29	33

NOTES (1) Based on 15% sample, hence, figures represent estimates only.
(2) Calculated by dividing "Civilian Labor Force" by "Potential Civilian Labor Force"

SOURCE U S Bureau of the Census, 1992

Exhibit B

SPORTS COMPLEX
Mainland Case Studies

APPENDIX B:
CASE STUDIES ON THE US MAINLAND

Key sources of information used in this report include the following sports complexes. In this appendix, facilities, operational economics, and some of the history that shapes operational arrangements are detailed. Specific cost and revenue information used to model costs and revenues for the East Kapolei Sports Complex was largely gathered from the cases listed here.

FLORIDA

Osceola County Stadium and Sports Complex. This stadium is located in Kissimmee. It is owned and operated by the County of Osceola. In addition to the stadium, there are clubhouse facilities and concessions. The stadium was built in 1985 and can accommodate 5,130 spectators in the stadium. Besides the main stadium field, there are also four practice fields.

Osceola Country Stadium is home to the spring training camp of the Houston Astros, who use the facility from mid-February through the end of March. The Kissimmee Cobras, a Florida State Class A minor league teams use the facilities from April through August. In addition to these uses, the complex is home to professional Fantasy Camps, baseball clinics, umpire schools, college baseball tournaments, and television commercial shoots. Indoor meeting room facilities are also available for off-field activities.

Operations of the Stadium and Sports Complex generate revenues of approximately $600,000. Operating expenses total nearly $1.6 million, annually.

Thomas J. White Stadium, Port St. Lucie Florida. The Thomas J. White Stadium is a county-operated facility. This 20-year old facility is the spring training home for the New York Mets. It can accommodate nearly 9,000 spectators, 7,800 stadium seating and approximately 1,500 bleacher seating. There are five fields and a practice infield. The New York Mets use the facility for approximately six weeks for spring training, February 15 - March 31. The St. Lucie Mets, a Florida Class A minor league team, uses the stadium for its home games from April to September.

During off-times, the facility is also used for activities such as concerts, festivals, exhibitions and religious gatherings. Generally, non-baseball activities are confined to the 600 paved parking lot area.

Stadium operations generate approximately $720,000 in revenues. Annual operating expenses total approximately $1.2 million. The stadium was built within a planned community. The developer of that community, Thomas J. White, build

the stadium using the tourism development tax. Part of the agreement between the county and developer is that the developer will make up the shortfall between revenues and expenditures. This agreement will expire around the year 2003, after which the County retains the facility free and clear.

The relationship with the New York Mets has been for many years somewhat adversarial. They have generally been able to dictate to the County what will take place on the field. Furthermore, it appears that provisions of the County's contract with the Mets have not been enforced over the years. The Mets reportedly stay beyond their time and actually rent out the fields to other minor leagues. This has meant that the County has foregone some revenue. The Stadium is generally recognized as a "white elephant" in the community. With a new County administration, efforts are being made to rebuild the image of the stadium and the relationship with the club. While the General Manager of the stadium feels that he could generate enough other uses of the stadium if the Mets weren't there, there is a "glamour" in having the Mets and they do want to keep the club there and are currently undertaking some upgrading of the facility.

Roger Dean Stadium. This newly build facility is located in Jupiter, Florida. The 1998 Spring Training season will be its first season. The Roger Dean Stadium will play host to spring training for two major league clubs — the Montreal Expos and the St. Louis Cardinals. (Similarly, the new Peoria Sports Complex near Phoenix hosts both the Padres and the Mariners.) The stadium is part of an 110-acre complex which includes the main stadium, 12 practice fields, and two club houses, one for each team. The main stadium can seat 7,000. There are six sky boxes, two of which are controlled by the clubs. The other four are available for corporate sales. Spring training for the two major league teams extends from mid-February to the end of March. The Jupiter Hammerheads, a Florida State Class A minor league team affiliated with the Montreal Expos, play approximately 70 games at the stadium beginning in April.

The stadium was built by the County but with the understanding that ongoing operations and maintenance would be borne by the two teams. The teams have created a joint venture which will operate and maintain the facility.

The county is entitled to use the facility for 12 days during the year, bearing costs associated with such use. The facility is open to the community so long as it doesn't affect the general purpose for which it was built — spring training. Four of the twelve practice fields are also available to the County athletic association for ten months of the year (e.g., Little League). The costs to the community would be only for the upkeep of the fields.

Because this will be the first spring training season for the Roger Dean Stadium, there is no history of revenues derived from operations. The General Manager was very optimistic, expecting that the stadium would be sold out during the spring training camp. He expects the costs associated with operating the Stadium will be approximately $1.3 million annually.

