



EXECUTIVE CHAMBERS

HONOLULU

BENJAMIN J. CAYETANO
GOVERNOR

'98 SEP 22 P1:19

September 23, 1998

TO: The Honorable Donald K. W. Lau, Executive Director
Housing and Community Development Corporation of Hawaii

SUBJECT: Acceptance of the Final Environmental Impact Statement
for the East Kapolei Master Plan

With this memorandum, I accept the Final Environmental Impact Statement for East Kapolei Master Plan, Kapolei, the island of Oahu, as satisfactory fulfillment of the requirements of Chapter 343, Hawaii Revised Statutes. The economic, social and environmental impacts, which will likely occur should this project be implemented, are adequately described in the statement. The analysis, together with the comments made by reviewers, provides useful information to policymakers and the public.

My acceptance of the statement is an affirmation of the adequacy of that statement under the applicable laws but does not constitute an endorsement of the proposed action.

I find that the mitigation measures proposed in the environmental impact statement will minimize the negative impacts of the project. Therefore, if this project is implemented, the Housing and Community Development Corporation of Hawaii and/or its agents should perform these or alternative and at least equally effective mitigation measures at the discretion of the permitting agencies. The mitigation measures identified in the environmental impact statement are listed in the attached document.

BENJAMIN J. CAYETANO

Attachment

c: Honorable Lawrence Miike
Office of Environmental Quality Control

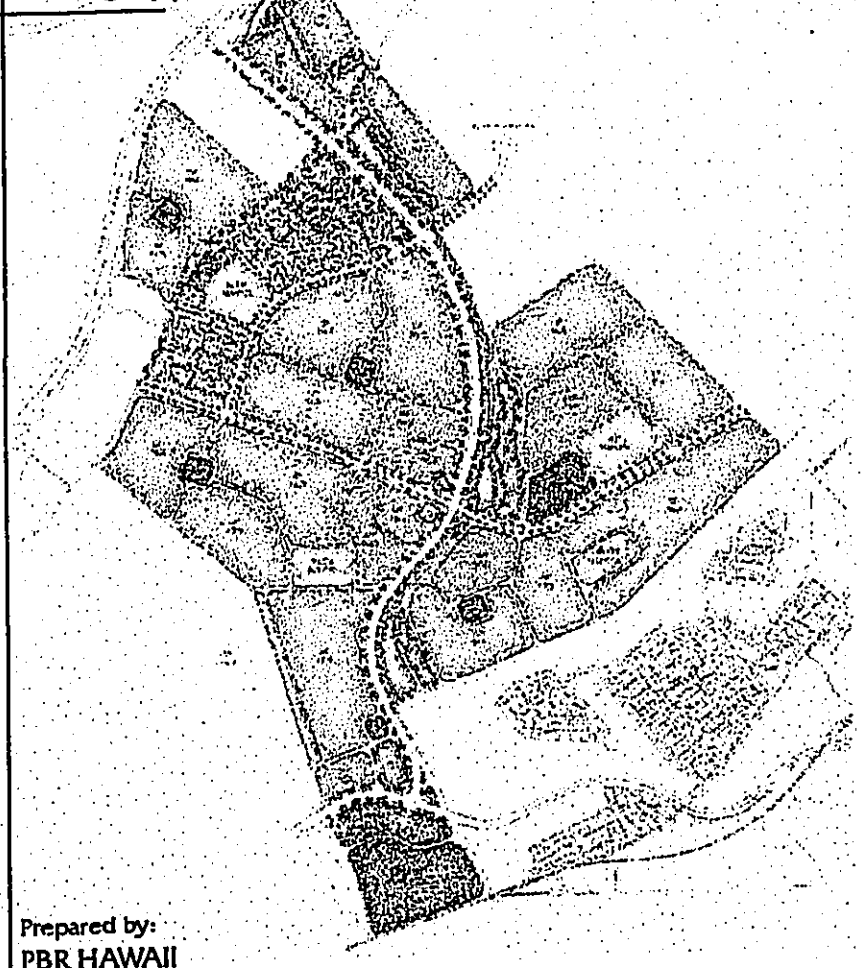
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East Kapolei

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EAST KAPOLEI MASTER PLAN

Final Environmental Impact Statement

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



Prepared by:
PBR HAWAII

July 1998

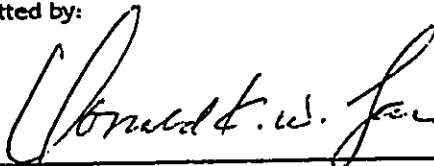


EAST KAPOLEI MASTER PLAN

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

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EXECUTIVE

SUMMARY

HCDCH EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT
FINAL ENVIRONMENTAL IMPACT STATEMENT

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.

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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.

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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.

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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 HFDCHCDCH 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.

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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. HFDCHCDCH 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 HFDCHCDCH. 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.

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FINAL ENVIRONMENTAL IMPACT STATEMENT

UNRESOLVED ISSUES

All of the identified "Unresolved Issues" identified are in the process of being resolved by HFDCH 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 HFDCH revolving funds and issuance of revenue bonds by HFDCH.

HawaiiKapolei 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 HawaiiKapolei 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 andn' 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

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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, 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, 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 District Boundary Amendment	Plant Mitigation Plan HCDCH	Alteration of Waters of the United States State Land Use Commission
US Army Corps of Engineers/State Dept. of Health Change of 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

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INTRODUCTION

HCDCH EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT
FINAL ENVIRONMENTAL IMPACT STATEMENT

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

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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 (HFDGHCDC). A Letter of Authorization from the landowner will be provided in the State Land Use Petition which gives the HFDGHCDC 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:

HCDCH EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT
FINAL ENVIRONMENTAL IMPACT STATEMENT

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.

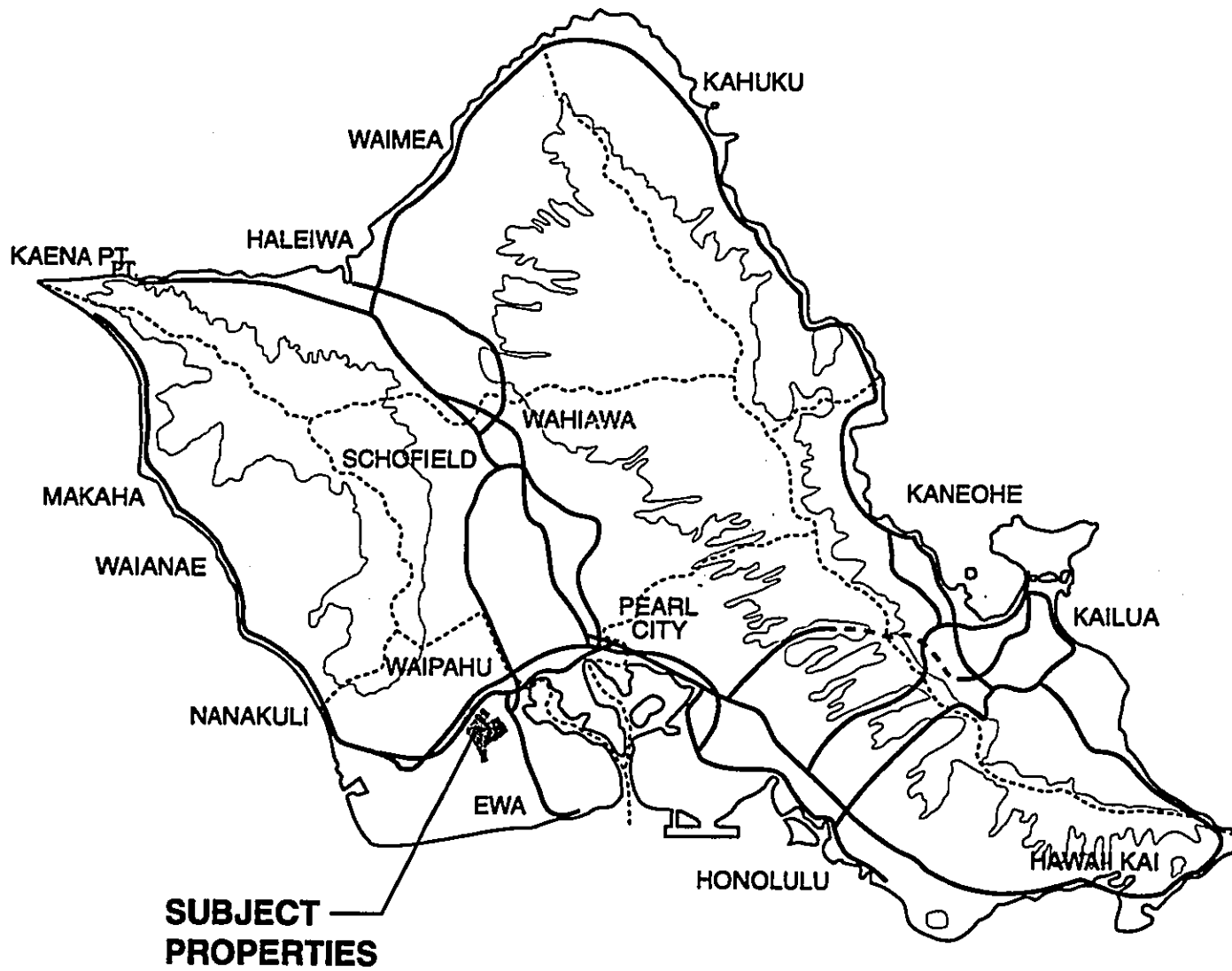
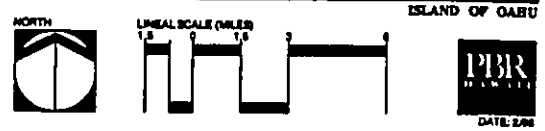


FIGURE 1
 LOCATION MAP
HCDHC EAST KAPOLEI



**HCDCH EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT
FINAL ENVIRONMENTAL IMPACT STATEMENT**

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 melon 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

**HCDCH EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT
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followed 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**).

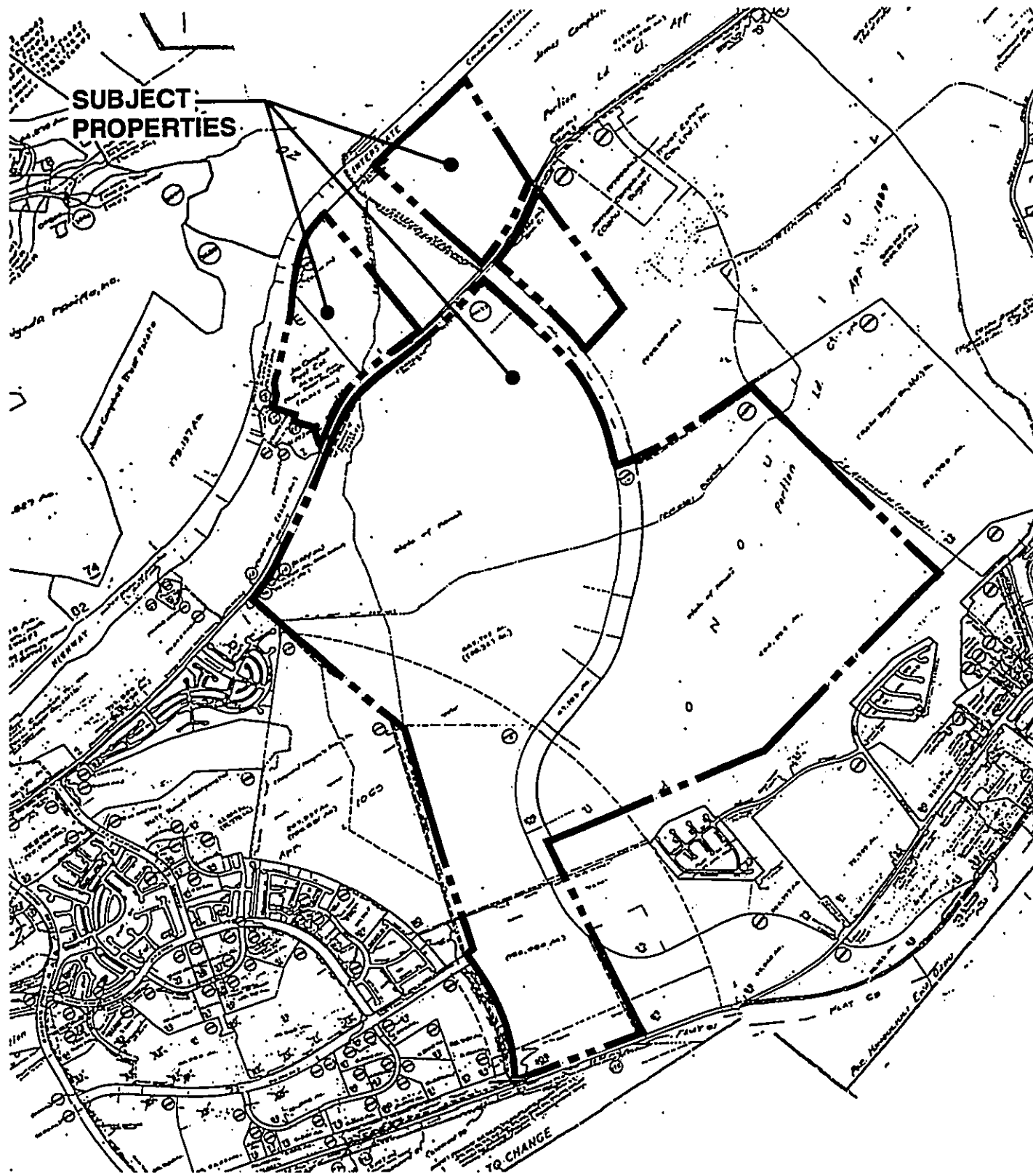


FIGURE 2
 TAX MAP KEY
 HCDCH EAST KAPOLEI

ISLAND OF OAHU

NORTH

LINEAL SCALE (FEET)
 0 500 1000 2000

PBR
 DATE 2/98

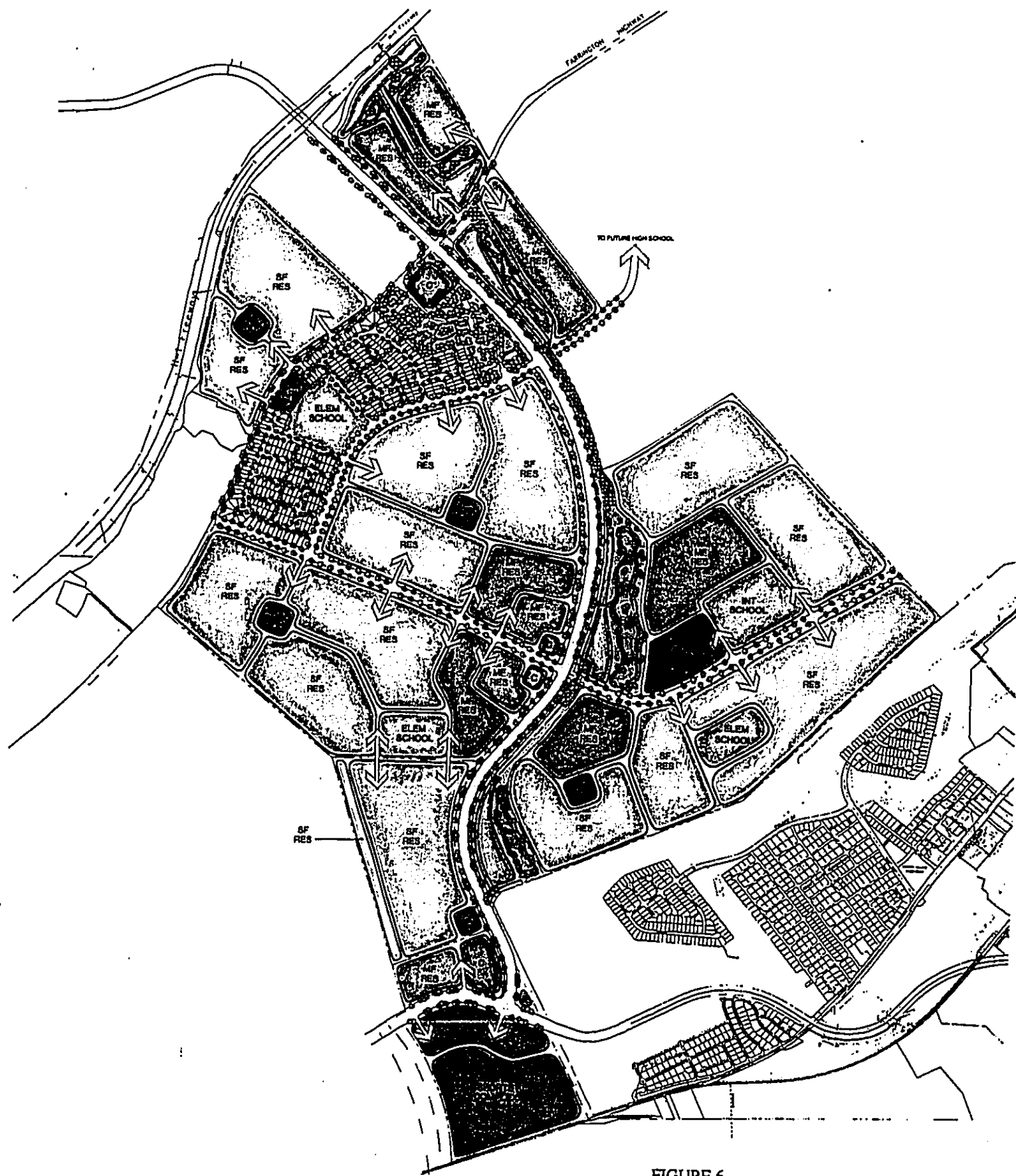


FIGURE 6
 EAST KAPOLEI CONCEPTUAL
 DEVELOPMENT PLAN
HCDCH EAST KAPOLEI

NORTH

ISLAND OF OAHU

LINEAL SCALE (FEET)
 400 0 400 800 1600

February 11, 1988

PBR
 PLANNING & BOUNDARY RESOURCES

DATE: 2/88

2.0

DESCRIPTION OF THE PROJECT

**HCDCH EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT
FINAL ENVIRONMENTAL IMPACT STATEMENT**

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 (HFBDGHCDCH) 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 HFBDGHCDCH to individual developers. None of the proposed land uses (i.e. residential, commercial) will be developed by HFBDGHCDCH. 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 HFBDGHCDCH 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.

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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 HFDGHCDCH were based on more "conservative" assumptions. It was also assumed, after discussion with HFDGHCDCH 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 HFDGHCDCH cash flows is estimated well over \$60 million (with a discount rate of 8 percent). The net present value of HFDGHCDCH 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, HFDGHCDCH 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

**HCDCH EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT
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space, and recreational land uses. A major sports complex is also planned for a 6364.3 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 HFDGHCDCH 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 HFDGHCDCH. 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.

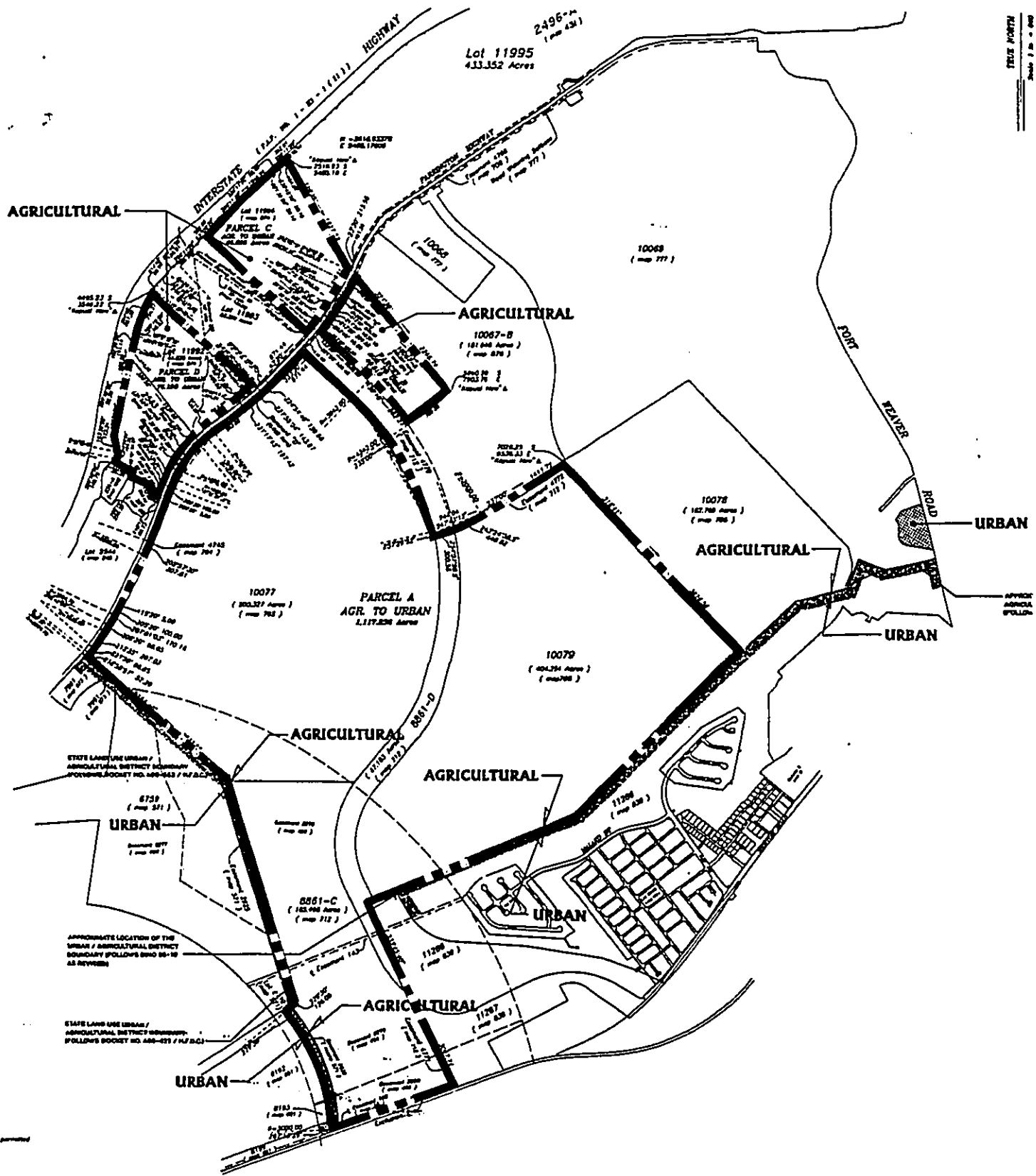


FIGURE 4
EXISTING STATE LAND USE
DISTRICT BOUNDARY INTERPRETATION
HCDCH EAST KAPOLEI

ISLAND OF OAHU

NORTH

LINEAL SCALE (FEET)
 0 1000 2000 4000

PBR

DATE: 2/96

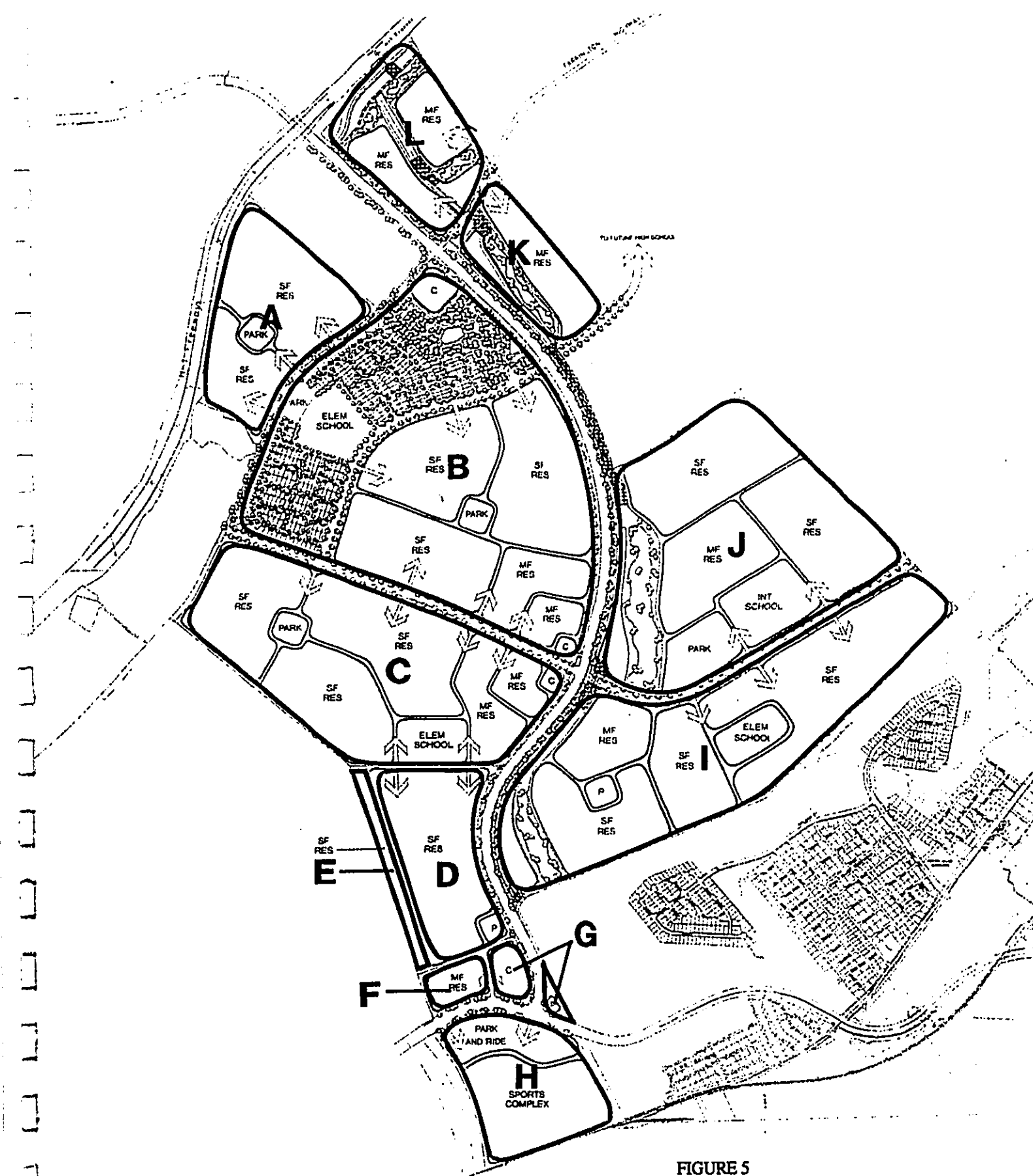


FIGURE 5
 PARCEL IDENTIFICATION MAP
 HCDCH EAST KAPOLEI

ISLAND OF OAHU

NORTH

LINEAL SCALE (FEET)

0 400 800 1200

PBR
 HAWAII
 DATE: 2/98

**HCDCH EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT
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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.

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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 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 the 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 to utilize an internal system of pedestrian walkways and bike facilities to encourage alternative modes of transportation to and from the facility.

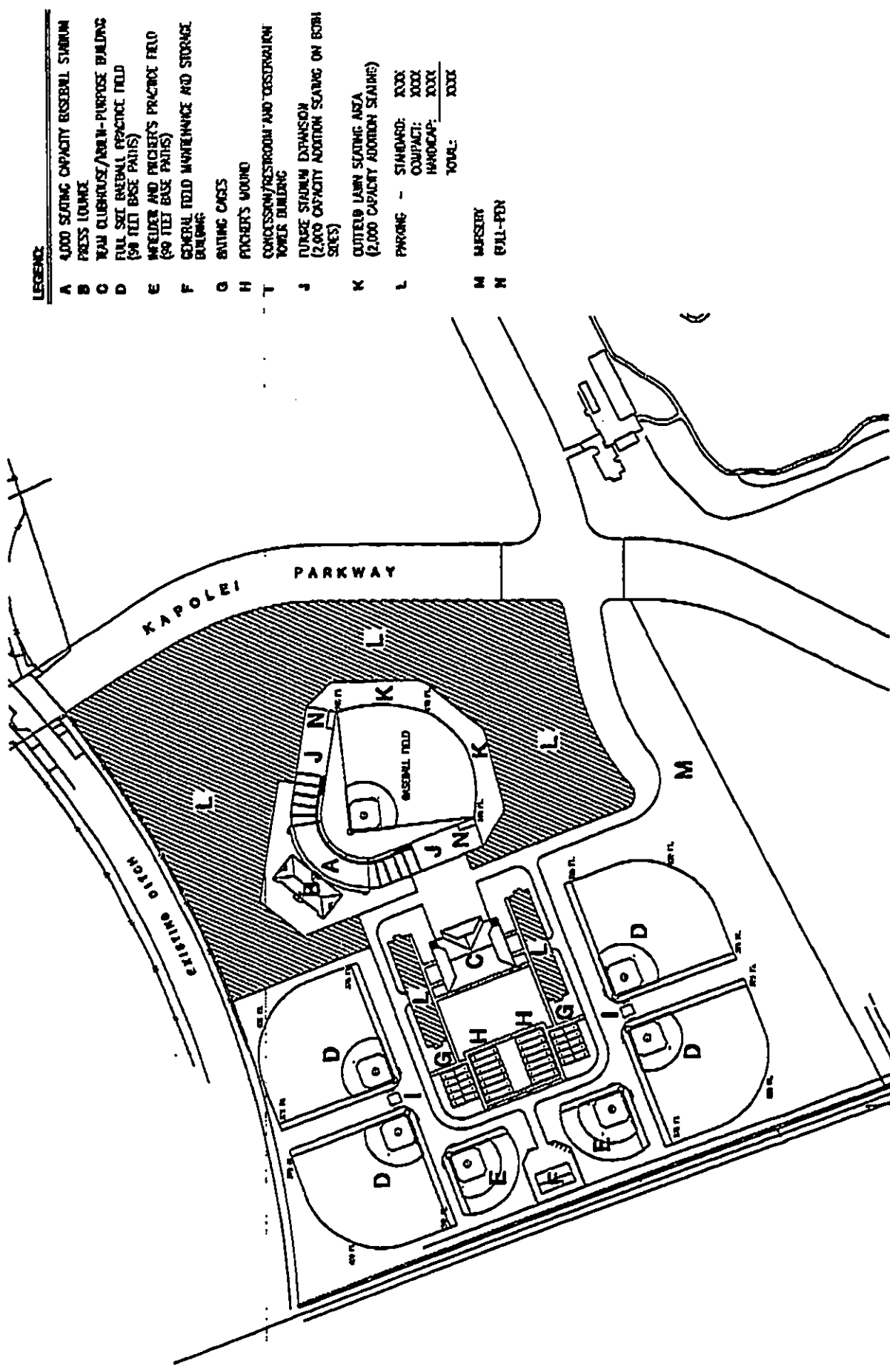
A conceptual layout of the sports complex and park and ride facility has been designed to support up to two professional baseball teams simultaneously. Approximately 2,000 parking stalls would be provided initially. This design was based on discussions with local teams, mainland operators, and international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



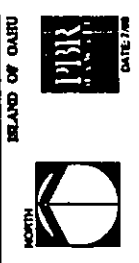
LEGEND:

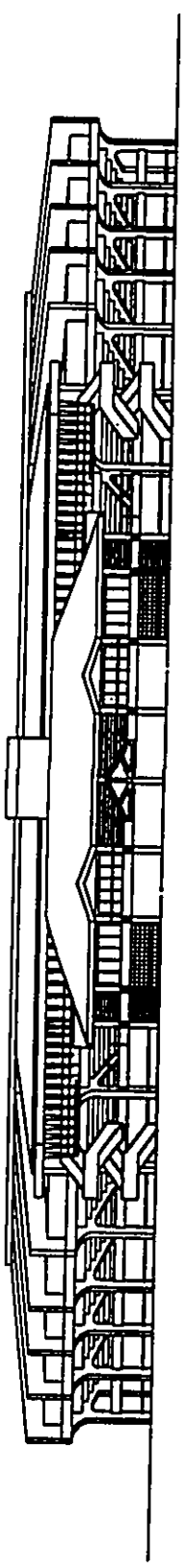
- A 4,000 SEATING CAPACITY BASEBALL STADIUM
- B PRESS LOUNGE
- C TEAM CLUBHOUSE/PURPOSE BUILDING
- D 90 FEET BASE PATHS
- E INFELDER AND PITCHER'S PRACTICE FIELD (90 FEET BASE PATHS)
- F GENERAL FIELD MAINTENANCE AND STORAGE BUILDING
- G BATTING CAGES
- H PITCHER'S MOUND
- I CONCESSION/RESTROOM AND OBSERVATION TOWER BUILDING
- J LOUNGE 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 MESSERY
- N FULL-PEN

ARCHITECTURAL SITE PLAN
MAY 1984

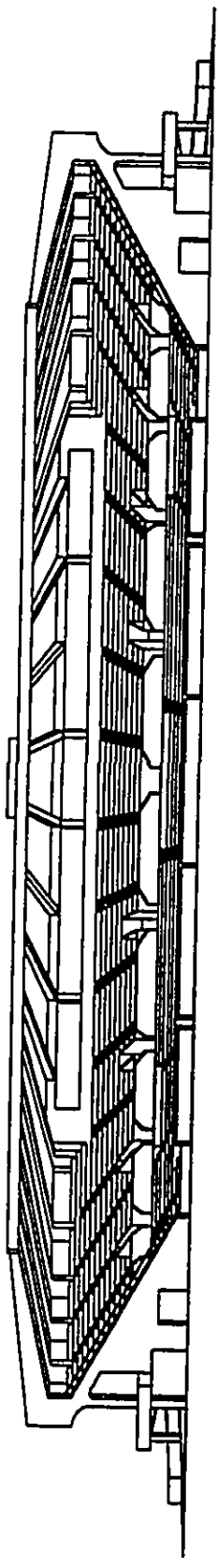
FIGURE 7A
SPORTS COMPLEX SITE PLAN

HCDCH EAST KAPOLEI

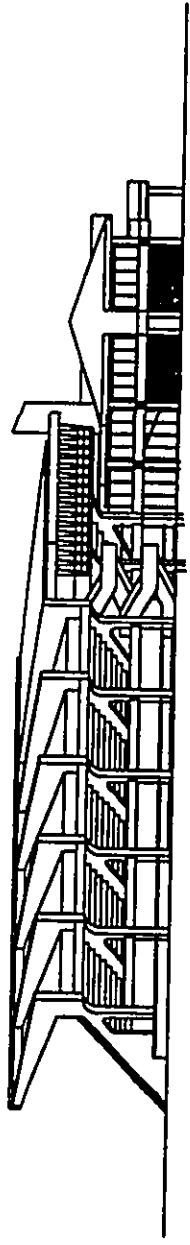




FRONT ELEVATION



FIELD ELEVATION



SIDE ELEVATION

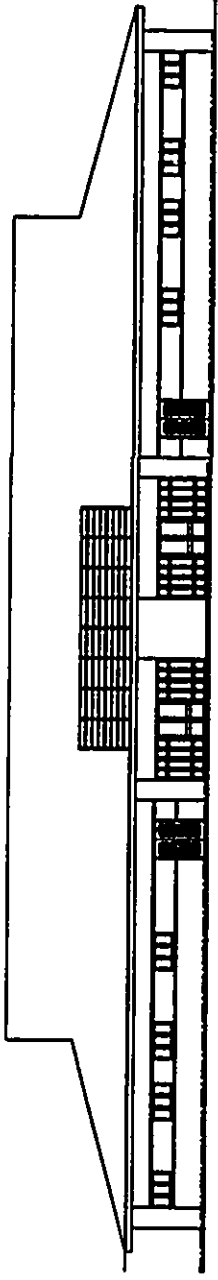
FIGURE 7B
SPORTS COMPLEX MULTI-PURPOSE
BUILDING ELEVATIONS

HCDCH EAST KAPOLEI

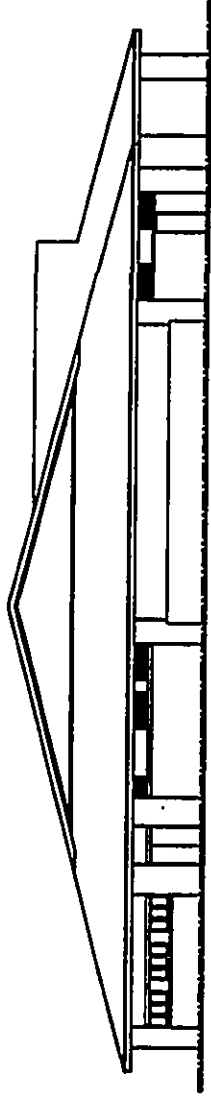
RELAND OF OAHU
NORTH



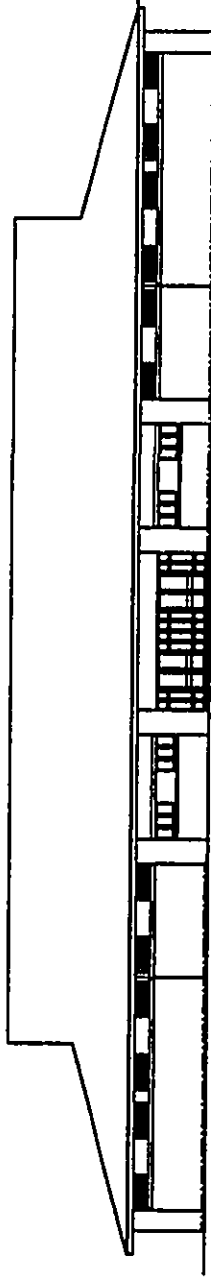
DATE: 7/98



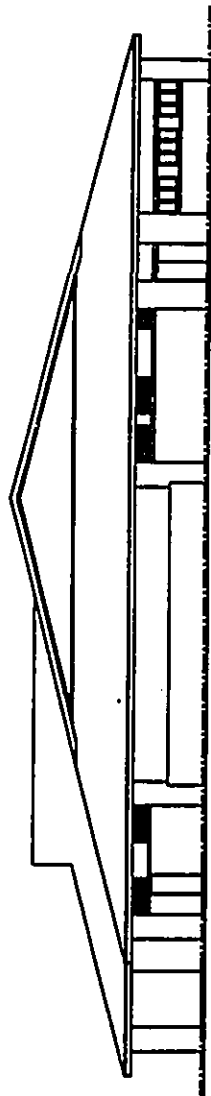
FRONT ELEVATION - MULTI-PURPOSE/CLUB HOUSE BUILDING
DATE: 10/1/14



RIGHT ELEVATION - MULTI-PURPOSE/CLUB HOUSE BUILDING
DATE: 10/1/14



REAR ELEVATION - MULTI-PURPOSE/CLUB HOUSE BUILDING
DATE: 10/1/14



LEFT ELEVATION - MULTI-PURPOSE/CLUB HOUSE BUILDING
DATE: 10/1/14

FIGURE 7C
SPORTS COMPLEX STADIUM ELEVATIONS

HCDCH EAST KAPOLEI

ISLAND OF OAHU



**HCDCH EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT
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- 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.

**HCDCH EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT
FINAL ENVIRONMENTAL IMPACT STATEMENT**

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:

**HCDCH EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT
FINAL ENVIRONMENTAL IMPACT STATEMENT**

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

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

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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 HFDCH 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-foot and 440-foot. 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

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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 Kaloι 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 Kaloι 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 Kaloι 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.

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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, HFDCHCDCH 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 HFDCHCDCH's engineering and architectural consultants.

As such, Design Guidelines will not be prepared by HFDCHCDCH 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 HFDCHCDCH during construction of the major infrastructure.

2.13 Phasing and Timing of Action

Upon completion of the major infrastructure by HFDCHCDCH, 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

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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

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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 OEQG 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

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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 HFDCHCDCH 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).

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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, HFDCHCDCH 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, HFDCHCDCH 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 IMPACTS,
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.

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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 Kalo 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

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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.

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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 Kalo 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 Kalo 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 Kalo 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.

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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 Statutes*, 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

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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

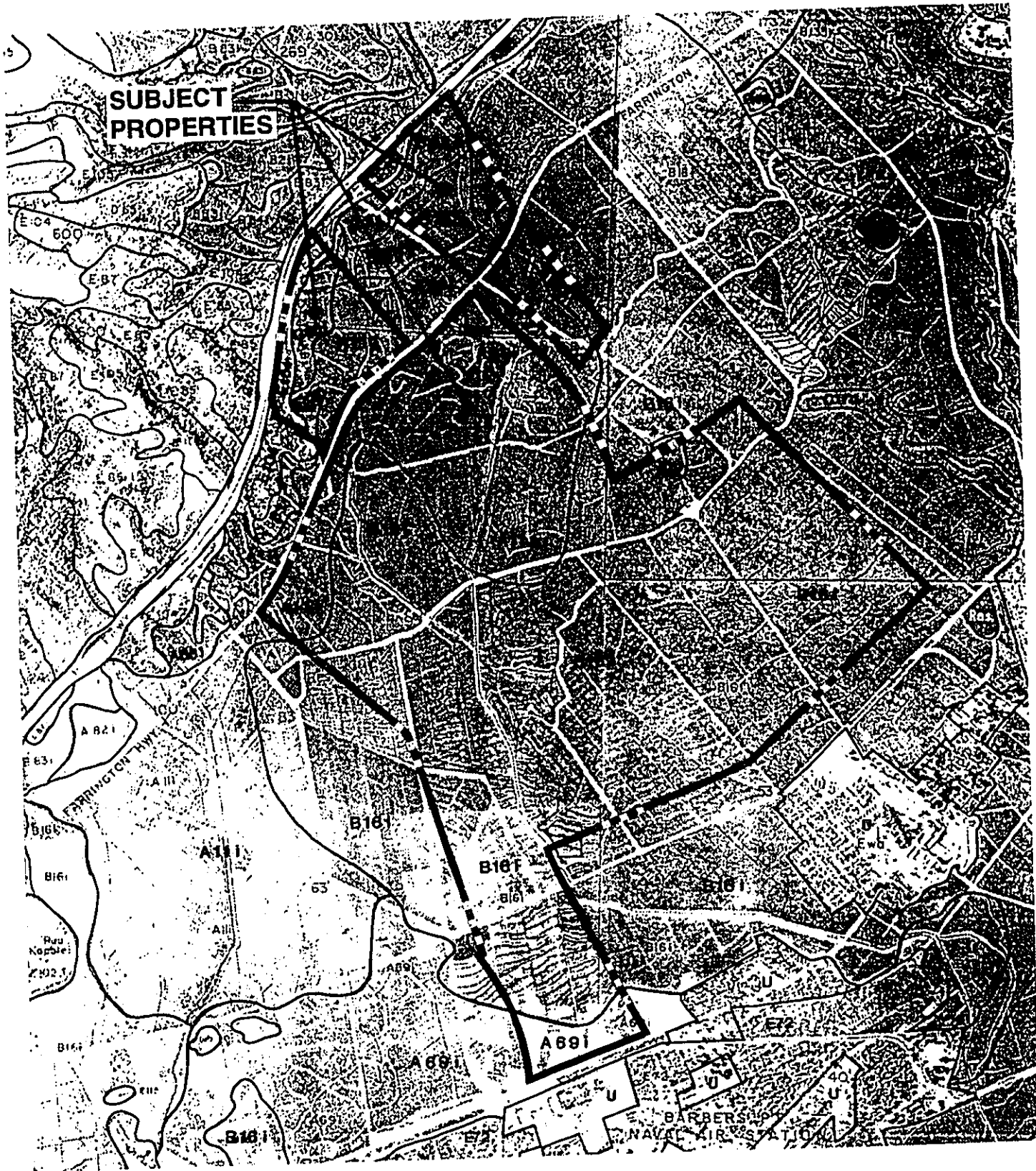
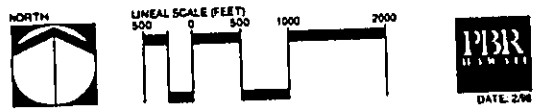


FIGURE 8
 DETAILED LAND CLASSIFICATION
 HCDCH EAST KAPOLEI
 ISLAND OF OAHU



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

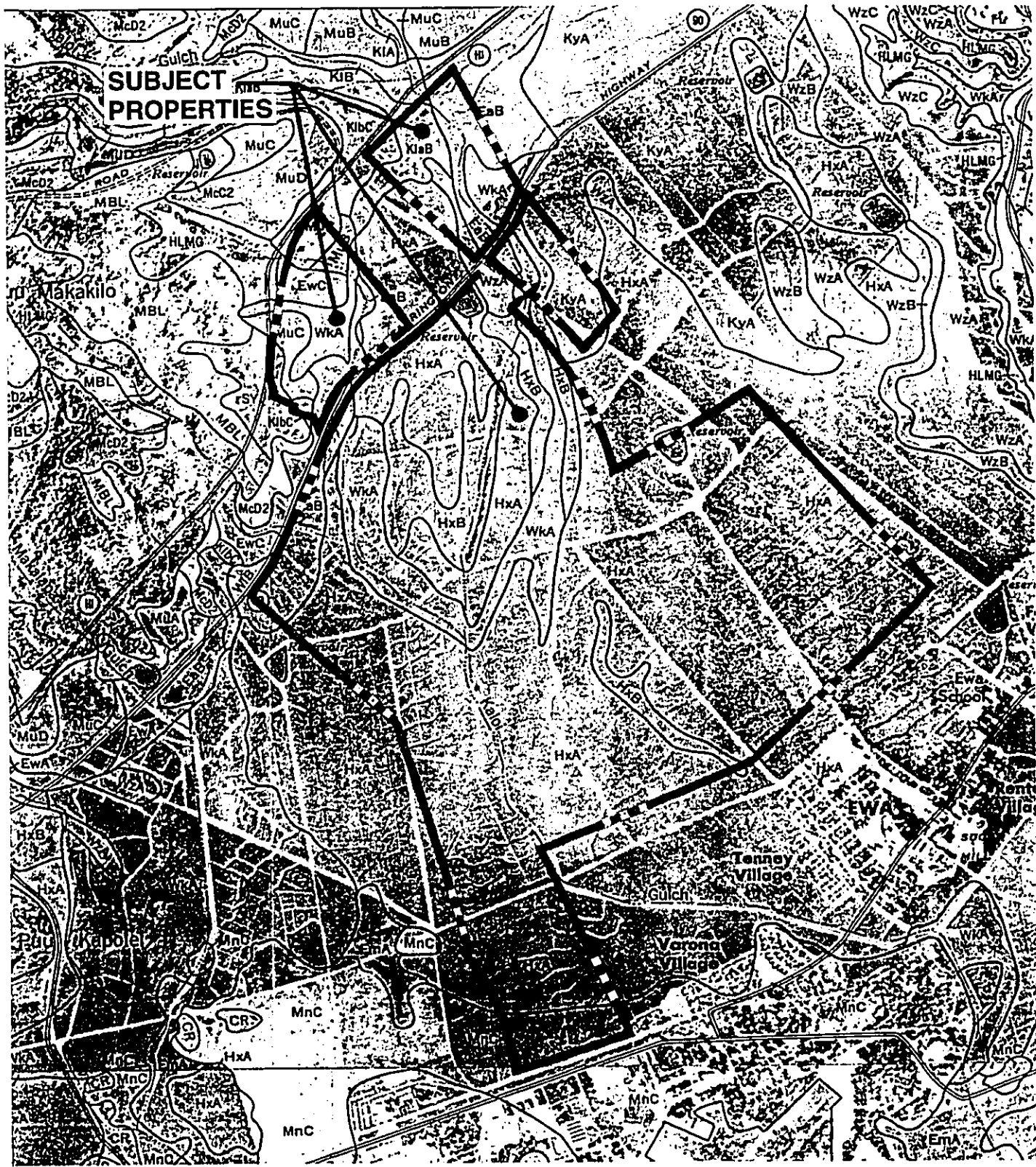
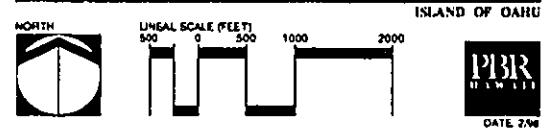


FIGURE 9
SCS SOIL SURVEY
HCDCH EAST KAPOLEI



SOURCE: US DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE / THE UNIVERSITY OF HAWAII AGRICULTURAL EXPERIMENT STATION

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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.