ARIZONA

Phoenix Municipal Stadium and Papago Baseball Facility. The stadium has nearly 8,000 fixed seats. Built in the 1960s, the stadium is one of the oldest in the Cactus League. However, the nearby four-field practice facility is only three years old. The Oakland A's play at Phoenix Municipal during spring training. The field does not have a minor league tenant.

The complex generates annual revenues of about $550,000. Annual operating costs come to $1.2 million.

Tempe Diablo Stadium. The California Angels play in Tempe during spring training. The stadium seats 9,785. One of the older stadiums in the area, Tempe had $5.5 million in renovation costs in 1993. Tempe also has two practice fields, two practice infields, and five soccer fields. Revenues from tickets and concessions are split by the Angels and the municipal stadium operator. Parking revenues are split by the Angels and a booster organization, the Diablos. Stadium costs are paid out of several different municipal accounts. Spring training revenues for the city amount to about $200,000.

HoHoKam Park. The Chicago Cubs have been training in Mesa for over forty years. Over time, they have attracted the largest attendance in the Cactus League, averaging 10,000 spectators per game. The new HoHoKam Park, built on the site of the old venue, has 8,000 fixed seats, 2,000 bleacher seats, and space for an additional 2,500 on a grassy berm around the field. Construction costs for the stadium and a four-field training facility amounted to some $28 million, of which a state tax on rental cars has covered two thirds, and the City of Mesa and its Convention and Visitors Bureau have paid the remainder.

The Cubs do not pay a spring training rent. The city of Mesa gains a share of ticket and concession revenues The HoHoKam booster group, that originally attracted the Cubs and was instrumental in the decision to replace the old facility, also takes a share. The amount of operating costs is a matter of dispute in Mesa, with estimates of the city's costs ranging widely.

APPENDIX C

Key Informant Interviews

Appendix C: Key Informant Interviews

Name	Affiliations
Arasaki, Jayne	Director, Seagull School at Kapolei Resident, Kapolei
Atchinson, John	Board Member, Villages of Kapolei Association
Buckley, Brent	Member, Makakilo/Kapolei/Honokai Hale Neighborhood Board
Guynes, Scott	Kapolei resident; member Hope Chapel Resident, Villages of Kapolei
Hee, Daven	Pastor, Hope Chapel Kapolei Resident, Villages of Kapolei
Honold, John	Pastor, Hope Chapel Kapolei Resident, Villages of Kapolei
Burke, James	Member, Makakilo/Kapolei/Honokai Hale Neighborhood Board Chairman, St. Jude Roman Catholic Church Parish Council
Clark, Kauila	Member, Makakilo/Kapolei/Honokai Hale Neighborhood Board President, West Oahu Development Corporation Chairman, Wai'anae Coast Comprehensive Health Center Chairman, Kapolei Elementary SCBM Task Force Member, Kapolei Middle School Board Member, School to Work Opportunities Consortium, Leeward District Resident, Makakilo
Delahanty, Kathleen	Director, Community Relations, Kahi Mohala
Donlin, Obed	Assistant Regional Commissioner, AYSO Resident, Villages of Kapolei
Ebel, Alfred	Pastor, Messiah Lutheran Church and School Resident, 'Ewa Beach
Eng, Henry	Manager, Land Planning, The Estate of James Campbell
Espero, Willie	Member, 'Ewa Neighborhood Board Resident, 'Ewa Beach
Gaynor, Vicki	Manager, Community and Government Affairs, 'Ewa Marina Project, HASEKO ('Ewa), Inc.

Name	Affiliations
Hill, Chuck	Manager, Commercial and Office Properties, The Estate of James Campbell
Iwamasa, Merle	Principal, Ilima Intermediate School
Kaopua, Nani	Officer, Juvenile Services Division, Honolulu Police Department Site Coordinator, AKAMAI Youth Project, 'Ewa
Kushima, Lezley	President, Villages of Kapolei Community Association
Ledward, Arthur	Lieutenant, Juvenile Services Division, Honolulu Police Department Director, AKAMAI Youth Project
Lee, Andrew	Architect Developer, Kapolei Park Square
Lehner, Jan	Resident, Villages of Kapolei
Moses, Mark	Member, Hawaii State House of Representatives Member, 'Ewa Development Plan Task Force Ex-member, Makakilo, Kapolei, Honokai Hale Neighborhood Board Member, Kapolei Middle School Planning Group Resident, Makakilo
Musto, J.N.	Executive Director, University of Hawaii Professional Assembly
Nakamoto, Irene	Principal, 'Ewa Elementary School Board Member, Friends for 'Ewa
Nicolai, Wouder	Manger, Agricultural and Natural Resources, The Estate of James Campbell
Niino, Eleanor	Resident, Fernandez Village Member, 'Ewa Community Association Member, 'Ewa Task Force
Parker, David	Pastor, Friendship Bible Church and School Resident, 'Ewa Villages
Perry, Stanley	Resident, Tenney Village President, Old 'Ewa Community Association
Ramos, Rodolpho	President, 'Ewa Villages Community Association Resident, 'Ewa Villages