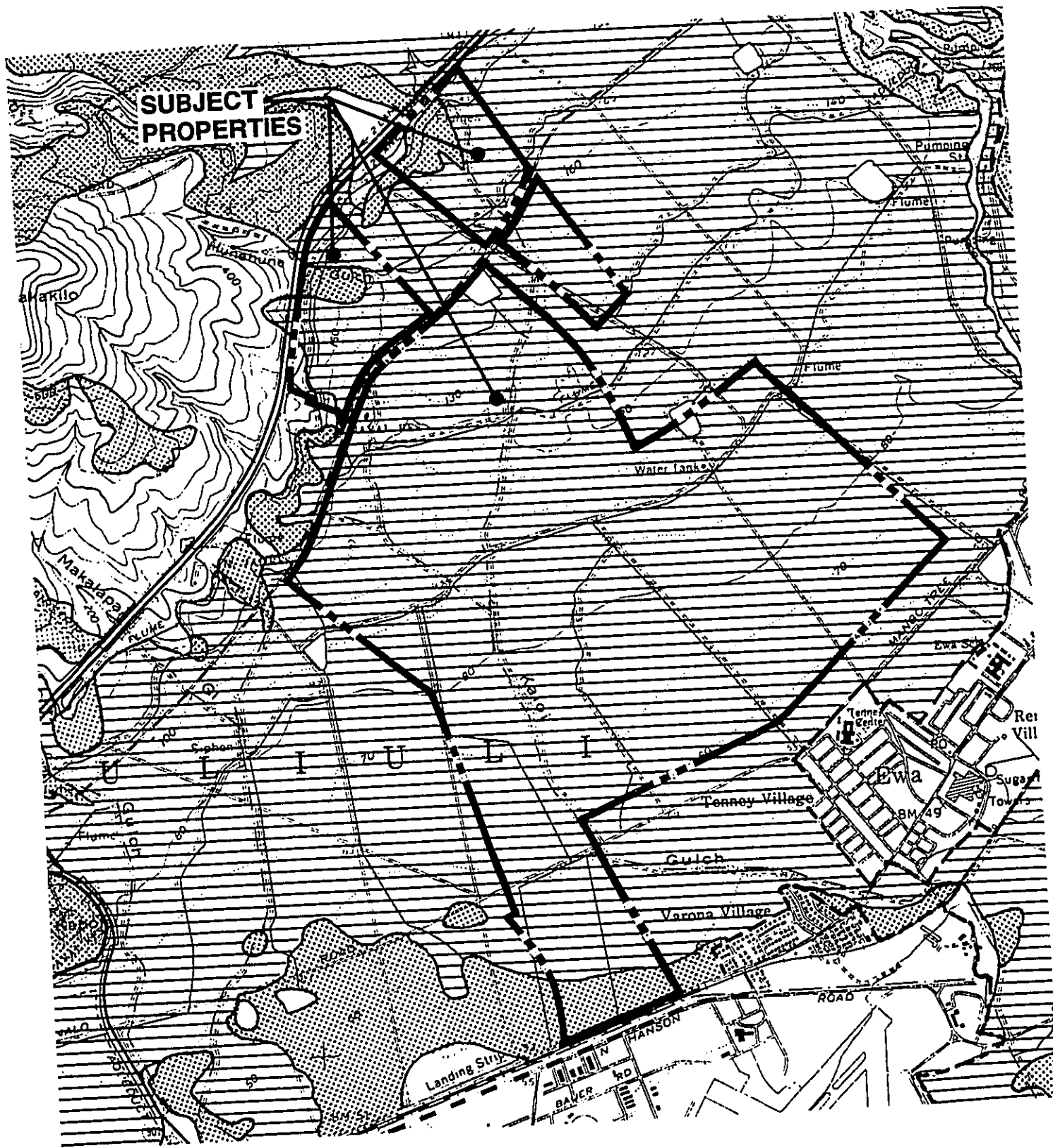
As shown on **Figure 10**, nearly all of the Subject property is located on lands designated as "Prime Agricultural Land" (a small portion along the OR&L boundary is classified "Other Important Agricultural Land"). The reservoir sites are unclassified.






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



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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.

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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

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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 HFDGHCDCH 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 Kaloι 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 Kaloι 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.

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4.7 Natural Hazards

Existing Conditions

Natural hazards are events such as tsunamis, 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

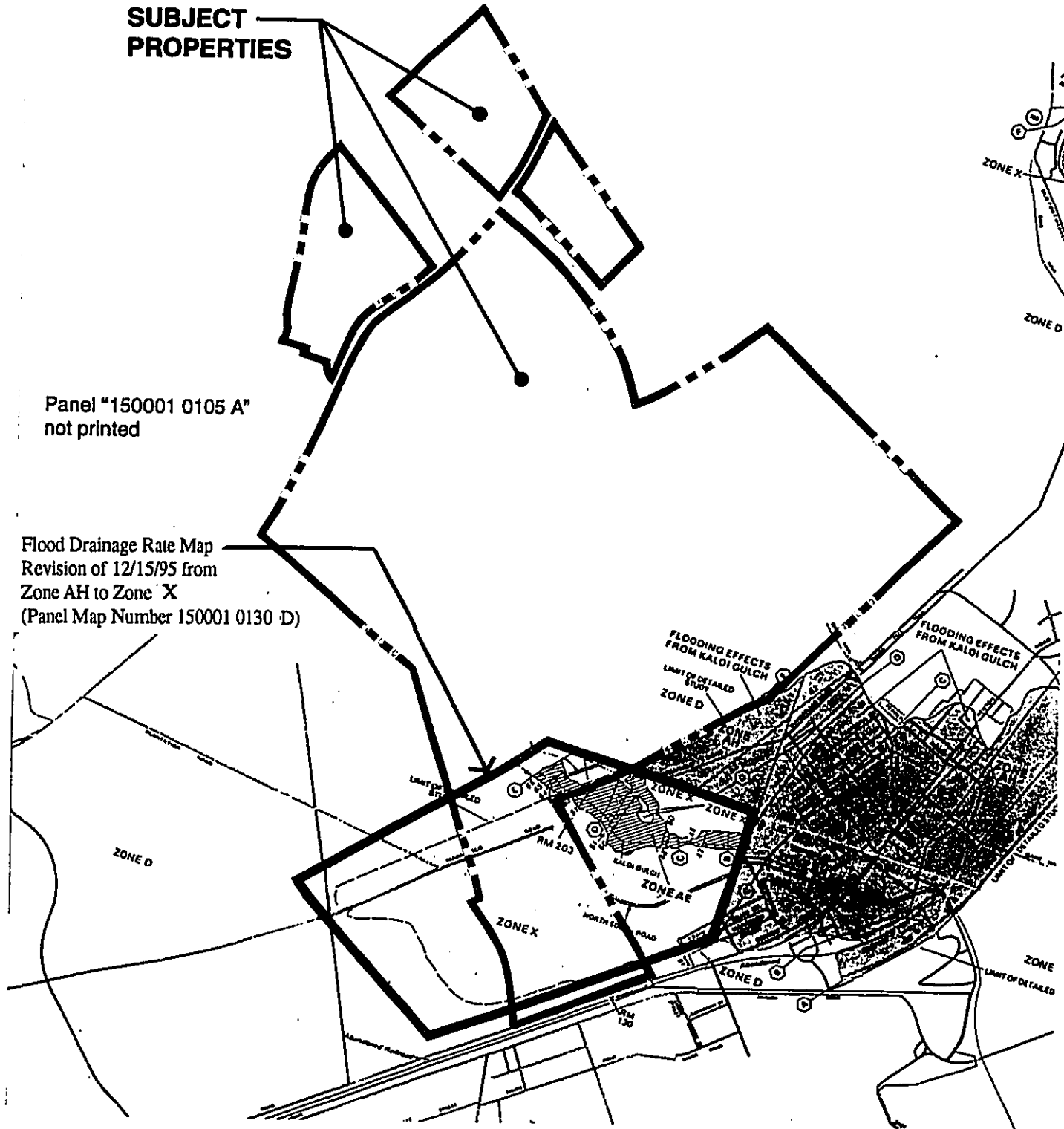
Existing Conditions

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

**SUBJECT
PROPERTIES**



Panel "150001 0105 A"
not printed

Flood Drainage Rate Map
Revision of 12/15/95 from
Zone AH to Zone X
(Panel Map Number 150001 0130 D)



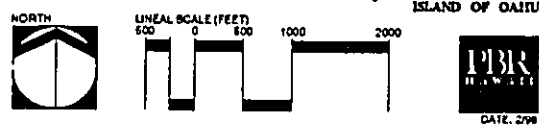
LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

-  **ZONE X** AREAS DETERMINED TO BE OUTSIDE 500-YEAR FLOOD PLAIN
-  **ZONE AE** 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



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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.

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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~~

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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.

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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 IMPACTS,
AND MITIGATION MEASURES

HCDCH EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT
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**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 Papapahu Point. The Monsarrat survey map of 1878 documents substantial settlement at the "Honolulu Taro Lands" in the Papapahu 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 Papapahu 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.

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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

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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."

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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 than 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.

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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:

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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.

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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 odors 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

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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

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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

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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



(A) 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.



(B) 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.

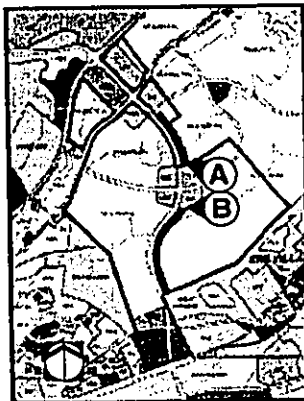


FIGURE 12 a
SITE PHOTO ANALYSIS
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ISLAND OF OAHU





© 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.



© 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.

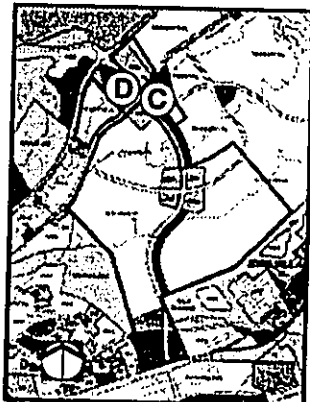
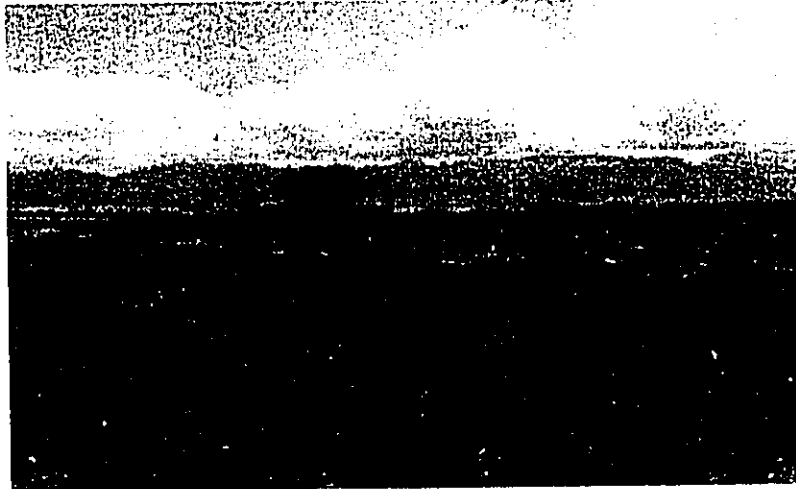
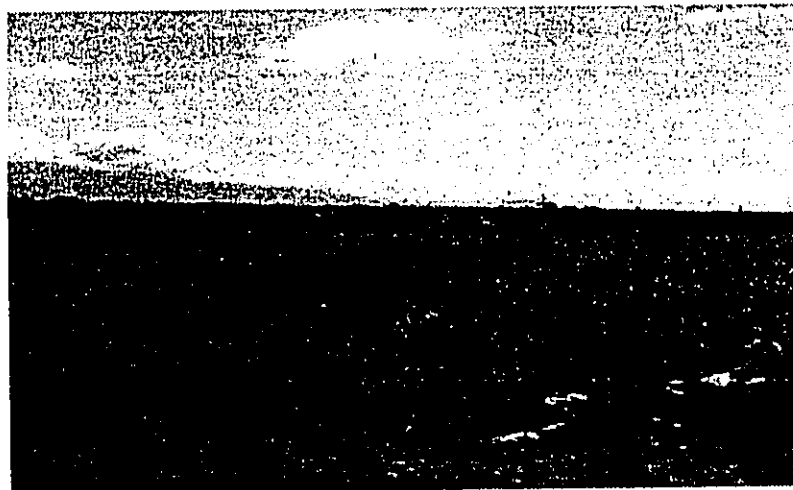


FIGURE 12 b
SITE PHOTO ANALYSIS
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Ⓔ View of Kalo Stream and existing vegetation. Note current cultivation area abuts closely to stream edge.



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

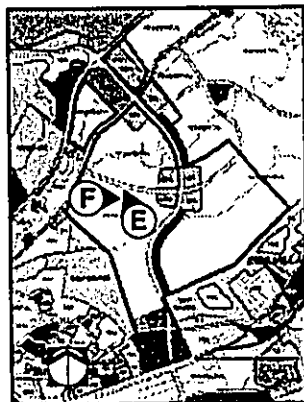


FIGURE 12 c
SITE PHOTO ANALYSIS
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the City zoning process.

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.

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- 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 HFDCHCDCH, 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

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A) has determined that the HFDGHCDCH 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:

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- 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

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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

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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 HFDBHCDCH 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 HFDBHCDCH, this discount could range from 5 percent to 15 percent depending on the amount of land to be "bulk-purchased".

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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.

HFDCHDCH 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.

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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 HFDCDCH East Kapolei Development.

The East Kapolei project spans two Board of Water Supply service pressure zones, 215-foot and 440-foot. 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

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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 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.

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.

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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 HFDGHCDCH 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

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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).

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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

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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 Kalo Stream at the upper boundary. Due to the increase in watershed area for Kalo 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 Kalo 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 Kalo 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 Kalo 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

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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

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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 Statutes, 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

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(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 57,857,808.992 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 without 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

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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

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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 plus 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

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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.

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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

<u>Name</u>	<u>Type</u>	<u>Size (acres)</u>
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

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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 Kaloι 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

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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.

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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 Kalo 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).

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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.

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- 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

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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

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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, HFDEHCDCH 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 HFDEHCDCH in accordance with pertinent regulations prior to any alteration to Kaloi Gulch.

Abutilon menziesii, or Ko'oloa'ula, 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, HFDEHCDCH, 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.*

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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.

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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.

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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.

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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.

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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. HFDGHCDCH 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.

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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. HFDGHCDCH 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

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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.

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- (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 HFDCH 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

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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 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.

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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.*

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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

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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.

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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 through 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: HFDCDCH will provide the major backbone transportation infrastructure required to support the proposed project and to connect regional transportation linkages.

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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~~

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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 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

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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.

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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

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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 inland 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

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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, HFDCHCDCH 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.

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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.

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Discussion: The applications for required land use entitlements will be reviewed by both City and State land use planning agencies. Further, HFBGHCDCH 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.

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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

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~~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 HFDCHCDCH 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.

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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.

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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

EWA DEVELOPMENT PLAN

Urban Land Use Map

- Low and Medium Density Residential
- High Density Residential
- Community Commercial Center
- City of Kapolee (High Density Residential and Commercial)
- Recreation/Recreation Area
- Industrial
- Military
- Public Institution
- Agricultural and Pastureland
- Parks and Golf Courses
- Transit Node (High Density Residential and Commercial)
- Urban Growth Boundary

EXISTING FUTURE

- Civic Center
- Electric Power Plant
- Wastewater T.P.
- Intermediate School
- High School
- U.H. West Oahu
- Hospital
- Small Boat Marina
- Commercial Harbor
- Airfield
- Highways, Arterial & Major Streets
- Historic Railway



Planning Department
City & County of Honolulu
August 1997

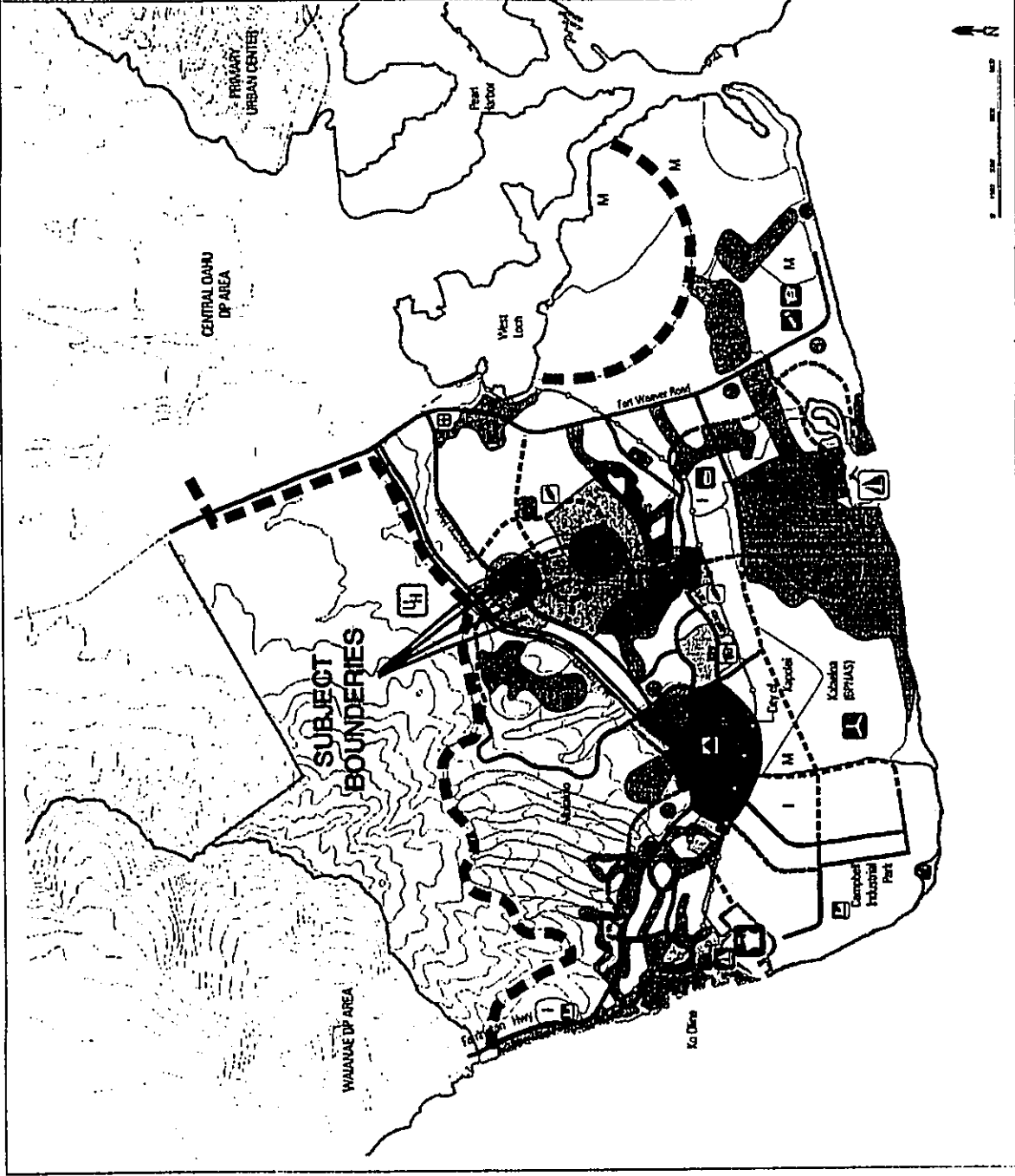


FIGURE 13
EWA DEVELOPMENT PLAN LAND USE MAP

HCDCH EAST KAPOLEI

ISLAND OF OAHU



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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

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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 6064.3 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 planning 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 their intersection of Farrington

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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~~

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~~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 (1/2 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

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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,

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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.

EWA DEVELOPMENT PLAN

Public Facilities Map

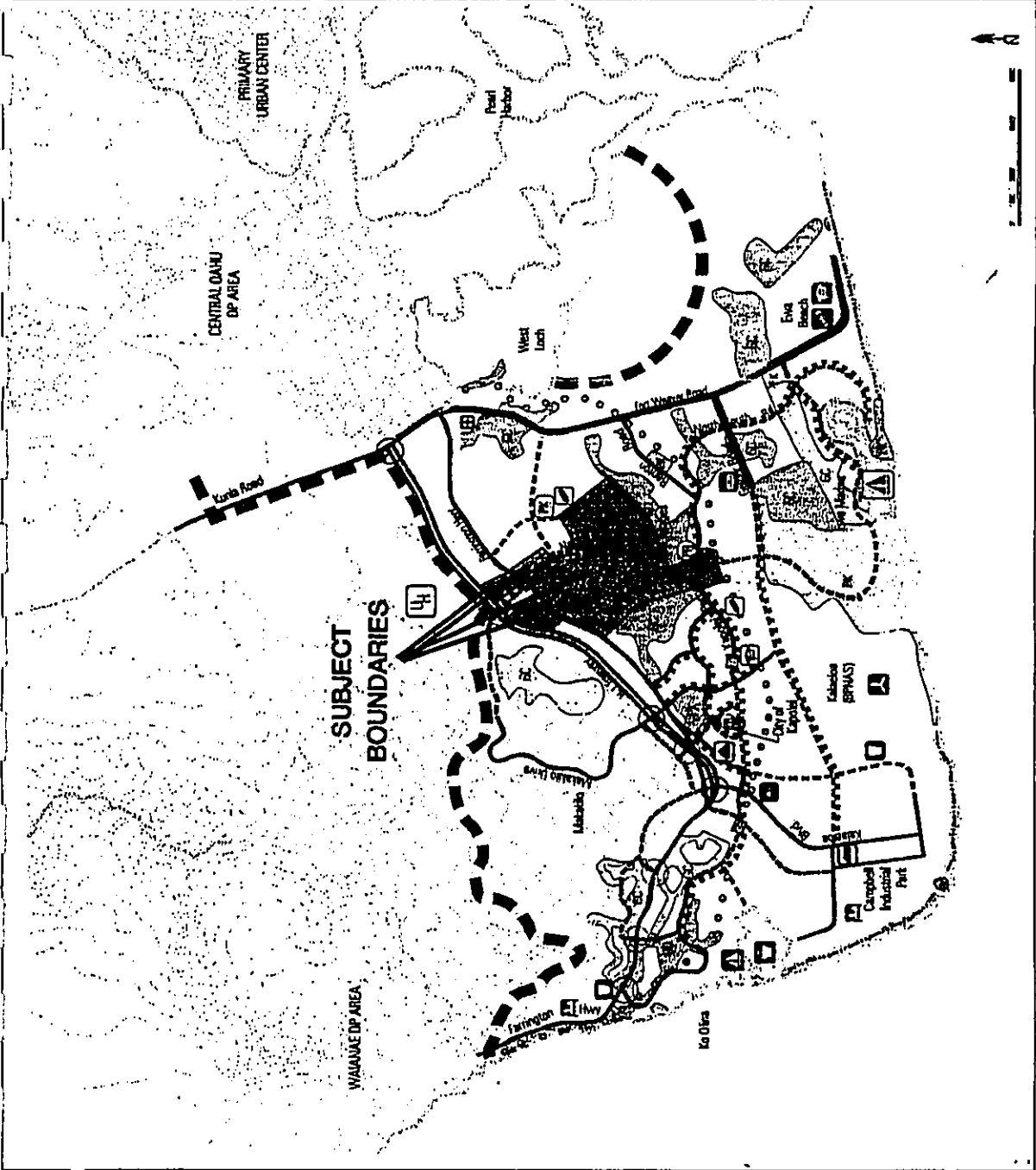
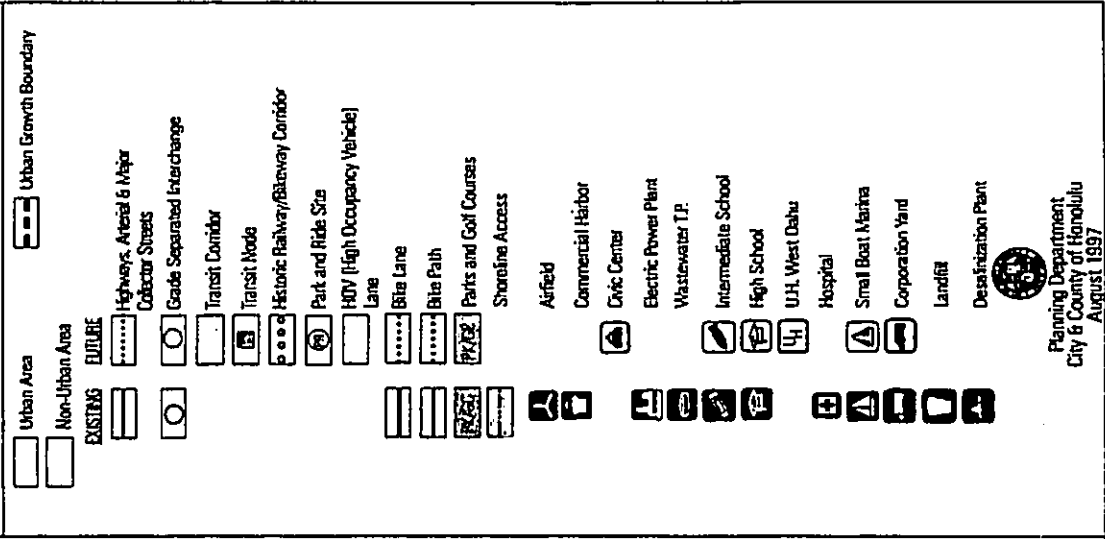


FIGURE 14
 EWA DEVELOPMENT PLAN
 PUBLIC FACILITIES MAP

HCDCH EAST KAPOLEI

ISLAND OF OAHU



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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

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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 Kalo'i 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 Kalo'i 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.

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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.

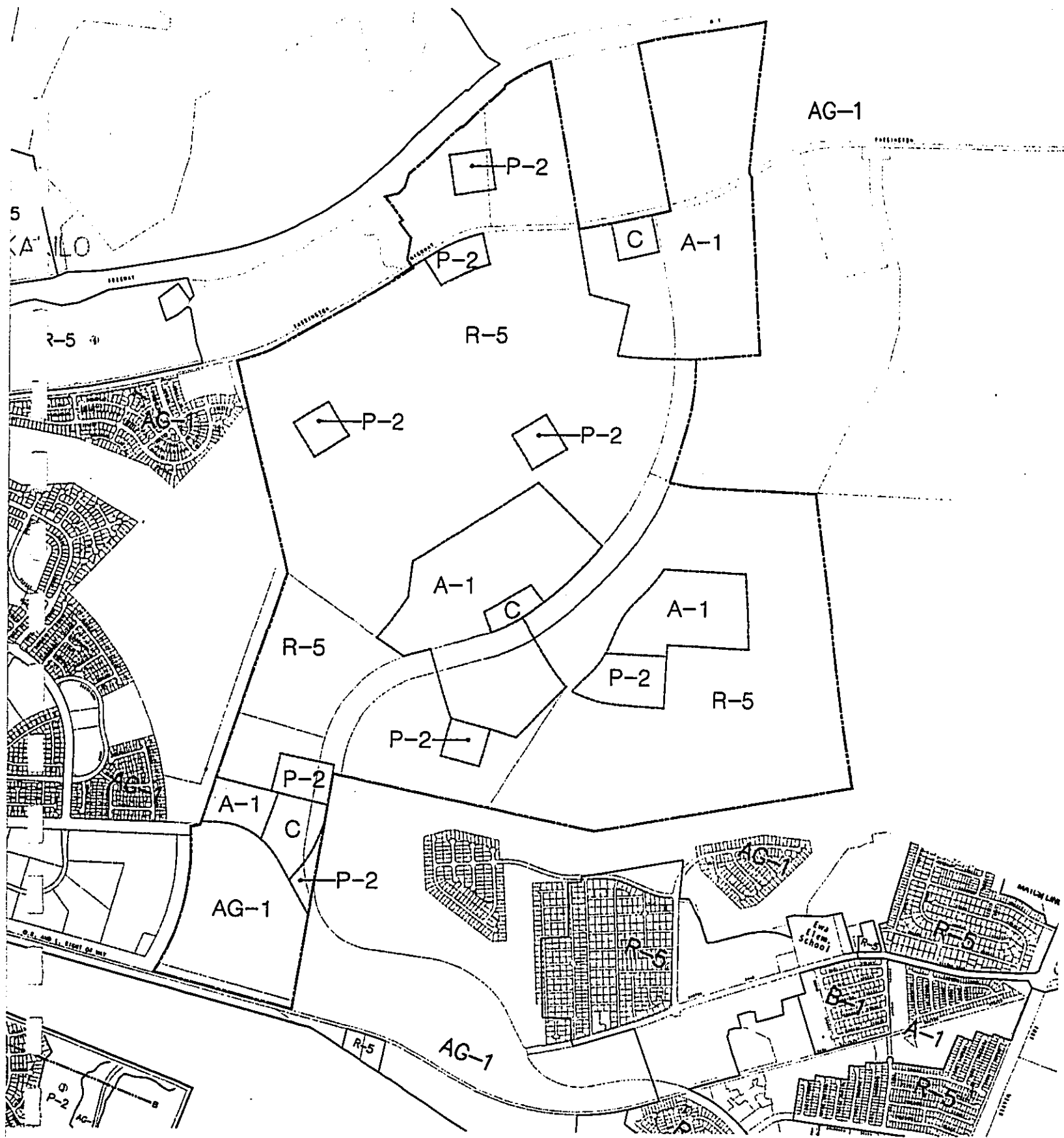


FIGURE 15
 PROPOSED ZONING MAP
HCDCH EAST KAPOLEI

ISLAND OF OAHU

NORTH

LINEAL SCALE FEET
 400 800 1600

PBR
 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

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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 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.

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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.

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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 develop 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.

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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.

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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

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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 HFDCHCDCH 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

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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

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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 HFDGHCDCH 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.

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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 HFDCHDCH revolving funds and issuance of revenue bonds by HFDCHDCH.

HawaiiKapolei 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 HawaiiKapolei 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 HFDCHDCH, 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

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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.

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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.

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12.2 Preparers of the Environmental Impact Statement

~~This~~The Draft and Final Environmental Impact Statement has been 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

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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. Congressman Neil Abercrombie
State Representative Mark Moses
Councilmember Mufi Hannemann

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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 Resources (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

Wipac Jones

14.0

COMMENTS AND RESPONSES TO THE DEIS

**HCDCH EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT
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14.0 COMMENTS AND RESPONSES TO THE EISNOPSIS

14.1 Agencies that Responded to the EISNOPSIS

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	8/24/98
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	Hawai Audubon Society		
35	William Halliday		
36	Haalelo (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	5/26/98	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	Makalo Neighborhood Board		
60	Honolulu Municipal Reference and Records Center		
61	Ewa Neighborhood Board		

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FINAL ENVIRONMENTAL IMPACT STATEMENT**

14.2 EIS/NOPEIS Comment Letters and the Applicant's Responses

The following are the EIS/NOPEIS comment letters received and applicable responses.

BENJAMIN J. CAYETANO
604-4002



STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL

215 SOUTH BERETANIA STREET
SUITE 702
HONOLULU, HAWAII 96813
TELEPHONE (808) 551-4115
FACSIMILE (808) 551-4116

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 requirements 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

Mr. Oshiro
Page 2

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 Honolulu 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 accommodate 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.

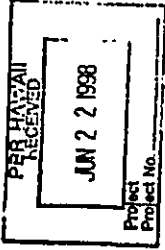
Should you have any questions, please call Jayan Thirugnanam at 586-4185.

Sincerely,

Gary Gill
Director

c: ✓ PBR Hawaii

GARY GILL
DIRECTOR



BENJAMIN CASTELANO
GOVERNOR



STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
HONOLULU, HAWAII 96813
417 OAKEN STREET, SUITE 200
TEL: (808) 587-0130
FAX: (808) 587-0130

ROY S. OSHIRO
EXECUTIVE DIRECTOR

DATE: 6/24/98

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

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Gary Gill, Director
June 24, 1998
Page 2

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 nakai 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 X (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

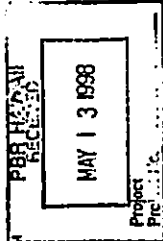


ESTHER M. DEEA
RECORDS OFFICER

STATE OF HAWAII
DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM
LAND USE COMMISSION

P.O. Box 2339
Honolulu, HI 96804-2339
Telephone: 808-587-3822
Fax: 808-587-3827

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:

LUC Docket No. A94-798/Office of State Planning - 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.

LUC Docket No. A96-718/Schuler Homes, Inc. - The project site is adjacent to the property that was the subject of this docket. The docket had proposed

Mr. Steve Thomas
May 12, 1998
Page 2

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.

LUC Docket No. A97-720/City and County of Honolulu, State of Hawaii, by its Director of the Department of Housing and Community Development - 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). 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.

Mr. Steve Thomas
May 12, 1998
Page 3

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: OEOC
David Hulse, PBR Hawaii



STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
877 OULOUA STREET, SUITE 200
HONOLULU, HAWAII 96813
FAX (808) 587-3800

ROY S. OSHIRO
EXECUTIVE DIRECTOR

TELEPHONE

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

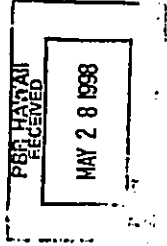


**DEPARTMENT OF BUSINESS,
ECONOMIC DEVELOPMENT & TOURISM**

ENERGY, RESOURCES, AND TECHNOLOGY DIVISION
235 South Berliana St., 5th Fl., Honolulu, Hawaii 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

BENJAMIN J. CATELANO
GOVERNOR
SELE F. MAYA
DIRECTOR
BRADLEY J. MOSSMAN
DEPUTY DIRECTOR

Tel.: (808) 587-3807
Fax: (808) 586-2536



May 21, 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
Maurice H. Kaya
Energy, Resources, and Technology
Program Administrator

C: OEQC
PBR



**STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION**

417 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX: (808) 587-5000

ROY S. OSHIRO
EXECUTIVE DIRECTOR

MEMO 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 *RSO*

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 Hulsee, PBR Hawaii



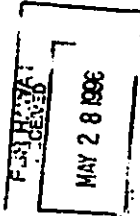
BENJAMIN J. CASTILLO
GOVERNOR



STATE OF HAWAII
DEPARTMENT OF EDUCATION
P.O. BOX 2189
HONOLULU, HAWAII 96824

OFFICE OF THE SUPERINTENDENT

HERMAN M. AIZAWA, Ph.D.
SUPERINTENDENT



May 19, 1998

Mr. Steve Thomas
Page 2
May 19, 1998

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

MEMO TO: Mr. Steve Thomas, Housing Development Specialist
Housing Development Section, HFDC

F R O M: Herman M. Aizawa, Ph.D., Superintendent
Herman M. Aizawa

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).

AN AFFIRMATIVE ACTION AND EQUAL OPPORTUNITY EMPLOYER



STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
817 QUEEN'S STREET, SUITE 200
HONOLULU, HAWAII 96813
TEL (808) 547-0800

98:DEV/1953

June 1, 1998

TO: Herman M. Aizawa, Ph.D., Superintendent
Department of Education

FROM: Roy S. Oshiro, Executive Director *RSO*

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, PRR Hawaii



RECEIVED JUN 1 1998

BENJAMIN J. CAYTELAGO
GOVERNOR OF HAWAII

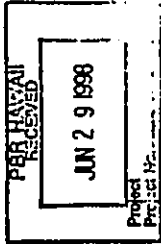


STATE OF HAWAII
DEPARTMENT OF HEALTH
P.O. BOX 3378
HONOLULU, HAWAII 96801

LAWRENCE S. MACE
DIRECTOR OF HEALTH

In reply, please refer to

97-064A/epo



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
THK: 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. CAYTELAGO
GOVERNOR



STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
877 QUEEN STREET, SUITE 200
HONOLULU, HAWAII 96813
FAX: (808) 587-0000

ROY S. OSHIRO
EXECUTIVE DIRECTOR

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





STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

LAND DIVISION
P.O. BOX 621
HONOLULU, HAWAII 96809

June 10, 1998

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.

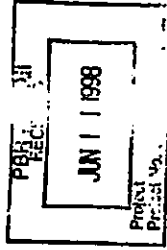
Should you have any questions, please contact Nicholas Vaccaro of our Support Services Branch at 587-0438.

Very truly yours,

Deean Y. Uchida
DEEAN Y. UCHIDA
Administrator

c: Oahu District Land Office
Oahu Land Board Member

AGRICULTURE DEVELOPMENT
ADULTS RESOURCES
BOATING AND OCEAN RECREATION
CONSERVATION AND
COURT REPORTS
COURT REPORTS
FORESTRY AND WILDLIFE
HYDROLOGICAL SERVICES
LAND DIVISION
LAND MANAGEMENT
STATE RESOURCE MANAGEMENT



STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

P.O. BOX 621
HONOLULU, HAWAII 96809

MAY 20 1998

MEMORANDUM:

TO: Nick Vacarro
Central
Nick Vacarro
FROM: 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 Kaiwi Channel not being installed at the completion of this development. Currently the main Kaiwi 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 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 671
HONOLULU, HAWAII 96809

PLANNING AND DEVELOPMENT
ADULT RESOURCES
BOATING AND OCEAN RECREATION
CONSERVATION AND
COUNSELING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
LAND USE
STATE WATER
WATER RESOURCE MANAGEMENT

WILLIAM J. EASTLAND
COMMISSIONER



STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT
P.O. BOX 671
HONOLULU, HAWAII 96809

MEMORANDUM
DATE: 10 23

May 29, 1998

TO: Nick Vacarro
Central Office

FROM: Cecil Santos
Oahu District Land Agent

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

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 Herbicide 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

JUN 2 4 06 PM '98

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.
- 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.
- 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.
- 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.
- 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).
- If the proposed project alters the bed and banks of a stream channel, the project may require a stream channel alteration permit.

RONALD D. WILSON
CHAIRMAN

ROBERT G. CARL
DAVID J. HONORA
TIMOTHY E. JOHNS
HERBERT M. RICHARDS, JR.

TIMOTHY E. JOHNS
SECRETARY

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 I. GASTALDO
DIRECTOR

ROY S. OSHIRO
EXECUTIVE DIRECTOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
117 QUEEN STREET, SUITE 309
HONOLULU, HAWAII 96813
FAX: (808) 547-0900

STATE OF HAWAII

DEPARTMENT OF BUDGET AND FINANCE

HOUSING FINANCE AND DEVELOPMENT CORPORATION

117 QUEEN STREET, SUITE 309

HONOLULU, HAWAII 96813

FAX: (808) 547-0900

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 *RSO*

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.

RSO
H.F.D.C.

Dean Y. Uchida
June 16, 1998
Page 2

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 (HCDC). In any event, the spill area is not scheduled for development in the near future. HFDC and its successor HCDC 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.

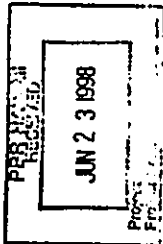
We will continue to coordinate with the DLNR/CWRM to incorporate this project into the State Water Projects Plan.

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 1109
HONOLULU, HAWAII 96811-1109

REGISTRATION
DIVISION
HONOLULU, HAWAII 96811-1109
JOSEPH K. W. JAMES
DIRECTOR



June 18, 1998

To: Mr. Roy S. Oshiro, Executive Director
Housing Finance and Development Corporation

From: *Roy S. Oshiro*
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.

Mr. Roy S. Oshiro
June 18, 1998
Page 2

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



STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
817 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 551-9000

ROY S. OSHIRO
EXECUTIVE DIRECTOR

98:DEV/2314

June 26, 1998

June 26, 1998

TO: The Honorable Kali Watson, Chairman
Hawaiian Homes Commission
Department of Hawaiian Home Lands

FROM: Roy S. Oshiro, Executive Director *RSO*

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 Home Lands (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

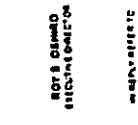


The Honorable Kali Watson, Chairman
June 26, 1998
Page 2

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



STATE OF HAWAII
 DEPARTMENT OF BUDGET AND FINANCE
 HOUSING FINANCE AND DEVELOPMENT CORPORATION
 877 QUEEN STREET, SUITE 300
 HONOLULU, HAWAII 96813
 FAX (808) 587-0800

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 effect 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.



STATE OF HAWAII
 DEPARTMENT OF LAND AND NATURAL RESOURCES
 STATE HISTORIC PRESERVATION DIVISION
 33 SOUTH KING STREET, 8TH FLOOR
 HONOLULU, HAWAII 96813

May 18, 1998

Steve Thomas
 State Housing Finance and Development Corporation
 677 Queen Street, Suite 300
 Honolulu, Hawaii 96813

Dear Mr. Thomas

SUBJECT: Chapter 6E-8 Historic Preservation Review -- Draft Environmental Impact Statement Notice of Preparation (DEIS) East Kapolei Master Plan Development Project
 Honolulu, 'Ewa, O'ahu
TMK: 9-1-18:8, 108 & 109; 9-1-17: 71, 72, & 9-1-18: DOI.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,

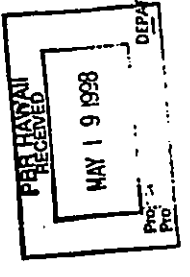
Don Hibbard, Administrator
 Historic Preservation Division

EJ:jk

c: DEOC, 235 S. Beretania Street, Room 702, Honolulu, HI 96813
 Mr. David Hulise, PBR Hawaii, Pacific Tower, Suite 650 1001 Bishop Street, Honolulu, HI 96813



STATE OF HAWAII
 DEPARTMENT OF LAND AND NATURAL RESOURCES
 STATE HISTORIC PRESERVATION DIVISION
 33 SOUTH KING STREET, 8TH FLOOR
 HONOLULU, HAWAII 96813



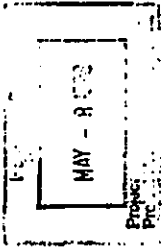
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BENJAMIN J. CASTILANO
 GOVERNOR OF HAWAII

BENJAMIN J. CASTILANO
 GOVERNOR

MICHAEL S. WILSON, CHIEF EXECUTIVE
 OFFICER
 BOARD OF LAND AND NATURAL RESOURCES

DEPUTY CHIEF OF STAFF
 AGRICULTURE DEVELOPMENT PROGRAM
 ADULT RESOURCES
 CONSERVATION AND RECREATION
 HISTORIC PRESERVATION
 LAND DIVISION
 STATE PARKS
 WATERS AND LAND DEVELOPMENT



(P)1258.8

MAY 5 1998

TO: Mr. Roy Oshiro, Executive Director
Housing Finance and Development Corporation

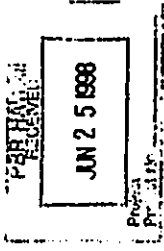
SUBJECT: East Kapolei Draft EIS

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.

Jordan Matsuoaka
JORDAN MATSUOKA
Public Works Administrator

AS:jk
C: Mr. Steven Thomas
Mr. David Hulise
Mr. John Kirkpatrick
Mr. Jerry Nishida
Mr. Steve Wong



(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.

Jordan Matsuoaka
JORDAN MATSUOKA
Public Works Administrator

RC:jj
Attachment
C: OEQC w/attach.
Mr. David Hulise, PBR Hawaii w/attach.

ROY E. OSWALD
EXECUTIVE DIRECTOR

TELEPHONE NO.

98:DEV/2370



STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
817 QUEEN STREET, SUITE 200
HONOLULU, HAWAII 96813
FAX (808) 457-0900

BENJAMIN J. CAYTELAND
DIRECTOR

A:\UTSFA\1138\HFDC.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.

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



Attachment A

Mr. Gordon Matsuoka
June 30, 1998
Page 2

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, 8th Fl., Honolulu, Hawaii 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

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.

SEYMOUR J. CAYEZANO
GOVERNOR
SELBY MATA
DIRECTOR
BRADLEY J. MOSES
DEPUTY DIRECTOR
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Mr. Roy S. Oshiro
Page 2
June 30, 1998

Section 2.1.3 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 avert 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 E: Habitat Conservation Plan (HCP), has been developed to address the existence of the endangered plant - *Ahulia munitzifii* (Ko'oloa 'ulu or Red 'Ulu). 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 *Ahulia* 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



EDUARDO J. CASTRANO
GOVERNOR

DONALD K.W. LAU
EXECUTIVE DIRECTOR

EMARTH L. WILSON
DEPUTY EXECUTIVE DIRECTOR

STATE OF HAWAII
DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM
HOUSING AND COMMUNITY DEVELOPMENT CORPORATION OF HAWAII

877 KOLEA DRIVE, SUITE 230
HONOLULU, HAWAII 96813
FAX (808) 547-0800

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)

Rick Egged, Director
July 10, 1998
Page 2

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) Kalo 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 Abutlon 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.

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.



University of Hawai'i at Mānoa

Environmental Center
A Unit of Water Resources Research Center
Crawford 317 • 2540 Campus Road • Honolulu, Hawaii 96822
Telephone: (808) 956-7661 • Facsimile: (808) 956-4940

June 22, 1998
RE:0690

David Hulise
PBR Hawaii
1001 Bishop Street, Pacific Tower 650
Honolulu, Hawaii 96813

Dear Mr. Hulise;
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 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

David Hulise
June 22, 1998
Page 2

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 uia* (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 Huise
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 FIS 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 FIS will further enhance the Master Plan.