NAME	AFFILIATIONS
Rivero, Frances	Director, Boys & Girls Club, 'Ewa Beach
Singlehurst, Robert	Vice President, Quarry Operations, Grace Pacific Corporation
Timson, Maeda	Chair, Makakilo/Kapolei/Honokai Hale Neighborhood Board Commissioner, Barbers Point NAS Redevelopment Commission Resident, Makakilo
Tokuhara, Jacque	Resident, Villages of Kapolei Member, Hope Chapel Kapolei
Vincent, Kerri	Resident, Villages of Kapolei Member, Hope Chapel Kapolei
Wegesend, Warren	General Manager, Villages of Kapolei Association
Wickramatna, Ray	Resident, Makakilo Community Relations Representative, Makakilo Community Association Member, Makakilo Elementary School PTA President, Senior Citizens, District 3
Young, Darrell	Member, 'Ewa Neighborhood Board Treasurer, 'Ewa Beach Community Association Resident, 'Ewa by Gentry
Yu, Robert	Vice President, West Loch Estates Community Association Resident, West Loch

NOTE: Affiliations are listed to indicate the range of community groups and networks which the interview process tried to reach. Interviewees were asked about opinions in the community, not to speak on behalf of organizations. No claim is made that the groups and organizations mentioned above take any position with regard to the project.

APPENDIX D

Community Interview Guide and Handout

APPENDIX E: KEY INFORMANT ISSUES AND CONCERNS

Issue/Concern	Comment
Traffic	Concerned that increase in resident population will aggravate existing traffic congestion
Inadequate facilities	
Parks	Parks need to have recreational facilities and should be built early on in the development. Concern regarding who would be maintaining the parks.
Schools	Will over-tax existing schools if those planned for the project site are not built in a timely fashion.
Land for churches	No land has been provided on which community religious organizations could establish their churches.
Waste Treatment	Concerned whether the Honouliuli treatment plant has the capacity to handle the project.
Community character	The proposed project will reinforce the evolving bedroom character of 'Ewa. Concern for the effect the development might have on agriculture.
Housing in general	Questioned the necessity of new housing in light of existing conditions.
Employment	Concerned that more housing was preceding the creation of new jobs.

APPENDIX E

Key Informant Issues and Concerns

APPENDIX F

References

REFERENCES

Arnett, P. "'Boys of Winter' won't play in Hawai'i." *Honolulu Star Bulletin*, February 7, 1998, p. A1.

Bakutis, B. "Panel supports ballpark plan." *The Honolulu Advertiser*, July 21, 1997, p. B3.

City and County of Honolulu Office of Information and Complaint, *Departmental and Agency Reports of the City and County of Honolulu, For Fiscal Year July 1, 1995 - June 30, 1996*, Honolulu, 1996.

City and County of Honolulu, Planning Department. *Forecast of Population, Housing and Employment on O'ahu by Small Area 1990 - 2010.* Honolulu, 1993.

City and County of Honolulu, Planning Department. Unpublished forecast of population, housing and employment on O'ahu by small area 1990 - 2020. Honolulu, 1997.

Community Resources, Inc. and Datametric Research. *Survey of Employee Characteristics and Housing Patterns: Westin Mauna Kea and Mauna Lani Resort.* Prepared for Mauna Kea Properties and Mauna Lani Resort, Inc. Honolulu, HI, 1987a.

Community Resources, Inc. *Description of Micro-Computer Models for Determining Socio-Economic Impacts of West Hawai'i Resort Development.* Prepared for Mauna Kea Properties, Ritz-Carlton Hotels, and Mauna Lani Resort, Inc. Honolulu, HI, 1987b.

Decision Analysts Hawai'i, Inc. *Cost to Government of Supporting New Development in 'Ewa and Central O'ahu.* Prepared for The Land Use Research Foundation. Honolulu, 1995.

Dingeman, Robbie. "Group proposes theme park for 'Ewa. *The Honolulu Advertiser*, May 1, 1997, p. B-1

Don Smith Consultants, Inc. *A Long-Term Sports Development Program for the State of Hawai'i.* Prepared for The Chamber of Commerce of Hawai'i, Hawai'i International Sports Foundation, and Hawai'i Visitors Bureau. New York, NY, 1989.

Gould Evans Architects, P.A. *Minor League Facility Survey*. Prepared for Honolulu Sharks. Lawrence, KS., 1993.

Hawai'i State Department of Business and Economic Development. "Economic Trends and Outlook." Statement of Pearl Imada Iboshi, Economic Research Administrator, before the House Committee on Finance, January, 1998.

Hawai'i State Department of Business and Economic Development. *Population and Economic Projections for the State of Hawai'i to 2020 (DBEDT 2020 Series)*. Honolulu, HI, 1997.

Hawai'i State Department of Business, Economic Development and Tourism. *Hawai'i Sports Economic Impact Report: Fiscal Year 1990-1991*. Honolulu, HI, 1991

Hawaii State Department of Business, Economic Development, and Tourism. *The State of Hawaii Data Book, 1996*. Tables available over Internet from http://www.hawaii.gov/dbedt. Honolulu, 1997.

Hawaii State Department of Business, Economic Development, and Tourism. *The State of Hawaii Data Book, 1995*. Honolulu, HI, 1996.

Hawaii State Department of Business, Economic Development, and Tourism, *The 1992 Hawaii State Input-Output* Study (Preliminary Report). Honolulu, HI, 1997.

Hawaii State Department of Education, *Enrollment Projections of the Public Schools in Hawaii, 1995-2000*, Honolulu, 1995.

Hawai'i State Department of Labor and Industrial Relations. *1996 Employment and Payrolls in Hawai'i*. Honolulu, HI, 1997.

Hawai'i State Department of Taxation. *Hawai'i Income Patterns, Corporations - 1989*. Honolulu, HI, 1991.

Helber Hastert & Fee, Planners, *Naval Air Station Barbers Point, Community Redevelopment Plan*. Honolulu, HI, 1997.

Hill and Knowlton. *A Sports Plan for Hawai'i: 1992 and Beyond*. Prepared for the Hawai'i State Department of Business, Economic Development and Tourism. Honolulu, HI, 1991.

Kosaki, Keith. "Asia ball clubs being sought," *The Honolulu Advertiser*. Honolulu, HI, September 1, 1997, p. B-1.

KPMG Peat Marwick. *Assessment for a Hawai'i Sports Authority: Interim Report. Prepared for Office of State Planning*. 2 vol. Honolulu, HI, 1991.

Mitsunaga and Associates, Inc. *Kapolei Sports and Recreation Center: Alternative Sites Analysis*. Prepared for Hawai'i State Department of Accounting and General Services. Honolulu, HI, 1990.

Mitsunaga and Associates, Inc. *Kapolei Sports Complex: Final Environmental Impact Statement*. Prepared for Hawai'i State Department of Accounting and General Services. Honolulu, HI, 1992.

PMG Associates, Inc. *Economic Impact of Major League Baseball, Palm Beach County*. Palm Beach, FL, 1993.

Sports Management Research Institute. *1996 Montreal Expos Spring Training Marketing Survey Results*. Prepared for Montreal Expos. Miami, FL, 1996.

The Prudential Locations, Inc. *East Kapolei Market Study, March 14, 1997*. Honolulu,, 1997.

United States Department of Commerce, Bureau of the Census. *1990 Census of Population and Housing, Summary Tape File 3-A: Alaska, Hawai'i, Oregon. CD90-3A-02*. Washington, D.C., 1992.

United States Department of Commerce, Bureau of the Census. *1990 Census of Population and Housing, Summary Tape File 1-A: Pacific Division, Vol. I. CD90-1A-9-1*. Washington, D.C., 1991.

Urban Institute, Center for Public Finance and Housing, *Housing Problems and Needs of Native Hawai'ians*. Washington, D.C., 1995.

L. STATE LAND USE COMMISSION BOUNDARY INTERPRETATION

BENJAMIN J. CAYETANO
GOVERNOR

ESTHER UEDA
EXECUTIVE OFFICER

STATE OF HAWAII
DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM
LAND USE COMMISSION
P.O. Box 2359
Honolulu, HI 96804-2359
Telephone: 808-587-3822
Fax: 808-587-3827

NOV 26

November 25, 1997

Mr. David Hulse
PBR Hawaii
Pacific Tower
1001 Bishop Street, Suite 650
Honolulu, Hawai`i 96813-3429

Dear Mr. Hulse:

Subject: BOUNDARY INTERPRETATION No.: 97-35 for Tax Map Key: 9-1-16: 8, 108, 109; 9-1-17: 71, 72, por. 4; 9-1-18: por. 3 & 5, Honouliuli, Ewa, O`ahu

Pursuant to your September 24, 1997, letter requesting a boundary interpretation for the East Kapolei Master Plan Project, please be advised that we have determined an approximate location of the State Land Use Urban / Agricultural District boundary.

It is our understanding that the East Kapolei Mater Plan Project is comprised of the subject tax map key numbers, which are listed on your survey map.

Our determination is based on the Commission's records and official maps currently on file at our office and the map that Al Bumanglag of R.M. Towill Corporation provided for this interpretation.

A copy of the map with an approximate location of the State Land Use Urban / Agricultural District boundary delineated is enclosed for your reference.