Sincerely,
John T. Harrison
John T. Harrison
Environmental Coordinator

- OEQC
- Roger Fujioka
- Paul Ekern
- Frank Howard
- Victoria Cullins



STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
877 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 547-4880

SENIOR PROJECT MANAGER

NOTES: OHP/MSD
E/EN/MSD/2/2/98

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.



Mr. John T. Harrison
June 30, 1998
Page 3

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.

Mr. John T. Harrison
June 30, 1998
Page 2

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

Mr. John T. Harrison
June 30, 1998
Page 4

We hope our comments have addressed each of your concerns. Once again, thank you for participating in the environmental review process.

Sincerely,



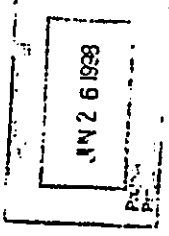
ROY S. OSHIRO
Executive Director

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100



United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Ecoregion
300 Ala Moana Boulevard, Room 3-172
Box 30088
Honolulu, Hawaii 96850



In Reply Refer To: LTG

Sieve Thomas
State Housing Finance and Development Corporation
677 Queen Street, Suite 300
Honolulu, HI 96813

JUN 25 1998

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.

Pages 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

BENJAMIN A. CASTLE
GOVERNOR



STATE OF HAWAII

DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION

617 QUEEN STREET, SUITE 200
HONOLULU, HAWAII 96813
FAX (808) 587-0899

NOTES: 03/19/90
ESTABLISHED

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: L7G

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.



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* from 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

Mr. Brooks Harper, Field Supervisor
June 30, 1998
Page 5

area. Other signage will inform visitors to refrain from activities that could potentially be harmful to Abutilon.

Pages 14 -15, Strategy 2: 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 96811 • 808 546-4311

BEHAVIORAL CONTRACTING
Contract



STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
877 QUEEN STREET, SUITE 508
HONOLULU, HAWAII 96813
FAX (808) 587-0009

ROY S. OSHIRO
EXECUTIVE DIRECTOR

98:DEV/2369

June 24, 1998

Reply to
HIABY3

JUN 29 1998
FBI

June 30, 1998

Mr. David Hulse
PBR Hawaii
1001 Bishop Street, Pacific Tower #650
Honolulu, HI 96813

Mr. Paul K. Hanohano
Designer - Access Design
GTE Hawaiian Telephone
P.O. Box 2200
Honolulu, Hawaii 96841

Dear Mr. Hulse:

Subject: East Kapolei Master Plan Draft Environmental Impact Statement

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 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.

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.

If you have any questions or require assistance in the future on the project, please call me at 840-1447.

Sincerely,

Sincerely,

Paul K. Hanohano

Paul K. Hanohano
Designer - Access Design

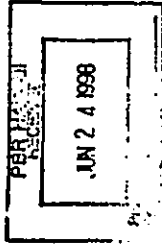
ROY S. OSHIRO
Executive Director



17PM 9/20/98



Scott W.H. Sev, P.E.
Manager
Environmental Department



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 Barbours 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 66: "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



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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,

cc: OECC

Office of the Governor
c/o OECC
235 S. Beretania St., Rm. 702
Honolulu, HI 96813

PBR Hawaii
1001 Bishop Street, Pacific Tower, #650
Honolulu, HI 96813
Attn: David Huske

B. Muench
F. Hirakami
M. Goo

BENJAMIN J. CASTELANO
CITY ENGINEER



STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
877 QUEEN STREET, SUITE 300
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FAX: (808) 547-0928

ROY S. OSHIRO
EXECUTIVE DIRECTOR

REPLY NUMBER IS

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

Mr. Scott W. H. Seu, P. E.
June 26, 1998
Page 2

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 (Ewa), Inc.

630 Middle Street, Suite 810 Honolulu, Hawaii 96813-5938
Phone: (808) 599-1444 Fax: (808) 515-5790

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 Kaloii 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 Kaloii 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.

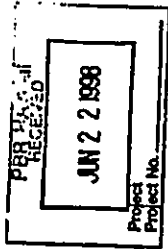
We recently started our first phase of the Ocean Pointe project and we look forward to working with HFDC and the other developers in the watershed in implementing the drainage improvements for the region.

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. CATELANO
GOVERNOR



STATE OF HAWAII

DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION

817 QUEEN STREET, SUITE 300
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FAX: (808) 587-2600

June 26, 1998

Mr. Nelson W. G. Lee
Executive Vice-President
Haseko (EWA), Inc.
820 Millilani 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

cc: David Hulsey, PBR Hawaii



ROY S. OSHIRO
EXECUTIVE DIRECTOR

PHONE: 587-2600

98:DEV/2313

DEPARTMENT OF PUBLIC WORKS
CITY AND COUNTY OF HONOLULU

850 SOUTH KING STREET, 15TH FLOOR • HONOLULU, HAWAII 96813
PHONE: (808) 525-2241 • FAX: (808) 525-2821



JONATHAN K. SHIMADA, PH.D.
DIRECTOR AND CHIEF ENGINEER
ROLAND D. LIBBY, JR.
SENIOR DIRECTOR

ENV 98-120

May 27, 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,

J. Shimada
JONATHAN K. SHIMADA, PH.D.
Director and Chief Engineer

cc: OEQC
PBR Hawaii (David Hulsey)



STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX: (808) 527-2600

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,

R. Oshiro
ROY S. OSHIRO
Executive Director



DEPARTMENT OF LAND UTILIZATION
CITY AND COUNTY OF HONOLULU
 450 SOUTH KING STREET, 7TH FLOOR • HONOLULU, HAWAII 96813
 PHONE: (808) 533-4416 • FAX: (808) 537-8743



JEREMY HARRIS
 DIRECTOR

JANUARY SULLIVAN
 DIRECTOR
 LORETTA C. CHIE
 DEPUTY DIRECTOR
 '98 EA Comments Zone 9
 JUN 25 1998

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.

Mr. Joseph K. Conant, Executive Director
 Page 2
 June 23, 1998

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 Eva Development Plan (DP) Public Facilities Map. This reference is to the map attached to the new Eva DP under Ordinance No. 97-49 (effective August 22, 1997). There is also, however, a Public Infrastructure Map for Eva 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 Eva 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	Acres Triggering Chapter 343, HR8 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

Mr. Joseph K. Conant, Executive Director
Page 3
June 23, 1998

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 Kalo'i 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
✓ FBR Hawaii (David Hulse)

9:14:01am/epol1.djt



STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE

98:DEV/2368

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION

177 OULAKA STREET, SUITE 200
HONOLULU, HAWAII 96813
PHONE: (808) 537-4888

June 30, 1998

BENJAMIN J. CAYTELANO
Governor

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 foot 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.



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

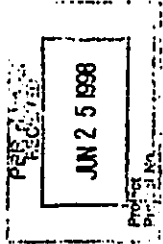
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LEWIS HARRIS
 JUNIOR

ROBERT AGRES JR.
 DIRECTOR
 DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT

June 18, 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 L. CATTIANG
 DIRECTOR

STATE OF HAWAII
 DEPARTMENT OF BUDGET AND FINANCE
 HOUSING FINANCE AND DEVELOPMENT CORPORATION
 877 QUEEN STREET, SUITE 300
 HONOLULU, HAWAII 96813
 FAX (808) 527-3188

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



PLANNING DEPARTMENT
CITY AND COUNTY OF HONOLULU

430 SOUTH KING STREET, 8TH FLOOR • HONOLULU, HAWAII 96813-3017
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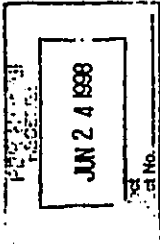


LEWIS HARRIS
MAYOR

PATRICK T. OMIEN
CHIEF PLANNING OFFICER
DONALD W. HARRIS
DEPUTY CHIEF PLANNING OFFICER

RNS 5/98-0965

June 22, 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
(IMK: 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)

Mr. Roy Oshiro, Director
Housing Finance and Development Corporation
June 22, 1998
Page 2

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

Mr. Roy Oshiro, Director
Housing Finance and Development Corporation
June 22, 1998
Page 3

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

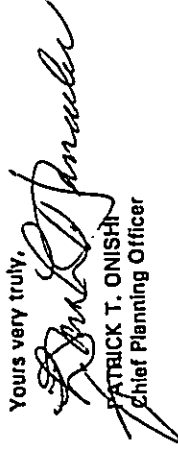
Mr. Roy Oshiro, Director
Housing Finance and Development Corporation
June 22, 1998
Page 4

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:rms

cc: State Office of Environmental Quality Control
VPBR Hawaii



REJANE J. CARRILLO
CONFIRM

KOYE CHANG
SUPERVISOR

98-DEV/2365

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION

877 QUEEN STREET, SUITE 200
HONOLULU, HAWAII 96813
FAX (808) 547-9600

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 been 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



Mr. Patrick T. Onishi
June 30, 1998
Page 2

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, Palalalai, 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, Palalalai, 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 been 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 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 establish 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 Plant (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 ORNL 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**

401 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, TRMs: 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 DONOHUE
Chief of Police

By *James Fenita*
JAMES FENITA
Assistant Chief
Administrative Bureau

cc: Ofc. of Environmental Quality Control
Mr. David Hulse, PBR Hawaii
Major Cary Tokunaga, District 8



STATE OF HAWAII

DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION

677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 517-4900

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:

- 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.
- 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
ROY S. OSHIRO
Executive Director



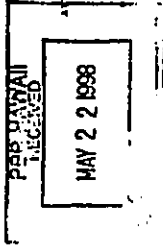
NOTES: DEIS/MS
EIS/IMPACT STATEMENT

DATE: 6/16/98

98:DEV/2167

**FIRE DEPARTMENT
CITY AND COUNTY OF HONOLULU**

3375 KONA PARK STREET, SUITE 2025
HONOLULU, HAWAII 96819



REPLY HEREIN
BY FAX

Mr. David Hulise
PBR Hawaii
1001 Bishop Street
Pacific Tower, Suite 650
Honolulu, Hawaii 96813

Dear Mr. Hulise:

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
Fire Chief

AKJ/CW:bh

BENJAMIN A. CASTILLO
GOVERNOR



STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
877 OAKEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 541-0909

May 27, 1998

Mr. Attilio K. Leonard, Fire Chief
Fire Department
City and County of Honolulu
3375 Kiapaka Street, Suite H425
Honolulu, Hawaii 96819-1869

Dear Mr. Leonard:

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



DEPARTMENT OF WASTEWATER MANAGEMENT
CITY AND COUNTY OF HONOLULU
630 SOUTH KING STREET, 3RD FLOOR • HONOLULU, HAWAII 96813
PHONE: (808) 527-5662 • FAX: (808) 527-6975



WASTEWATER
MANAGEMENT

KENNETH E. SPRAGUE, P.E., Ph.D.
DIRECTOR
CHERYL L. OLSON, DEPE 6510
DEPUTY DIRECTOR

In reply refer to:
WCC 98-112

June 16, 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, 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

Mr. Steve Thomas
Page 2
June 16, 1998

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 Mammala 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.

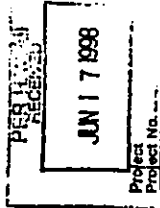
If you have any questions, please contact Ms. Tessa Ching of the Service Control Branch at 523-4956.

Sincerely,

CHERYL L. OLSON, DEPE

KENNETH E. SPRAGUE
for Director

cc: Office of the Governor (c/o Office of Environmental Quality Control)
Mr. David Hulise (PBR HAWAII)





STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
877 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 521-0400

ROY S. OSHIRO
EXECUTIVE DIRECTOR

98:DEV/2258

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



The Honorable Kenneth E. Sprague, Director
June 22, 1998
Page 2

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 LA 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

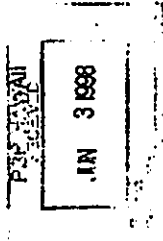
DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU

630 SOUTH KING STREET, 10TH FLOOR • HONOLULU, HAWAII 96813
PHONE: (808) 533-4192 • FAX: (808) 533-4024



WILLIAM D. BALFOUR, JR.
DIRECTOR
MICHAEL T. ARM
DEPUTY DIRECTOR

MAY 28, 1998



Mr. Steve Thomas
Page 2
May 28, 1998

Neighborhood Parks - approximately 6 acres in size and serving approximately 5,000 people.

Community Parks - approximately 10 acres in size and serving 10,000 people.

District Parks - 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 linear park/open space associated with the Kalo 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

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:

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. 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 playgrounds, 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 playgrounds, playcourts, passive areas, and a recreation building.
- Neighborhood Parks** : Approximately 6 acres in size and serving approximately 5,000 people. Facilities may include playgrounds, 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.*



DEV

FILE COPY

DONALD K W LAU
DIRECTOR

SPENCER L. MATSUDA
EXECUTIVE ASSISTANT

STATE OF HAWAII

DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM
HOUSING AND COMMUNITY DEVELOPMENT CORPORATION OF HAWAII

577 QUEEN STREET, SUITE 200
HONOLULU, HAWAII 96813
FAX (808) 587-0000

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

The Honorable William D. Balfour, Jr., Director

July 8, 1998

Page 2

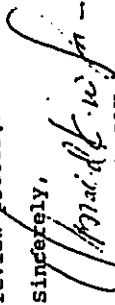
passive park areas will have slopes no greater than 5 percent (5%) and the width will range between 108 feet to 360 feet. These areas will provide a major recreation resource to the community. For example, the combined land area of the proposed district park and the adjoining passive park area is over 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
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

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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 visible from the HI 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 Genery Waiala begins delivering units between 1997 and 2000, and Castle and Cooke is allowed to rezoned 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 Makiwa 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 must 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

The Prudential Locations, Inc. Research & Consulting Division, 3485 Waialae Ave., Fourth Floor, Honolulu, HI 96818 Telephone: (808) 738-3220 Fax: (808) 735-5999

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 1-1 East Kapolei Projected Unit Absorption and Pricing

Table with columns: Year, Units (SF, MF, Total), Unit Price (SF, MF, Total), Gross Revenue from Unit Sales (SF, MF, Total). Rows show years 2001-2019 and a total row.

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 1-2 East Kapolei Projected Developer Price per Acre

Table with columns: Year, Acres (SF, MF, Total), Gross Rev from Unit Sales (SF, MF, Total), Land Acquisition (SF, MF, Total), Developer Price per Acre (SF, MF, Average). Rows show years 1999-2017 and a total row.

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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

Developer Sale Date	Acres	Type	Unit Sales Year	Developer Price per Acre	Developer Sale Price	Discount for Bulk Sales	Discounted Sale Price
1999	400	SF/MF	2001 - 2009	\$347,000	\$138,800,000	83%	\$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
2013	11	SF	2014	\$498,000	\$5,478,000	100%	\$5,478,000
2013	37	SF	2015	\$444,000	\$16,428,000	100%	\$16,428,000
2014	31	SF	2015	\$507,000	\$15,723,000	100%	\$15,723,000
2014	37	SF	2016	\$453,000	\$16,781,000	100%	\$16,781,000
2014	11	SF	2016	\$519,000	\$5,668,000	100%	\$5,668,000
2015	37	SF	2017	\$481,000	\$17,657,000	100%	\$17,657,000
2015	11	SF	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	SF	2018	\$519,000	\$5,709,000	100%	\$5,709,000
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	Sale Price
2003	2	\$2,979,612
2008	6	\$9,703,524
2014	8	\$14,570,360
2020	8	\$16,408,612
Total	24	\$43,612,158

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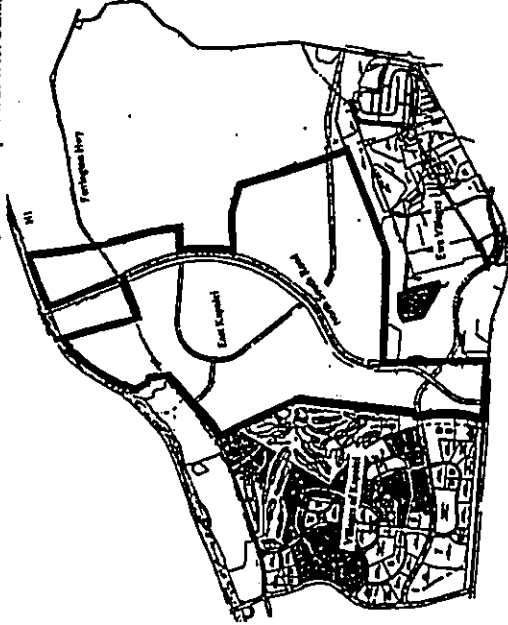
II. INTRODUCTION

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 RS, 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 better climate and lower precipitation compared to most competitive developments in the Ewa 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, consumer traffic, and the current lack of local white collar jobs. However, these drawbacks should also trouble any new development in West Oahu.



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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 8.8% 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 HI 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 growing 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 2.40 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 cross-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). Virtually, 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). Virtually, 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%	68%	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.

Table VII-1

Table with columns: Area, Type, Before 1960, 1960-1969, 1970-1979, 1980-1989, 1990-1995, Totals. Rows include Central Oahu DPA, Ewa DPA, and West Oahu.

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.

Table VII-2

Table with columns: Year Built, Single Family, Multi-family. Rows for years 1990, 1991, 1992, 1993, 1994, 1995, 1996, and Total.

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.

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East Kapolei Market Study

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.

Table VII-2 West Oahu Estimated Absorption Schedule (1997 - 2020)

Table with columns: Development Plan Area, Annual Unit Demand, 5 Year Unit Demand. Rows include Central Oahu, Ewa, and Oahu Total.

Ewa Development Plan Area

Table with columns: Map Ref., 1997-2000, 2001-2005, 2006-2010, 2011-2015, 2016-2020, Total. Rows include various map areas like Village of Kapolei, Ewa Village, etc.

Central Oahu Development Plan Area

Table with columns: Map Ref., 1997-2000, 2001-2005, 2006-2010, 2011-2015, 2016-2020, Total. Rows include various map areas like Leialua Valley, Waikele, etc.

Central Oahu & Ewa Development Plan Areas

Summary table for Central Oahu & Ewa Development Plan Areas with columns for years 1997-2000 through 2016-2020 and Total.

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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 Manuka, 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

Year	Units		Acres	
	SF	MF	Total	Total
1999			21.90	8.28
2000			36.89	10.71
2001	133	88	221	36.89
2002	225	150	375	36.89
2003	225	150	375	36.89
2004	225	150	375	36.89
2005	225	150	375	36.89
2006	225	150	375	36.89
2007	225	150	375	36.89
2008	225	150	375	36.89
2009	225	150	375	36.89
2010	225	150	375	36.89
2011	225	150	375	36.89
2012	225	150	375	36.89
2013	225	150	375	36.89
2014	225	150	375	36.89
2015	225	112	337	36.89
2016	225	112	337	36.89
2017	225	112	337	36.89
2018	225	112	337	36.89
2019	225	112	337	36.89
Total	4,183	2,300	6,483	686
				164
				850

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. 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 analysis 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.

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Telephone: (808) 736-3220 Fax: (808) 735-3199

Figure IX-2
Estimated Sales Price Per Acre

Year	Annual Net Income per Acre	Sales Price per Acre
2001	\$352,404	\$1,407,619
2002	\$359,460	\$1,438,098
2003	\$366,648	\$1,469,808
2004	\$373,960	\$1,494,092
2005	\$381,458	\$1,523,938
2006	\$389,068	\$1,554,446
2007	\$396,878	\$1,585,597
2008	\$404,800	\$1,617,264
2009	\$412,800	\$1,649,637
2010	\$421,164	\$1,682,808
2011	\$429,568	\$1,716,788
2012	\$438,180	\$1,750,595
2013	\$446,940	\$1,785,371
2014	\$455,800	\$1,821,205
2015	\$464,800	\$1,857,745
2016	\$474,000	\$1,894,899
2017	\$483,292	\$1,932,857
2018	\$493,664	\$1,971,478
2019	\$503,328	\$2,010,853
2020	\$513,398	\$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	\$2,929,812
2008	6	\$9,703,574
2014	8	\$14,570,360
2020	8	\$18,408,072
Total	24	\$43,612,168

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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%, \$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	\$7,820,812
2008	6	\$9,703,574
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 as 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.

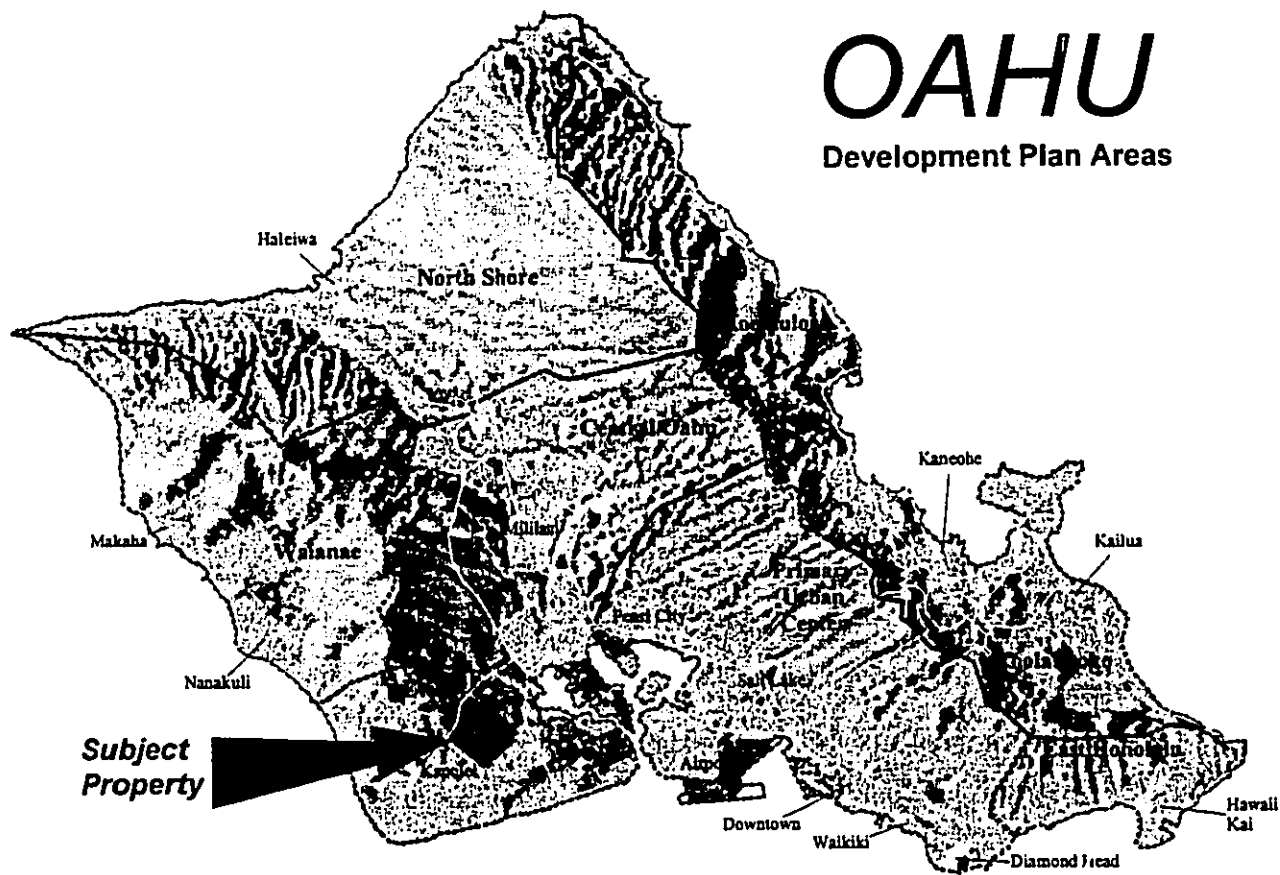
The following table shows a likely scenario for residential land sales at East Kapolei. This scenario assumes there would be 13 transactions, two of which would be bulk land sales. Developer land sales are estimated to begin in 1999 with a bulk land sale of 400 acres and a second bulk land sale of 180 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

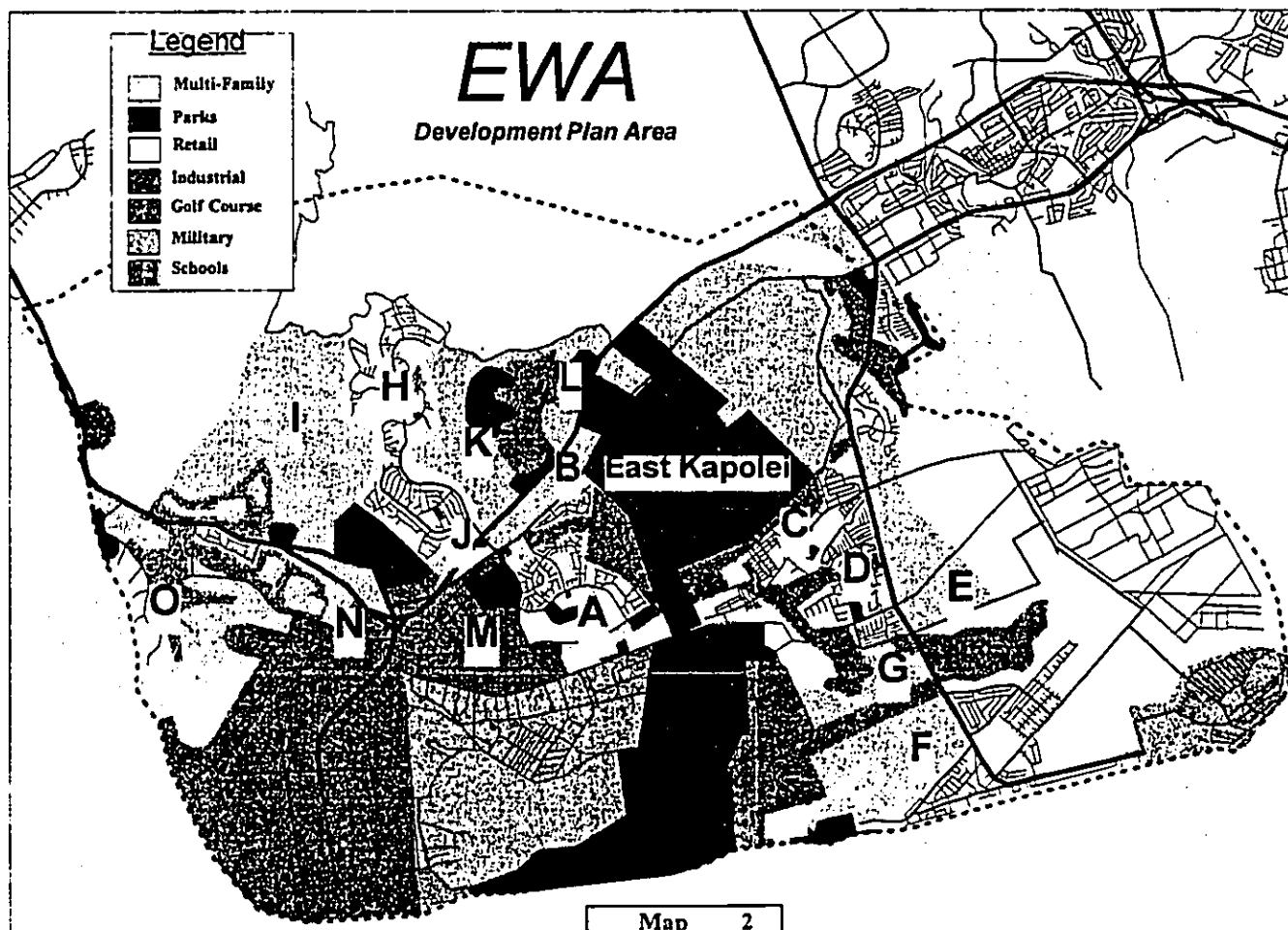
Developer Sale Date	Acres	Type	Unit Sales Year	Developer Price Per Acre	Developer Sale Prices	Discount for Bulk Sales	Discounted Sale Prices
1999	400	SF/MF	2001 - 2009	\$347,000	\$138,800,000	87%	\$113,816,000
2007	180	SF/MF	2009 - 2013	\$407,000	\$73,260,000	85%	\$60,597,000
2012	37	SF	2014	\$435,000	\$16,095,000	100%	\$16,095,000
2013	11	SF	2014	\$498,000	\$5,458,000	100%	\$5,458,000
2014	37	SF	2015	\$444,000	\$16,428,000	100%	\$16,428,000
2015	11	SF	2015	\$507,000	\$5,577,000	100%	\$5,577,000
2016	37	SF	2016	\$453,000	\$16,781,000	100%	\$16,781,000
2017	11	SF	2017	\$518,000	\$5,698,000	100%	\$5,698,000
2018	37	SF	2018	\$461,000	\$17,057,000	100%	\$17,057,000
2019	11	SF	2018	\$528,000	\$5,808,000	100%	\$5,808,000
2020	37	SF	2019	\$471,000	\$17,427,000	100%	\$17,427,000
2021	11	SF	2019	\$539,000	\$5,929,000	100%	\$5,929,000
2022	30	SF	2019	\$481,000	\$14,430,000	100%	\$14,430,000
Total	850						\$310,079,000

OAHU

Development Plan Areas

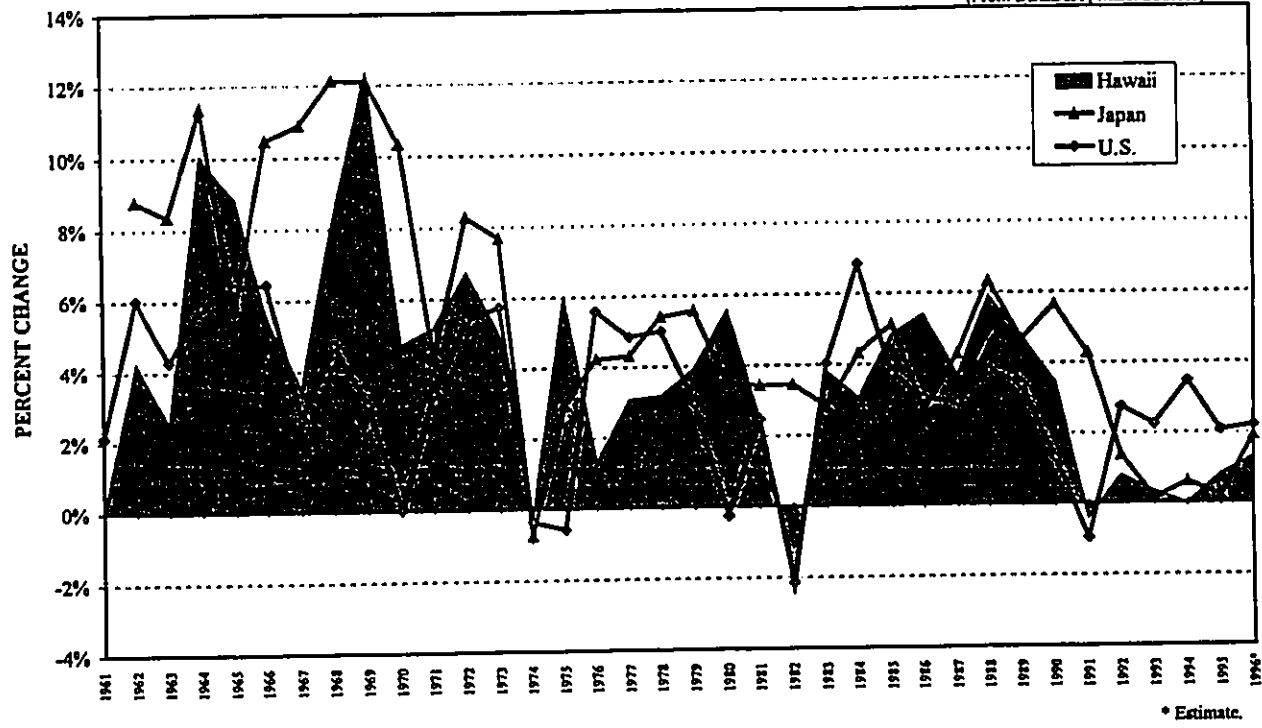


Map 1



ANNUAL CHANGE IN GROWTH OF THE ECONOMY
(Hawaii, Japan, U.S.)

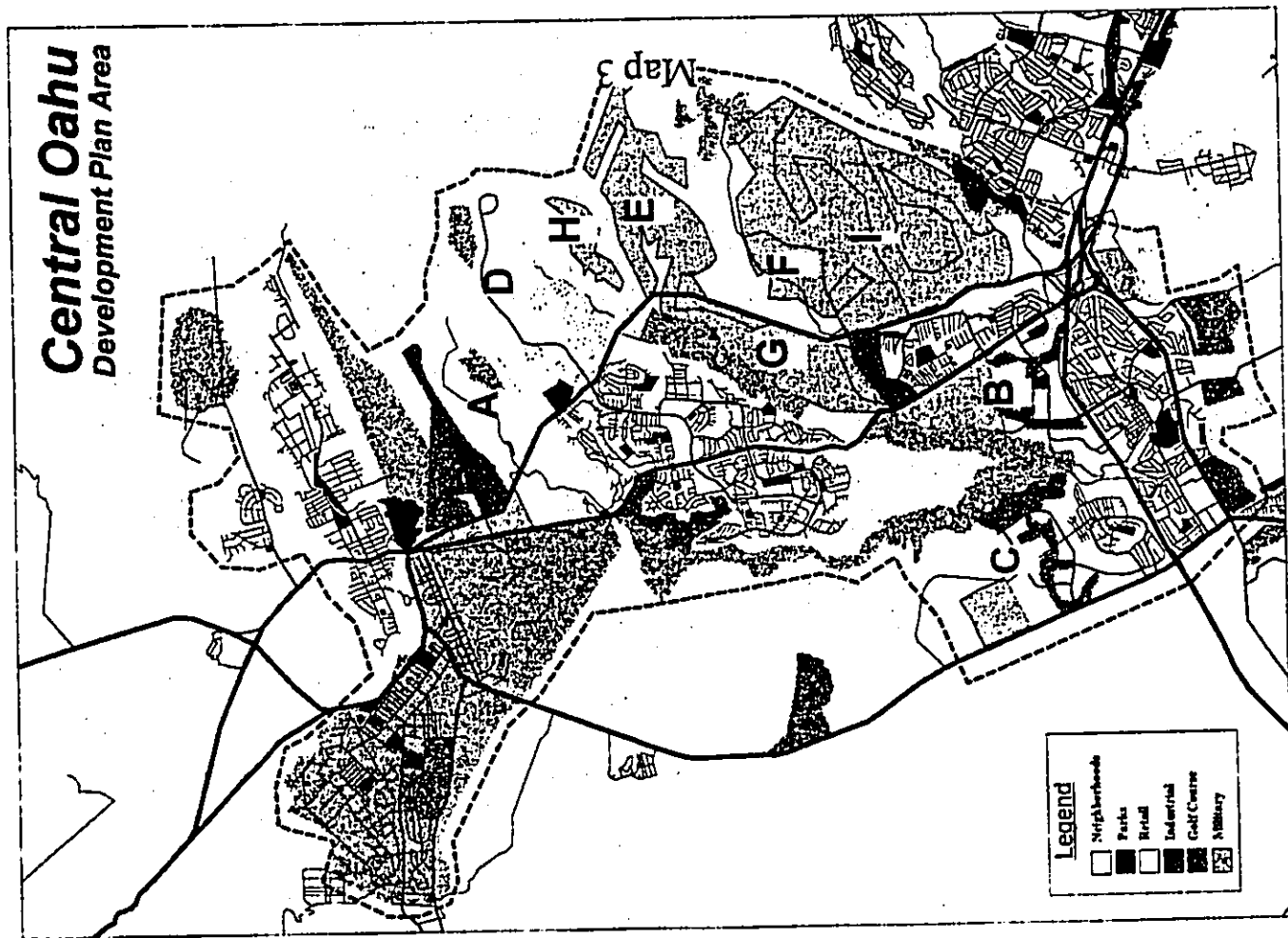
(From DBED&T, Misc. Sources)



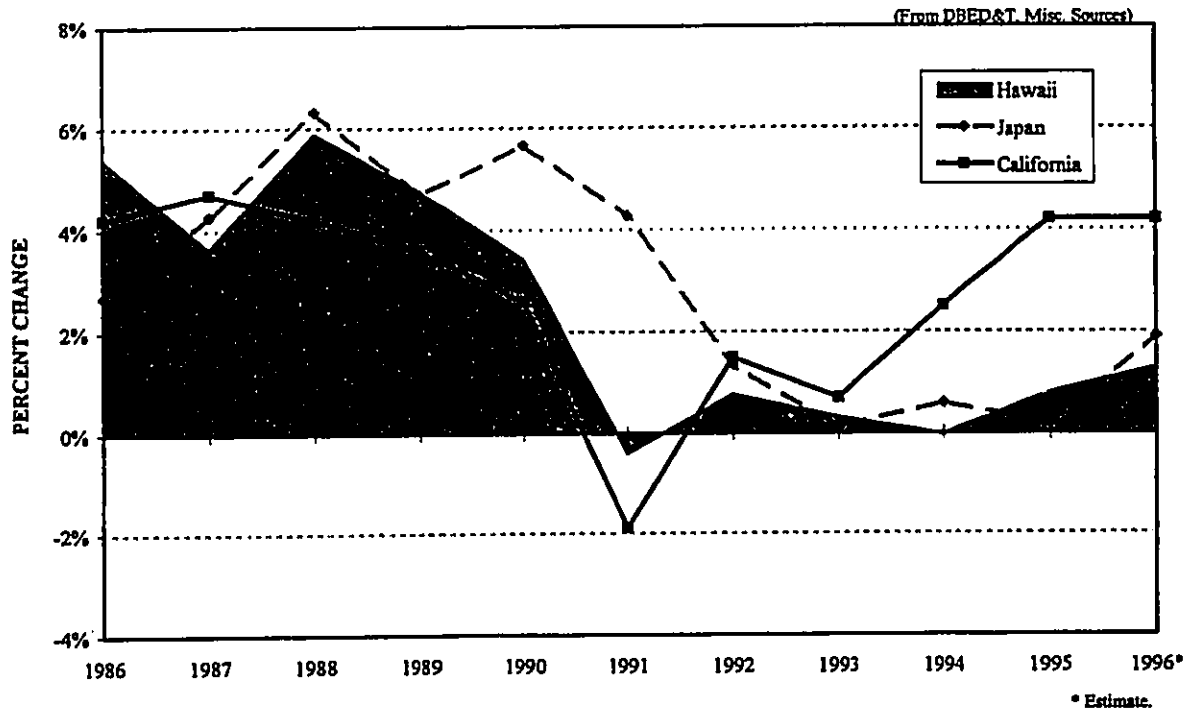
* Estimate.

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Figure IV - 1



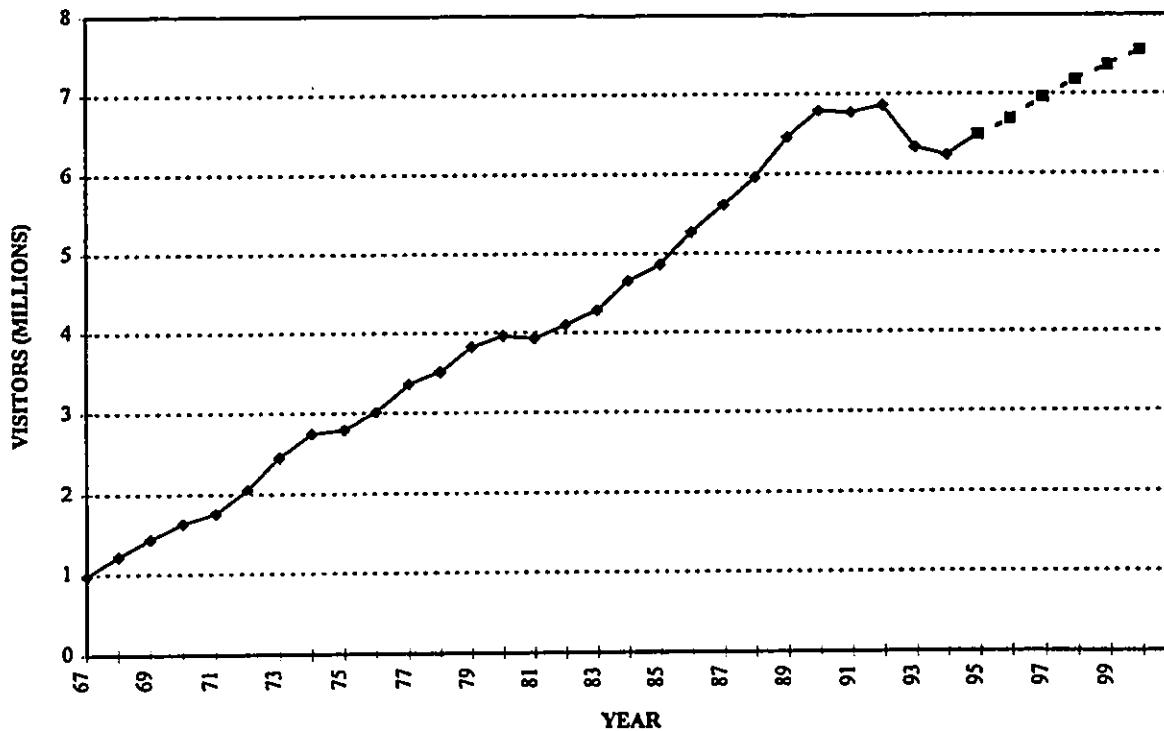
**ANNUAL CHANGE IN GROWTH OF THE ECONOMY
(Hawaii, Japan, California)**



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure IV - 2

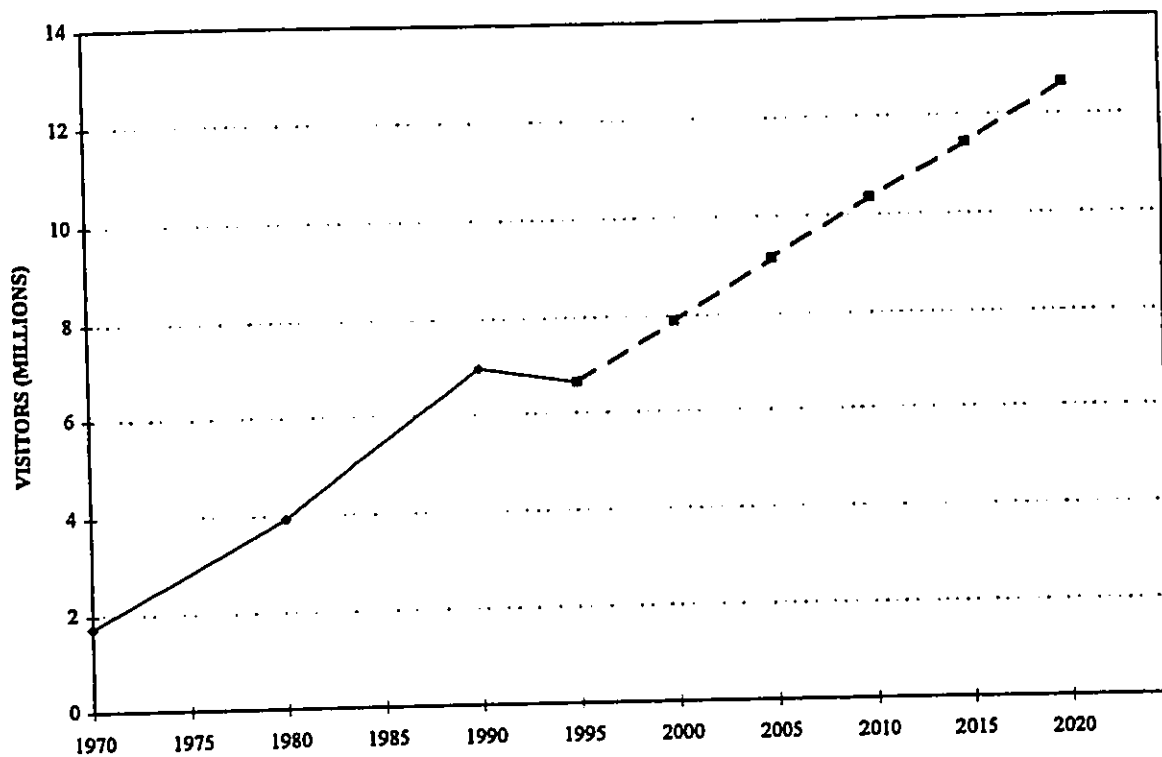
HAWAII VISITOR ARRIVALS AND FORECAST



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure IV - 3

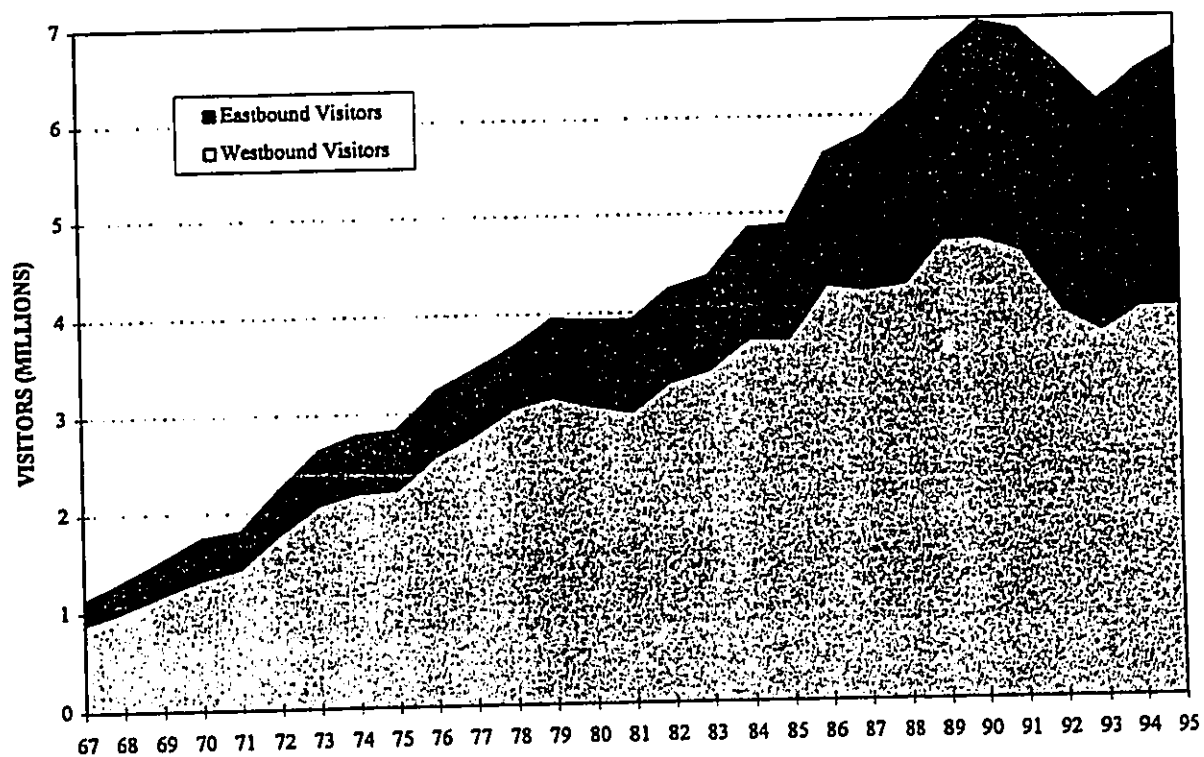
HAWAII ANNUAL VISITOR ARRIVALS AND FORECAST