If you have any questions, please call Fred Talon or Bert Saruwatari of my staff at 587-3822.

Sincerely,

Bert Saruwatari
for ESTHER UEDA
Executive Officer

EU:rg

encl: Boundary Interpretation Map dated November 25, 1997

cc: Jan Sullivan, C&C of Honolulu DLU Director (w/encl.)
Attn: Carolyn Miyata
Glenn Y. Sato, Tax Maps & Records Supervisor (w/encl.)
C&C of Honolulu, Department of Finance

7. An EA/EIS may not be required for future zone changes within the East Kapolei Master Plan Development Project area provided the specific zone change involves development substantially the same as that covered by the subject Draft EIS. The Draft EIS should be corrected to acknowledge this possibility.

8. The Final EIS should identify all proposed park and open space parcels planned to be dedicated to the City.

9. Page 20 of the Draft EIS mentions that landscaped recreation land will be available to the community. What type of recreation is proposed?

10. A drainage master plan is included in the Draft EIS. The Final EIS should discuss how the Kaloi Gulch watershed will be able to accommodate the increased runoff from the proposed residential community.

Thank you for the opportunity to comment. Should you have any questions, please contact Dana Teramoto of our staff at 523-4648.

Very truly yours,

JAN NAOE SULLIVAN
Director of Land Utilization

JNS:am

cc: Office of Environmental Quality Control
√PBR Hawaii (David Hulse)

g:ppd\ekapolei.djt

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

ROY S. OSHIRO
EXECUTIVE DIRECTOR

IN REPLY REFER TO:
98:DEV/2368

June 30, 1998

The Honorable Jan Naoe Sullivan, Director
Department of Land Utilization
City and County of Honolulu
650 South King Street, 7th Floor
Honolulu, HI 96813

Dear Ms. Sullivan:

SUBJECT: COMMENTS REGARDING HOUSING FINANCE AND DEVELOPMENT CORPORATION (HFDC) EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)

Thank you for your comments of June 23, 1998, regarding the East Kapolei Master Plan Development Project - Draft Environmental Impact Statement. We offer the following response to each of your comments.

1. As you suggested in your comments, we will provide a preliminary proposed zoning map in the Final Environmental Impact Statement (FEIS). However, at this early stage of the entitlement review process, this exhibit will be subject to change. HFDC's tentative schedule is to submit a Change of Zone application for the entire project area soon after the State Land Use Commission acts to reclassify the property from the Agriculture to Urban District.

2. Our purpose in selecting the R-5 Residential zoning was two fold: 1) larger lots are more desirable to consumers from a marketing perspective, and 2) the 5,000 square feet minimum lot size gives the future developers more opportunities to create larger yards and open space areas. No zero lot line subdivisions are planned at this time, however, this decision will be made by the private developer of each large lot development parcel. We note that the minimum lot width and depth for the R-3.5 and R-5 Residential zoning districts are the same. Therefore, we see little advantage in requesting the R-3.5 Residential zoning at this time.

HFDC

3. As you know, the East Kapolei Master Plan only conceptually identifies residential areas, schools, and parks. HFDC intends to impose deed restrictions requiring developers of the large-lot parcels to dedicate school and park sites in accordance with Department of Education requirements. Inasmuch as schools are permitted uses within all zoning districts, the exact location of schools can remain flexible until the optimum site is determined by DOE. During design of the East Kapolei Master Plan, HFDC was discouraged by DOE from establishing joint school and park uses due to potential security concerns. HFDC will continue to consult with the Department of Parks and Recreation to determine the appropriate level of recreational resources for the project.

4. The location of the two commercial areas proposed near the middle of the East Kapolei Master Plan, were determined based vision of the Ewa Development Plan. These commercial nodes will be located within the higher density residential areas near the intersections of 1) Farrington Highway/North-South Road, 2) East-West Road/North-South Road, and 3) Kapolei Parkway/North-South Road. Therefore, we believe that a separate commercial node off the North-South Road near the proposed Intermediate School would not be consistent with the vision of the Ewa Development Plan. As indicated in the DEIS, HFDC is acting as the master developer only and will not be developer of any new commercial projects.

5. We will reference the Public Infrastructure Map for Ewa and discuss its consistency with the East Kapolei Master Plan in the FEIS as recommended in your comments.

6. Thank you for informing us of the zone changes that trigger Chapter 343, HRS. We will revise the FEIS to clarify that zone changes of 25 acres or more do not require an EA with the zone change application. We also wish to emphasize that the DP's definition of "Project Master Plan" means "a conceptual plan that covers all phases of a development project. The project master plan shall be that portion of an EA or EIS which illustrates and describes how the project conforms to the vision for Ewa, and the relevant policies, principles, and guidelines for the site, the surrounding lands, and the region." Therefore, your comment that "the 25-acre milestone is relevant only to whether a project master plan will also be required as part of the EA/EIS" seems to apply to the East Kapolei Master Plan and EIS. We believe that we have provided the Project Master Plan (which is a conceptual plan) in conformance with the Ewa DP definition and prepared an "EIS which illustrates and

describes how the project conforms to the vision for Ewa, and the relevant policies, principles, and guidelines for the site, the surrounding lands, and the region."

7. We agree that "An EA/EIS may not be required for future zone changes within the East Kapolei Master Plan Development Project area provided the specific zone change involves development substantially the same as that covered by the subject DEIS." The FEIS will be revised to acknowledge this interpretation of the Ewa Development Plan requirements.

8. At the present time, the only proposed neighborhood parks and district park would eventually be dedicated to the City in accordance with deed restrictions placed on the sale of the large lots to private developers. This will ensure that all applicable park dedication requirements are satisfied. Private parks and recreation centers will also be developed for the multi-family projects by the private developers.

9. Within the open space areas adjacent to the four major drainage basins, the "landscaped recreation land available to the City" will consist of: 1) walking paths and trails, 2) bike paths, 3) outdoor furniture, and 4) grassed and irrigated lawn areas, all within an extensively landscaped urban park setting.

10. Please review the Drainage Master Plan provided in Appendix B of the DEIS and page 65 which states, "According to the *Ewa Villages Drainage Master Plan*, the Ewa Villages Golf Course is designed to accept the Plate 6 flow of 7,075 cfs from Kaloi Stream at the upper boundary. Due to the increase in watershed area for Kaloi Gulch, by the North-South Road alignment, a larger Plate 6 flow of 7,400 cfs was studied entering the golf course. The study is based on both interim conditions, where the OR&L Railroad bridge is not constructed, and the ultimate conditions, where the bridge is in. It was determined that the golf course can accommodate the increase in flow for both conditions, with an increase in water surface elevation of approximately 0.45-feet."

In addition, Tables 5-1 to 5-5 of the Drainage Report concludes that the amount of runoff volume for the developed condition will actually **decrease** 43 Ac-ft compared to the existing undeveloped condition of the property. Consequently, development of the East Kapolei project will decrease the amount of runoff leaving the property rather than increasing runoff as indicated in your comments.

Once again, thank you for participating in the environmental review process.

Sincerely,

ROY S. OSHIRO
Executive Director

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

KAZU HAYASHIDA
DIRECTOR

DEPUTY DIRECTORS
BRIAN K. MINAAI
GLENN M. OKIMOTO

IN REPLY REFER TO:
STP 8.8684

July 20, 1998

PBR HAWAII
RECEIVED
JUL 23 1998

TO: MR. ROY S. OSHIRO, EXECUTIVE DIRECTOR
HOUSING FINANCE AND DEVELOPMENT CORPORATION

ATTN: MR. STEVE THOMAS

FROM: KAZU HAYASHIDA
DIRECTOR OF TRANSPORTATION

SUBJECT: EAST KAPOLEI MASTER PLAN DRAFT ENVIRONMENTAL IMPACT STATEMENT

Thank you for the opportunity to review your East Kapolei Master Plan Draft Environmental Impact Statement (DEIS).

We have the following comments:

1. Based on the traffic projections contained in the DEIS Traffic Impact Analysis Report, we recommend double left-turn lanes for northbound traffic on North-South Road turning left to East Kapolei Avenue, and double left-turn lanes for eastbound traffic on East Kapolei Avenue turning left to North-South Road.

2. As in other developments in the Ewa region, developers implementing the East Kapolei Master Plan should be required to contribute their fair share of regional highway improvements.

3. We discourage additional access to North-South Road from the East Kapolei project, and recommend that the project be designed accordingly.

c: OEQC
PBR Hawaii

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM
HOUSING AND COMMUNITY DEVELOPMENT CORPORATION OF HAWAII

98:DEV/316

July 24, 1998

TO: The Honorable Kazu Hayashida, Director
Department of Transportation

FROM: Donald K. W. Lau, Executive Director

SUBJECT: Comments Regarding Housing and Community Development Corporation of Hawaii (HCDCH) East Kapolei Master Plan Development Project - Draft Environmental Impact Statement (DEIS)

Thank you for your comments of July 20, 1998 regarding the East Kapolei Master Plan Development Project - Draft Environmental Impact Statement.

We offer the following response to each of your comments:

1. As recommended in your comments, East Kapolei Avenue will be designed to accommodate double left-turn lanes for eastbound traffic turning left to North-South Road. The North-South Road design is currently underway under separate agreements with various consultants.

2. HCDCH will contribute its fair share of regional highway improvements in accordance with fair-share allocations similar to other developments in the Ewa region.