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure IV - 4

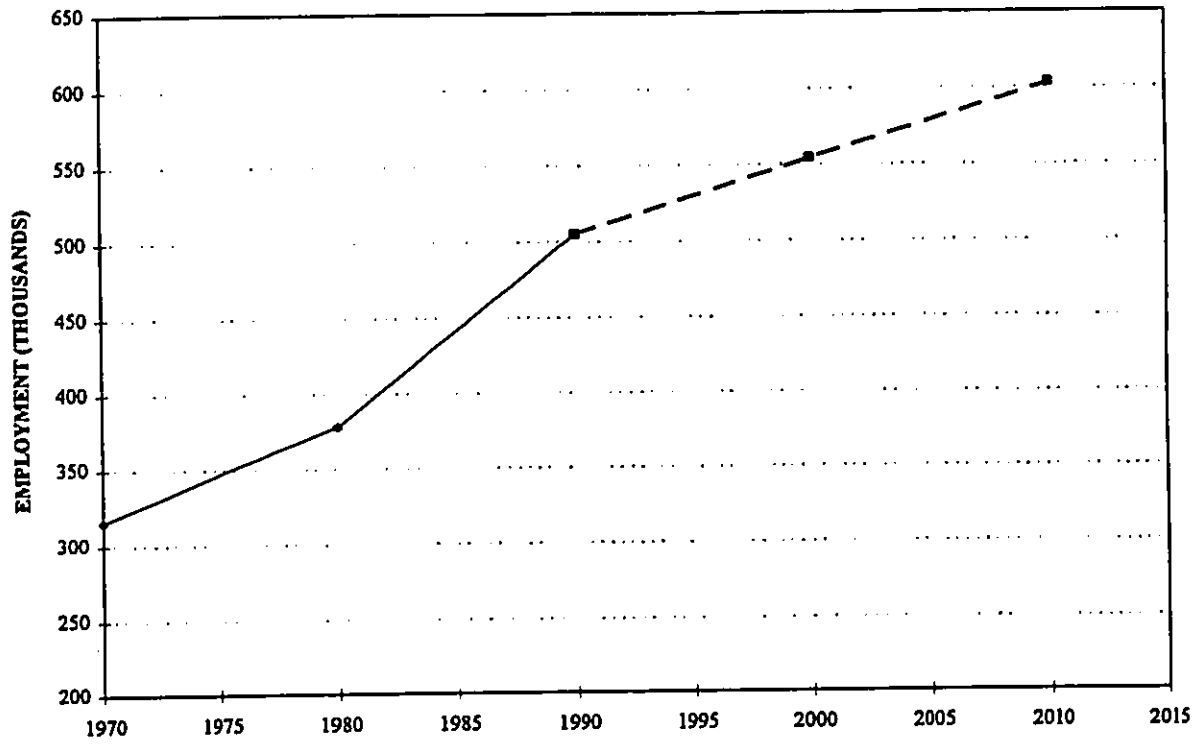
HAWAII ANNUAL VISITOR ARRIVALS



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Figure IV - 5

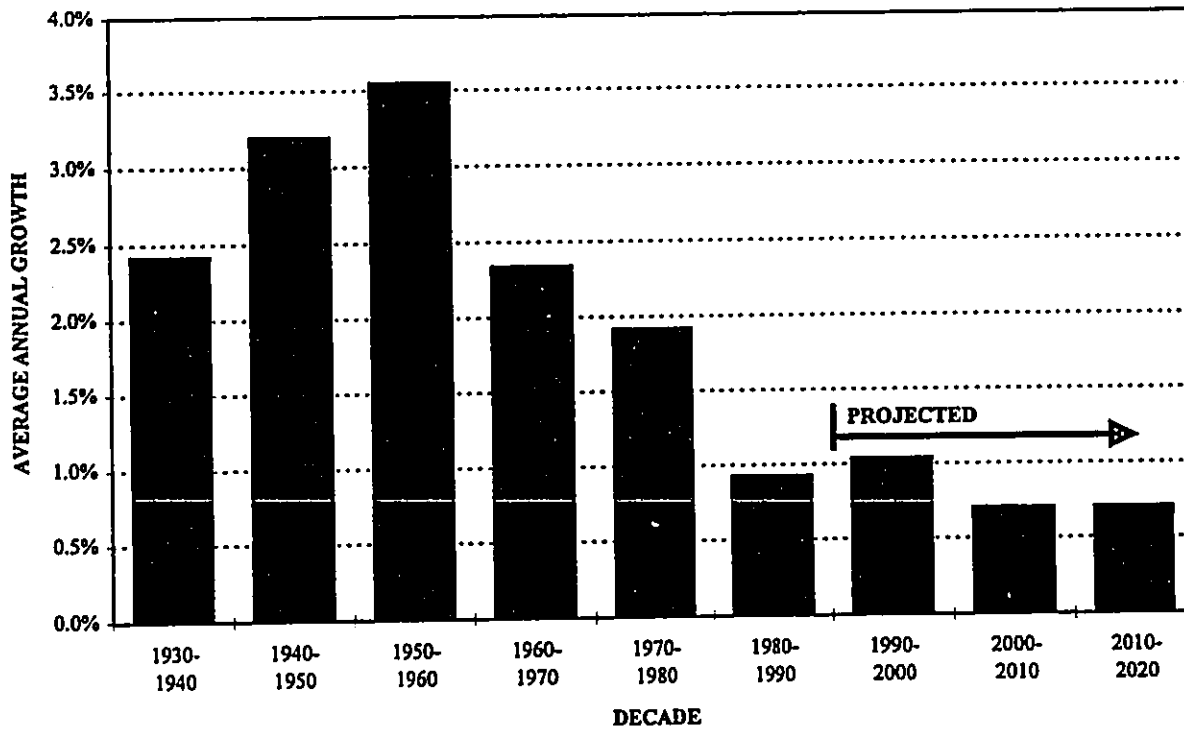
OAHU TOTAL EMPLOYMENT AND FORECAST



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Figure IV - 6

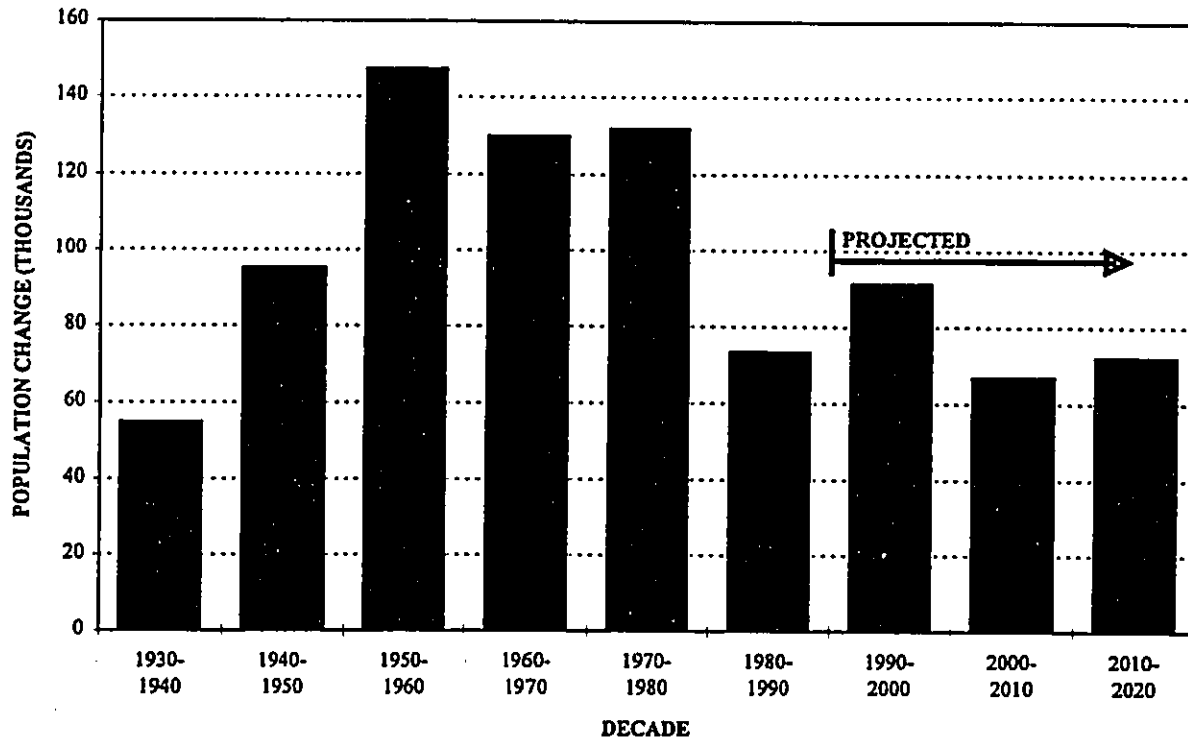
OAHU AVERAGE ANNUAL POPULATION GROWTH



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure IV - 7

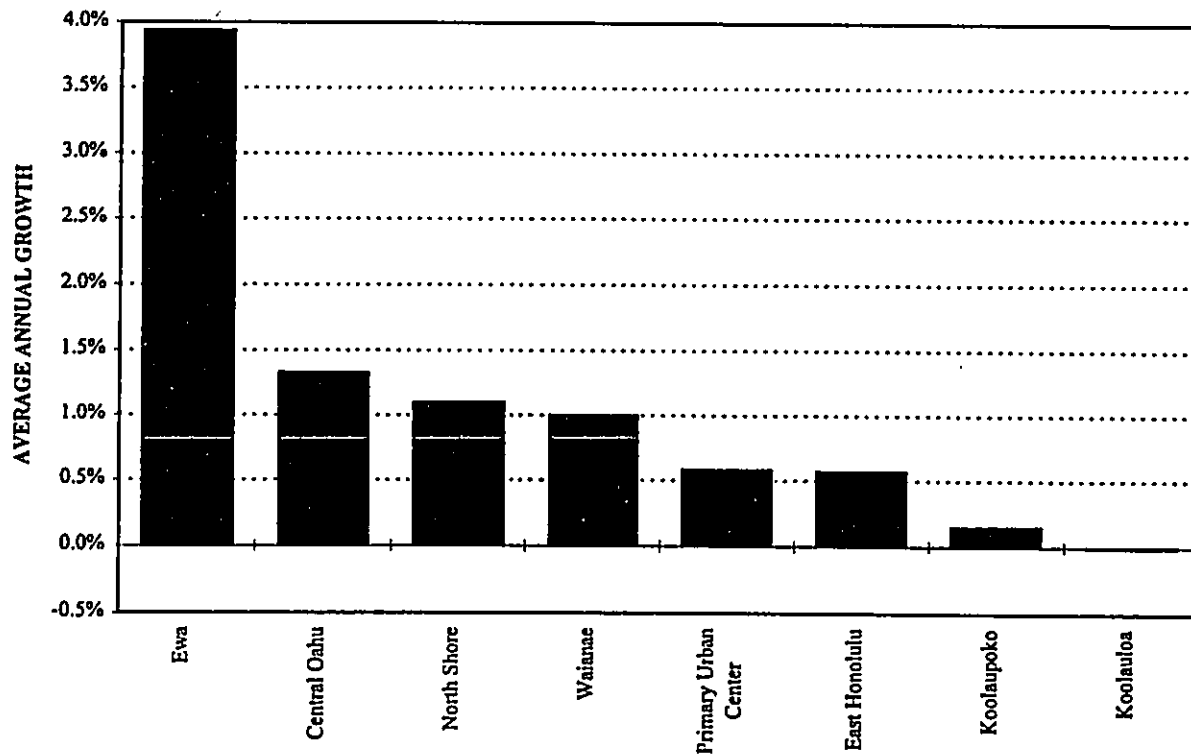
OAHU POPULATION CHANGE BY DECADE



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure IV - 8

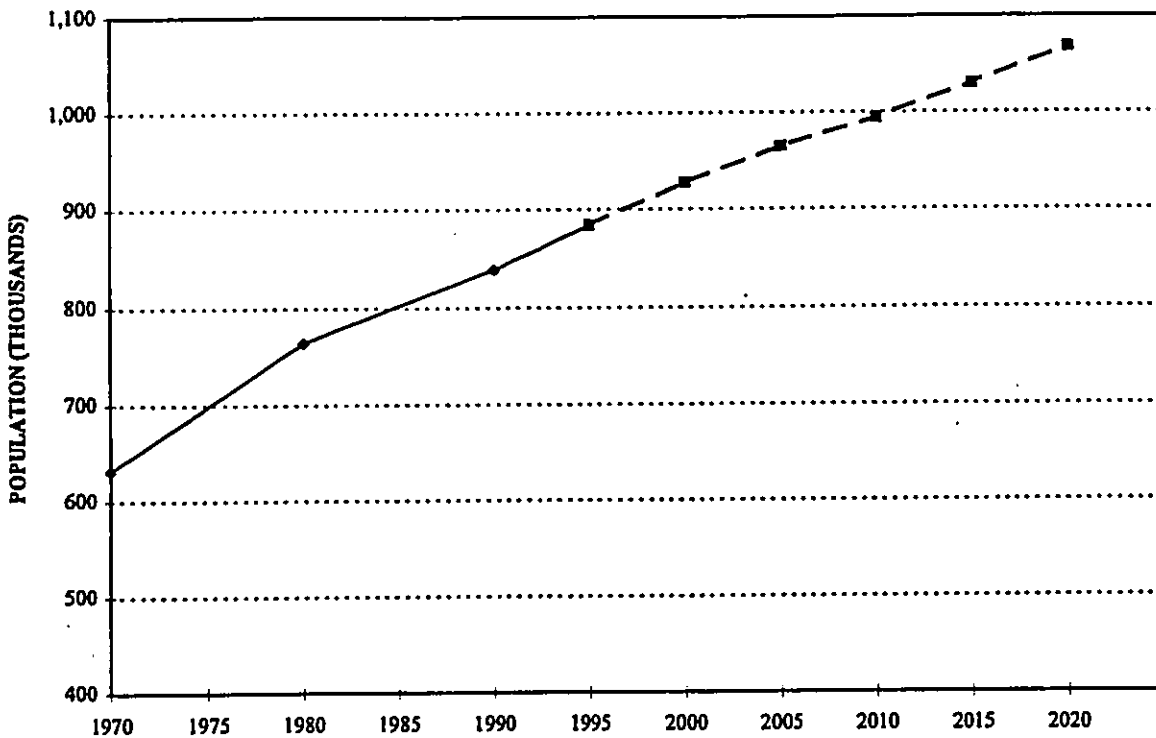
OAHU 1990-2010 PROJECTED AVERAGE ANNUAL POPULATION GROWTH BY DPA



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure IV - 9

OAHU RESIDENT POPULATION AND FORECAST

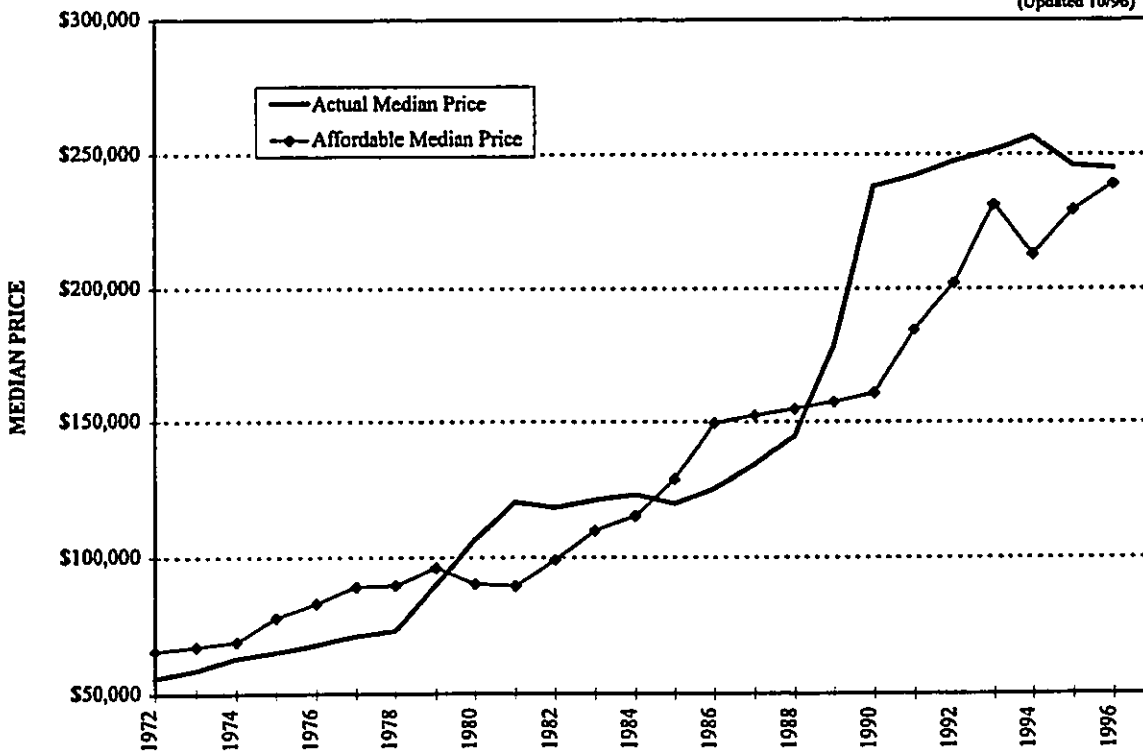


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Figure IV - 10

OAHU ACTUAL VS AFFORDABLE HOME PRICE

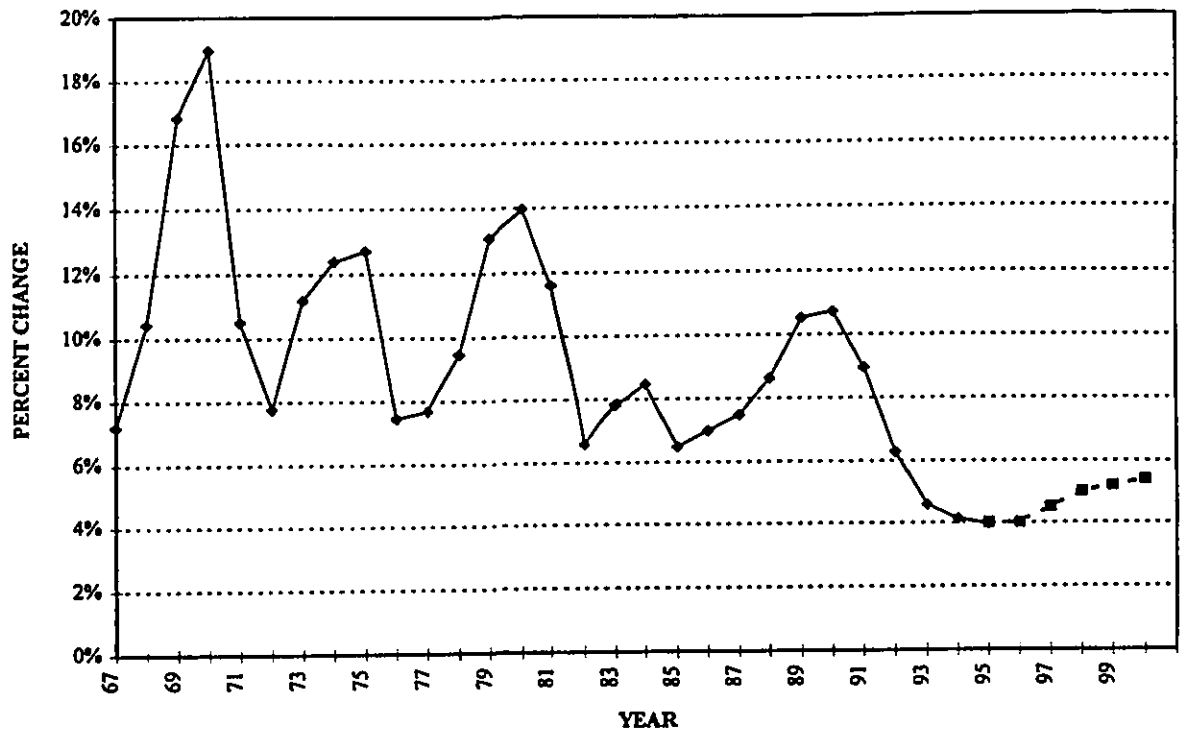
(Updated 10/96)



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Figure IV - 11

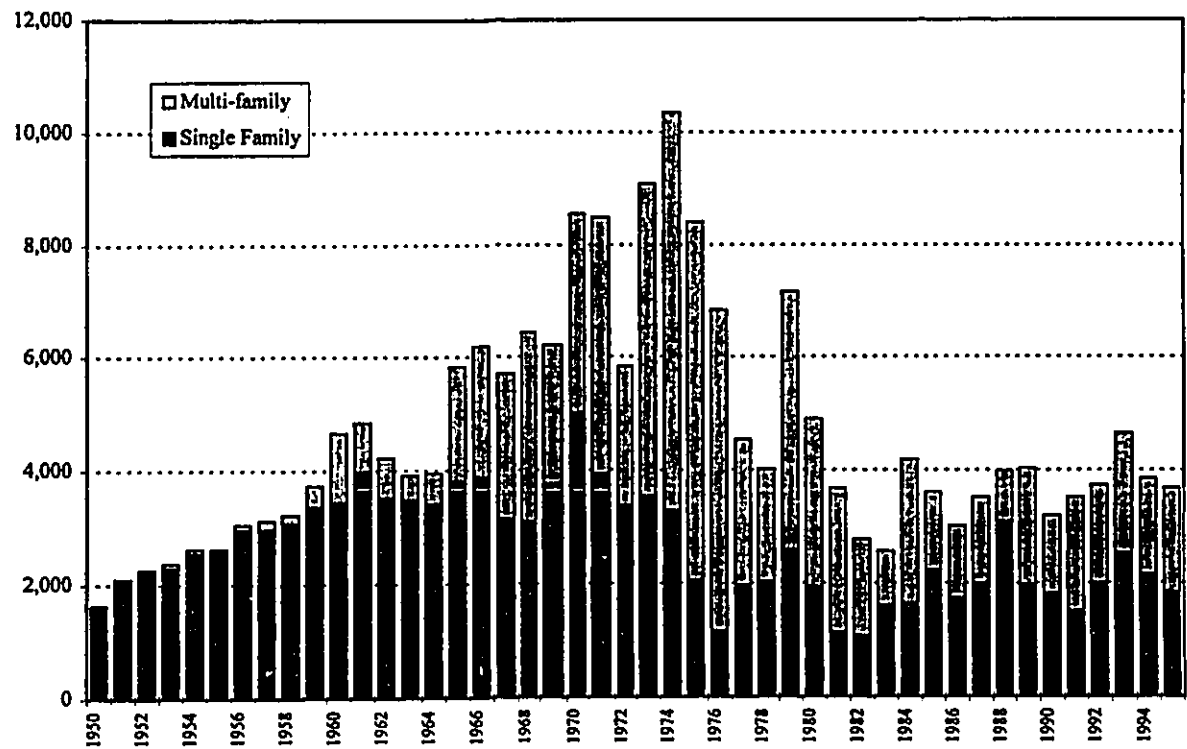
HAWAII TOTAL PERSONAL INCOME PERCENT CHANGE AND FORECAST



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Figure IV - 12

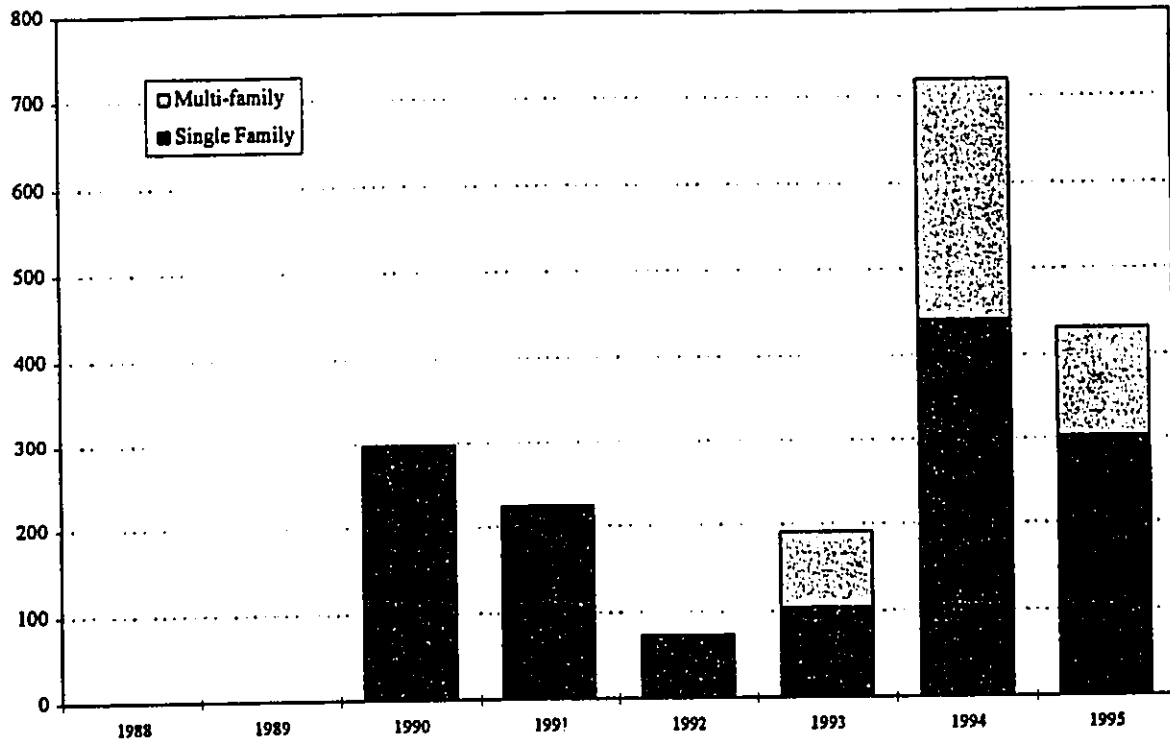
OAHU ANNUAL HOUSING CONSTRUCTION



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure IV - 13

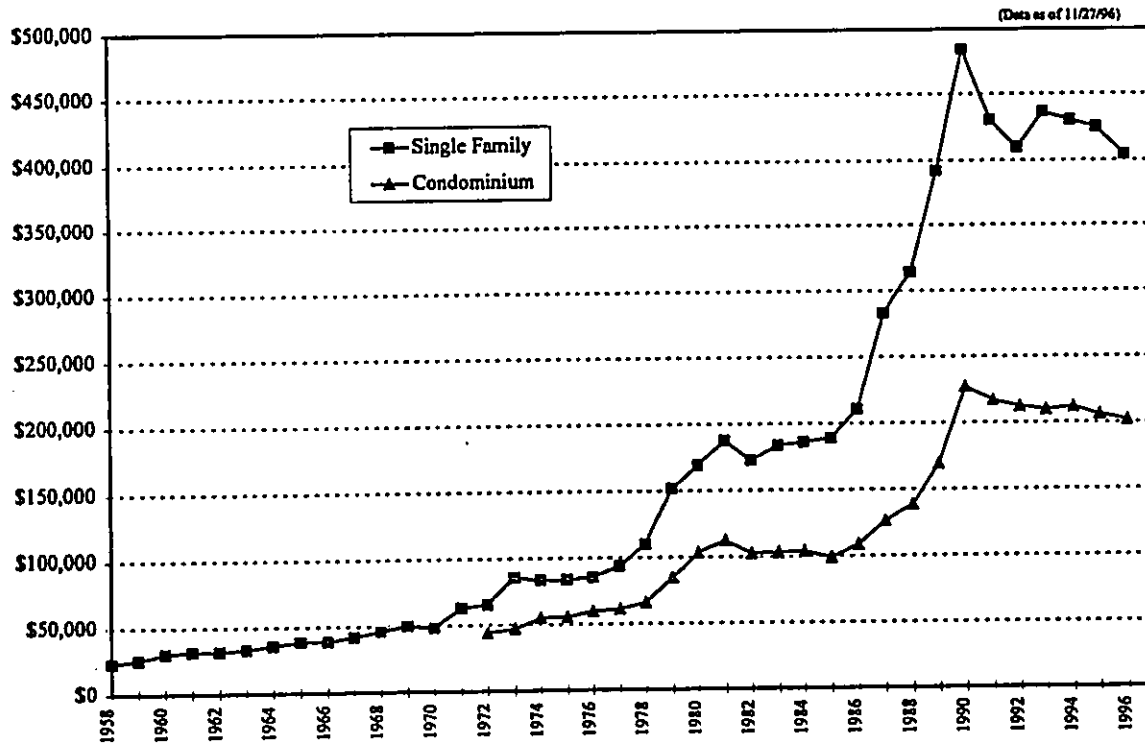
KAPOLEI ANNUAL HOUSING CONSTRUCTION



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Figure IV - 14

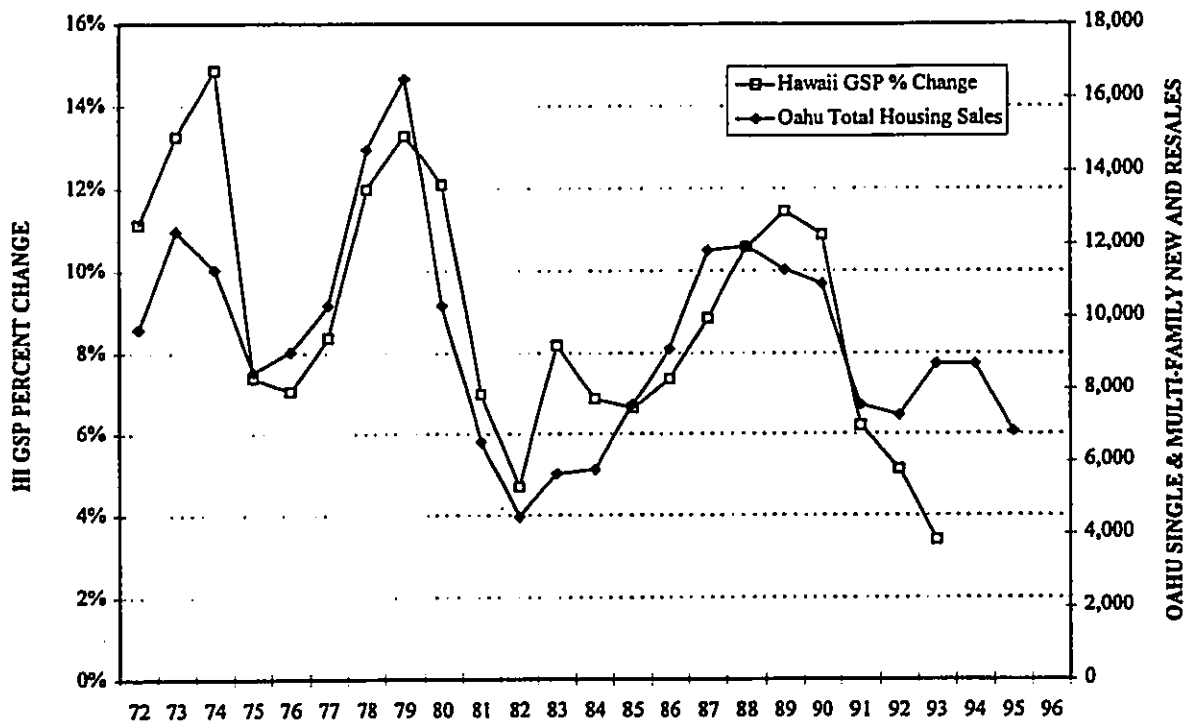
OAHU SINGLE FAMILY & CONDOMINIUM AVERAGE RESALE PRICES



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure IV - 15

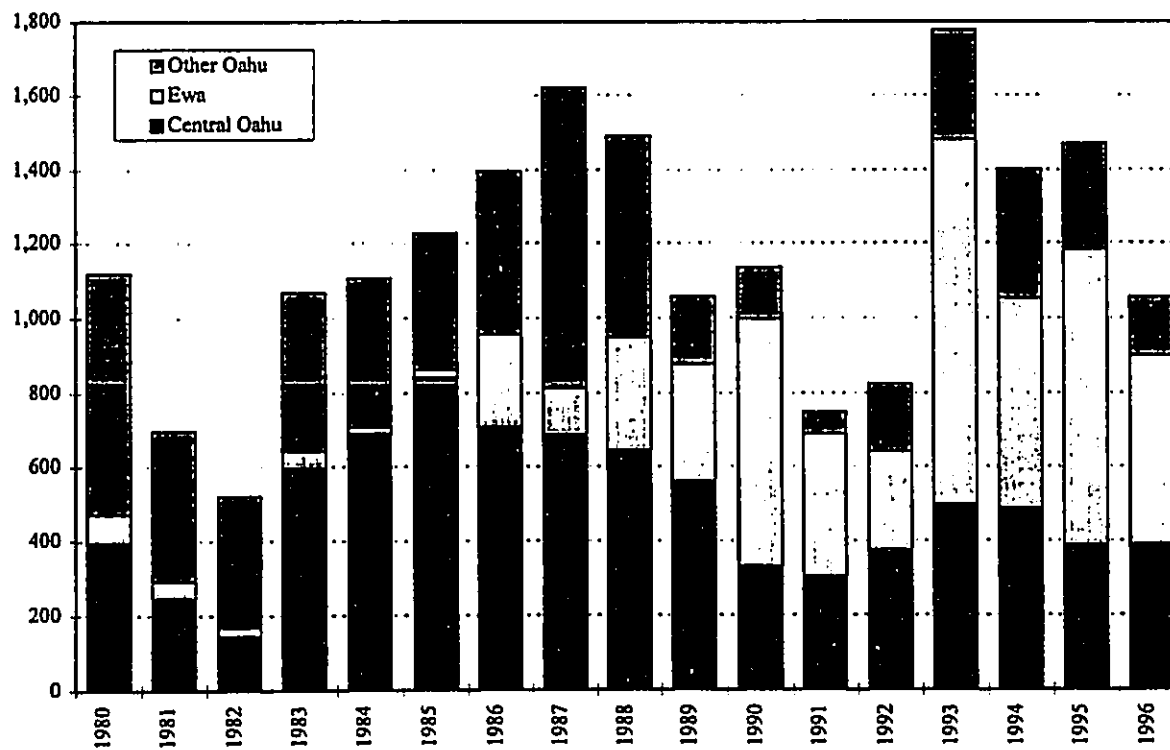
HAWAII GSP PERCENT CHANGE VS. OAHU TOTAL HOUSING SALES



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure IV - 16

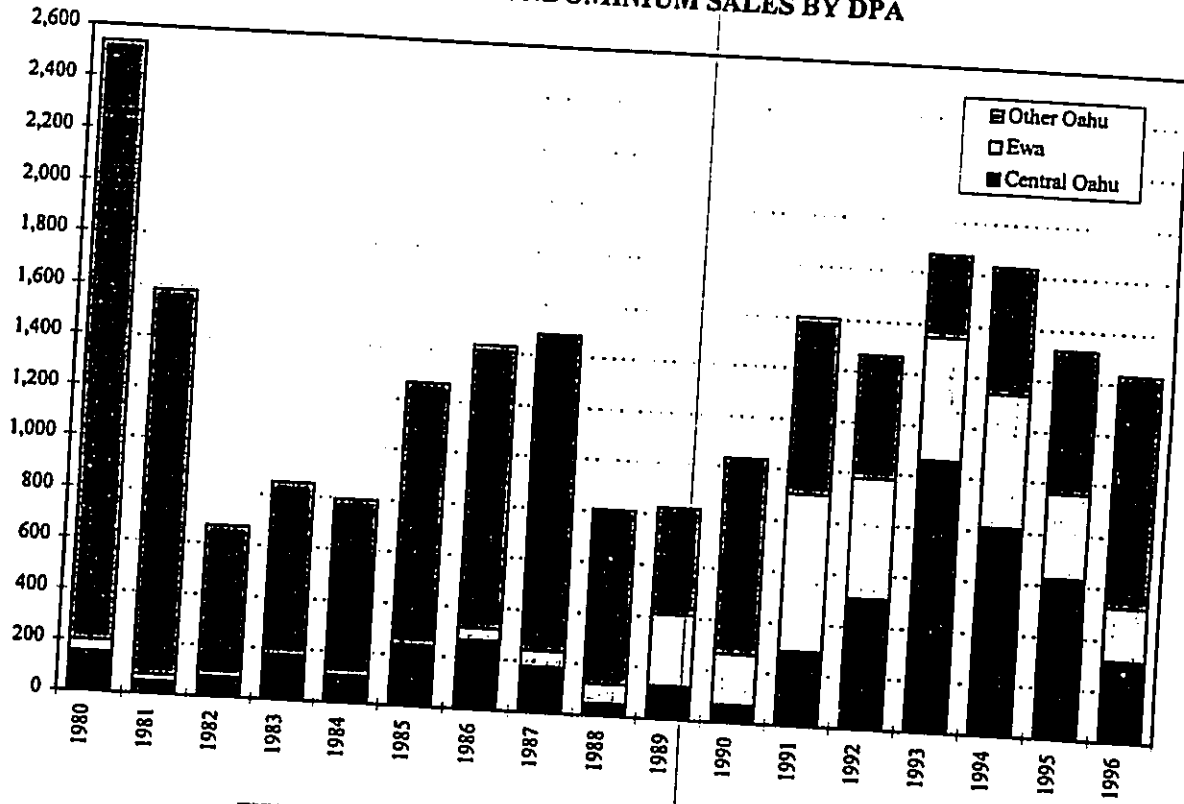
OAHU NEW SINGLE FAMILY SALES BY DPA



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure V - 1

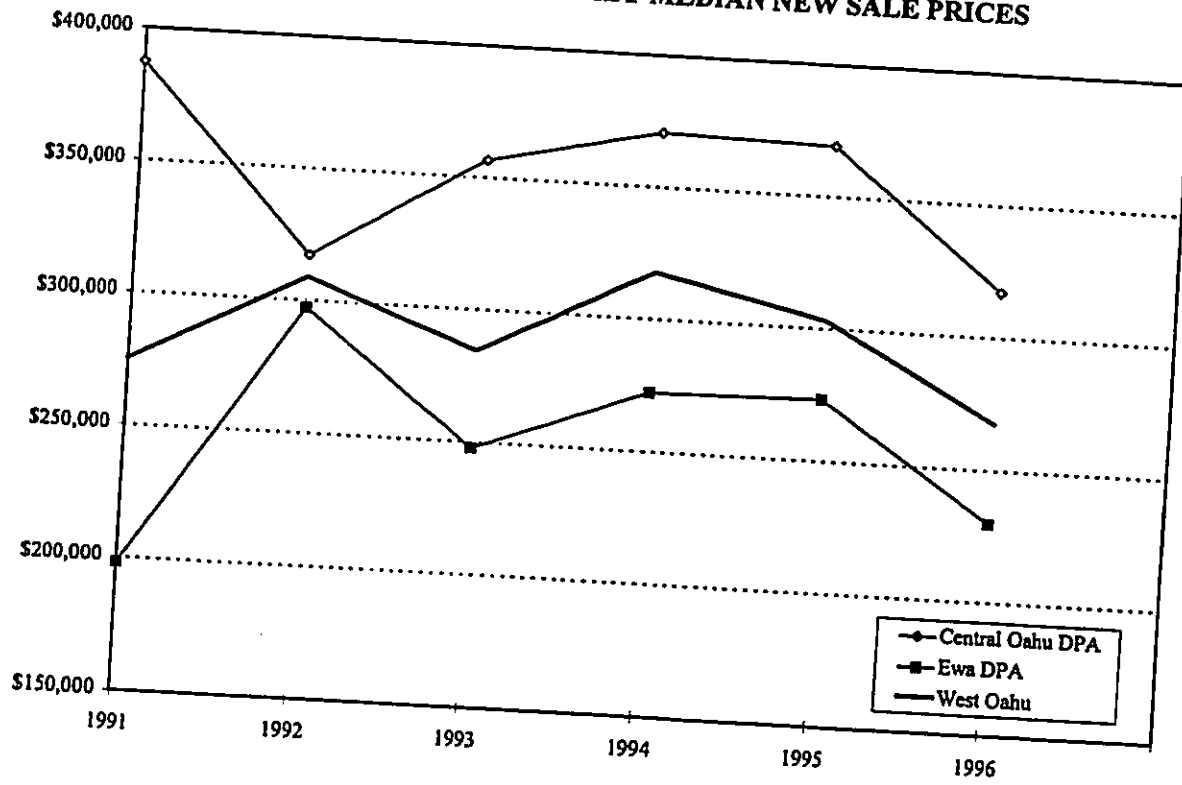
OAHU NEW CONDOMINIUM SALES BY DPA



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure V - 2

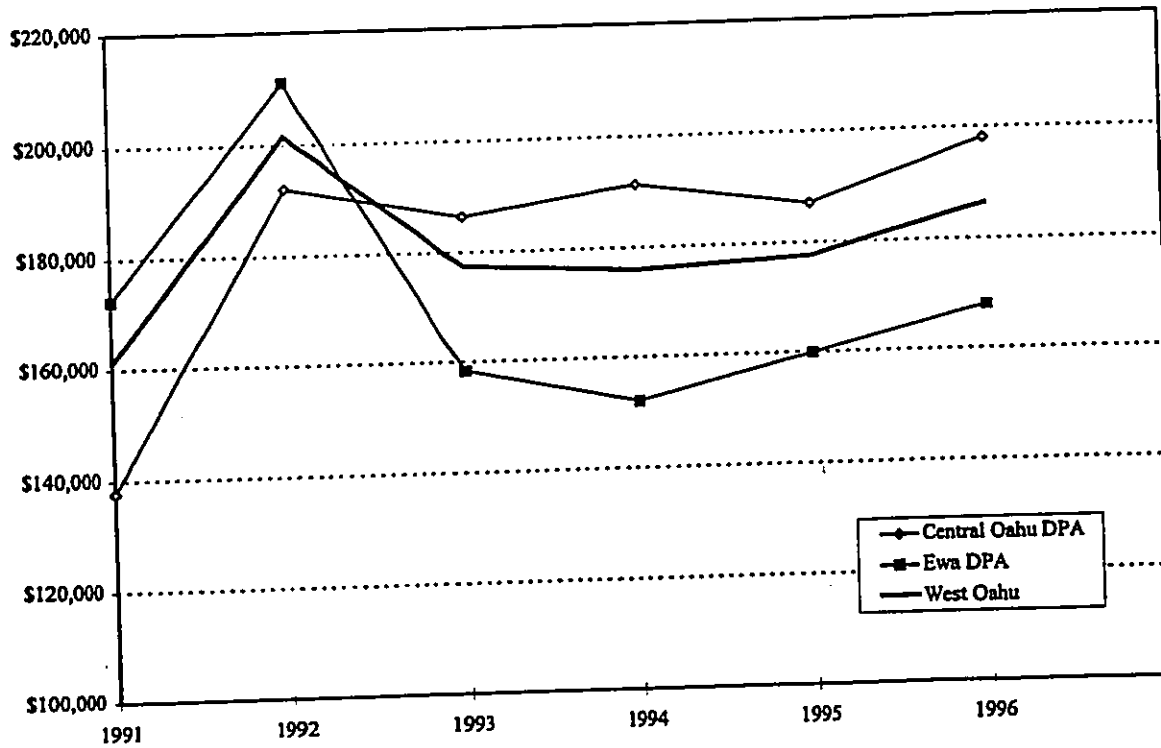
WEST OAHU SINGLE FAMILY MEDIAN NEW SALE PRICES



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure V - 3

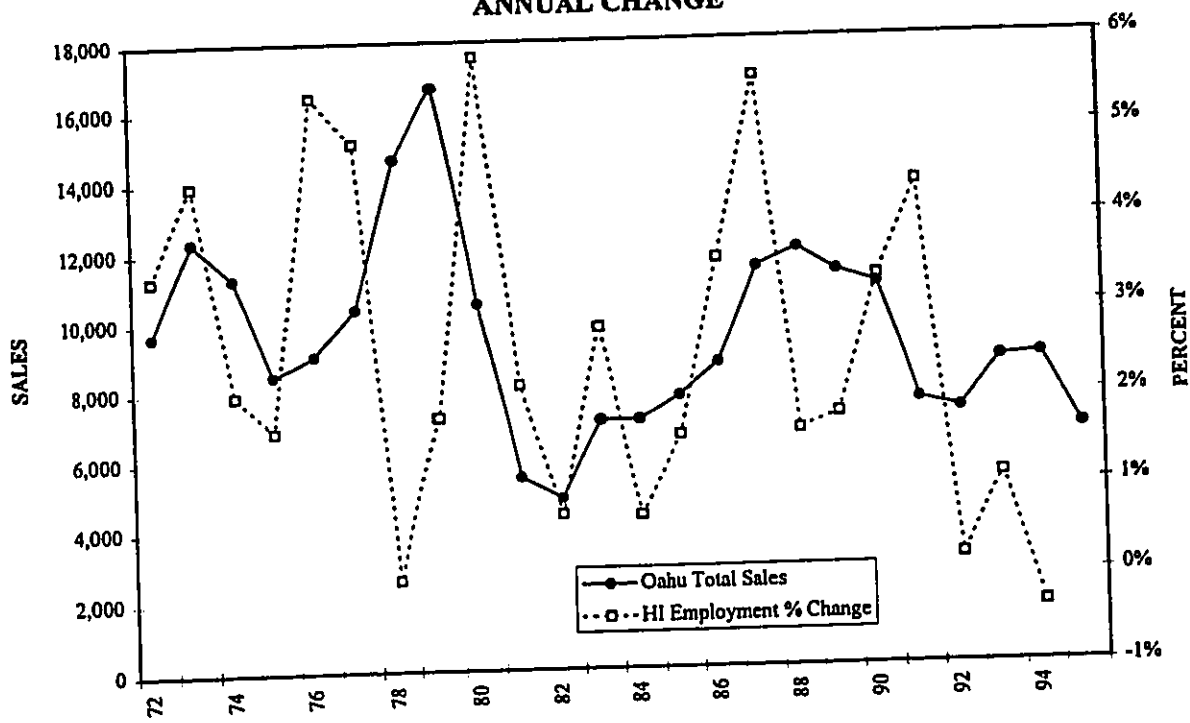
WEST OAHU MULTI-FAMILY MEDIAN NEW SALE PRICES