3. We concur that additional access to North-South Road from the East Kapolei project should be discouraged. Consequently, we have designed the East Kapolei project to provide access to North-South Road only at Kapolei Parkway, East Kapolei Avenue, and Farrington Highway.

Once again, thank you for participating in the environmental review process.

PHONE (808) 594-1888

FAX (808) 594-1865

STATE OF HAWAI'I
OFFICE OF HAWAIIAN AFFAIRS
711 KAPI'OLANI BOULEVARD, SUITE 500
HONOLULU, HAWAI'I 96813

RECEIVED
H.F.D.C.
JUN 25 2 04 PM '98

June 17, 1998

Doc. EIS 25

Mr. Steve Thomas
State Housing Finance and Development Corporation
677 Queen Street, Suite 300
Honolulu, HI 96813

Subject: Draft Environmental Impact Statement (DEIS) for East Kapolei Master Plan, Island of Oahu

Dear Mr. Thomas:

Thank you for the opportunity to review the Draft Environmental Impact Statement (DEIS) for East Kapolei Master Plan, Island of Oahu. The applicant, the State Housing Finance and Development Corporation, is proposing the use of 1300 acres of state lands acquired from the Campbell Estate to implement a so-called "East Kapolei Master Plan Development Project". This plan consists of a mixture of residential, commercial, public facility, and open space recreation land uses that will replace existing fallow agricultural lands.

The Office of Hawaiian Affairs (OHA) has serious concerns with the Master Plan and DEIS. First, this development will result in the irreversible loss of prime agricultural lands. This loss of agricultural lands is a major concern of OHA. As unemployment rises, agriculture (specifically diversified agriculture) is a feasible alternative to provide much needed economic relief.

OHA fears that development projects such as the East Kapolei plan will further downsize the land resource base available for agriculture and will ultimately restrict the ability of residents to cope with economic hardship.

Second, OHA is concerned about the Board of Water Supply's request to utilize current agricultural water allocations for urban use. OHA has strong reservations about transfer of water use permits. The Governor has indicated a strong conservation ethic to allow water to be available for diversified agriculture. If state agencies are to follow this guideline, it makes no sense to transfer agricultural rights of water usage to urban residential developments.

Therefore, OHA urges the Commission on Water Resources Management to handle the Board's transfer request as a new application and the allocation be granted based on the merits of the new request. OHA strongly believes that water use permits are nontransferable and once the need for a given water allocation no longer exists, such water use permit becomes invalid.

Third, on the subject of archaeological resources, OHA is concerned about the lack of details on the field inspection undertaken to support the view that no cultural resources exist in the area (See Appendix G). OHA finds the whole section on archaeological resources shallow and lacking substance to dispel the view that the project area is devoid of cultural resources. OHA urges the applicant to undertake a more comprehensive review of cultural resources in the area.

Finally, OHA is disturbed about the lack of specifics in the DEIS on the views of the community, particularly those of the Hawaiian community, toward the proposed development. Nothing indicates in the DEIS whether the proposed development conflicts with Hawaiian traditional and customary access and gathering rights. OHA urges the applicant to seek close consultation with Native Hawaiians as a mechanism to ascertain local perceptions pertaining to East Kapolei.

Please contact Colin Kippen (594-1938), Officer of the Land and Natural Resources Division, or Luis A. Manrique (594-1758), should you have any questions on this matter.

Sincerely yours,

Randall Ogata
Administrator

Colin Kippen
Officer, LNR

cc Board of Trustees

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM
HOUSING AND COMMUNITY DEVELOPMENT CORPORATION OF HAWAII
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

DONALD K.W. LAU
EXECUTIVE DIRECTOR

SHARYN L. MIYASHIRO
EXECUTIVE ASSISTANT

98:DEV/160

July 15, 1998

TO: Randall Ogata, Administrator
Office of Hawaiian Affairs

FROM: Donald K. W. Lau, Executive Director

SUBJECT: **COMMENTS REGARDING HOUSING AND COMMUNITY DEVELOPMENT CORPORATION OF HAWAII (HCDCH) EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)**

Thank you for your comments of June 17, 1998 regarding the East Kapolei Master Plan Development Project - Draft Environmental Impact Statement. We offer the following response to each of your comments:

1. We concur the development of the proposed East Kapolei Master Plan will irretrievably remove agricultural land from potential production. However, we do not agree that the project will create economic hardship. As indicated in the Socio-Economic Impact Assessment (Appendix K), the project will generate approximately 1,250 to 1,375 permanent on-site jobs and 1,100 to 1,250 additional jobs in the Hawaii economy, many of which will be absorbed by the Hawaiian community. We feel this is a significant benefit to all residents of Hawaii especially when compared to the relatively few jobs presently produced by the subject property.