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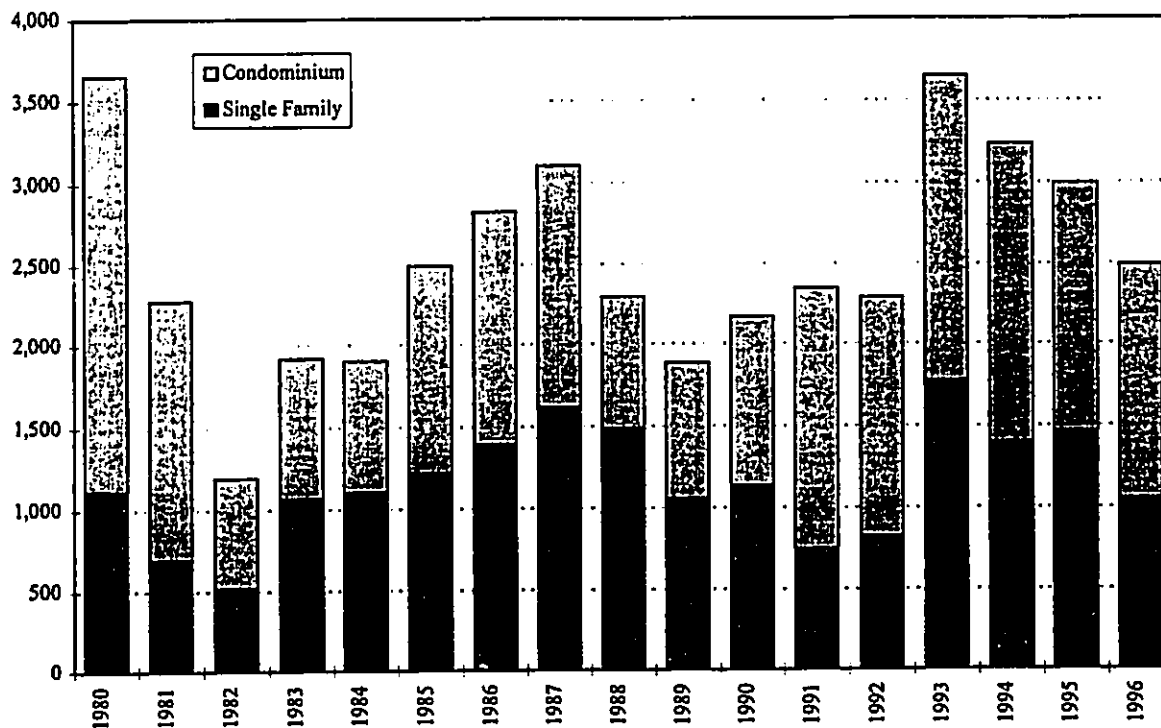
Figure V - 4

OAHU TOTAL REAL ESTATE SALES AND HAWAII EMPLOYMENT ANNUAL CHANGE



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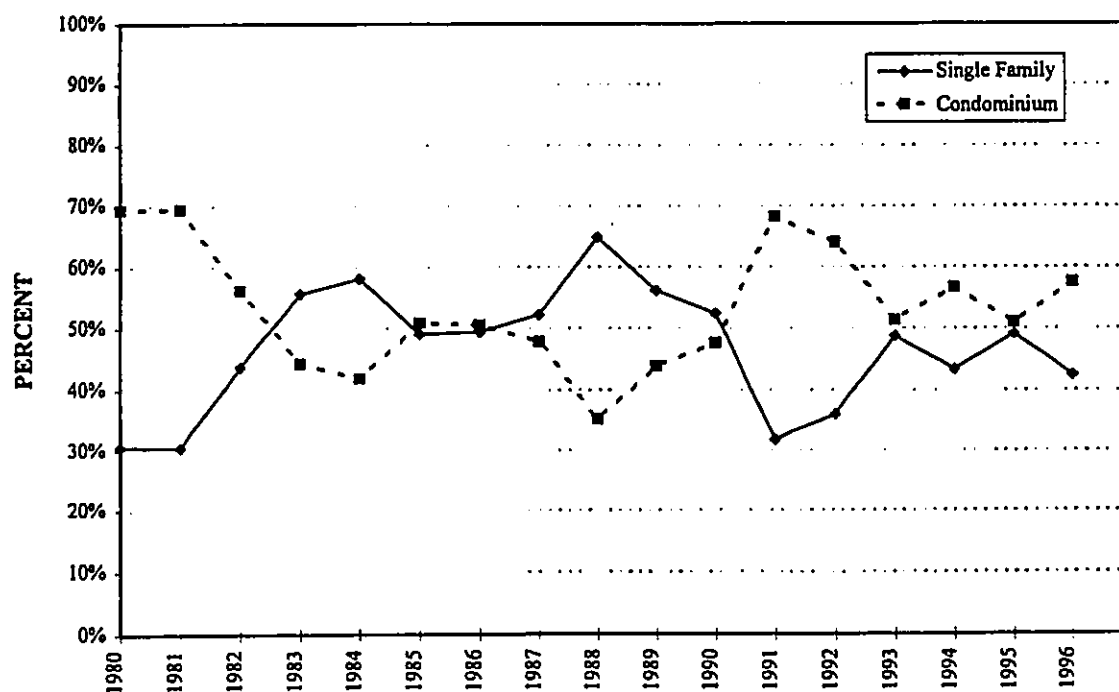
OAHU SINGLE FAMILY AND CONDOMINIUM NEW SALES



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Figure VI - 2

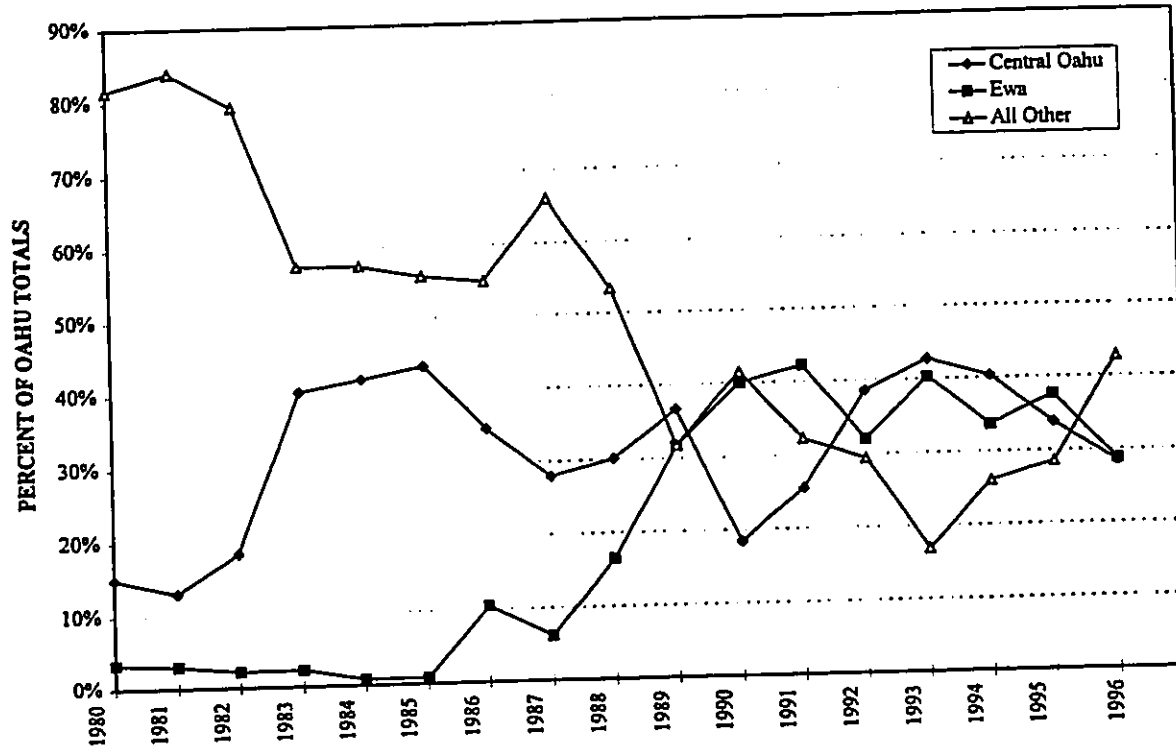
OAHU NEW SALES BY TYPE



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure VI - 3

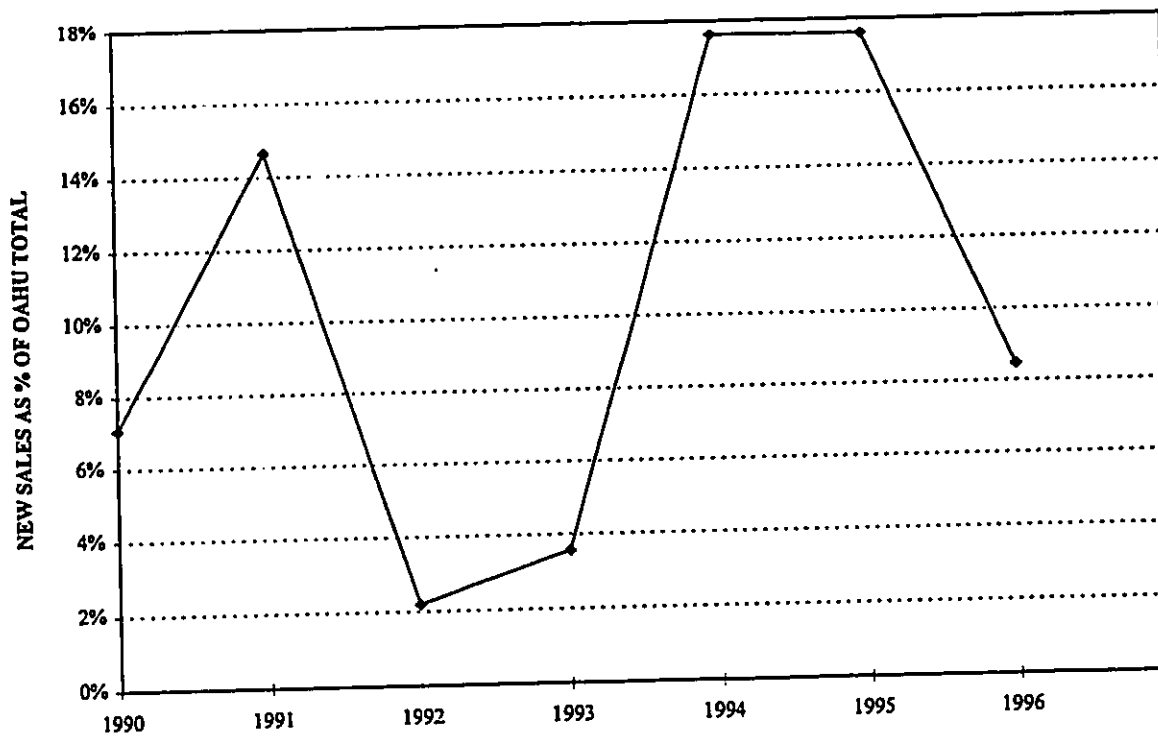
NEW SALES AS % OF OAHU TOTAL BY DPA



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Figure VI - 4

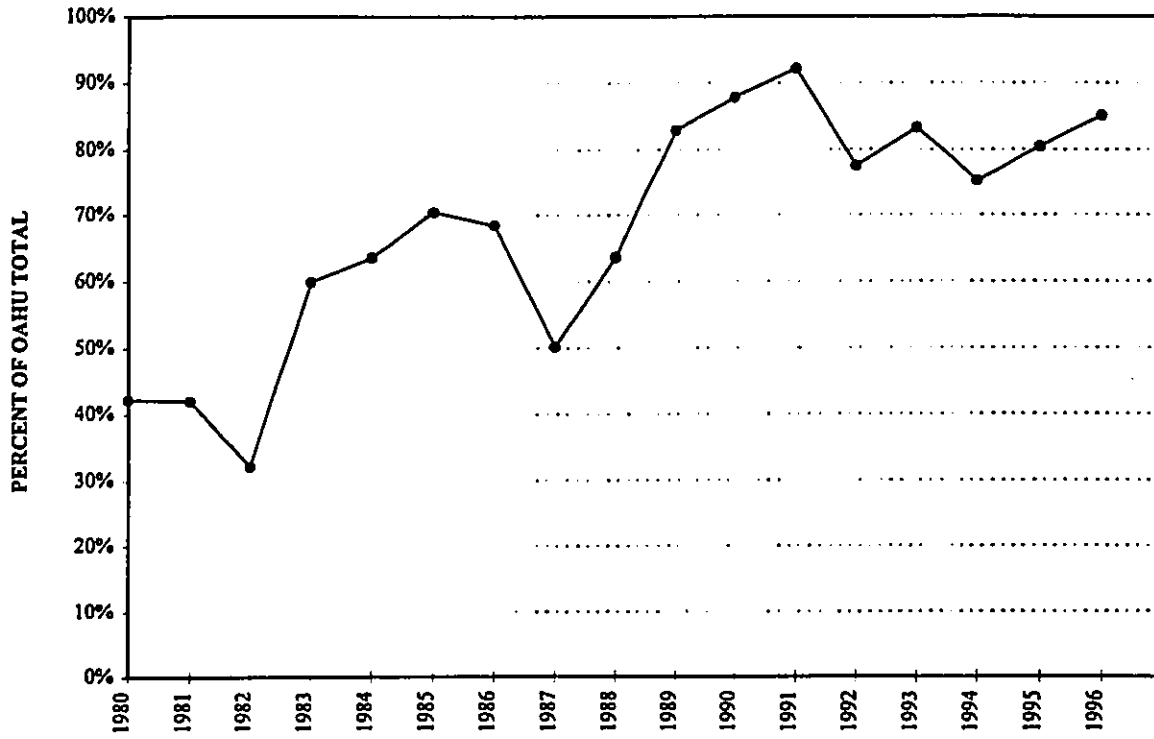
KAPOLEI TOTAL NEW SALES AS % OF OAHU TOTAL



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure VI - 5

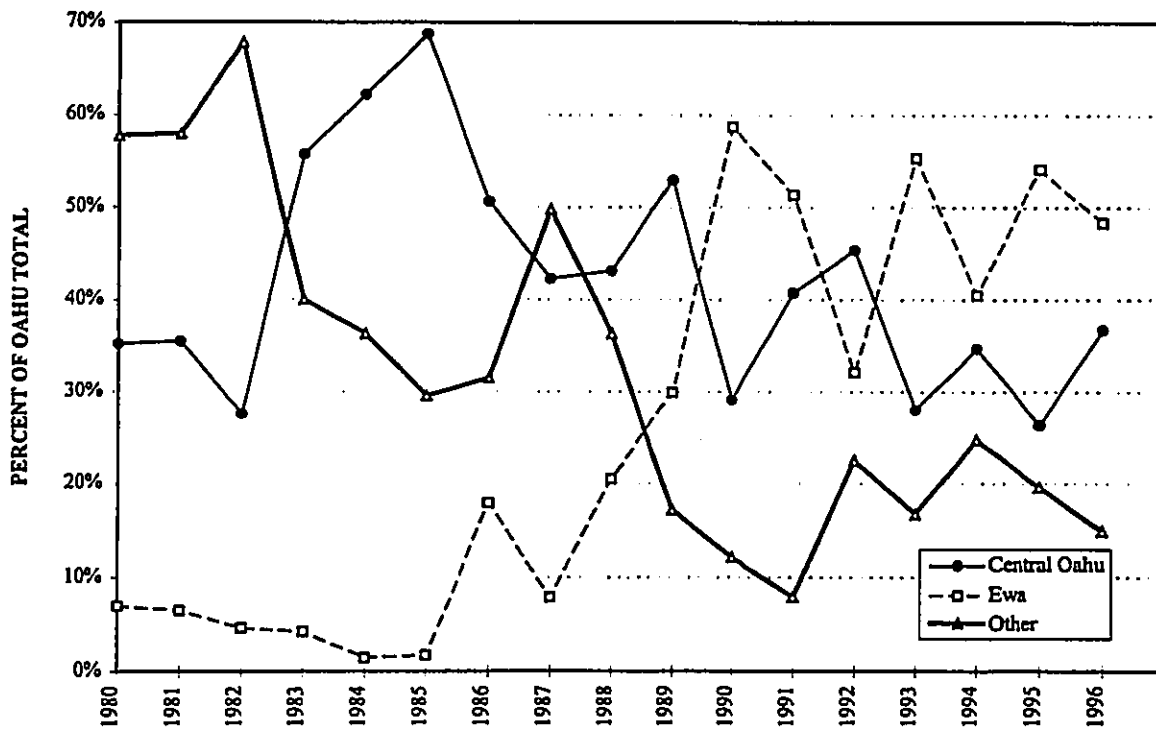
WEST OAHU NEW SINGLE FAMILY SALES AS % OF OAHU TOTAL



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure VI - 6

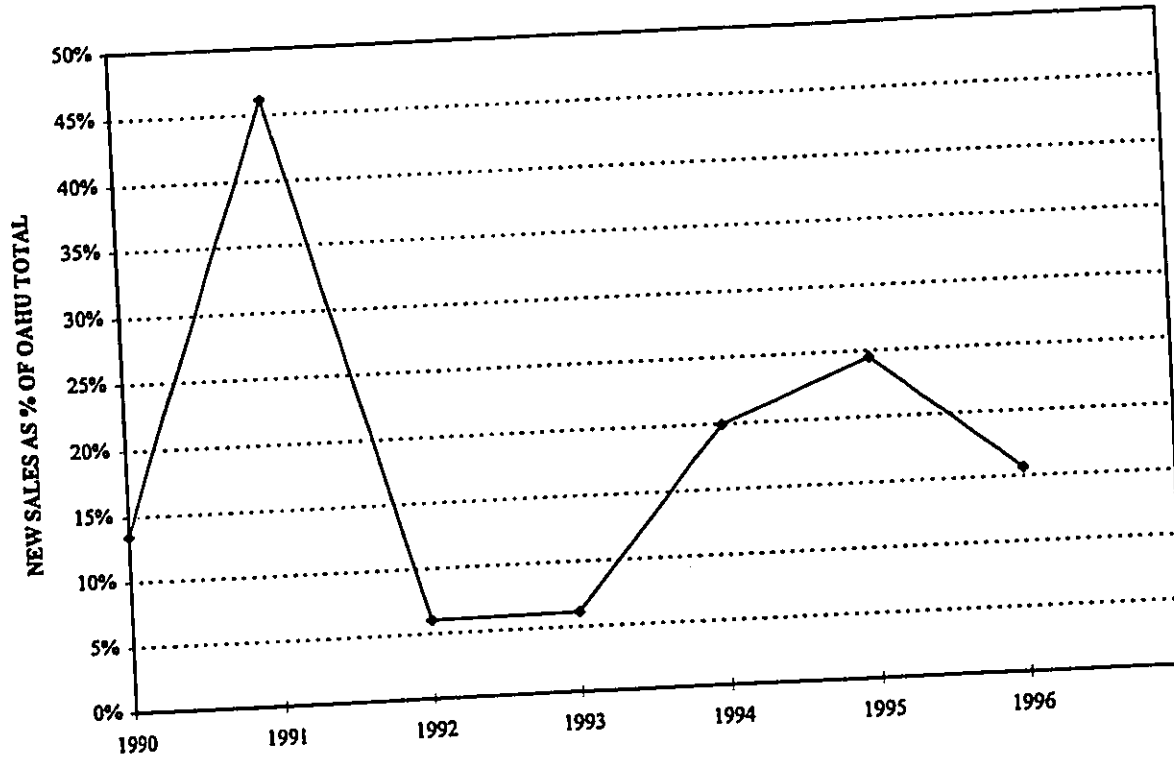
OAHU NEW SINGLE FAMILY SALES AS % BY DPA



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure VI - 7

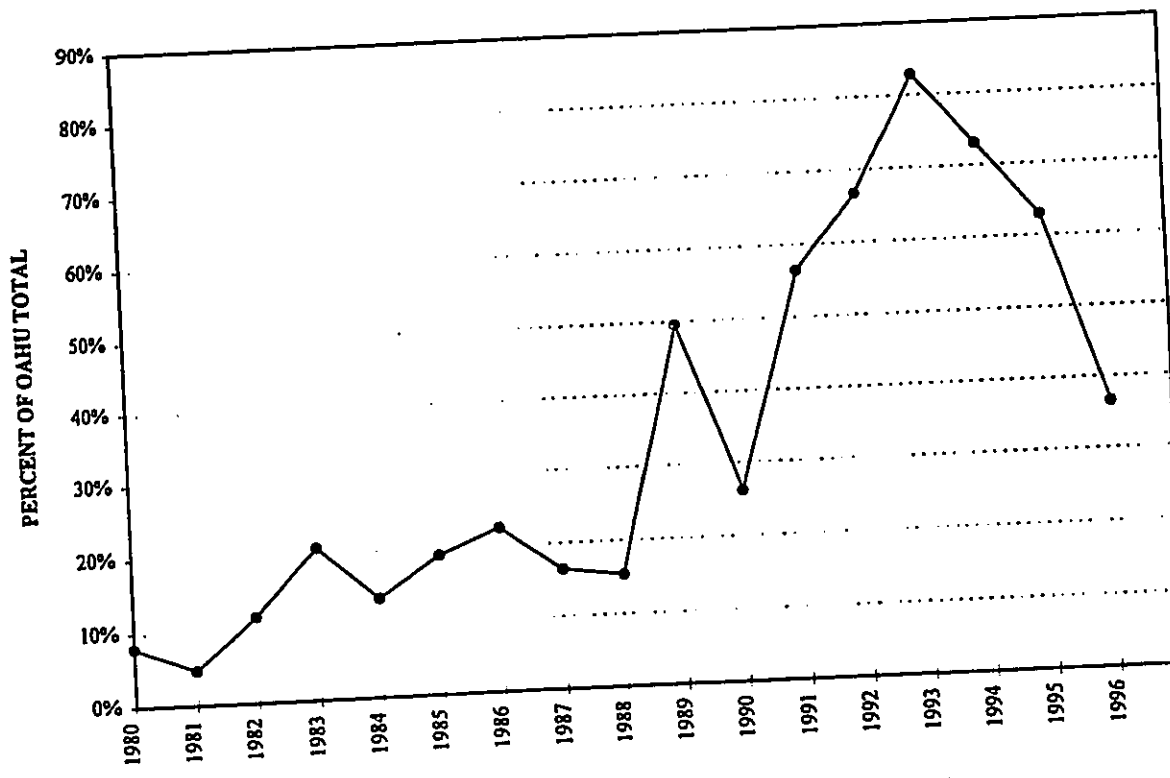
KAPOLEI SINGLE FAMILY NEW SALES AS % OF OAHU TOTAL



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure VI - 8

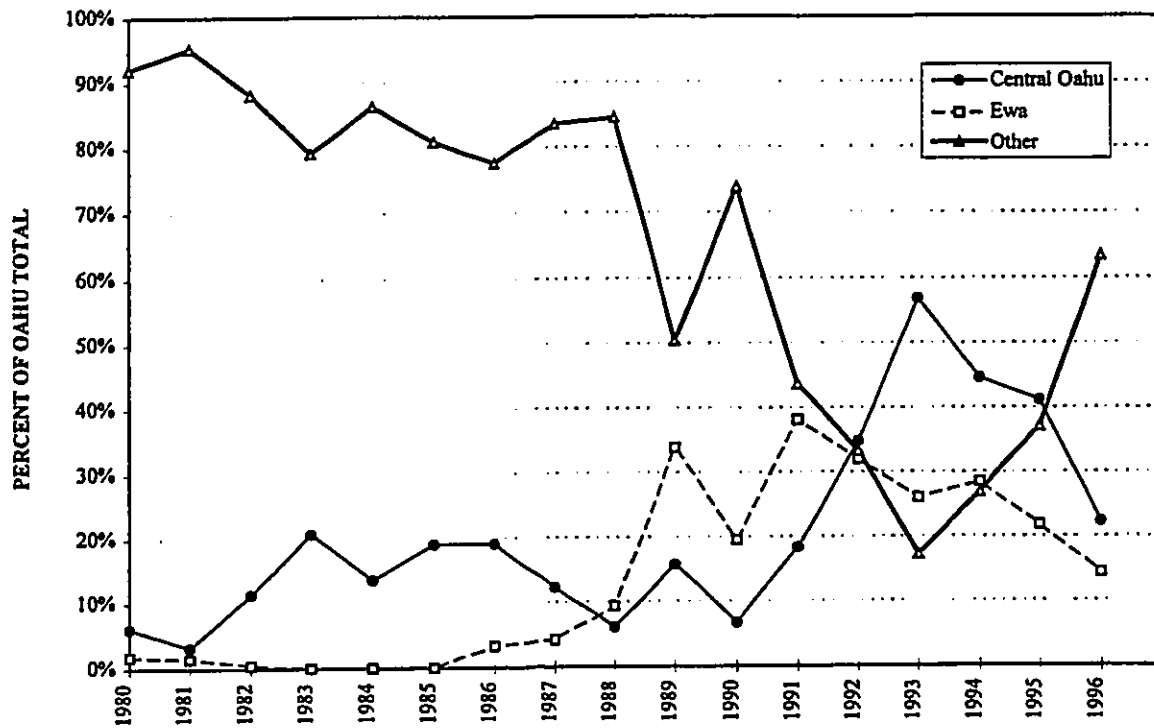
WEST OAHU NEW CONDOMINIUM SALES AS % OF OAHU TOTAL



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure VI - 9

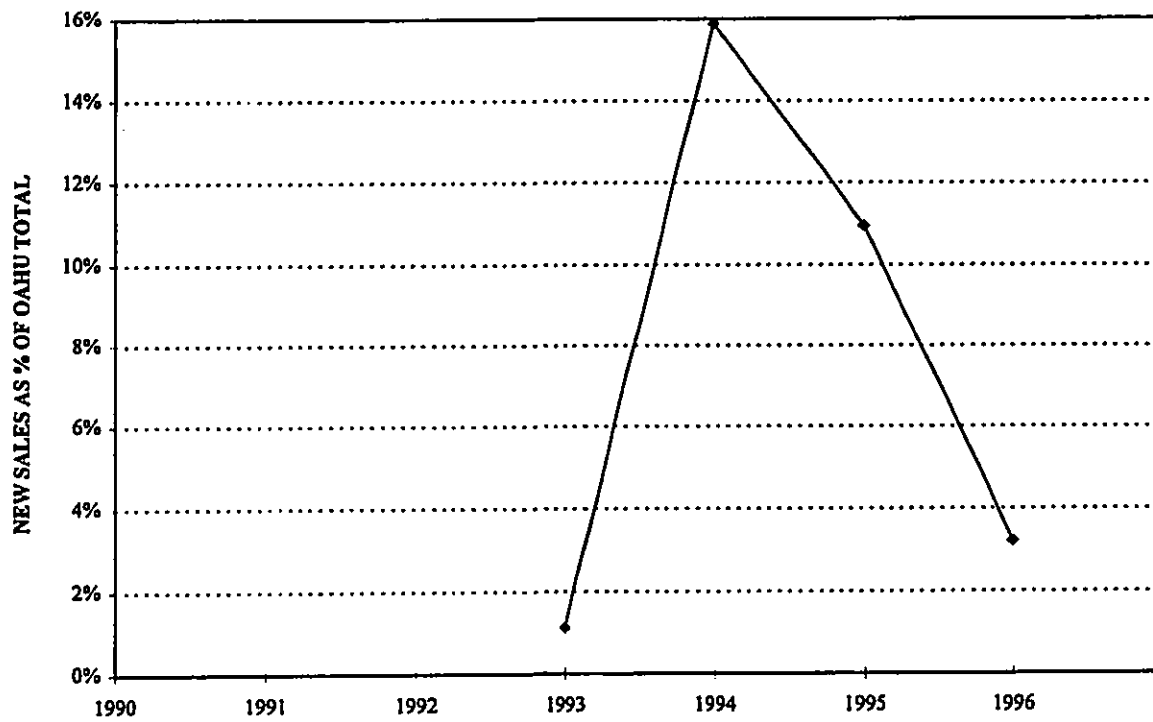
OAHU NEW CONDOMINIUM SALES AS % BY DPA



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

prcmg	Project																						Grand Total														
	Aeoloa	Champions	Country Cottages/Lanes	Country Gardens	Court Yard	Ewa Villages	Fiesta	Hawaii Loa Ridge	Highland View Estates	Island Bungalows	Islander	Iwaliani	Kulalei	Lofts By Gentry	Mall Kai	Misc	Na Kuli	Na Pali Haweo	Pacific Heritage	Pacific Islander	Pacific Traditions	Royal Kulia		Royal Pines	Royal Ridge	Sea Breeze	Signatures	Soda Creek	Summer Hill	The Bluffs	The Palms at Kekulani	Tropics At Waikale	Village at Pokai Bay	West Hills	West Park	Woodcrest	
<\$100				1																																1	
\$100-\$125						1												2																		1	15
\$125-\$150						13																														2	15
\$150-\$175						29							2		1	1																		6		38	
\$175-\$200	7	8			66									10	5	2																		10		107	
\$200-\$225	18	7	1		7	38						21		5	27	8											5							5		140	
\$225-\$250	8	48	2		2	78						10	13		18	5									2		1	1		2		2			181		
\$250-\$275		15				3						8	18		3	4	3								2		1	7		6	7				77		
\$275-\$300	7	17			1		3				9		11	5		3	13	1				1		2									15		100		
\$300-\$325	8	1	1	4							5	4	18				5	26				6		1						2	25		1	1	106		
\$325-\$350	12	11	4					1			15	6			5	29	1		6		1	4	4		3				3		5	1		111			
\$350-\$375	5	1	5	3						14				4	5		10	7	1	2	1	3		1								2		64			
\$375-\$400	6	1						4		1				5			4	1	4	1	2	1	3	6										37			
\$400-\$425	8	1					1	4								7		2	6	1	1	1	1	1					2					30			
\$425-\$450																1		2	1																5		
\$450-\$475																1																				2	
\$475-\$500	3															3	1		1																1	8	
>\$500	1							8								11		2																	1	23	
Grand Total	79	3	108	4	12	118	123	9	9	14	34	76	38	16	53	65	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

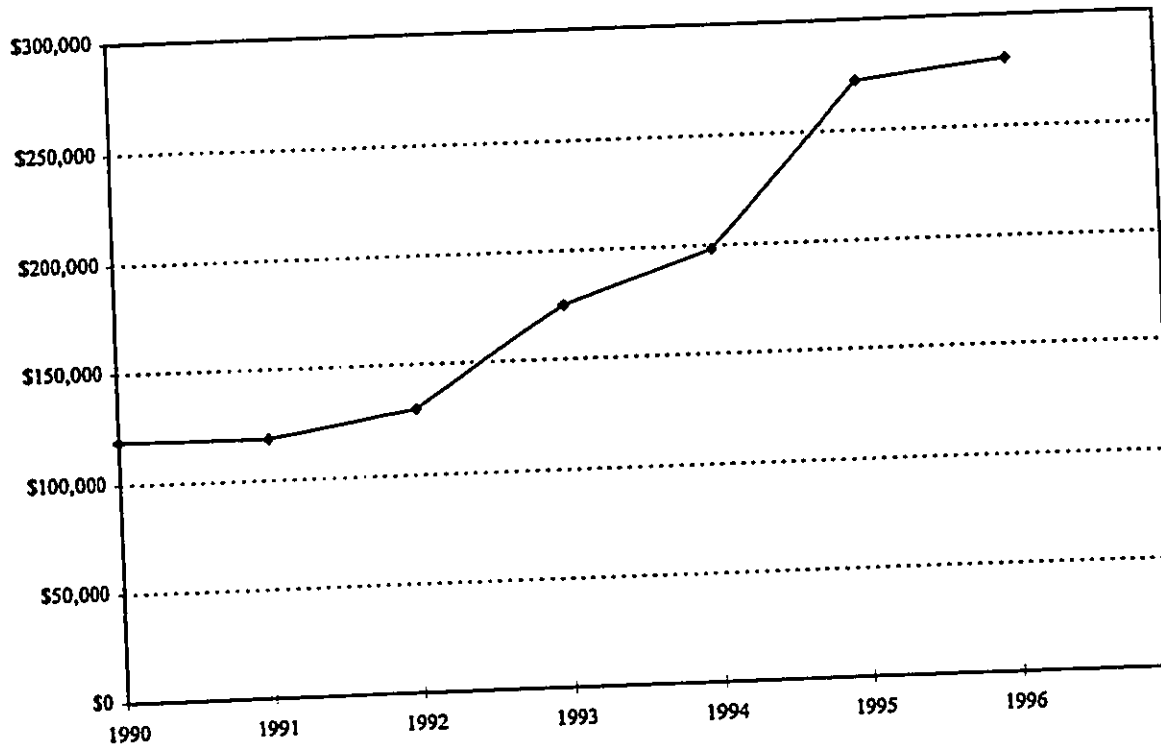
type Single Family

Month	Project																						Grand Total													
	Aeoloa	Champions	Country Cottages/Lanes	Country Gardens	Court Yard	Ewa Villages	Fiesta	Hawaii Loa Ridge	Highland View Estates	Island Bungalows	Islander	Iwaliani	Kulalei	Lofts By Gentry	Mall Kai	Misc	Na Kuli	Na Pali Haweo	Pacific Heritage	Pacific Islander	Pacific Traditions	Royal Kulia		Royal Pines	Royal Ridge	Sea Breeze	Signatures	Soda Creek	Summer Hill	The Bluffs	The Palms at Kekulani	Tropics At Waikale	Village at Pokai Bay	West Hills	West Park	Woodcrest
Jan	2		15			14				1	4				5	8					2		1					3						1		60
Feb	8		2			1	8				5	1			6	6					1					1		3		1		5		1	1	60
Mar	8		16	3	3	6	1	13			3	4	11	1							1	2	2			2		2		2	3	1			85	
Apr	10	3	18	3	2	12	2	1		12	9				8	4	23				8	3	4	1		3		1		4	2	2	1		137	
May	15		9			14	13			2	4			5	8	5	1							3				1	1		1	5	3	2		92
Jun	6		8			40	21	2	1		5			6	8	3					1					6	1			6	3	1			118	
Jul	3		4			20	15	2	1		6	2		6	9	1					1							3		4	1				80	
Aug	8		5		1	3	14	2	1		14	4		3	9	8						1	1					2		6	3				83	
Sep	1		6		1	15	3	1		3	20	10		5	7	4	1					3				1	1	1	1	6	2	1			93	
Oct	3		2		1	7	5			1	8	7	3	1	1	7												3		4					58	
Nov	4		6	1	1	6	9		3	1	1	4	5	3	5		3					1	2	2				2		9				1	69	
Dec	13		16	3	2	7	3		1	9	1	4	9	8	3	1	10		16	14					2			1	1	8					132	
Grand Total	79	3	108	4	12	118	123	9	9	14	34	76	38	16	53	65	77	4	19	14	13	12	8	11	4	10	8	20	4	10	50	22	8	2	2	1,057

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Figure VIII - 2

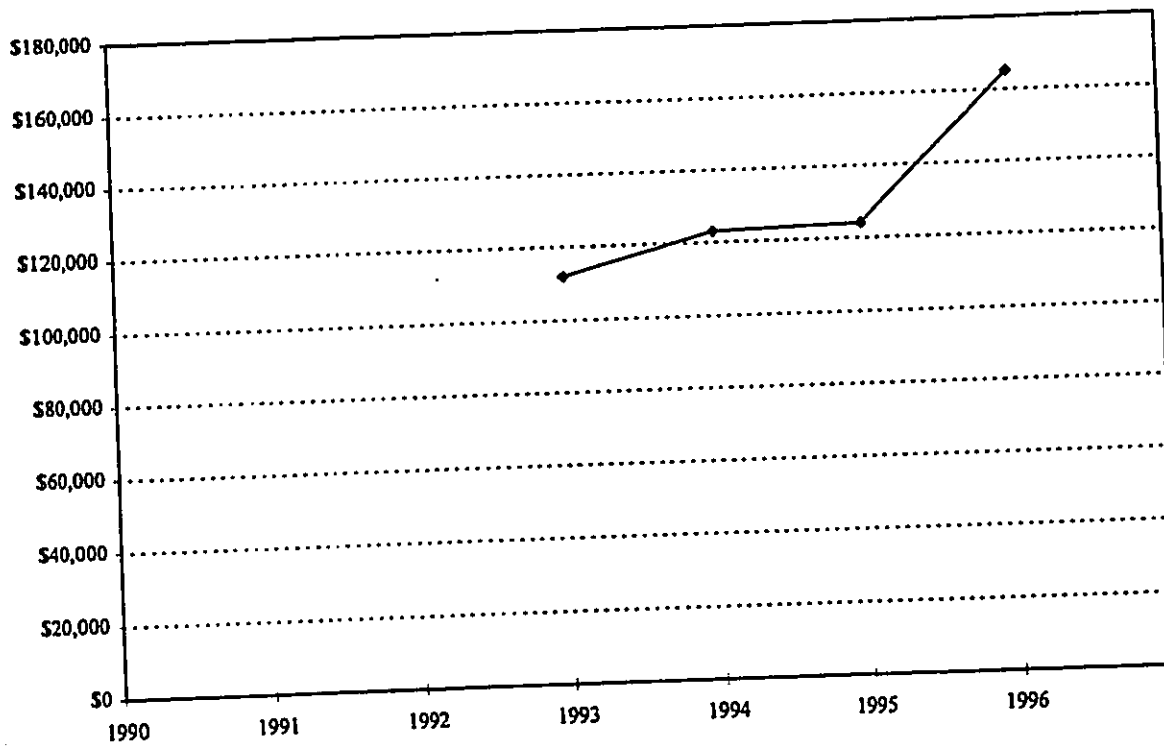
KAPOLEI SINGLE FAMILY MEDIAN NEW SALE PRICE



THE PRUDENTIAL LOCATIONS INC RESEARCH & CONSULTING

Figure VIII - 5

KAPOLEI MULTI-FAMILY MEDIAN NEW SALE PRICE



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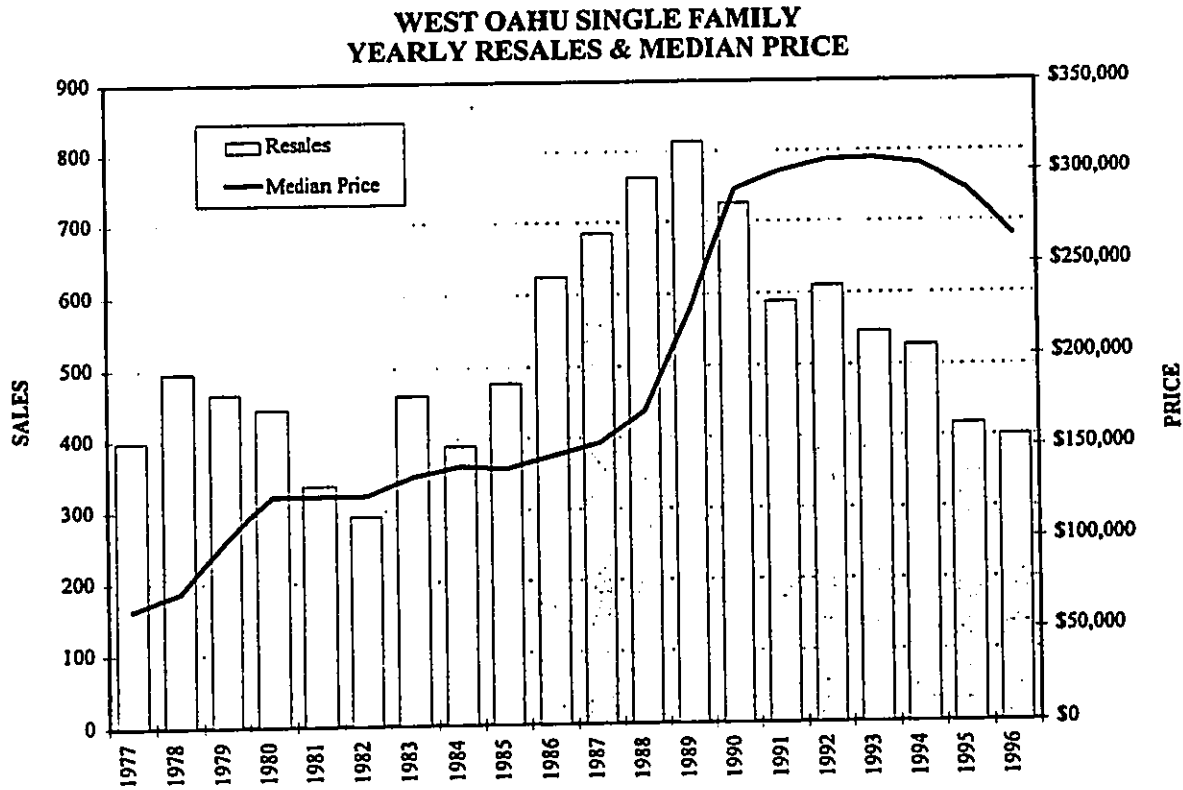
Figure VIII - 6

MLS Resale Summary

Year	Single Family						Condominium						Single Family		Condominium	
	West Oahu		Ewa DPA		Central Oahu DPA		West Oahu		Ewa DPA		Central Oahu DPA		Kapolei			
	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	188	\$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	468	\$101,500	235	\$93,000	231	\$120,000	882	\$70,750	239	\$83,000	643	\$82,000				
1980	444	\$125,000	185	\$110,000	259	\$139,000	661	\$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	183	\$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	478	\$139,000	145	\$119,000	333	\$145,000	375	\$97,000	78	\$101,750	299	\$97,000				
1986	625	\$148,000	154	\$127,200	471	\$153,000	405	\$102,375	87	\$108,000	318	\$97,000				
1987	685	\$152,500	177	\$131,500	608	\$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	848	\$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	548	\$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	\$188,000	340	\$188,600	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	\$143,650

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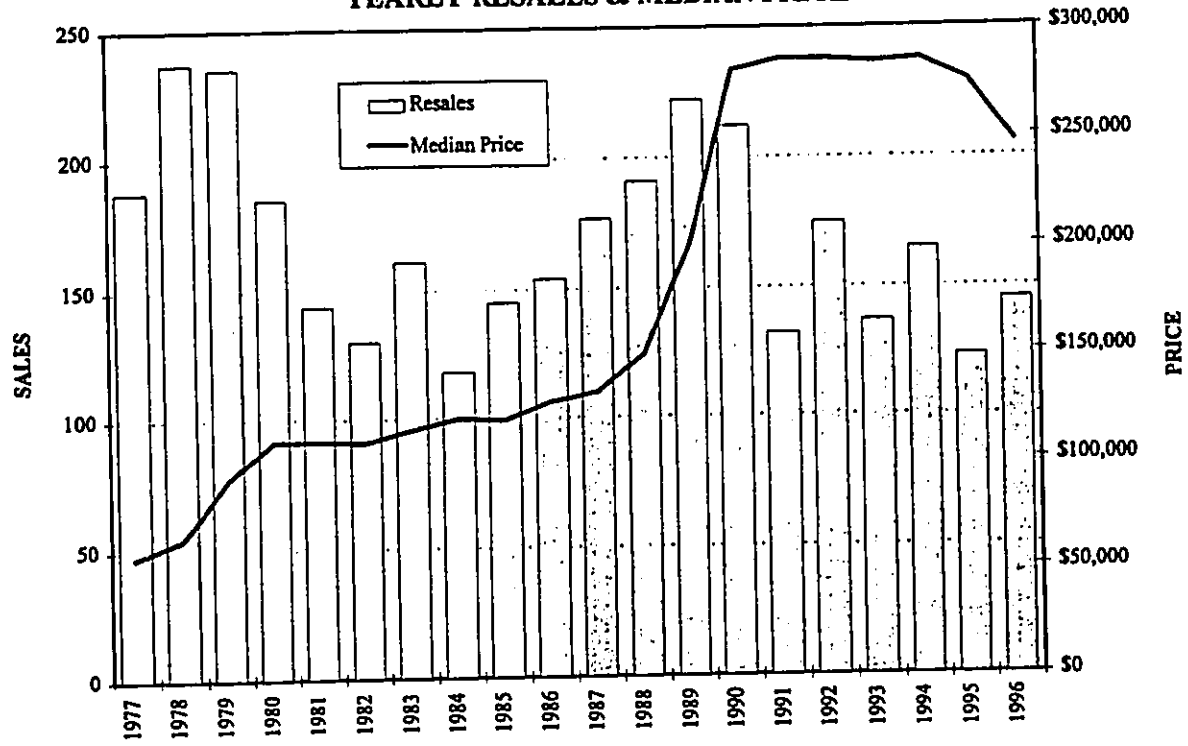
Figure VIII - 7



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure VIII - 8

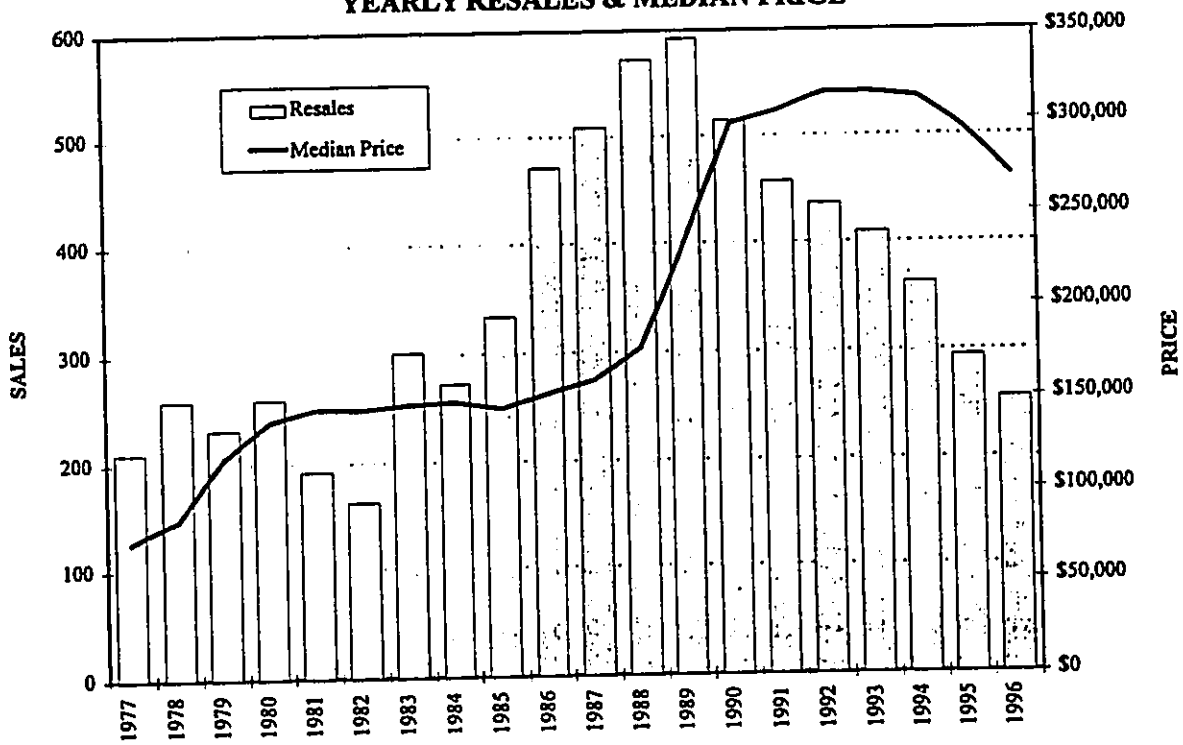
**EWA DPA SINGLE FAMILY
YEARLY RESALES & MEDIAN PRICE**