   In addition, agricultural rents are determined by the underlying profitability of farming and market conditions (the demand for farm land versus the supply, competition among farmers and landowners, etc.), and not the future development potential of agricultural land. Also, the City's property assessment for agricultural land that is farmed is based on the relatively low agricultural value of the land-not its much higher market value. Thus, increasing market values of land do not translate into higher property taxes on agricultural land that is farmed.

   We also wish to emphasize that 200 acres of the project area will be developed by the Department of Hawaiian Home Lands for the benefit of their Hawaiian beneficiaries. The Board of Land and Natural Resources has authorized the conveyance of 200 acres of land to the Department of Hawaiian Home Lands within the 1,300 acre project site. We are currently working with the DLNR to convey ownership of the 1,300 acres to HCDCH and subsequent transfer of 200 acres to DHHL. We are still working to achieve the late 1998 transfer; however, this date could potentially be delayed into 1999.

   Funds from the sale of improved development parcels will be partially used to fund development of the University of Hawaii West Oahu Campus mauka of the H-1 Freeway. We believe that this facility will also provide a tremendous new expansion of educational opportunities for DHHL beneficiaries who will reside in the East Kapolei community.

2. We concur that the Commission of Water Resources Management will decide on the appropriate allocation of water for the project.

3. The subject property has been extensively surveyed by previous owners and developers to ascertain the presence of any significant archaeological sites. Consequently, the State Office of Historic Preservation has determined that the proposed project will have no effect on historic sites based on their assessment of historical research, past land uses, and a field survey documenting existing conditions.

4. As you may know, the potential development conflicts with Hawaiian traditional and customary access and gathering rights must be addressed in the reclassification petition that will be submitted to the State Land Use Commission. However, based on our meetings with the community and representatives of DHHL, there have been no indications of any traditional and customary access or gathering rights associated with the property.

Once again, thank you for participating in the environmental review process.

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM
HOUSING AND COMMUNITY DEVELOPMENT CORPORATION OF HAWAII
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

DONALD K.W. LAU
EXECUTIVE DIRECTOR

SHARYN L. MIYASHIRO
EXECUTIVE ASSISTANT

98:DEV/159

July 15, 1998

Mr. Randall K. Fujiki
Director and Building Superintendent
Building Department
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Fujiki:

SUBJECT: COMMENTS REGARDING HOUSING AND COMMUNITY DEVELOPMENT CORPORATION OF HAWAII (HCDCH) EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT - DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)

Thank you for your comments of May 12, 1998 regarding the East Kapolei Master Plan Development Project - Draft Environmental Impact Statement.

We offer the following response to each of your comments:

1. We prefer to leave the statement which indicates that the station will be complete by the year 2000 unchanged since the term "currently" does not specifically indicate the availability of the police station for use. We concur that the new station is under construction at the time of your comments.

2. Thank you for providing the additional information regarding the new city Office Building No. 1. This statement will be included in the Final Environmental Impact Statement.

Once again, thank you for participating in the environmental review process.

Sincerely,

Donald K. W. Lau, Jr.

Donald K. W. Lau
Executive Director

BUILDING DEPARTMENT

CITY AND COUNTY OF HONOLULU

HONOLULU MUNICIPAL BUILDING
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

JEREMY HARRIS
MAYOR

RANDALL K. FUJIKI
DIRECTOR AND BUILDING SUPERINTENDENT

ISIDRO M. BAQUILAR
DEPUTY DIRECTOR AND BUILDING SUPERINTENDENT

RECEIVED
H.F.D.C.

PB 98-280

May 12, 1998

Mr. Steve Thomas
State Housing Finance and Development Corporation
677 Queen Street, Suite 300
Honolulu, Hawaii 96813

Dear Mr. Thomas:

Subject: HFDC East Kapolei Master Plan Development Project
Draft Environmental Impact Statement (DEIS)
TMK: 9-1-16: 8, 108 and 109; 9-1-17: 4, 71
and 9-1-18: 3 and 5
Kapolei, Oahu, Hawaii

This is in response to your request of May 7, 1998 to review and comment on the subject material.

Our comments are as follows:

1) In Paragraph 5.9.2, Police Protection, on Page 70, we recommend that your statement, "The new Regional Kapolei Police Station is currently being designed and will be constructed across the street..." be changed to, "The new Kapolei Police Station serving the Ewa Plains region is currently under construction across the street..."

2) We would also like to point out that the new City Office Building No. 1 is under construction in the joint City and State civic center in Kapolei. The new office building will provide office space for over 400 employees and feature a permitting center, community meeting rooms and satellite city hall in addition to the municipal offices.

Thank you for the opportunity to review and comment on the document.

Should there be any questions, please contact Douglas Collinson at 527-6375.

Very truly yours,

RANDALL K. FUJIKI
Director and Building Superintendent