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure VIII - 9

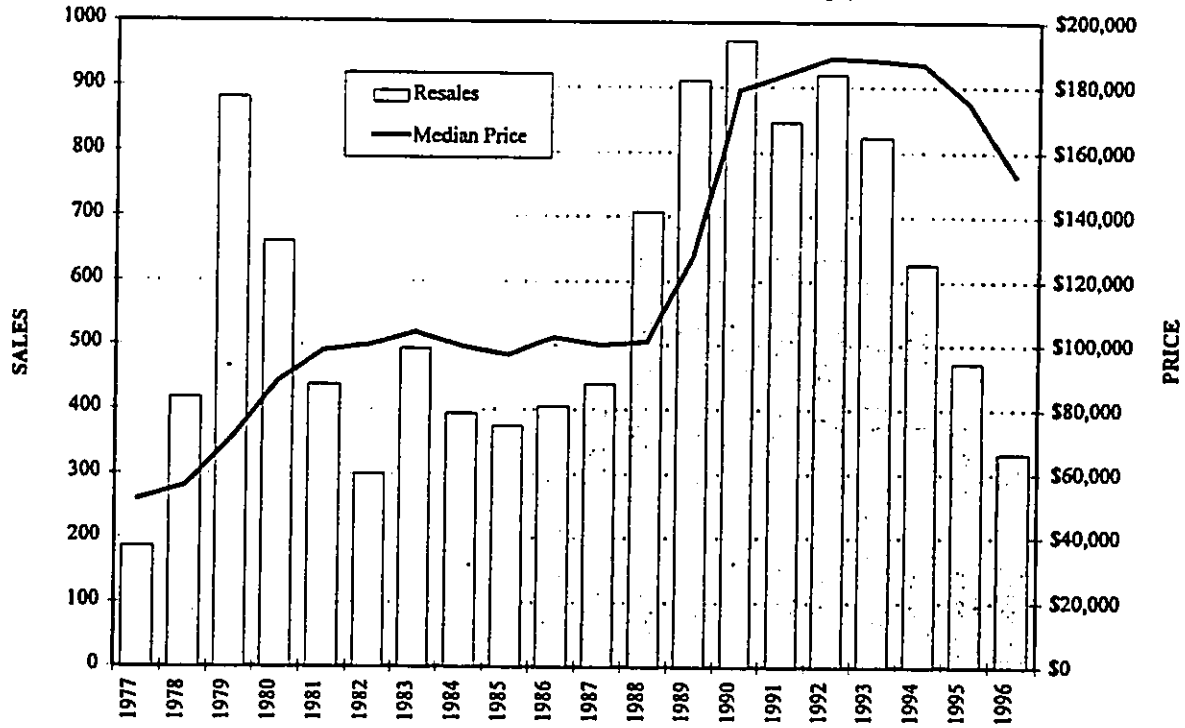
**CENTRAL OAHU DPA SINGLE FAMILY
YEARLY RESALES & MEDIAN PRICE**



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure VIII - 10

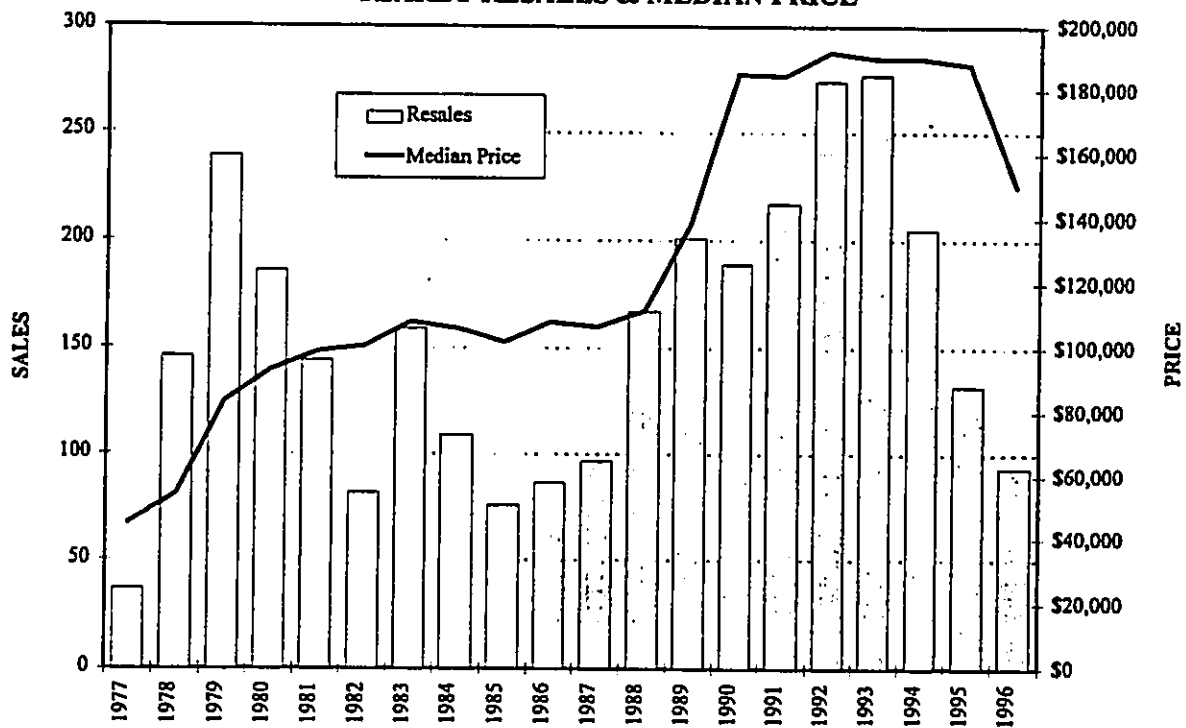
**WEST OAHU CONDOMINIUM
YEARLY RESALES & MEDIAN PRICE**



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure VIII - 11

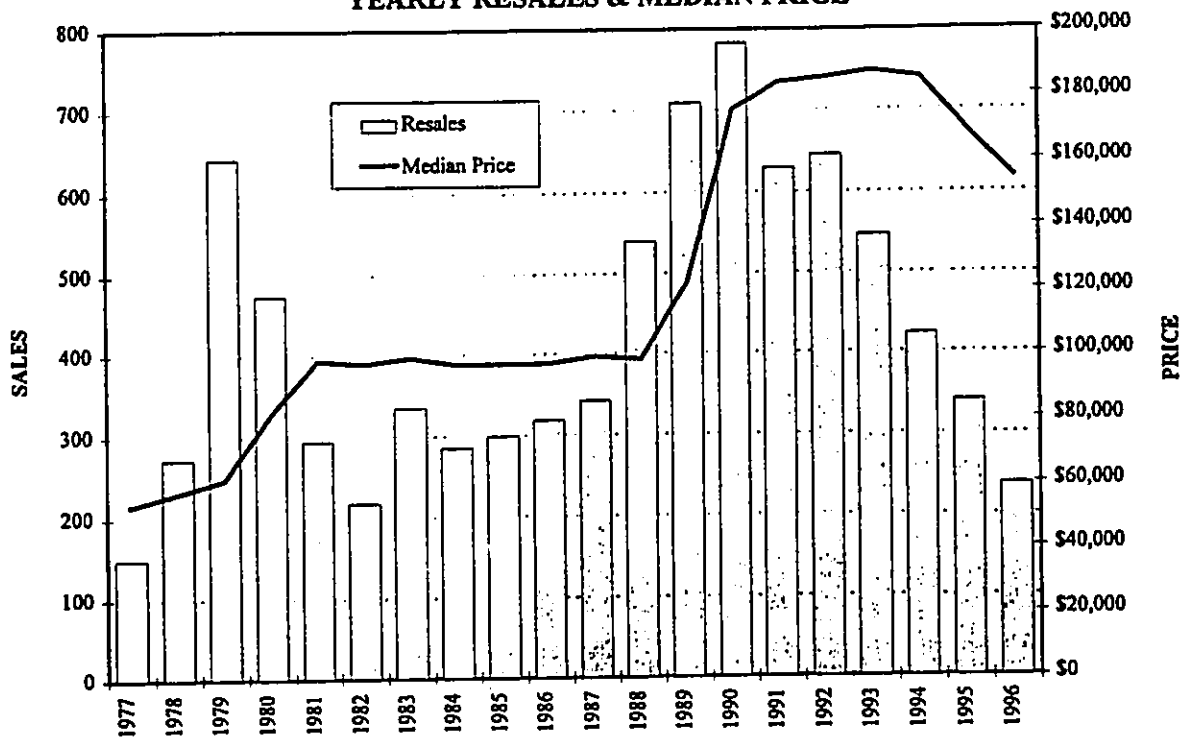
**EWA DPA CONDOMINIUM
YEARLY RESALES & MEDIAN PRICE**



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure VIII - 12

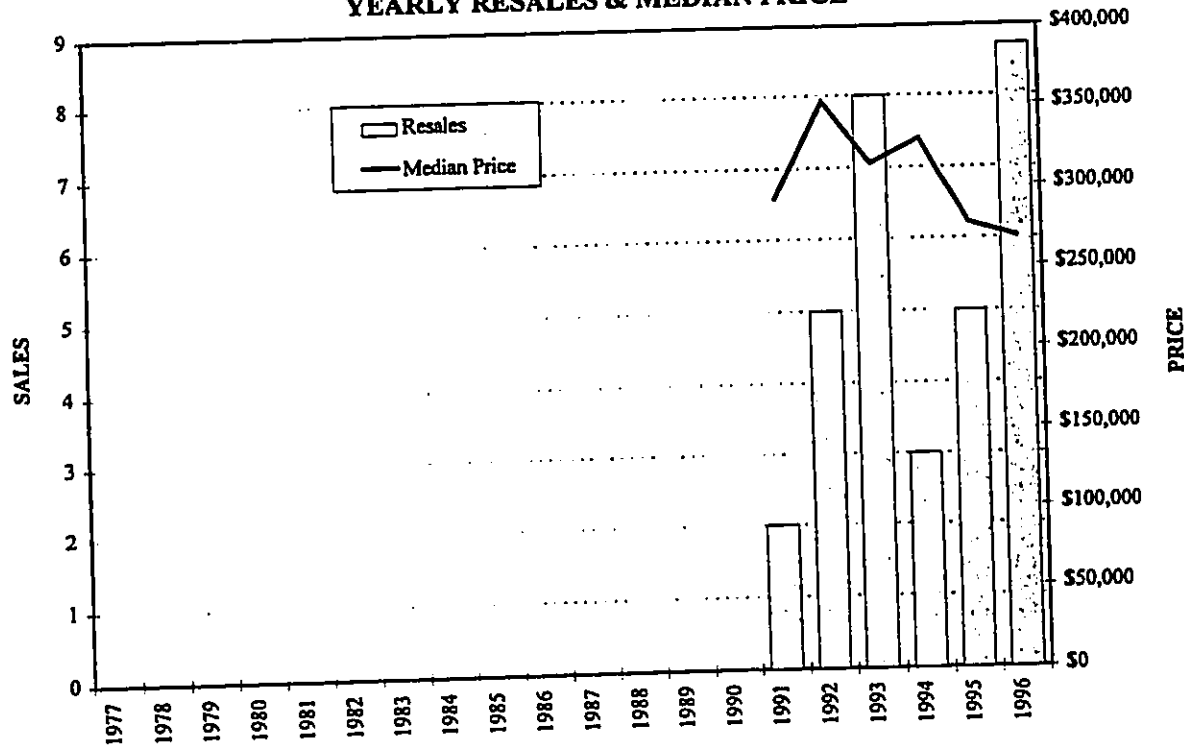
**CENTRAL OAHU DPA CONDOMINIUM
YEARLY RESALES & MEDIAN PRICE**



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure VIII - 13

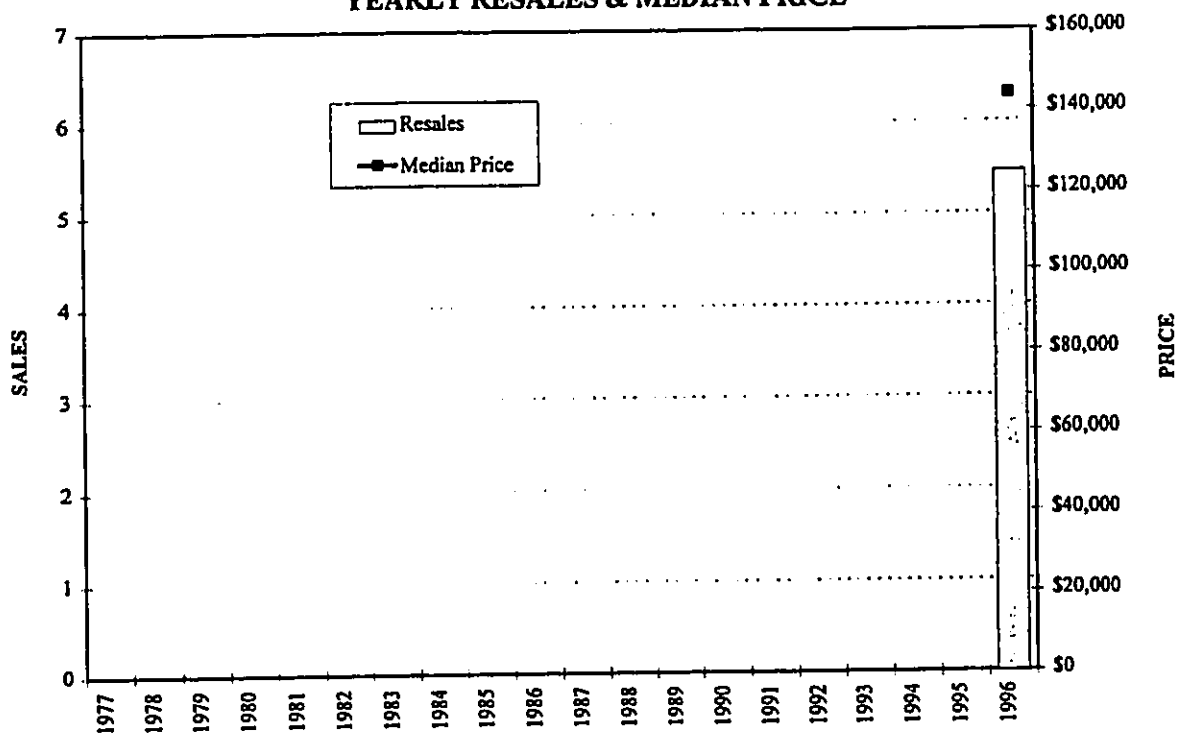
**KAPOLEI SINGLE FAMILY
YEARLY RESALES & MEDIAN PRICE**



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure VIII - 14

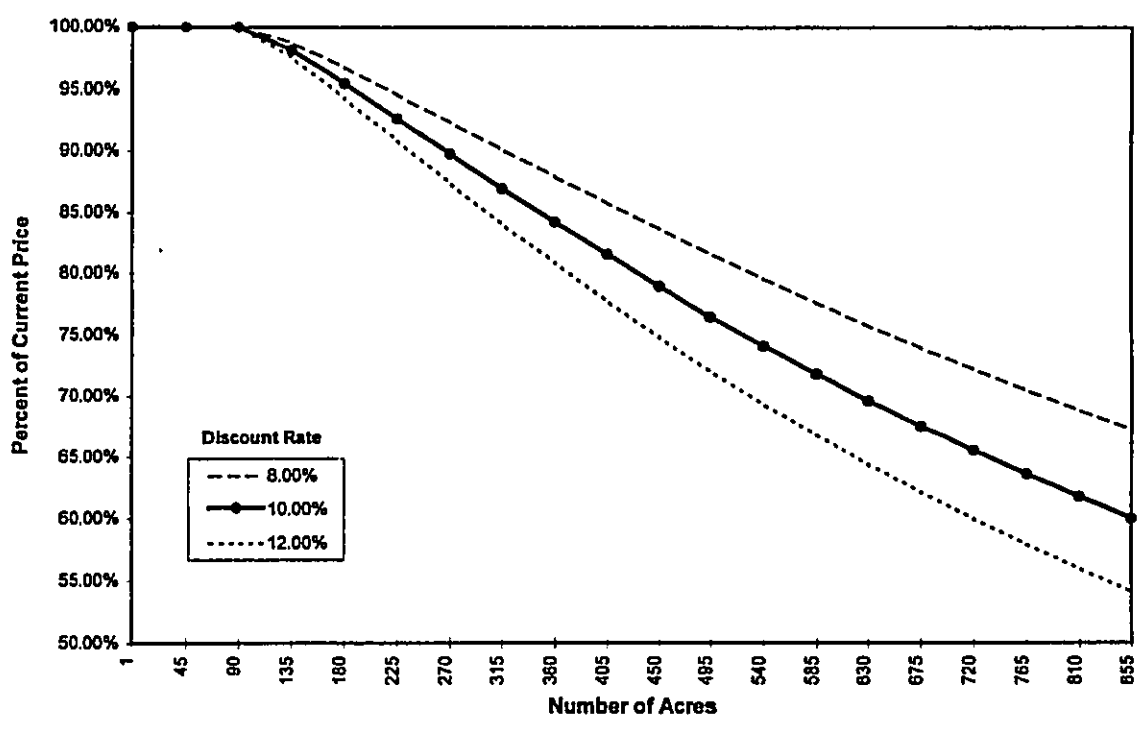
**KAPOLEI CONDOMINIUM
YEARLY RESALES & MEDIAN PRICE**



THE PRUDENTIAL LOCATIONS RESEARCH & CONSULTING

Figure VIII - 15

ESTIMATED DISCOUNT FOR BULK PURCHASE



ESTIMATED DISCOUNT FOR BULK PURCHASE

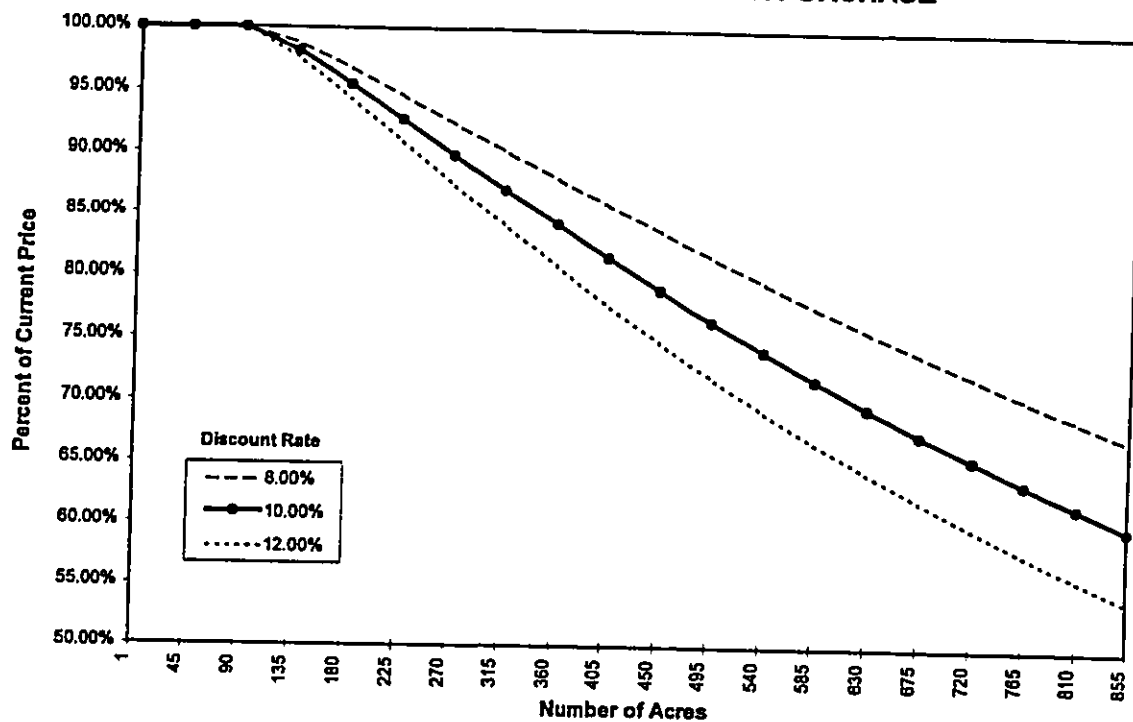


Figure VIII-16

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

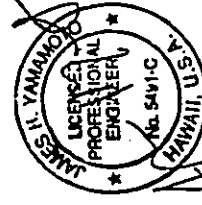
RMTC

R. M. Towill Corporation
420 Waiakamilo Rd., Suite 411
Honolulu, Hawaii 96817-4941
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**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



June 22, 1998

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▶ 100-Year, 24-hour HEC-1 Computations (Kaloi Watershed)

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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.

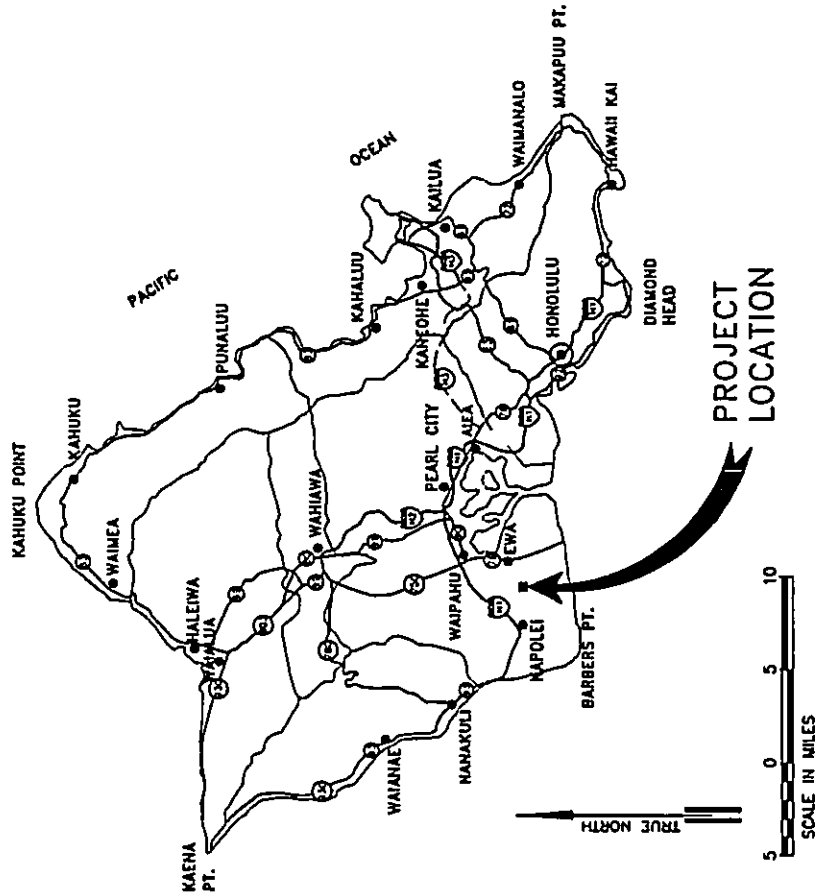
The scope of this master plan includes:

- 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. W. TOWELL CORPORATION

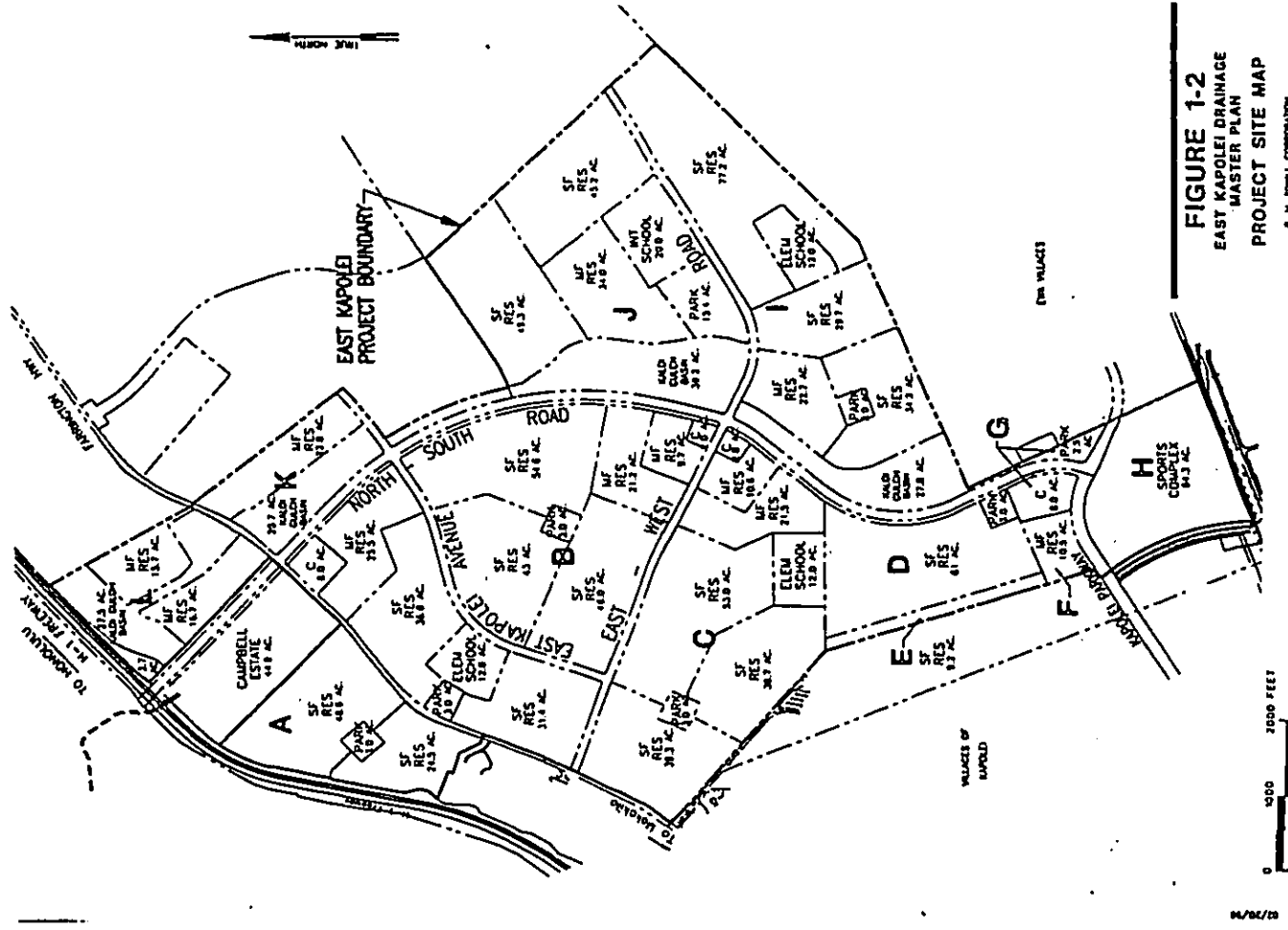


FIGURE 1-2
 EAST KAPOLEI DRAINAGE
 MASTER PLAN
 PROJECT SITE MAP
 R. W. TOWELL CORPORATION

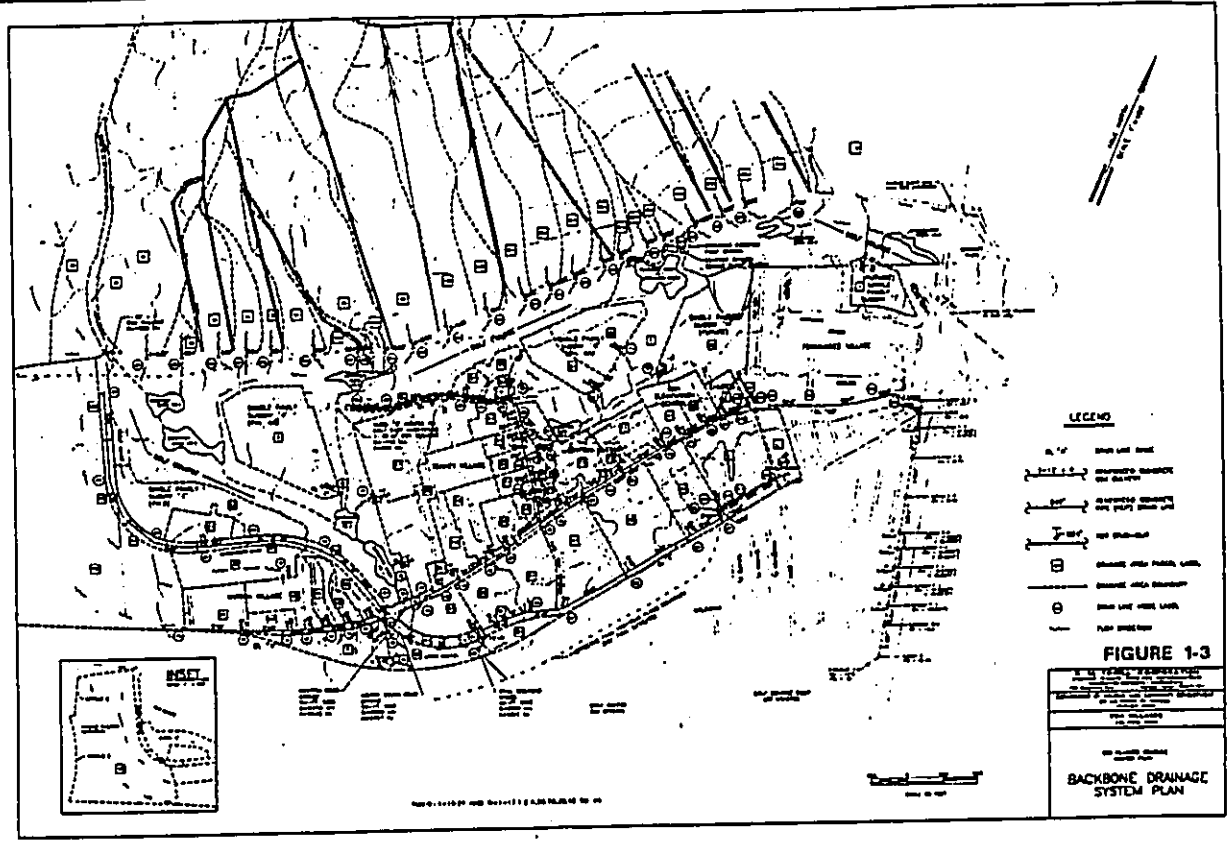
Villages Master Plan prepared by R. M. Towill Corporation, April 1996 (revised March 1997) discusses improvements that accept runoff from East Kapolei. Runoff is shown to enter the Ewa Villages Golf Course at several locations via several existing culverts. However, the majority of the flow is planned 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.



**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 Kalo 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), Waihua (WxA), Waipahu (WzA and WzB), Mamala (McA), Ewa (EwC, EwB), Kumia (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 Kalo Gulch and the Hunehune Gulch. The Kalo 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 Kalo to form one stream. The Kalo 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 Kalo Stream Watershed

The Kalo 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. Kalo 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 Kalo 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.

Kalo Stream is gauged above the H-1 Freeway by the U.S. Geological Survey (Gauge No. 16212450 Drainage Area = 1.70 sq. mi.).

3.5.3 Kaloi-Ewa Villages Watershed

Drainage subareas S17 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.

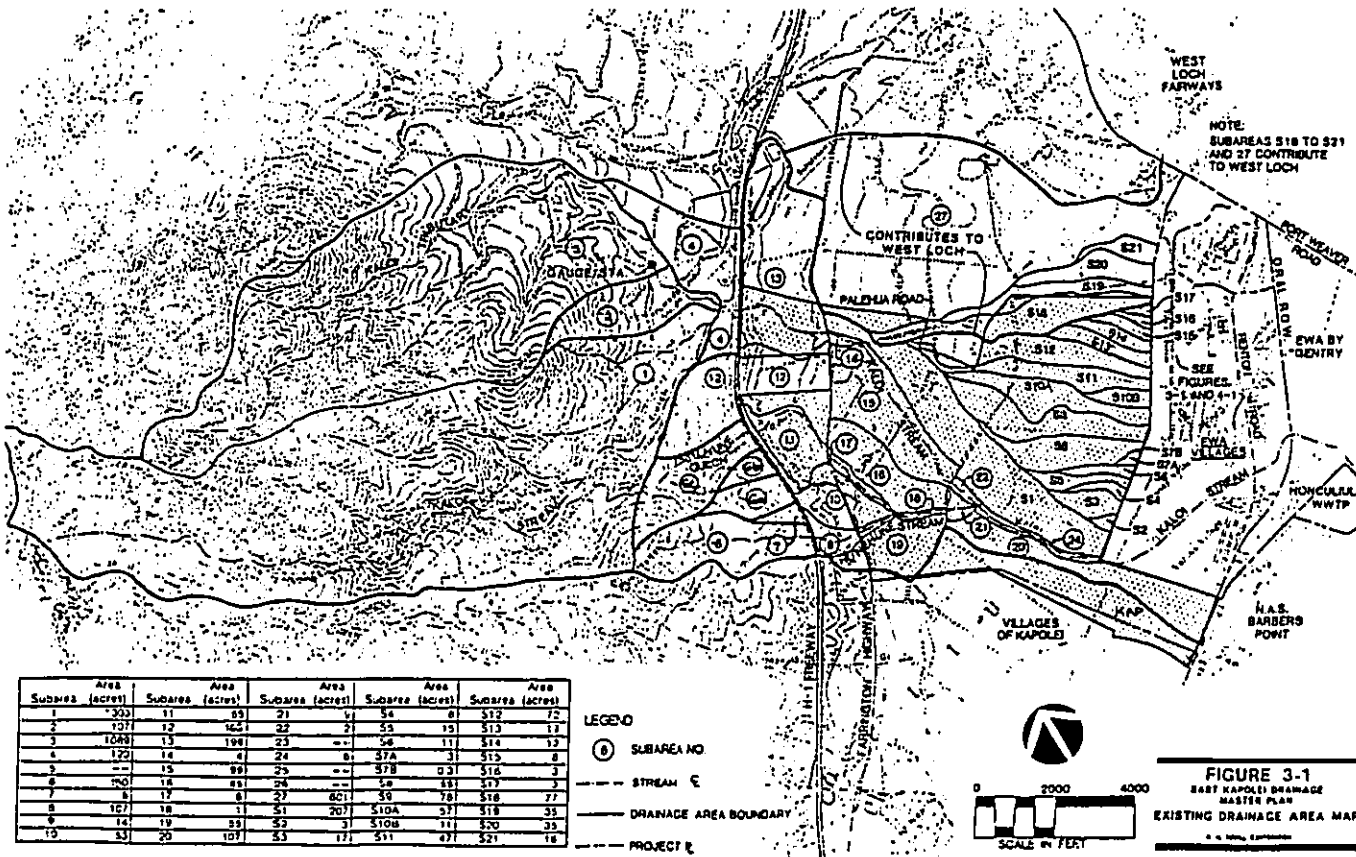
3.5.4 Varona Village Sub-Watershed

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 Remton 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

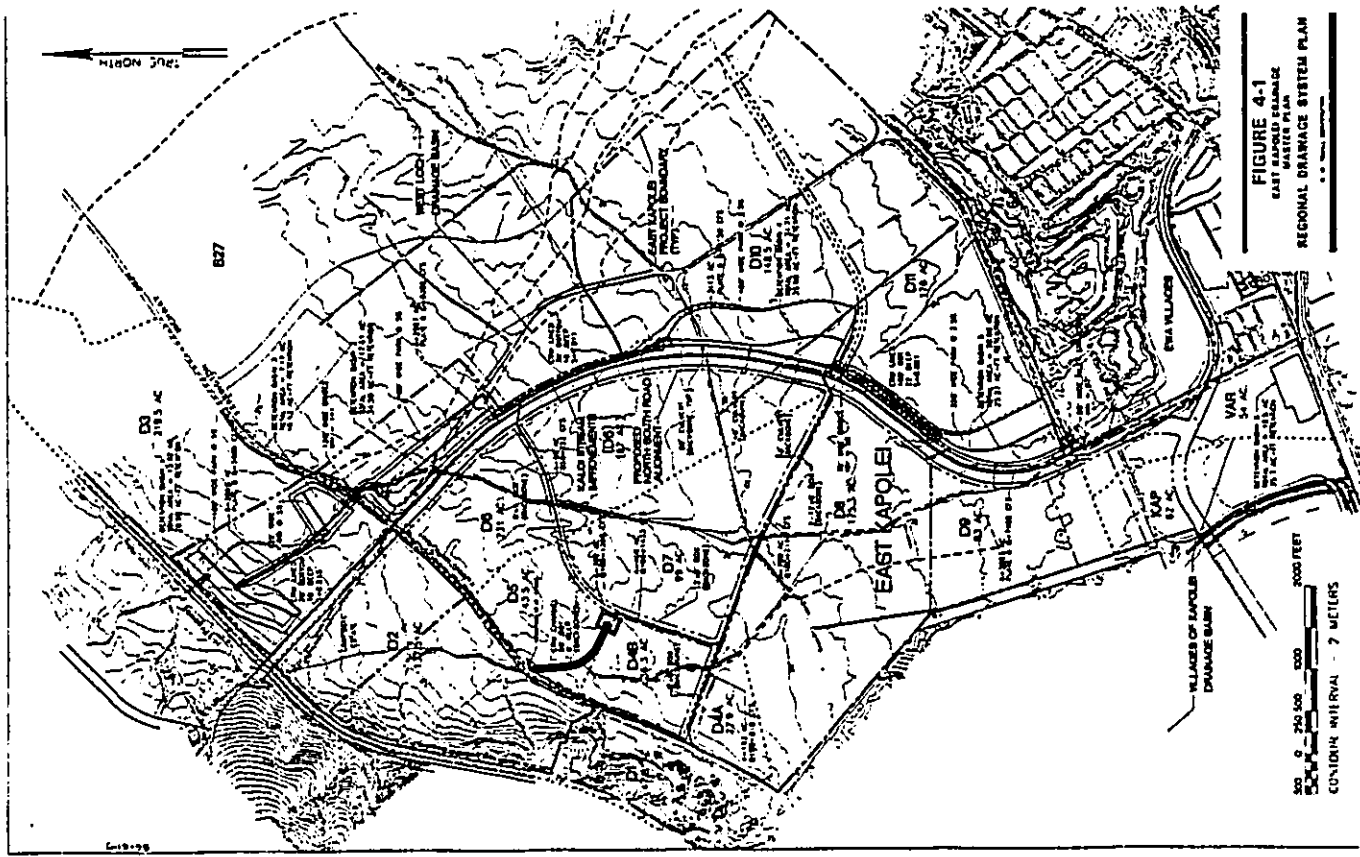
The intent of the drainage plan is to control flooding and provide adequate storm water disposal for on-site and off-site generated runoff.

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 Villeges 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.



4.2.1 Kaloï Channel Improvements

The Kaloï 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 Kaloï 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 Kaloï 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 Kaloï channel to cross the intersecting road. A 30-foot wide (minimum) bridge is required to replace the existing Kaloï 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 Hunehe 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

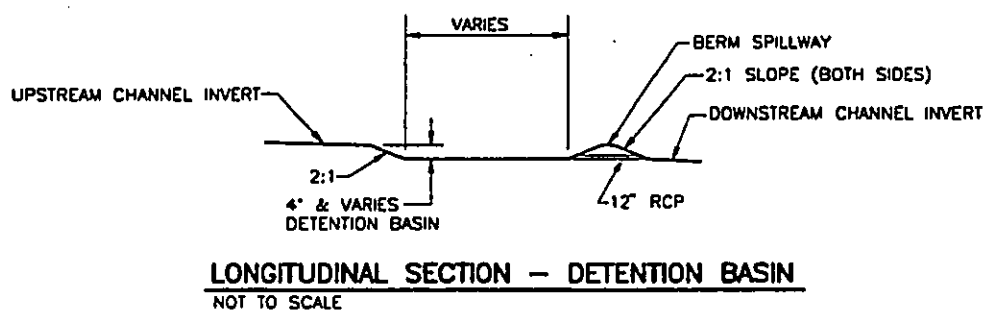
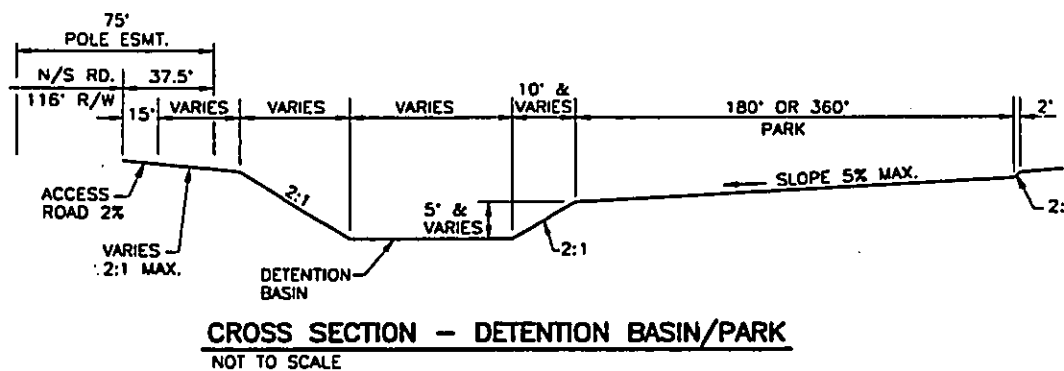


FIGURE 4-2
 EAST KAPOLEI DRAINAGE
 MASTER PLAN
 PROPOSED DETENTION BASIN SECTIONS
 © H. K. ROY & COMPANY

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

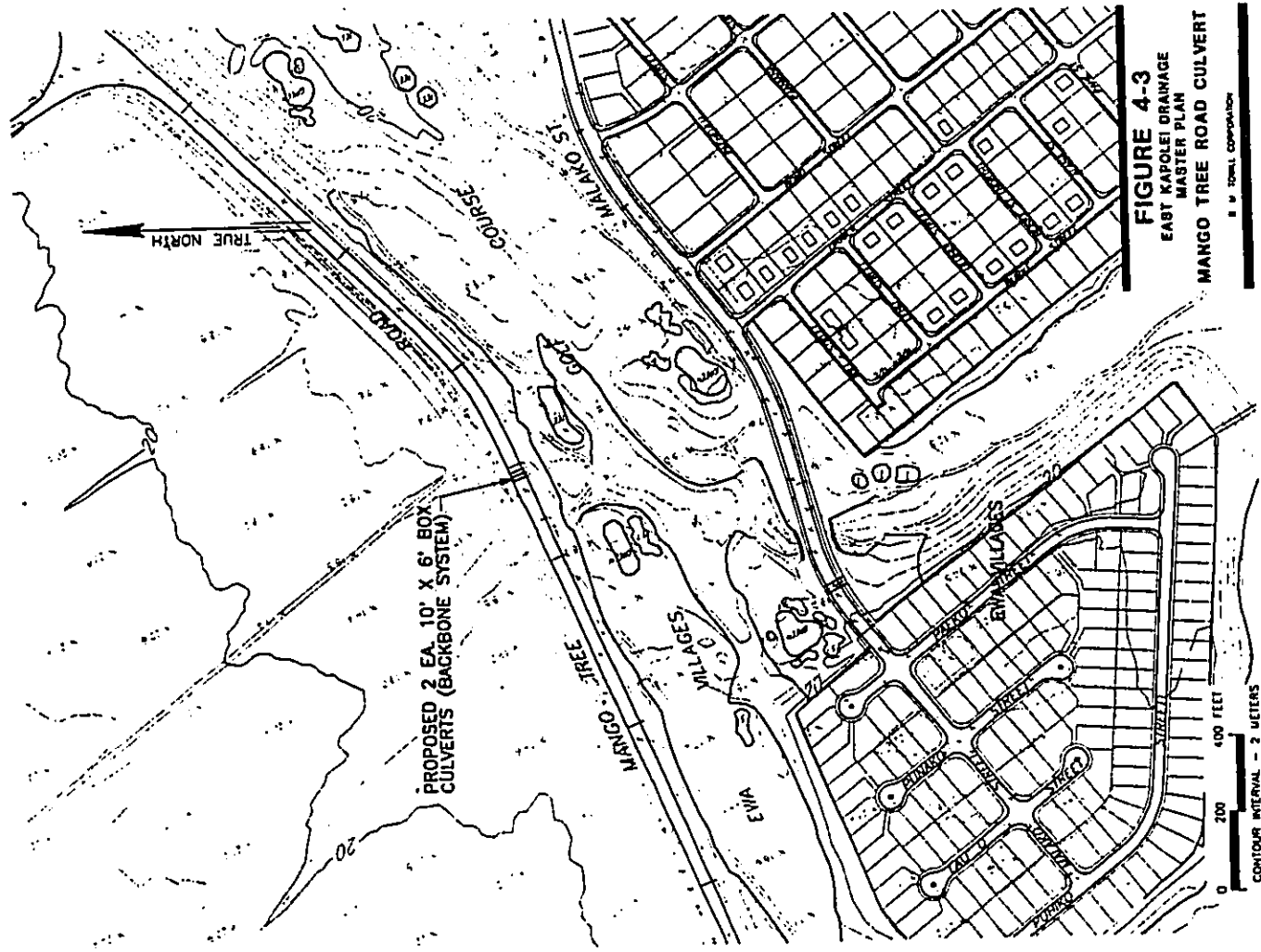
The proposed sports complex falls within the existing Varona Village sub-watershed and developed drainage area. A detention basin is proposed within the lower regions of the sports complex which will reduce storm water runoff into Varona Village. Due to the deferral of the Varona Village box drain construction, 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.

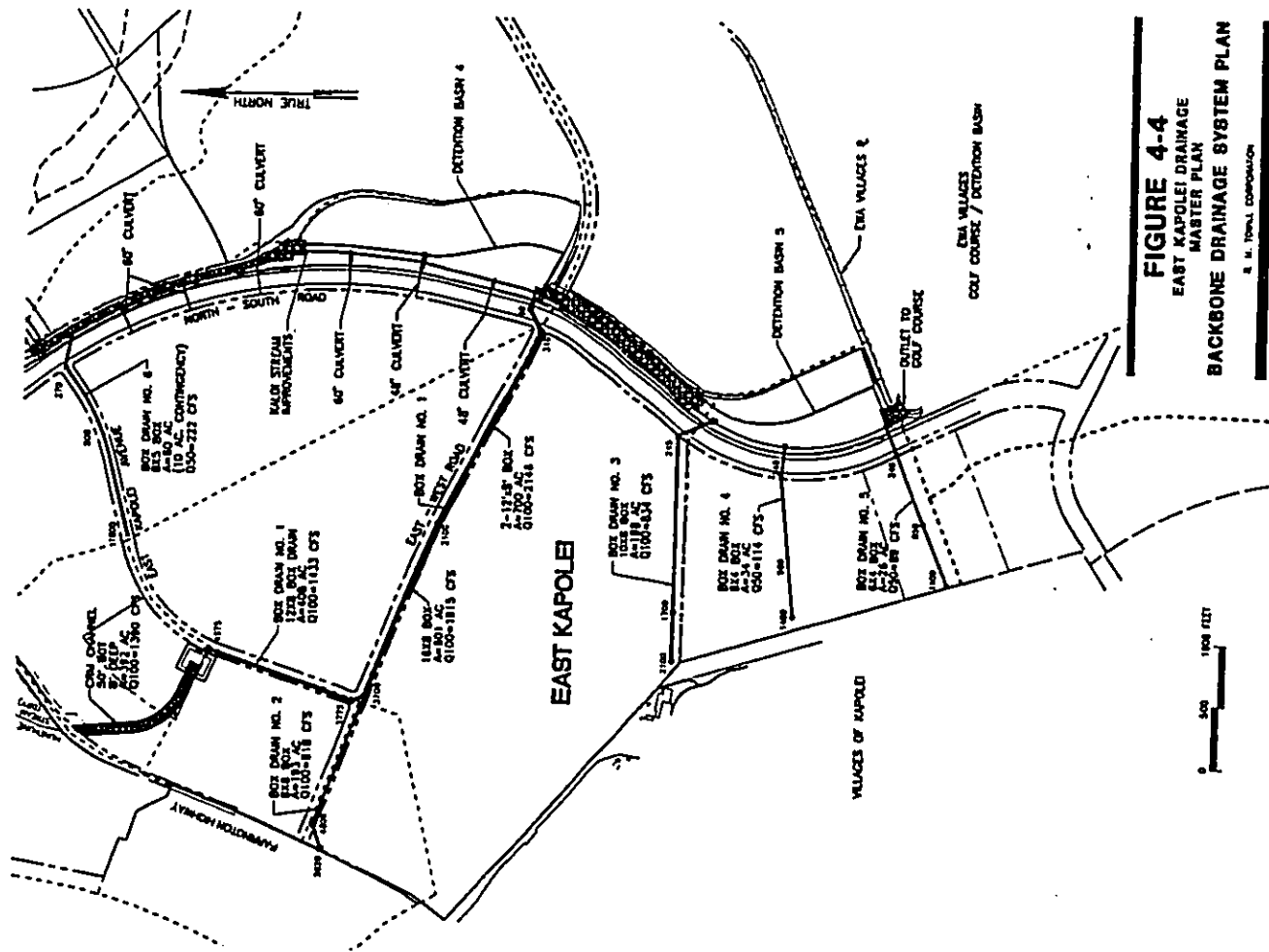
A smaller 8' x 5' box drain along East Kapolei Avenue, at the North-South Road intersection, is planned to convey runoff from the area between Farrington Highway and East Kapolei Avenue. Two 48" pipe culverts and four 60" pipe culverts are proposed to carry runoff from the area just below East Kapolei Avenue across the North-South Road into the Kaloi channel. Three other box



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

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

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 5-2
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
Kaloï Gulch (E. Kapolei)	3,190	3,238	48
Kaloï 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
Kaloï Gulch (E. Kapolei)	5,643	5,674	31
Kaloï 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)
Kaloï Gulch (E. Kapolei)	3,850	7,075	4,051	7,400
Kaloï - (Central Ewa Villages)	420	1,400	324	1,100
West Loch	764	2,100	762	2,100

LIST OF REFERENCES

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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	SEC15	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	3,190	5,643
		4,273 Ac.		

EXISTING KALOI GULCH (MARONA)

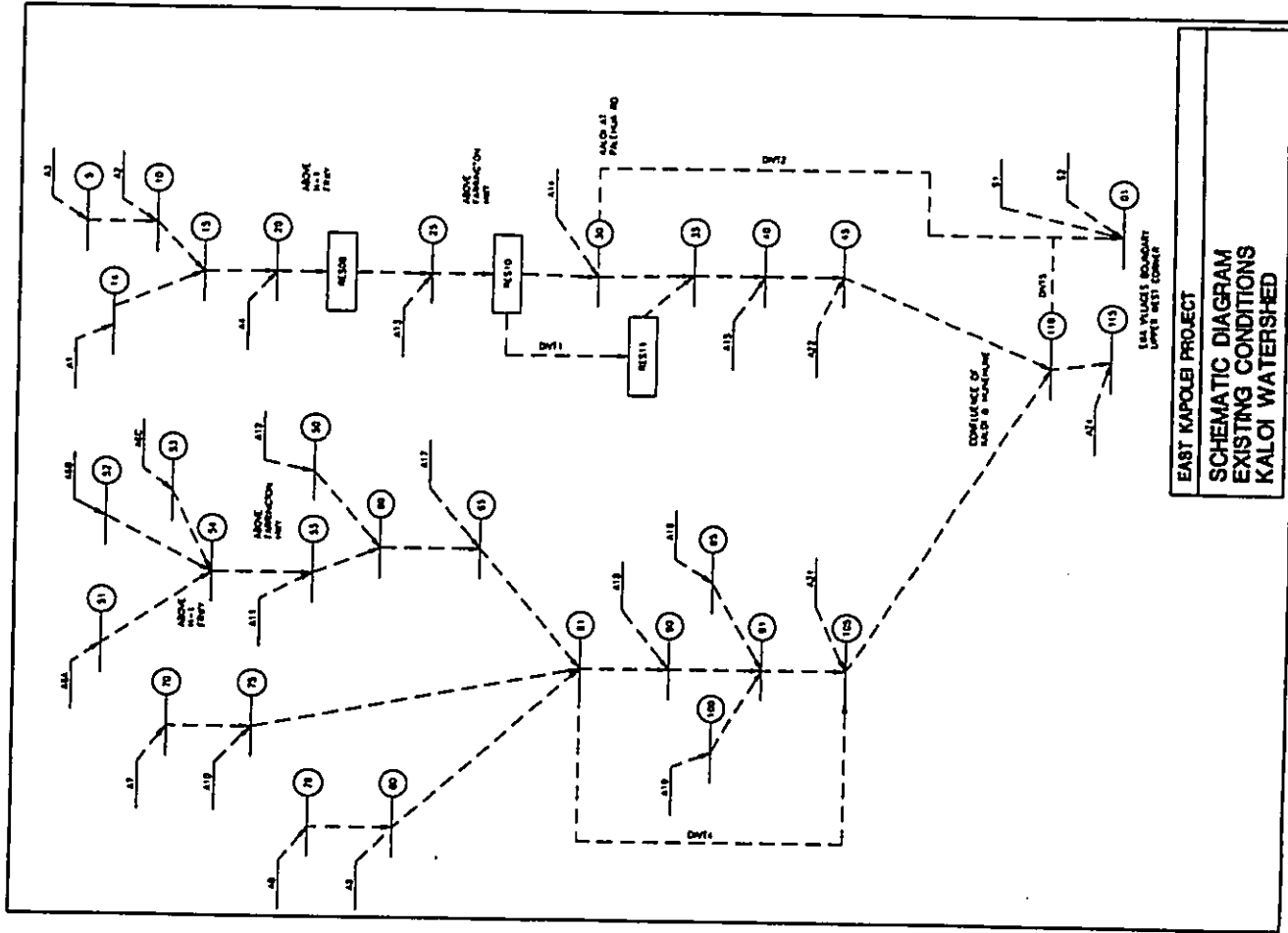
File:	AREA	Area (Sq.Mi.)	Runoff (Ac-ft)	Peak Q (cfs)
X101-C.DAT	VAR	0.167	97	221
		107 Ac.		

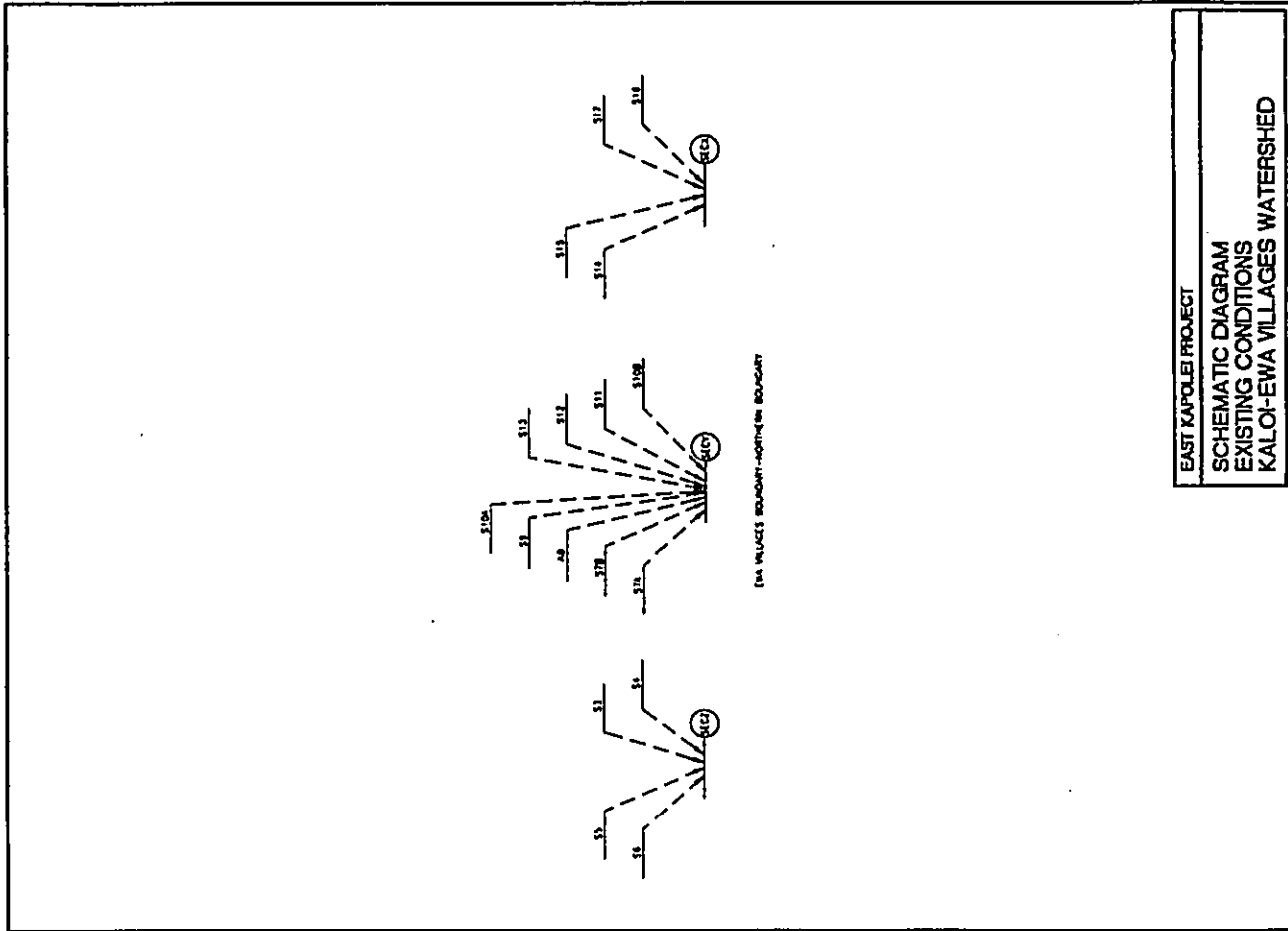
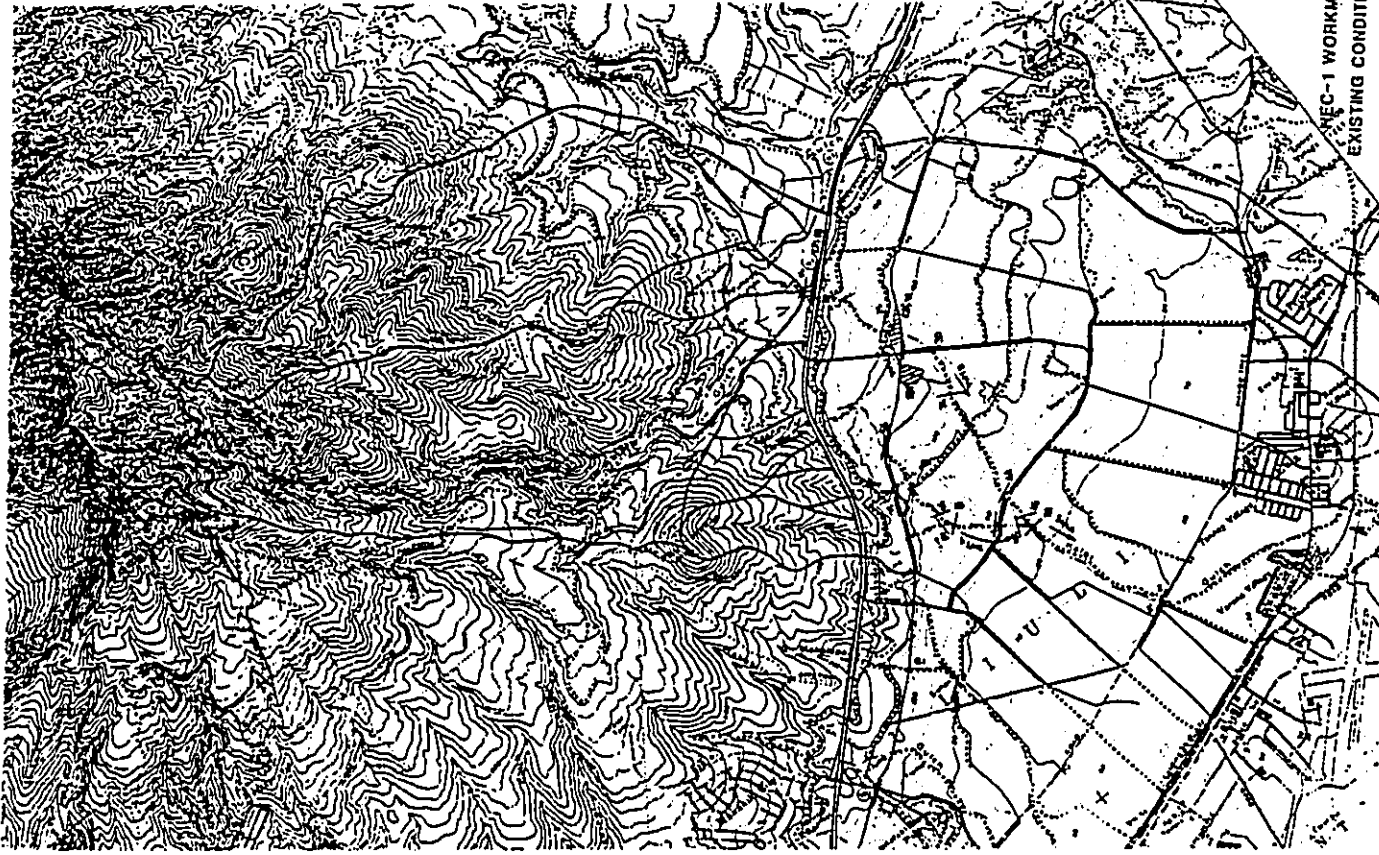
EXISTING VILLAGES OF KAPOLEI

File:	AREA	Area (Sq.Mi.)	Runoff (Ac-ft)	Peak Q (cfs)
X101-C.DAT	KAP	0.170	97	176
		109 Ac.		

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	690	1,101
		764 Ac.		





FLOOD HYDROGRAPH PACKAGE (HEC-1)
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 HYDROLOGIC ENGINEERING CENTER
 605 SECOND STREET
 DAVIS, CALIFORNIA 95616
 (916) 531-3700

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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1CS, HEC1D, AND HEC1M.
 THE DEFINITIONS OF VARIABLES, SETING, AND ACTION HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
 THE DEFINITION OF "ANSEL" ON IN-CHANNEL HAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTHCOMING VERSION.
 NEW OPTIONS: DAMBREAK OUTFLOW SUBSEQUENCE, SINGLE EVENT DAMAGE CALCULATION, DESIRED STAGE FALLOUTLET.
 DSS: READ TIME SERIES AT DESIRED CALCULATION INTERVAL. LOSS RATE: GREEN AND ADPT INFILTRATION
 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

35 BA 2.016 2.016 .69 1.40 2.60 3.70 4.75 6.85 9.30 12.70
 36 PM 0 70
 37 LE 0 70
 38 UD 1.034
 39 KK SEC10
 40 KM COMBINE HYDROGRAPHS AT SEC10
 41 KC 2
 42 KK SEC10
 43 KM ROUTE RALOI TRIBUTARY FLOW FROM SEC10 TO SEC10
 44 RS 2 FLOW
 45 RC .035 .035 200 0.025 207
 46 RE 0 160 180 190 205 260 400 550
 47 RV 215 215 215 191 194 209 210 215
 HEC-1 INPUT

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 LINE

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 54 LE 0 66
 55 UD 0.430
 56 KK SEC10
 57 KM COMBINE HYDROGRAPHS AT SEC10
 58 KC 2
 59 KK RES100
 60 KM ROUTE FLOW FROM SEC10 THROUGH RES100
 61 RS 1 ELEV 193.5
 62 RV 0 0.1 0.8 2.3 6.9 12.1 18.8 29.5 41.1
 63 RE 191.5 210 202 204 206 208 210 212 215
 64 RV 0 500 755 964 1285 2089 3121 3541 3906
 65 SE 191.5 200 202 204 206 208 210 212 215

ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
 LINE

66 KK SEC15
 67 KM ROUTE RALOI TRIBUTARY FLOW FROM RES10 TO SEC15
 68 RS 2 FLOW
 69 RC .035 .035 2350 0.013 165
 70 RE 0 270 330 310 355 610 700 900
 71 RV 170 165 165 165 166 166 165 167 170
 72 KK A13
 73 KM GENERATE HYDROGRAPH FROM SUBBASIN A13 TO SEC15
 74 PM MID-WATERSHED PRECIPITATION DATA
 75 BA 0.307 0.307 .65 3.32 2.45 3.55 4.60 6.75 9.20 12.30
 76 PM 0 75
 77 LS 0 75
 78 UD 2.046
 79 KK SEC15
 80 KM COMBINE HYDROGRAPHS AT SEC15
 81 KC 2
 82 KK RES10
 83 KM ROUTE FLOW FROM SEC15 THROUGH RES10
 84 RS 1 ELEV 150
 85 RV 0 6.3 9.3 14.8 21.0
 86 RE 150 165 166 167 168
 87 RV 0 0 2350 6364 18388
 88 SE 150 165 166 167 168
 89 KK RES10
 90 KM DIVERT RALOI OVERFLOW FROM RES10 TO RES11
 91 DT DIV1
 92 DI 0 2010 2011 3500 3000 3500 4000
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94 KK SEC10
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 LINE

96 KK SEC10
 97 KM ROUTE RALOI TRIBUTARY FLOW FROM RES10 TO SEC10

ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
 LINE

98 KK SEC10
 99 KM ROUTE RALOI TRIBUTARY FLOW FROM RES10 TO SEC10

ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
 LINE

100 KK SEC10
 101 KM ROUTE RALOI TRIBUTARY FLOW FROM RES10 TO SEC10

ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
 LINE

102 KK SEC10
 103 KM ROUTE RALOI TRIBUTARY FLOW FROM RES10 TO SEC10

ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
 LINE

160 BA 0.003 0.003 .65 1.32 2.65 3.55 4.60 6.75 9.20 12.30
161 PM 0 0 86
162 LS 0
163 UD 0.012

164 KE SECS5
165 MC 2
166
167 KE A1A
168 PM 0
169 PM 0
170 SA 0.002
171 PM 0
172 LS 0 74
173 UD 0.100

174 KE A1B
175 PM 0
176 PM 0
177 SA 0.007
178 PM 0
179 LS 0 77
180 UD 0.102

181 KE A1C
182 PM 0
183 PM 0
184 SA 0.104
185 PM 0
186 LS 0 79
187 UD 0.106

188 KE SECS4
189 MC 1
190
191 KE SECS5
192 RM 0
193 SA 2
194 KE 0.015 0.015 0.015 0.015 0.015 173
195 AX 0 15.6 28.3 35.9 38 45.1 54.3
196 AY 173 170.6 170.6 170.6 173.5 173.5 173.2

197 KE A11
198 PM 0
199 PM 0
200 SA 0.101
201 PM 0
202 LS 0 77
203 UD 0.090

204 KE SECS5
205 MC 2
206
207 KE A12
208 PM 0
209 PM 0
210 SA 0.359
211 PM 0
212 LS 0 81
213 UD 0.064

214 KE SECS6
215 PM 0
216 MC 2
217 KE SECS5
218 RM 0
219 SA 2
220 MC 0.015 0.015 0.015 0.015 0.015 110
221 AX 0 600 610 700 715 725 810 1370
222 AY 120 115 110 103 101 110 110 115

224 KE SECS6
225 PM 0
226 MC 2
227 KE SECS5
228 RM 0
229 SA 2
230 MC 0.015 0.015 0.015 0.015 0.015 110
231 AX 0 600 610 700 715 725 810 1370
232 AY 120 115 110 103 101 110 110 115

233 KE A14
234 PM 0
235 PM 0
236 SA 0.007
237 PM 0
238 LS 0 78
239 UD 0.090

240 KE SECS7
241 PM 0
242 MC 2
243 KE SECS7
244 DI 0
245 DI 0
246 DO 0
247 KE SECS5
248 AS 2
249 MC 0.015 0.015 0.015 0.015 0.015 135
250 AX 0 160 300 305 345 350 520 700
251 AY 141 140 335 318 318 335 340 335

252 KE RES11
253 OM 0
254 DM 0
255 KE RES11
256 RM 0
257 MC 2
258
259 KE SECS6
260 AS 2
261 MC 0.155 0.155 0.155 0.155 0.155 95
262 AX 0 250 320 330 340 350 380 600
263 AY 105 95 90 80 80 90 95 100

264 KE A15
265 PM 0
266 PM 0
267 SA 0.155
268 LS 0 79
269 UD 0.318

270 KE SECS7
271 PM 0
272 MC 2
273 KE SECS5
274 AS 2
275 MC 0.015 0.015 0.015 0.015 0.015 85
276 AX 0 200 380 390 400 410 460 1100
277 AY 90 90 85 77 77 85 87 90

278 KE A12
279 PM 0
280 PM 0
281 SA 0.155
282 LS 0 79
283 UD 0.318

284 KE SECS7
285 RM 0
286 SA 2
287 MC 0.015 0.015 0.015 0.015 0.015 110
288 AX 0 600 610 700 715 725 810 1370
289 AY 120 115 110 103 101 110 110 115

```

LINE 10.....3.....2.....3.....4.....5.....6.....7.....8.....9.....10
223 KK A17 GENERATE HYDROGRAPH FROM SUBBASIN A17 TO SECS7
224 RN 2 FLOW 0
225 BA 0.009 0.009 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
226 PH 0 70
227 LS 0
228 LD 0.066
229
230 KK SECS7 COMBINE HYDROGRAPHS AT SECS7
231 RN 2
232 MC 2
233
234 KK A7 GENERATE HYDROGRAPH FROM SUBBASIN A7 TO SECS7
235 RN 2 UPPER WATERSHED PRECIPITATION DATA
236 BA 0.009 0.009 .66 1.35 2.50 3.60 4.65 6.80 9.25 12.50
237 PH 0 52
238 LS 0
239 LD 0.072
240
241 KK SECS7 COMBINE HYDROGRAPHS AT SECS7
242 RN 2
243 MC 2
244
245 KK A10 GENERATE HYDROGRAPH FROM SUBBASIN A10 TO SECS7
246 RN 2 FLOW 0
247 BA 0.035 .035 .035 2100 0.025 130
248 PH 0 210 360 344 348 352 400 600
249 LS 0
250 LD 135 130 130 126 126 130 130 130
251
252 KK A10 GENERATE HYDROGRAPH FROM SUBBASIN A10 TO SECS7
253 RN 2 UPPER WATERSHED PRECIPITATION DATA
254 BA 0.082 0.082 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
255 PH 0 76
256 LS 0
257 LD 0.336
258
259 KK SECS7 COMBINE HYDROGRAPHS AT SECS7
260 RN 2
261 MC 2
262
263 KK A1 GENERATE HYDROGRAPH FROM SUBBASIN A1 TO SECS7
264 RN 2 UPPER WATERSHED PRECIPITATION DATA
265 BA 0.169 0.169 .65 1.35 2.50 3.60 4.65 6.80 9.25 12.50
266 PH 0 64
267 LS 0
268 LD 0.312
269
270 KK SECS7 COMBINE HYDROGRAPHS AT SECS7
271 RN 2
272 MC 2
273
274 KK A10 GENERATE HYDROGRAPH FROM SUBBASIN A10 TO SECS7
275 RN 2 FLOW 0
276 BA .035 .035 .035 1040 0.016 110
277 PH 0 200 400 407 417 426 460 650
278 LS 0
279 LD 110 110 110 103 103 110 110 110
280
281 KK A10 GENERATE HYDROGRAPH FROM SUBBASIN A10 TO SECS7
282 RN 2 MID-WATERSHED PRECIPITATION DATA
283 BA 0.014 0.014 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
284 PH 0 78
285 LS 0
286 LD 0.310
287
288 KK SECS7 COMBINE HYDROGRAPHS AT SECS7
289 RN 2
290 MC 2
291
292 KK A10 GENERATE HYDROGRAPH FROM SUBBASIN A10 TO SECS7
293 RN 2 MID-WATERSHED PRECIPITATION DATA
294 BA 0.014 0.014 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
295 PH 0 78
296 LS 0
297 LD 0.310
298
299 KK SECS7 COMBINE HYDROGRAPHS AT SECS7
300 RN 2
301 MC 2
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DI 0 1550 1550 2000 2000 2100 2100 2100 2100 2100 2100 2100
DQ 0 0 0 1 472 302 1493 1342 2162
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LINE 10.....3.....2.....3.....4.....5.....6.....7.....8.....9.....10
348 KK A15 GENERATE HYDROGRAPH FROM SUBBASIN A15 TO SECS7
349 RN 2 FLOW 0
350 BA 0.133 0.133 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
351 PH 0 85
352 LS 0
353 LD 1.050
354
355 KK SECS7 COMBINE HYDROGRAPHS AT SECS7
356 RN 2
357 MC 2
358
359 KK A15 GENERATE HYDROGRAPH FROM SUBBASIN A15 TO SECS7
360 RN 2 UPPER WATERSHED PRECIPITATION DATA
361 BA 0.169 0.169 .65 1.35 2.50 3.60 4.65 6.80 9.25 12.50
362 PH 0 64
363 LS 0
364 LD 0.312
365
366 KK SECS7 COMBINE HYDROGRAPHS AT SECS7
367 RN 2
368 MC 2
369
370 KK A15 GENERATE HYDROGRAPH FROM SUBBASIN A15 TO SECS7
371 RN 2 MID-WATERSHED PRECIPITATION DATA
372 BA 0.014 0.014 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
373 PH 0 78
374 LS 0
375 LD 0.310
376
377 KK SECS7 COMBINE HYDROGRAPHS AT SECS7
378 RN 2
379 MC 2
380
381 KK A15 GENERATE HYDROGRAPH FROM SUBBASIN A15 TO SECS7
382 RN 2 MID-WATERSHED PRECIPITATION DATA
383 BA 0.014 0.014 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
384 PH 0 78
385 LS 0
386 LD 0.310
387
388 KK SECS7 COMBINE HYDROGRAPHS AT SECS7
389 RN 2
390 MC 2
391
392 KK A15 GENERATE HYDROGRAPH FROM SUBBASIN A15 TO SECS7
393 RN 2 MID-WATERSHED PRECIPITATION DATA
394 BA 0.014 0.014 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
395 PH 0 78
396 LS 0
397 LD 0.310
398
399 KK SECS7 COMBINE HYDROGRAPHS AT SECS7
400 RN 2
401 MC 2
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EK SEC115
 RN 2 FLOW 0
 RC -.035 -.035 3170 .0229 60
 RE 2 32 45 60 65 74 104 150
 RF 65 66 70 60 60 60 65 65
 RW 3 INPUT
 LINE ID.....3.....4.....5.....6.....7.....8.....9.....10.....11.....12.....

EK SEC115
 RN 2 FLOW 0
 RC -.035 -.035 3170 .0229 60
 RE 2 32 45 60 65 74 104 150
 RF 65 66 70 60 60 60 65 65
 RW 3 INPUT
 LINE ID.....3.....4.....5.....6.....7.....8.....9.....10.....11.....12.....

EK SEC115
 RN 2 FLOW 0
 RC -.035 -.035 3170 .0229 60
 RE 2 32 45 60 65 74 104 150
 RF 65 66 70 60 60 60 65 65
 RW 3 INPUT
 LINE ID.....3.....4.....5.....6.....7.....8.....9.....10.....11.....12.....

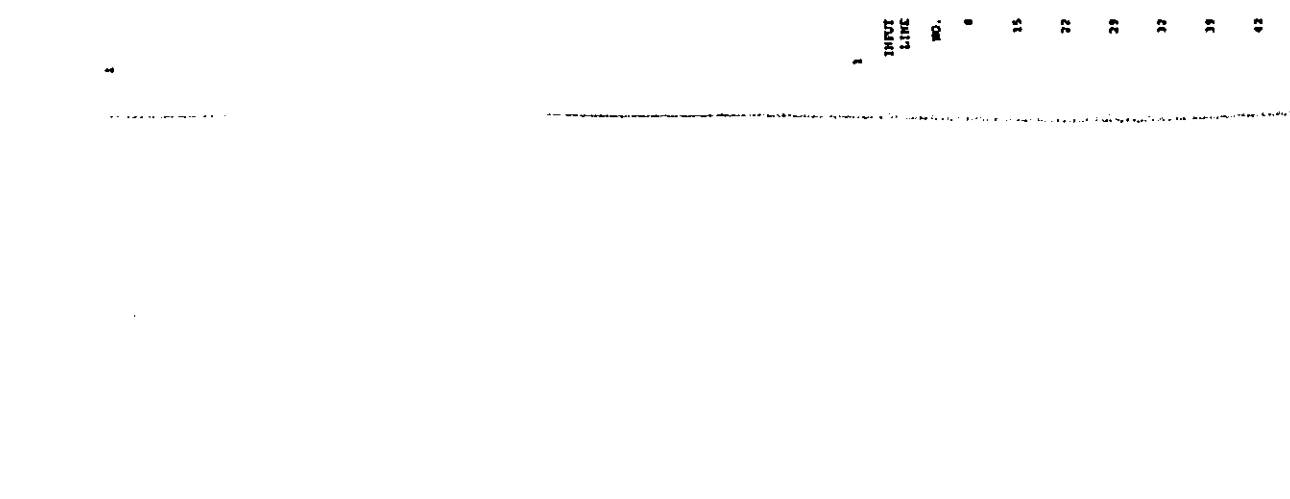
EK SEC115
 RN 2 FLOW 0
 RC -.035 -.035 3170 .0229 60
 RE 2 32 45 60 65 74 104 150
 RF 65 66 70 60 60 60 65 65
 RW 3 INPUT
 LINE ID.....3.....4.....5.....6.....7.....8.....9.....10.....11.....12.....

EK SEC115
 RN 2 FLOW 0
 RC -.035 -.035 3170 .0229 60
 RE 2 32 45 60 65 74 104 150
 RF 65 66 70 60 60 60 65 65
 RW 3 INPUT
 LINE ID.....3.....4.....5.....6.....7.....8.....9.....10.....11.....12.....

EK SEC115
 RN 2 FLOW 0
 RC -.035 -.035 3170 .0229 60
 RE 2 32 45 60 65 74 104 150
 RF 65 66 70 60 60 60 65 65
 RW 3 INPUT
 LINE ID.....3.....4.....5.....6.....7.....8.....9.....10.....11.....12.....

EK SEC115
 RN 2 FLOW 0
 RC -.035 -.035 3170 .0229 60
 RE 2 32 45 60 65 74 104 150
 RF 65 66 70 60 60 60 65 65
 RW 3 INPUT
 LINE ID.....3.....4.....5.....6.....7.....8.....9.....10.....11.....12.....

EK SEC115
 RN 2 FLOW 0
 RC -.035 -.035 3170 .0229 60
 RE 2 32 45 60 65 74 104 150
 RF 65 66 70 60 60 60 65 65
 RW 3 INPUT
 LINE ID.....3.....4.....5.....6.....7.....8.....9.....10.....11.....12.....



SCHEMATIC DIAGRAM OF STREAM NETWORK
 (V) ROUTING (-----) DIVERSION OR PUMP FLOW
 (.) CONNECTOR (-----) RETURN OF DIVERTED OR PUMPED FLOW

INPUT LINE NO. 8
 A1
 V
 V
 SEC10
 15
 22
 29
 SEC10
 32
 39
 SEC10
 42

```

335 V ..... DIVTS
336 SECS5 .....
337 .....
338 SECS5 .....
339 .....
340 SECS5 .....
341 .....
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(*** REMOVT ALSO COMPUTED AT THIS LOCATION ***
FLOOD HYDROGRAPH PACKAGE (HEC-1)
JUN 01 1992
VERSION 4.0.1E
RUN DATE 07/17/77 TIME 11:35:49

```

```

.....
U.S. ARMY CORPS OF ENGINEERS
HYDROLOGIC ENGINEERING CENTER
609 SECOND STREET
DAVIS, CALIFORNIA 95616
(916) 551-1740
.....

```

```

381 V .....
382 SECS5 .....
383 .....
384 .....
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EMA VILLAGES PROJECT FLOOD (100-YEAR STORM)
PM, 5:181 DAY
PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
                    EAST WATERSHED - EXISTING CONDITIONS
                    KAL01 - RESERVE NETWORK MODEL
OUTPUT CONTROL VARIABLES
PRINT 5 PRINT CONTROL
PLOT 0 PLOT CONTROL
SCALE 0. HYDROGRAPH PLOT SCALE
HYDROGRAPH TIME DATA
MIN 7 MINUTES IN COMPUTATION INTERVAL
DATE 1987 STARTING DATE
TIME 1200 STARTING TIME
NO 100 NUMBER OF HYDROGRAPH COORDINATES
BEFORE 2 FIRST ENDING DATE
AFTER 210 ENDING TIME
ICENT 15 CENTURY MARK
COMPUTATION INTERVAL 0.12 HOURS
TOTAL TIME BASE 34.99 HOURS
ENGLISH UNITS
DRAINAGE AREA SQUARE MILES

```



OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD	6-HOUR	24-HR	72-HR	36.01-HR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	A1	1621	13.10	933	364	243	243	243	1.70	313.67	13.42
ROUTED TO	SEC10	1621	13.42	933	364	243	243	243	1.70	313.67	13.42
HYDROGRAPH AT	A2	270	12.48	91	36	25	25	25	0.17		
2 COMBINED AT	SEC10	1726	13.10	1028	421	288	288	288	1.67		
HYDROGRAPH AT	A1	1866	13.45	1148	476	326	326	326	2.04		
2 COMBINED AT	SEC15	1546	13.42	2174	696	415	415	415	3.90		

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD	6-HOUR	24-HR	72-HR	36.01-HR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	A1	2529	7.93	544	544	544	544	544	1.70		
ROUTED TO	SEC10	2529	8.25	544	544	544	544	544	1.70		
HYDROGRAPH AT	A1	1746	12.48	91	36	25	25	25	0.17		
2 COMBINED AT	SEC10	1746	12.48	91	36	25	25	25	0.17		

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD	6-HOUR	24-HR	72-HR	36.01-HR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	A1	2529	7.93	544	544	544	544	544	1.70		
ROUTED TO	SEC10	2529	8.25	544	544	544	544	544	1.70		
HYDROGRAPH AT	A1	1746	12.48	91	36	25	25	25	0.17		
2 COMBINED AT	SEC10	1746	12.48	91	36	25	25	25	0.17		

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD	6-HOUR	24-HR	72-HR	36.01-HR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	A1	2529	7.93	544	544	544	544	544	1.70		
ROUTED TO	SEC10	2529	8.25	544	544	544	544	544	1.70		
HYDROGRAPH AT	A1	1746	12.48	91	36	25	25	25	0.17		
2 COMBINED AT	SEC10	1746	12.48	91	36	25	25	25	0.17		

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD	6-HOUR	24-HR	72-HR	36.01-HR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	A1	2529	7.93	544	544	544	544	544	1.70		
ROUTED TO	SEC10	2529	8.25	544	544	544	544	544	1.70		
HYDROGRAPH AT	A1	1746	12.48	91	36	25	25	25	0.17		
2 COMBINED AT	SEC10	1746	12.48	91	36	25	25	25	0.17		

05

```

.....
FLOOD HYDROGRAPH PACKAGE (REC-1)
JUN 03 1992
VERSION 4.0.1E
RUN DATE 06/23/92 TIME 11:33:55
.....
U.S. ARMY CORPS OF ENGINEERS
HYDROLOGIC ENGINEERING CENTER
609 SECOND STREET
DAVIS, CALIFORNIA 95616
(916) 533-1748
.....

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```

36 BA 0.017
37 PH 0.017
38 LS 0
39 UD 0.014
40 KK SECT
41 ED 3
42 RC 4
43 ZZ

```

SCHEMATIC DIAGRAM OF STREAM NETWORK

```

INPUT LINE (V) ROUTING (.....) DIVERSION OR PUMP FLOW
NO. (.) CONNECTOR (.....) RETURN OF DIVERTED OR PUMPED FLOW

```

```

0 8)
16 54
24 55
32 56
40 SECT

```

***** RUNOFF ALSO COMPUTED AT THIS LOCATION *****

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.....
FLOOD HYDROGRAPH PACKAGE (REC-1)
JUN 03 1992
VERSION 4.0.1E
RUN DATE 06/23/92 TIME 11:33:55
.....

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```

.....
U.S. ARMY CORPS OF ENGINEERS
HYDROLOGIC ENGINEERING CENTER
609 SECOND STREET
DAVIS, CALIFORNIA 95616
(916) 533-1748
.....

```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF REC-1 KNOWN AS REC1 (JAN 71), REC105, REC106, AND REC107.

THE DEFINITIONS OF VARIABLES -RTING- AND -RTIC- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE. THE DEFINITION OF -MAYE- OR -M-CAD- HAS CHANGED WITH REVISIONS DATED 21 SEP 81. THIS IS THE FORTRAN77 VERSION OF THE PROGRAM. DOWNSIDE OUTPUT SUBSEQUENCE - SINGLE EVENT DAMAGE CALCULATION, DESIGN STAGE PRECISION, AND THE SERIES AT DESIRED CALCULATION INTERVAL - LOSS RATE/CREED AND AWT INITIATION. RERUN DATE: NEW FINITE DIFFERENCE ALGORITHM

PAGE 1

```

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
1 ID ENA VILLAGES PROJECT FLOOD (100-YEAR STORM)
2 ID PH: X181-1.DAT
3 ID PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
4 ID EAST WATERSHED - EXISTING CONDITIONS
5 ID FALGSI - RESERVOIR NETWORK MODEL
6 ID 1 01E997 3200 300
7 ID 1
8 ID 1
9 ID 1
10 ID 1
11 ID 1
12 ID 1
13 ID 1
14 ID 1
15 ID 1
16 ID 1
17 ID 1
18 ID 1
19 ID 1
20 ID 1
21 ID 1
22 ID 1
23 ID 1
24 ID 1
25 ID 1
26 ID 1
27 ID 1
28 ID 1
29 ID 1
30 ID 1
31 ID 1
32 ID 1
33 ID 1
34 ID 1
35 ID 1

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```

ENR VILLAGES PROJECT FLOOD (100-YEAR STORM)
PH: X181-1.DAT
PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
EAST WATERSHED - EXISTING CONDITIONS
FALGSI - RESERVOIR NETWORK MODEL

```

```

OUTPUT CONTROL VARIABLES
IPRINT 1 PRINT CONTROL
IPLOT 0 PLOT CONTROL
OSCAL 0 HYDROGRAPH PLOT SCALE

```

```

HYDROGRAPH TIME DATA
MWIN 5 MINUTES IN COMPUTATION INTERVAL
IYB97 17E97 STARTING DATE
ITIME 1200 STARTING TIME
M2 300 NUMBER OF HYDROGRAPH ordinates
RDATE 27E97 ENDING DATE
RTIME 1215 ENDING TIME
ICENT 19 CENTURY MARK

```

```

COMPUTATION INTERVAL 0.01 HOURS
TOTAL TIME BASE 24.32 HOURS

```

```

ENGLISH UNITS
DRAINAGE AREA SQUARE MILES
PRECIPITATION DEPTH INCHES
LENGTH, ELEVATION FEET
FLOW CUBIC FEET PER SECOND
STORAGE VOLUME ACRES-Feet
SURFACE AREA ACRES
TEMPERATURE DEGREES FAHRENHEIT

```

```

ENR VILLAGES PROJECT FLOOD (100-YEAR STORM)
PH: X181-1.DAT
PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
EAST WATERSHED - EXISTING CONDITIONS
FALGSI - RESERVOIR NETWORK MODEL

```

```

OUTPUT CONTROL VARIABLES
IPRINT 1 PRINT CONTROL
IPLOT 0 PLOT CONTROL
OSCAL 0 HYDROGRAPH PLOT SCALE

```

```

HYDROGRAPH TIME DATA
MWIN 5 MINUTES IN COMPUTATION INTERVAL
IYB97 17E97 STARTING DATE
ITIME 1200 STARTING TIME
M2 300 NUMBER OF HYDROGRAPH ordinates
RDATE 27E97 ENDING DATE
RTIME 1215 ENDING TIME
ICENT 19 CENTURY MARK

```

```

COMPUTATION INTERVAL 0.01 HOURS
TOTAL TIME BASE 24.32 HOURS

```

```

ENGLISH UNITS
DRAINAGE AREA SQUARE MILES
PRECIPITATION DEPTH INCHES
LENGTH, ELEVATION FEET
FLOW CUBIC FEET PER SECOND
STORAGE VOLUME ACRES-Feet
SURFACE AREA ACRES
TEMPERATURE DEGREES FAHRENHEIT

```

```

SUBBASIN RUMOFF DATA
SUBBASIN CHARACTERISTICS
TAREA 0.81 SUBBASIN AREA
PRECIPITATION DATA
DEPTH FOR 0-PERCENT HYPOTHETICAL STORM
5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 48-HR 7-DAY 10-DAY
0.65 1.32 3.45 4.60 6.75 9.20 12.30 0.00 0.00 0.00 0.00
STORM AREA = 0.01
SCS LOSS RATE
STRFL 0.35 INITIAL ABSTRACTION
CN2NR 89.00 CURVE NUMBER
RTIMP 9.69 PERCENT INTERVICIOUS AREA
SCS DIMENSIONLESS UNITDRAP
TLAG 0.59 LAG

```

```

20 BA
SUBBASIN CHARACTERISTICS
TAREA 0.81 SUBBASIN AREA
PRECIPITATION DATA
DEPTH FOR 0-PERCENT HYPOTHETICAL STORM
5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 48-HR 7-DAY 10-DAY
0.65 1.32 3.45 4.60 6.75 9.20 12.30 0.00 0.00 0.00 0.00
STORM AREA = 0.01
SCS LOSS RATE
STRFL 0.35 INITIAL ABSTRACTION
CN2NR 89.00 CURVE NUMBER
RTIMP 9.69 PERCENT INTERVICIOUS AREA
SCS DIMENSIONLESS UNITDRAP
TLAG 0.59 LAG

```

```

21 PH
SUBBASIN CHARACTERISTICS
TAREA 0.81 SUBBASIN AREA
PRECIPITATION DATA
DEPTH FOR 0-PERCENT HYPOTHETICAL STORM
5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 48-HR 7-DAY 10-DAY
0.65 1.32 3.45 4.60 6.75 9.20 12.30 0.00 0.00 0.00 0.00
STORM AREA = 0.01
SCS LOSS RATE
STRFL 0.35 INITIAL ABSTRACTION
CN2NR 89.00 CURVE NUMBER
RTIMP 9.69 PERCENT INTERVICIOUS AREA
SCS DIMENSIONLESS UNITDRAP
TLAG 0.59 LAG

```

```

22 LS
SUBBASIN CHARACTERISTICS
TAREA 0.03 SUBBASIN AREA
PRECIPITATION DATA
DEPTH FOR 0-PERCENT HYPOTHETICAL STORM
5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 48-HR 7-DAY 10-DAY
0.65 1.32 3.45 4.60 6.75 9.20 12.30 0.00 0.00 0.00 0.00
STORM AREA = 0.03
SCS LOSS RATE
STRFL 0.35 INITIAL ABSTRACTION
CN2NR 89.00 CURVE NUMBER
RTIMP 9.69 PERCENT INTERVICIOUS AREA
SCS DIMENSIONLESS UNITDRAP
TLAG 0.59 LAG

```

```

23 UD
HYDROGRAPH AT STATION 54
TOTAL RAINFALL = 12.30, TOTAL LOSS = 1.37, TOTAL EXCESS = 10.93
PEAK FLOW TIME 6-HR 24-HR 72-HR 24-92-HR
(CFS) (HR) (CFS) (HR)
1. 3. 6. 10. 15. 18. 20. 39. 10.
2. 12. 10. 8. 6. 3. 3. 3. 2.
3. 3. 3. 1. 1. 0. 0. 0. 0.
4. 0. 0. 0. 0. 0. 0. 0. 0.
CUMULATIVE AREA = 0.01 80 MI

```

```

24 EE
HYDROGRAPH AT STATION 54
TOTAL RAINFALL = 12.30, TOTAL LOSS = 1.37, TOTAL EXCESS = 10.93
PEAK FLOW TIME 6-HR 24-HR 72-HR 24-92-HR
(CFS) (HR) (CFS) (HR)
1. 3. 6. 10. 15. 18. 20. 39. 10.
2. 12. 10. 8. 6. 3. 3. 3. 2.
3. 3. 3. 1. 1. 0. 0. 0. 0.
4. 0. 0. 0. 0. 0. 0. 0. 0.
CUMULATIVE AREA = 0.01 80 MI

```

```

25 BA
SUBBASIN CHARACTERISTICS
TAREA 0.92 SUBBASIN AREA
PRECIPITATION DATA
DEPTH FOR 0-PERCENT HYPOTHETICAL STORM
5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 48-HR 7-DAY 10-DAY
0.65 1.32 3.45 4.60 6.75 9.20 12.30 0.00 0.00 0.00 0.00
STORM AREA = 0.02
SCS LOSS RATE
STRFL 0.35 INITIAL ABSTRACTION
CN2NR 89.00 CURVE NUMBER
RTIMP 9.69 PERCENT INTERVICIOUS AREA
SCS DIMENSIONLESS UNITDRAP
TLAG 0.59 LAG

```

```

26 BA
SUBBASIN CHARACTERISTICS
TAREA 0.92 SUBBASIN AREA
PRECIPITATION DATA
DEPTH FOR 0-PERCENT HYPOTHETICAL STORM
5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 48-HR 7-DAY 10-DAY
0.65 1.32 3.45 4.60 6.75 9.20 12.30 0.00 0.00 0.00 0.00
STORM AREA = 0.02
SCS LOSS RATE
STRFL 0.35 INITIAL ABSTRACTION
CN2NR 89.00 CURVE NUMBER
RTIMP 9.69 PERCENT INTERVICIOUS AREA
SCS DIMENSIONLESS UNITDRAP
TLAG 0.59 LAG

```

```

27 PH
SUBBASIN CHARACTERISTICS
TAREA 0.92 SUBBASIN AREA
PRECIPITATION DATA
DEPTH FOR 0-PERCENT HYPOTHETICAL STORM
5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 48-HR 7-DAY 10-DAY
0.65 1.32 3.45 4.60 6.75 9.20 12.30 0.00 0.00 0.00 0.00
STORM AREA = 0.02
SCS LOSS RATE
STRFL 0.35 INITIAL ABSTRACTION
CN2NR 89.00 CURVE NUMBER
RTIMP 9.69 PERCENT INTERVICIOUS AREA
SCS DIMENSIONLESS UNITDRAP
TLAG 0.59 LAG

```

```

28 BA
SUBBASIN CHARACTERISTICS
TAREA 0.03 SUBBASIN AREA
PRECIPITATION DATA
DEPTH FOR 0-PERCENT HYPOTHETICAL STORM
5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 48-HR 7-DAY 10-DAY
0.65 1.32 3.45 4.60 6.75 9.20 12.30 0.00 0.00 0.00 0.00
STORM AREA = 0.03
SCS LOSS RATE
STRFL 0.35 INITIAL ABSTRACTION
CN2NR 89.00 CURVE NUMBER
RTIMP 9.69 PERCENT INTERVICIOUS AREA
SCS DIMENSIONLESS UNITDRAP
TLAG 0.59 LAG

```

```

29 UD
HYDROGRAPH AT STATION 55
TOTAL RAINFALL = 12.30, TOTAL LOSS = 1.37, TOTAL EXCESS = 10.93
PEAK FLOW TIME 6-HR 24-HR 72-HR 24-92-HR
(CFS) (HR) (CFS) (HR)
1. 3. 6. 10. 15. 18. 20. 39. 10.
2. 12. 10. 8. 6. 3. 3. 3. 2.
3. 3. 3. 1. 1. 0. 0. 0. 0.
4. 0. 0. 0. 0. 0. 0. 0. 0.
CUMULATIVE AREA = 0.01 80 MI

```

```

30 BA
SUBBASIN CHARACTERISTICS
TAREA 0.03 SUBBASIN AREA
PRECIPITATION DATA
DEPTH FOR 0-PERCENT HYPOTHETICAL STORM
5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 48-HR 7-DAY 10-DAY
0.65 1.32 3.45 4.60 6.75 9.20 12.30 0.00 0.00 0.00 0.00
STORM AREA = 0.03
SCS LOSS RATE
STRFL 0.35 INITIAL ABSTRACTION
CN2NR 89.00 CURVE NUMBER
RTIMP 9.69 PERCENT INTERVICIOUS AREA
SCS DIMENSIONLESS UNITDRAP
TLAG 0.59 LAG

```

```

30 LS SCS LOSS RATE          0.25 INITIAL ABSTRACTION
      STRFL              09.00 CURVE NUMBER
      CRVBR              0.00 PERCENT IMPERVIOUS AREA
      RTIMP
      SCS DIMENSIONLESS UNITGRAPH
      TLAC              0.38 LAG

```

```

...
UNIT HYDROGRAPH
61 END-OF-PERIOD COORDINATES
  0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.
 11. 11. 11. 11. 11. 11. 11. 11. 11. 11. 11.
  5. 4. 3. 2. 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.

```

```

...
HYDROGRAPH AT STATION 55
TOTAL RAINFALL - 12.10, TOTAL LOSS - 1.37, TOTAL EXCESS - 10.73
PEAK FLOW TIME 6-HR 24-HR 72-HR 24.93-HR
(CFS) (HR) (CFS) (HR)
  10. 11.00 16. 6.382 10.812 10.812 10.812 6.
      (INCHES) (AC-FT) 0. 13. 13. 13.
      CUMULATIVE AREA - 0.02 SQ MI

```

```

...
40 KE * SECS *
...
41 ED OUTPUT CONTROL VARIABLES
      IPLOT 3 PRINT CONTROL
      IPLOT 0 PLOT CONTROL
      QSCALE 0. HYDROGRAPH PLOT SCALE

```

```

...
42 HC HYDROGRAPH COMBINATION
      ICOMP 4 NUMBER OF HYDROGRAPHS TO COMBINE

```

```

...
32 KE * 54 *
...
35 ED OUTPUT CONTROL VARIABLES
      IPLOT 3 PRINT CONTROL
      IPLOT 0 PLOT CONTROL
      QSCALE 0. HYDROGRAPH PLOT SCALE

```

```

...
36 BA SUBBASIN CHARACTERISTICS
      TABLE 0.02 SUBBASIN AREA
      PRECIPITATION DATA
      DEPTH FOR 0-PERCENT HYDROLOGICAL STORM
      5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 4-DAY 7-DAY 10-DAY
      0.65 1.32 2.45 3.55 4.60 6.75 9.30 12.30 0.00 0.00 0.00

```

```

...
37 PM
      SCS LOSS RATE          0.25 INITIAL ABSTRACTION
      STRFL              09.00 CURVE NUMBER
      CRVBR              0.00 PERCENT IMPERVIOUS AREA
      RTIMP
      SCS DIMENSIONLESS UNITGRAPH
      TLAC              0.38 LAG

```

```

...
UNIT HYDROGRAPH
61 END-OF-PERIOD COORDINATES
  0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.
 11. 11. 11. 11. 11. 11. 11. 11. 11. 11. 11.
  5. 4. 3. 2. 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.

```

```

...
HYDROGRAPH AT STATION 56
TOTAL RAINFALL - 12.10, TOTAL LOSS - 1.37, TOTAL EXCESS - 10.73
PEAK FLOW TIME 6-HR 24-HR 72-HR 24.93-HR
(CFS) (HR) (CFS) (HR)
  24. 12.83 12. 6.403 10.819 10.819 10.819 5.
      (INCHES) (AC-FT) 6. 10. 10. 10.
      CUMULATIVE AREA - 0.02 SQ MI

```

```

...
40 KE * SECS *
...
41 ED OUTPUT CONTROL VARIABLES
      IPLOT 3 PRINT CONTROL
      IPLOT 0 PLOT CONTROL
      QSCALE 0. HYDROGRAPH PLOT SCALE

```

```

...
42 HC HYDROGRAPH COMBINATION
      ICOMP 4 NUMBER OF HYDROGRAPHS TO COMBINE

```

```

...
32 KE * 54 *
...
35 ED OUTPUT CONTROL VARIABLES
      IPLOT 3 PRINT CONTROL
      IPLOT 0 PLOT CONTROL
      QSCALE 0. HYDROGRAPH PLOT SCALE

```

```

...
36 BA SUBBASIN CHARACTERISTICS
      TABLE 0.02 SUBBASIN AREA
      PRECIPITATION DATA
      DEPTH FOR 0-PERCENT HYDROLOGICAL STORM
      5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 4-DAY 7-DAY 10-DAY
      0.65 1.32 2.45 3.55 4.60 6.75 9.30 12.30 0.00 0.00 0.00

```


HYDROGRAPH AT 55 35. 13.00 18. 7. 6. 0.02
 56 24. 12.83 12. 5. 5. 0.02
 4 COMBINED AT SECTZ 113. 12.75 51. 23. 22. 0.08

*** NORMAL END OF NEC-1 ***

FLOOD HYDROGRAPH PACKAGE (NEC-1)
 JUN 03 1982
 VERSION 4.0.3E
 RUN DATE 06/21/77 TIME 13:35:06

U.S. ARMY CORPS OF ENGINEERS
 HYDROLOGIC ENGINEERING CENTER
 609 SECOND STREET
 DAVIS, CALIFORNIA 95616
 (916) 551-1711

X X XXXXX XXXX X
 X X X X X X
 X X X X X X
 XXXXX XXXX X
 X X X X X X
 X X X X X X
 X X XXXXX XXXX X

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF NEC-1 KNOWN AS NEC1 (JAN 73), NEC1G2, NEC1G3, AND NEC1G4.
 THE DEFINITIONS OF VARIABLES -RTIME- AND -RTIME- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
 THE DEFINITION OF -MESH- ON PUNCH WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE PORTLAND? VERSION
 NEW PUNCH PARAMETERS OUTPUT SUBSEQUENCE - SINGLE EVENT DAMAGE CALCULATION, DESCRIBE STAGE FREQUENCY,
 AS WELL AS THE SERIES AT DESIRED CALCULATION INTERVAL, LOSS RATE:GREEN AND AMPT INFILTRATION
 KINEMATIC WAVES: NEW FINITE DIFFERENCE ALGORITHM

NEC-1 INPUT

1 ID.....3.....2.....3.....4.....5.....6.....7.....8.....9.....10
 2 ID ENA VILLAGES PROJECT FLOOD (100-YEAR STORM)
 3 PR: X101-2.DAT
 4 PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
 5 EAST SAPOLEI - EXISTING CONDITIONS
 6 *QUADRAM
 7 17 5 01FEB77 1200 300
 8 10 5
 9 EK S7A
 10 EN GENERATE HYDROGRAPH FROM SUBBASIN S7A
 11 EN MID-WATERSHED PRECIPITATION DATA
 12 0.065 0.065 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
 13 0 00
 14 0.216
 15
 16 EK S7B
 17 EN GENERATE HYDROGRAPH FROM SUBBASIN S7B
 18 EN MID-WATERSHED PRECIPITATION DATA
 19 0.091 0.091 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
 20 0 00
 21 0.079
 22
 23 EK S8
 24 EN GENERATE HYDROGRAPH FROM SUBBASIN S8
 25 EN MID-WATERSHED PRECIPITATION DATA
 26 0.086 0.086 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
 27 0 00
 28 1.696
 29
 30 EK S9
 31 EN GENERATE HYDROGRAPH FROM SUBBASIN S9
 32 EN MID-WATERSHED PRECIPITATION DATA

36 BA 0.122 0.122 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
 37 PH 0 89
 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 KD 3
 44 BA 0.018
 45 PH 0.018 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
 46 LS 0 89
 47 UD 1.830

PAGE 3

REC-1 INPUT
 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 KD 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 KD 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 KD 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 1.868

72 KK S13
 73 KM GENERATE HYDROGRAPH FROM SUBBASIN S13
 74 KM MID-WATERSHED PRECIPITATION DATA
 75 KD 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 0.816

80 KK SECT
 81 PD 3
 82 MC 9
 83 22

HYDRAULIC DIAGRAM OF STREAM NETWORK

INPUT LINE NO. (.) DIVERSION OR PUMP FLOW
 (.) CONNECTOR (----) RETURN OF DIVERTED OR PUMPED FLOW

16 S78
 24 S9
 32 S9
 40 S10A

48 818
 56 811
 64 812
 72 813
 80 SECT 813

***** RUMOFF ALSO COMPUTED AT THIS LOCATION *****

FLOOD HYDROGRAPH PACKAGE (REC-1)
 RUN ON 12/82
 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) 531-1700

ENA VILLAGE PROJECT FLOOD (100-YEAR STORM)
 INPUT FILE: ENA.DAT
 PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
 EAST KAPOLES - EXISTING CONDITIONS
 RUMOFF - HYDROGRAPH NETWORK MODEL

7 10 OUTPUT CONTROL VARIABLES
 1 PRINT CONTROL
 2 PLOT CONTROL
 3 CALC

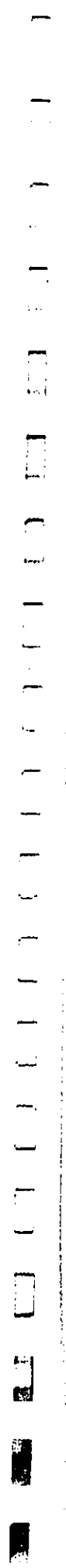
11 HYDROGRAPH TIME DATA
 1 DATE 12/82
 2 TIME 1700
 3 STARTING TIME
 4 NO 300
 5 NUMBER OF HYDROGRAPH ORDINATES
 6 DATE 2/27/97
 7 ENDING DATE
 8 TIME 1215
 9 ENDING TIME
 10 ECENT 33
 11 CENTURY MARK

COMPUTATION INTERVAL 0.01 HOURS
 TOTAL TIME BASE 21.52 HOURS
 ENGLISH UNITS
 DRAINAGE AREA SQUARE MILES
 PRECIPITATION DEPTH INCHES
 LENGTH, ELEVATION FEET
 FLOW CUBIC FEET PER SECOND
 STORAGE VOLUME ACRES-Feet
 SURFACE AREA ACRES
 TEMPERATURE DEGREES FAHRENHEIT

8 KK STA

11 KD OUTPUT CONTROL VARIABLES
 1 PRINT CONTROL
 2 PLOT CONTROL
 3 CALC

12 BA SUBBASIN CHARACTERISTICS



HYDROGRAPH AT STATION 51
 TOTAL RAINFALL = 12.30, TOTAL LOSS = 1.37, TOTAL EXCESS = 10.93
 PEAK FLOW TIME 6-HR 24-HR 72-HR 24.92-HR
 (CFS) (HR) (CFS) (HR) (CFS) (HR) (CFS) (HR)
 86. 13.83 58. 25. 24. 24.
 (INCHES) 6.219 10.638 10.638 10.634
 (AC-FIT) 29. 49. 49. 49.
 CUMULATIVE AREA = 0.89 SQ MI

OUTPUT CONTROL VARIABLES
 IFPRINT 3 PRINT CONTROL
 IPLOT 0 PLOT CONTROL
 OSCAL 0. HYDROGRAPH PLOT SCALE

SUBBASIN RUNOFF DATA
 SUBBASIN CHARACTERISTICS
 TABLE 0.12 SUBBASIN AREA

PRECIPITATION DATA
 HETRO-35 TP-40 TP-45
 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

SCS LOSS RATE
 STRL 0.35 INITIAL ABSTRACTION
 CURVR 89.00 CURVE NUMBER
 RTRMP 0.00 PERCENT IMPERVIOUS AREA

SCS DIMENSIONLESS UNITGRAPH
 TLAC 1.82 LAG

UNIT HYDROGRAPH
 111 END-OF-PERIOD ORDINATES
 0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12.
 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28.
 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41.
 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54.
 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67.
 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80.
 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92.
 93. 94. 95. 96. 97. 98. 99. 100. 101. 102. 103. 104.
 105. 106. 107. 108. 109. 110. 111. 112.

HYDROGRAPH AT STATION 51
 TOTAL RAINFALL = 12.30, TOTAL LOSS = 1.37, TOTAL EXCESS = 10.93
 PEAK FLOW TIME 6-HR 24-HR 72-HR 24.92-HR
 (CFS) (HR) (CFS) (HR) (CFS) (HR) (CFS) (HR)

HYDROGRAPH AT STATION 51
 TOTAL RAINFALL = 12.30, TOTAL LOSS = 1.37, TOTAL EXCESS = 10.93
 PEAK FLOW TIME 6-HR 24-HR 72-HR 24.92-HR
 (CFS) (HR) (CFS) (HR) (CFS) (HR) (CFS) (HR)
 86. 13.83 58. 25. 24. 24.
 (INCHES) 6.219 10.638 10.638 10.634
 (AC-FIT) 29. 49. 49. 49.
 CUMULATIVE AREA = 0.89 SQ MI

OUTPUT CONTROL VARIABLES
 IFPRINT 3 PRINT CONTROL
 IPLOT 0 PLOT CONTROL
 OSCAL 0. HYDROGRAPH PLOT SCALE

SUBBASIN RUNOFF DATA
 SUBBASIN CHARACTERISTICS
 TABLE 0.09 SUBBASIN AREA

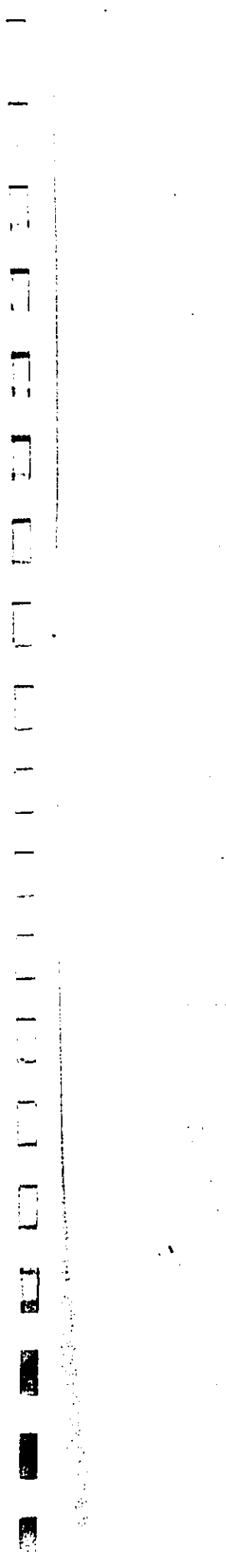
PRECIPITATION DATA
 HETRO-35 TP-40 TP-45
 5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 2-DAY 4-DAY 7-DAY 10-DAY
 0.65 1.32 2.45 3.55 4.60 6.75 9.20 12.30 0.00 0.00 0.00 0.00

SCS LOSS RATE
 STRL 0.35 INITIAL ABSTRACTION
 CURVR 89.00 CURVE NUMBER
 RTRMP 0.00 PERCENT IMPERVIOUS AREA

SCS DIMENSIONLESS UNITGRAPH
 TLAC 1.82 LAG

UNIT HYDROGRAPH
 111 END-OF-PERIOD ORDINATES
 0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12.
 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28.
 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41.
 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54.
 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67.
 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80.
 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92.
 93. 94. 95. 96. 97. 98. 99. 100. 101. 102. 103. 104.
 105. 106. 107. 108. 109. 110. 111. 112.

HYDROGRAPH AT STATION 51
 TOTAL RAINFALL = 12.30, TOTAL LOSS = 1.37, TOTAL EXCESS = 10.93
 PEAK FLOW TIME 6-HR 24-HR 72-HR 24.92-HR
 (CFS) (HR) (CFS) (HR) (CFS) (HR) (CFS) (HR)



PRECIPITATION DATA

..... HYDRO-35 DEPTH FOR 0-PERCENT HYPOTHEMETICAL STORM TP-49 TP-49

5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 3-DAY 4-DAY 7-DAY 10-DAY

0.65 1.32 2.65 4.60 6.75 9.20 12.30 16.00 0.00 0.00 0.00 0.00

STORM AREA = 0.07

61 PH

SCS LOSS RATE 0.25 INITIAL ABSTRACTION

STRIAL 89.00 CURVE NUMBER

RTIMP 0.09 PERCENT IMPERVIOUS AREA

SCS DIMENSIONLESS UNITGRAPH

TLAG 1.49 LAG

UNIT HYDROGRAPH

115 END-OF-PERIOD ORDINATES	4.	5.	6.	7.
0.	0.	1.	1.	2.
1.	1.	12.	13.	15.
2.	18.	18.	18.	17.
3.	15.	14.	12.	10.
4.	7.	7.	6.	5.
5.	4.	3.	3.	2.
6.	2.	2.	2.	2.
7.	1.	1.	1.	1.
8.	0.	0.	0.	0.
9.	0.	0.	0.	0.
10.	0.	0.	0.	0.

62 LS

HYDROGRAPH AT STATION S11

TOTAL RAINFALL = 12.30, TOTAL LOSS = 1.37, TOTAL EXCESS = 10.93

PEAK FLOW TIME 6-HR 24-HR 72-HR 24.92-HR

(CFS) (HR) (CFS) (INCHES) (INCHES) (AC-FT)

70. 14.00 (CFS) 48. 21. 20.

(INCHES) 6.164 10.575 10.575 10.575

(AC-FT) 24. 41. 41.

CUMULATIVE AREA = 0.87 SQ MI

64 RK

OUTPUT CONTROL VARIABLES

IPLOT 3 PRINT CONTROL

IPLOT 0 PLOT CONTROL

OSCAL 0. HYDROGRAPH PLOT SCALE

65 RO

SUBBASIN RUNCOFF DATA

SUBBASIN CHARACTERISTICS

TAREA 0.11 SUBBASIN AREA

66 BA

PRECIPITATION DATA

..... HYDRO-35 DEPTH FOR 0-PERCENT HYPOTHEMETICAL STORM TP-49 TP-49

5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 3-DAY 4-DAY 7-DAY 10-DAY

0.65 1.32 2.65 4.60 6.75 9.20 12.30 16.00 0.00 0.00 0.00 0.00

PRECIPITATION DATA

..... HYDRO-35 DEPTH FOR 0-PERCENT HYPOTHEMETICAL STORM TP-49 TP-49

5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 3-DAY 4-DAY 7-DAY 10-DAY

0.65 1.32 2.65 4.60 6.75 9.20 12.30 16.00 0.00 0.00 0.00 0.00

STORM AREA = 0.02

63 PH

SCS LOSS RATE 0.25 INITIAL ABSTRACTION

STRIAL 89.00 CURVE NUMBER

RTIMP 0.09 PERCENT IMPERVIOUS AREA

SCS DIMENSIONLESS UNITGRAPH

TLAG 0.47 LAG

UNIT HYDROGRAPH

30 END-OF-PERIOD ORDINATES	12.	13.	14.	15.	16.
1.	0.	0.	0.	0.	0.
2.	0.	0.	0.	0.	0.
3.	0.	0.	0.	0.	0.
4.	0.	0.	0.	0.	0.
5.	0.	0.	0.	0.	0.
6.	0.	0.	0.	0.	0.
7.	0.	0.	0.	0.	0.
8.	0.	0.	0.	0.	0.
9.	0.	0.	0.	0.	0.

64 RK

HYDROGRAPH AT STATION S108

TOTAL RAINFALL = 12.30, TOTAL LOSS = 1.37, TOTAL EXCESS = 10.93

PEAK FLOW TIME 6-HR 24-HR 72-HR 24.92-HR

(CFS) (HR) (CFS) (INCHES) (INCHES) (AC-FT)

33. 12.50 (CFS) 12. 5. 5.

(INCHES) 6.459 10.921 10.921 10.921

(AC-FT) 6. 10. 10.

CUMULATIVE AREA = 0.02 SQ MI

65 RO

OUTPUT CONTROL VARIABLES

IPLOT 3 PRINT CONTROL

IPLOT 0 PLOT CONTROL

OSCAL 0. HYDROGRAPH PLOT SCALE

66 BA

SUBBASIN RUNCOFF DATA

SUBBASIN CHARACTERISTICS

TAREA 0.07 SUBBASIN AREA

67 PH

PRECIPITATION DATA

..... HYDRO-35 DEPTH FOR 0-PERCENT HYPOTHEMETICAL STORM TP-49 TP-49

5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 3-DAY 4-DAY 7-DAY 10-DAY

0.65 1.32 2.65 4.60 6.75 9.20 12.30 16.00 0.00 0.00 0.00 0.00

70 LS SCS LOSS RATE 0.25 INITIAL ABSTRACTION
 STPL 0.00 CURVE NUMBER
 RTMP 0.00 PERCENT IMPERVIOUS AREA
 SCS DIMENSIONLESS UNITGRAPH
 TLAG 1.87 LAG

UNIT HYDROGRAPH
 116 END-OF-PERIOD ORDINATES
 0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11.
 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23.
 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35.
 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47.
 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59.
 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71.
 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82.
 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94.
 95. 96. 97. 98. 99. 100. 101. 102. 103. 104. 105. 106.
 107. 108. 109. 110. 111. 112. 113. 114. 115. 116.

HYDROGRAPH AT STATION S13
 TOTAL RAINFALL - 12.10, TOTAL LOSS - 1.37, TOTAL EXCESS - 10.73
 PEAK FLOW TIME 6-HR 21-HR 72-HR 24.92-HR
 (CFS) (HR) (CFS) (INCHES) (AC-FT) (CFS) (INCHES) (AC-FT)
 108. 16.20 75 22 31 10.864 10.864 10.864
 37 64 64
 CUMULATIVE AREA - 0.11 SQ MI

72 RK
 0. S13

 75 RD OUTPUT CONTROL VARIABLES 3 PRINT CONTROL
 IPMT 0 PLOT CONTROL
 OSCAL 0. HYDROGRAPH PLOT SCALE
 SUBBASIN RIFFOFF DATA

76 BA SUBBASIN CHARACTERISTICS
 TAXEA 0.03 SUBBASIN AREA
 PRECIPITATION DATA
 HYDRO-35 DEPTH FOR 0-PERCENT HYPOTHEITICAL STORM
 5-MIN 15-MIN 60-MIN 2-HR 6-HR 12-HR 24-HR 48-HR 72-HR 96-HR 120-HR
 0.65 1.22 2.45 3.65 4.60 5.75 6.75 7.75 8.75 9.75 10.75
 2-DAY 4-DAY 7-DAY 10-DAY
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 STORM AREA - 0.03

78 LS SCS LOSS RATE 0.25 INITIAL ABSTRACTION
 STPL 0.00 CURVE NUMBER
 RTMP 0.00 PERCENT IMPERVIOUS AREA
 SCS DIMENSIONLESS UNITGRAPH

STORM AREA - 0.11
 TLAG 0.88 LAG
 UNIT HYDROGRAPH
 52 END-OF-PERIOD ORDINATES
 0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11.
 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23.
 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35.
 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47.
 48. 49. 50. 51. 52.

HYDROGRAPH AT STATION S13
 TOTAL RAINFALL - 12.10, TOTAL LOSS - 1.37, TOTAL EXCESS - 10.73
 PEAK FLOW TIME 6-HR 21-HR 72-HR 24.92-HR
 (CFS) (HR) (CFS) (INCHES) (AC-FT) (CFS) (INCHES) (AC-FT)
 41. 12.92 21 9 8 10.864 10.864 10.864
 19 17 17
 CUMULATIVE AREA - 0.03 SQ MI

80 RK
 0. S13

 81 RD OUTPUT CONTROL VARIABLES 3 PRINT CONTROL
 IPMT 0 PLOT CONTROL
 OSCAL 0. HYDROGRAPH PLOT SCALE
 HYDROGRAPH COMBINATOR
 ICOP 5 NUMBER OF HYDROGRAPHS TO COMBINE

82 RK
 0. S13

 83 RD OUTPUT CONTROL VARIABLES 3 PRINT CONTROL
 IPMT 0 PLOT CONTROL
 OSCAL 0. HYDROGRAPH PLOT SCALE
 SUBBASIN RIFFOFF DATA

84 BA SUBBASIN CHARACTERISTICS
 TAXEA 0.03 SUBBASIN AREA
 PRECIPITATION DATA
 HYDRO-35 DEPTH FOR 0-PERCENT HYPOTHEITICAL STORM
 5-MIN 15-MIN 60-MIN 2-HR 6-HR 12-HR 24-HR 48-HR 72-HR 96-HR 120-HR
 0.65 1.22 2.45 3.65 4.60 5.75 6.75 7.75 8.75 9.75 10.75
 2-DAY 4-DAY 7-DAY 10-DAY
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 STORM AREA - 0.03

86 LS SCS LOSS RATE 0.25 INITIAL ABSTRACTION
 STPL 0.00 CURVE NUMBER
 RTMP 0.00 PERCENT IMPERVIOUS AREA
 SCS DIMENSIONLESS UNITGRAPH



35 KO 3
 36 BA 0.004
 37 PH 0
 38 LS 89
 39 LD 0.191
 40 EK SECK
 41 KO 3
 42 WC 4
 43 ZZ

SCHEMATIC DIAGRAM OF STREAM NETWORK
 (V) ROUTING (---) DIVERSION OR PUMP FLOW
 (.) CONNECTOR (---) RETURN OF DIVERTED OR PUMPED FLOW

NO. 8 S16
 16 S15
 24 S16
 32 S17
 40 SECK

(*) RUMOFF ALSO COMPUTED AT THIS LOCATION
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 JAN 09 1992
 VERSION 4.0.3E
 RUN DATE 09/12/97 TIME 09:10:33

8 KK S16
 11 KO OUTPUT CONTROL VARIABLES
 IPRT 3 PRINT CONTROL
 IPLOT 0 PLOT CONTROL
 OSCAL 0 HYDROGRAPH PLOT SCALE
 SUBBASIN RUMOFF DATA
 SUBBASIN CHARACTERISTICS
 TAREA 0.02 SUBBASIN AREA
 PRECIPITATION DATA
 DEPTNS FOR 0-PERCENT HYPOTHETICAL STORM
 1-HR 1.40 2-HR 2.40 3-HR 3.40 4-HR 4.40 5-HR 5.40
 6-HR 6.40 7-HR 7.40 8-HR 8.40 9-HR 9.40 10-HR 10.40
 11-HR 11.40 12-HR 12.40 13-HR 13.40 14-HR 14.40 15-HR 15.40
 16-HR 16.40 17-HR 17.40 18-HR 18.40 19-HR 19.40 20-HR 20.40
 21-HR 21.40 22-HR 22.40 23-HR 23.40 24-HR 24.40 25-HR 25.40
 26-HR 26.40 27-HR 27.40 28-HR 28.40 29-HR 29.40 30-HR 30.40
 S100M AREA = 0.02

12 QA
 13 PH
 14 LS
 15 UD
 SCS LOSS RATE
 STRAT 0.25 INITIAL ABSTRACTION
 CHVRBR 89.00 CURVE NUMBER
 RTIMP 0.00 PERCENT IMPERVIOUS AREA
 SCS DIMENSIONLESS UNITGRAPH
 TLAG 0.75 LAG
 UNIT HYDROGRAPH
 30 END-OF-PERIOD ORIGINATES
 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12.
 10. 8. 6. 5. 4. 3. 2. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8.

SCS DIMENSIONLESS UNITGRAPH
 TLAG 0.75 LAG
 UNIT HYDROGRAPH
 30 END-OF-PERIOD ORIGINATES
 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12.
 10. 8. 6. 5. 4. 3. 2. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8.

U.S. ARMY CORPS OF ENGINEERS
 HYDROLOGIC ENGINEERING CENTER
 409 SECOND STREET
 DAVIS, CALIFORNIA 95616
 (916) 531-1746

EVA VILLAGES PROJECT FLOOD (100-YEAR STORM)
 PRE: 210-3-DAY
 PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
 PROJECT CONDITIONS: EAST KAPPELET - EXISTING CONDITIONS
 KALOT - WAREHOUSE NETWORK MODEL

7 10 OUTPUT CONTROL VARIABLES
 IPRT 3 PRINT CONTROL
 IPLOT 0 PLOT CONTROL
 OSCAL 0 HYDROGRAPH PLOT SCALE
 HYDROGRAPH TIME DATA
 INTR 6 MINUTES IN COMPUTATION INTERVAL
 IDATE 17FEB97 STARTING DATE
 ITIME 1200 STARTING TIME
 INO 300 NUMBER OF HYDROGRAPH ORIGINATES
 MODATE 27FEB97 ENDING DATE
 BOTIME 1734 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 ACRES-FEET
 SURFACE AREA ACRES
 TEMPERATURE DEGREES FAHRENHEIT

16 LS SCS LOSS RATE
 STRAT 0.25 INITIAL ABSTRACTION
 CHVRBR 89.00 CURVE NUMBER
 RTIMP 0.00 PERCENT IMPERVIOUS AREA
 SCS DIMENSIONLESS UNITGRAPH
 TLAG 0.75 LAG
 UNIT HYDROGRAPH
 30 END-OF-PERIOD ORIGINATES
 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12.
 10. 8. 6. 5. 4. 3. 2. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8.

17 UD
 18 KO
 19 KO
 TOTAL RAINFALL = 12.30, TOTAL LOSS = 1.37, TOTAL EXCESS = 10.93
 PEAK FLOW TIME 6-HR 24-HR 72-HR 29.90-HR
 (CFS) (M3) (CFS) (M3)
 29. 12.80 (CFS) 14. 6. 5. 4. 3. 2. 1. 0. 0. 0. 0.
 (INCHES) 6.619 10.925 10.931 10.931
 (AC-FT) 7. 12. 12.
 CUMULATIVE AREA = 0.02 SQ MI

16 KK S15
 19 KO OUTPUT CONTROL VARIABLES
 IPRT 3 PRINT CONTROL

IPLOT 0 PLOT CONTROL
OSCAL 0. HYDROGRAPH PLOT SCALE

SUBBASIN RUNOFF DATA
SUBBASIN CHARACTERISTICS
TABLEA 0.01 SUBBASIN AREA

PRECIPITATION DATA

DEPTHS FOR 0-PERCENT HYPOTHEMETICAL STORM
..... HYDRO-35 1P-10 1P-49
5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 48-HR 72-HR 10-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 0.00

STORM AREA = 0.01

22 LS SCS LOSS RATE 0.25 INITIAL ABSTRACTION
STRTL 89.00 CURVE NUMBER
RTIMP 0.00 PERCENT IMPERVIOUS AREA

23 LD SCS DIMENSIONLESS LIMITGRAPH
TLAG 0.57 LAG

UNIT HYDROGRAPH
30 END-OF-PERIOD ORDINATES
1. 2. 3. 4. 5. 6. 7. 8. 9. 10.
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
(CFS) (MG) 6-HR 24-HR 72-HR 29.90-HR
20. 12.60 (CFS) 6.438 10.928 10.932 10.932
(INCHES) 6.438 10.928 10.932 10.932
(AC-FT) 4. 7. 7. 7.
CUMULATIVE AREA = 0.01 SQ MI

IPLOT 0 PLOT CONTROL
OSCAL 0. HYDROGRAPH PLOT SCALE

SUBBASIN RUNOFF DATA
SUBBASIN CHARACTERISTICS
TABLEA 0.01 SUBBASIN AREA

PRECIPITATION DATA

DEPTHS FOR 0-PERCENT HYPOTHEMETICAL STORM
..... HYDRO-35 1P-10 1P-49
5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 48-HR 72-HR 10-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

24 LS SCS LOSS RATE 0.25 INITIAL ABSTRACTION
STRTL 89.00 CURVE NUMBER
RTIMP 0.00 PERCENT IMPERVIOUS AREA

25 LD SCS DIMENSIONLESS LIMITGRAPH
TLAG 0.57 LAG

UNIT HYDROGRAPH
30 END-OF-PERIOD ORDINATES
1. 2. 3. 4. 5. 6. 7. 8. 9. 10.
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
(CFS) (MG) 6-HR 24-HR 72-HR 29.90-HR
20. 12.60 (CFS) 6.438 10.928 10.932 10.932
(INCHES) 6.438 10.928 10.932 10.932
(AC-FT) 4. 7. 7. 7.
CUMULATIVE AREA = 0.01 SQ MI

IPLOT 0 PLOT CONTROL
OSCAL 0. HYDROGRAPH PLOT SCALE

SUBBASIN RUNOFF DATA
SUBBASIN CHARACTERISTICS
TABLEA 0.01 SUBBASIN AREA

PRECIPITATION DATA

DEPTHS FOR 0-PERCENT HYPOTHEMETICAL STORM
..... HYDRO-35 1P-10 1P-49
5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 48-HR 72-HR 10-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

26 LS SCS LOSS RATE 0.25 INITIAL ABSTRACTION
STRTL 89.00 CURVE NUMBER
RTIMP 0.00 PERCENT IMPERVIOUS AREA

27 LD SCS DIMENSIONLESS LIMITGRAPH
TLAG 0.19 LAG

UNIT HYDROGRAPH
12 END-OF-PERIOD ORDINATES
1. 2. 3. 4. 5. 6. 7. 8. 9. 10.
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
(CFS) (MG) 6-HR 24-HR 72-HR 29.90-HR
11. 12.20 (CFS) 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

IPLOT 0 PLOT CONTROL
OSCAL 0. HYDROGRAPH PLOT SCALE

SUBBASIN RUNOFF DATA
SUBBASIN CHARACTERISTICS
TABLEA 0.00 SUBBASIN AREA

PRECIPITATION DATA

DEPTHS FOR 0-PERCENT HYPOTHEMETICAL STORM
..... HYDRO-35 1P-10 1P-49
5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 48-HR 72-HR 10-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

28 LS SCS LOSS RATE 0.25 INITIAL ABSTRACTION
STRTL 89.00 CURVE NUMBER
RTIMP 0.00 PERCENT IMPERVIOUS AREA

29 LD SCS DIMENSIONLESS LIMITGRAPH
TLAG 0.19 LAG

UNIT HYDROGRAPH
12 END-OF-PERIOD ORDINATES
1. 2. 3. 4. 5. 6. 7. 8. 9. 10.
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
(CFS) (MG) 6-HR 24-HR 72-HR 29.90-HR
11. 12.20 (CFS) 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

UNIT HYDROGRAPH
 12 END-OF-PERIOD ORIGINATES
 2. 1. 0. 0. 0.

HYDROGRAPH AT STATION S17
 TOTAL RAINFALL = 12.30, TOTAL LOSS = 1.37, TOTAL EXCESS = 10.93
 PEAK FLOW TIME
 (CFS) (HR)
 11. 12.20
 (INCHES) 6.473
 (AC-FT) 1. 10.932
 2. 10.932
 CUMULATIVE AREA = 0.00 SQ MI

*** NORMAL END OF REC-1 ***

40 XC
 SECK

41 NO OUTPUT CONTROL VARIABLES
 3 PRINT CONTROL
 0 PLOT CONTROL
 0. HYDROGRAPH PLOT SCALE

42 NC HYDROGRAPH COMBINATION 4 NUMBER OF HYDROGRAPHS TO COMBINE

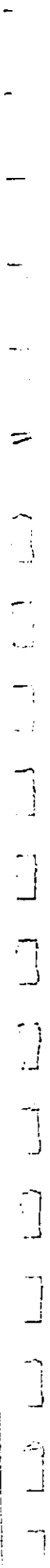
NAMEZ NPLAN,NSTN 1 0
 NAMEZ NPLAN,NSTN 1 0
 NAMEZ NPLAN,NSTN 1 0

HYDROGRAPH AT STATION SECK
 PEAK FLOW TIME
 (CFS) (HR)
 56. 12.60
 (INCHES) 6.420
 (AC-FT) 16. 10.932
 23. 10.932
 CUMULATIVE AREA = 0.04 SQ MI

| 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 | S16 | 29. | 12.60 | 16. | 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 | SECK | 56. | 12.60 | 20. | 12. | 9. | 0.04 | | |

*** NORMAL END OF REC-1 ***

*** NORMAL END OF REC-1 ***



```

.....
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* JAN 09 1992
* VERSION 4.0.3E
*
* RUN DATE 06/23/93 TIME 13:38:07
*
.....

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.....
* U.S. ARMY CORPS OF ENGINEERS
* HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET
* DAVIS, CALIFORNIA 95616
* (916) 551-1748
*
.....

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X X XXXXXX XXXX X
X X X X X X
X X X X X X
XXXXXX XXXX X XXXX X
X X X X X X
X X X X X X
X X XXXXXX XXXX XXX

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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 EXCEPT AS NOTED IN THE REVISIONS AND HISTORY.

THE DEFINITIONS OF VARIABLES -RTRN- AND -RTION- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE. THE DEFINITION OF -ANSRFA- ON AN-CAD HAS CHANGED WITH REVISIONS DATED 1 SEP 81. THIS IS THE CONSTRAINT VERSION.

NEW OPTIONS: DASHBREAK OUTFLOW SUBMERGENCE - SIMPLE EVENT CHANGE CALCULATION - DASHWRITE STAGE FREQUENCY.

CSS: HEAD TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE: GREEN AND ARTY INFILTRATION

KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

```

LINE ID .....3.....4.....5.....6.....7.....8.....9.....10.....
1 ID EAST KAPOLEI FLOOD (100-YEAR STORM)
2 PN 21JAN92
3 ID PROJECT CONDITIONS: EAST KAPOLEI - EXISTING CONDITIONS
4 ID FLOW TO WEST LOCK
5 ID FLOOD - HYDROLOGIC NETWORK MODEL
6 DIAGRAM
7 IT 6 27JAN92 1200 300
8 AK A37
9 PN GENERATE HYDROGRAPH FROM SUBBASIN 519 TO SECS
10 PN UPPERMOST WATERSHED PRECIPITATION DATA
11 PD 0.121
12 BA 0.955
13 PH 1.30 2.45 3.55 4.60 5.75 6.75 8.10 9.20 12.30
14 LS 0 89
15 UD 2.174
16 BK 519
17 PN GENERATE HYDROGRAPH FROM SUBBASIN 519 TO SECS
18 PN UPPERMOST WATERSHED PRECIPITATION DATA
19 PD 0.121
20 BA 0.955
21 PH 1.32 2.45 3.55 4.60 5.75 6.75 8.20 9.20 12.30
22 LS 0 89
23 UD 2.174
24 BK 519
25 PN GENERATE HYDROGRAPH FROM SUBBASIN 519 TO SECS
26 PN UPPERMOST WATERSHED PRECIPITATION DATA
27 PD 0.121
28 BA 0.955
29 PH 1.32 2.45 3.55 4.60 5.75 6.75 8.20 9.20 12.30
30 LS 0 89
31 UD 2.174
32 BK 520
33 PN GENERATE HYDROGRAPH FROM SUBBASIN 520 TO SECS
34 PN UPPERMOST WATERSHED PRECIPITATION DATA
35 PD 0.121

```

```

36 BA 0.956
37 PH 1.33 2.45 3.55 4.60 5.75 6.75 8.20 9.20 12.30
38 LS 0 89
39 UD 2.174
40 BK 521
41 PN GENERATE HYDROGRAPH FROM SUBBASIN 521 TO SECS
42 PN UPPERMOST WATERSHED PRECIPITATION DATA
43 PD 0.121
44 BA 0.956
45 PH 1.32 2.45 3.55 4.60 5.75 6.75 8.20 9.20 12.30
46 LS 0 89
47 UD 2.174
48 BK 522

```

SCHEMATIC DIAGRAM OF STREAM NETWORK

```

INPUT LINE 1(---) DIVERSION OR PUMP FLOW
NO. 1(---) RETURN OF DIVERTED OR PUMPED FLOW

```

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NO. 8 A37
16
24 519
32 520
40 521

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[***] RUNOFF ALSO COMPUTED AT THIS LOCATION
1.....
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* JAN 09 1992
* VERSION 4.0.3E
*
* RUN DATE 06/23/93 TIME 13:38:07
*
.....
* U.S. ARMY CORPS OF ENGINEERS
* HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET
* DAVIS, CALIFORNIA 95616
* (916) 551-1748
*
.....

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EAST KAPOLEI FLOOD (100-YEAR STORM)
 PN 21JAN92
 PROJECT CONDITIONS: EAST KAPOLEI - EXISTING CONDITIONS
 FLOW TO WEST LOCK

FLOOD - HYDROLOGIC NETWORK MODEL
 OUTPUT CONTROL VARIABLES
 IPRT 5 PLRT CONTROL
 IPLOT 8 PLOT CONTROL
 QSCL 0 HYDROGRAPH PLOT SCALE

HYDROGRAPH TIME DATA
 MHIN 6 MINUTES IS COMPUTATION INTERVAL
 IDATE 21JAN92 STARTING DATE
 ITIME 1200 STARTING TIME
 MO 300 NUMBER OF HYDROGRAPH ORDINATES
 EDATE 31JAN92 ENDING DATE
 MOTIME 1354 ENDING TIME
 ICENT 13 CENTURY MARK

COMPUTATION INTERVAL 6.10 HOURS
 TOTAL TIME BASE 23.90 HOURS

ENGLISH UNITS
 DRAINAGE AREA SQUARE MILES
 PRECIPITATION DEPTH INCHES
 LENGTH, ELEVATION FEET
 FLOW CUBIC FEET PER SECOND
 STORAGE VOLUME ACRES-Feet
 SURFACE AREA ACRES

07CAL 0. HYDROGRAPH PLOT SCALE
SUBBASIN RUMOFF DATA

28 BA SUBBASIN CHARACTERISTICS
TAREA 0.05 SUBBASIN AREA
PRECIPITATION DATA

..... HYDRO-35 TP-40 TP-49
5-MIN 15-MIN 60-MIN 2-HR 3-HR 4-HR 6-HR 12-HR 24-HR 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

SCS LOSS RATE
STRTL 0.25 INITIAL ABSTRACTION
CYMNR 89.00 CURVE NUMBER
RTIMP 0.00 PERCENT INTERVIOUS AREA
TLAG 1.02 LAG
STORM AREA = 0.05

UNIT HYDROGRAPH
53 END-OF-PERIOD ORDINATES

HYDROGRAPH AT STATION S20
TOTAL RAINFALL = 12.30, TOTAL LOSS = 1.37, TOTAL EXCESS = 10.93
PEAK FLOW TIME 6-HR 24-HR 72-HR 28.90-HR
(CFS) (HR) (CFS) (HR) (CFS) (HR) (CFS) (HR)
61 33.10 (CFS) 37 35 13
(INCHES) 6.373 10.914 10.914 10.914
(AC-FT) 18 31 31
CUMULATIVE AREA = 0.05 50 MI

.....
60 KE S21
.....

43 EO OUTPUT CONTROL VARIABLES
IPRNT 3 PRINT CONTROL
IPLOT 0 PLOT CONTROL
OSCAL 0 HYDROGRAPH PLOT SCALE

.....
SUBBASIN RUMOFF DATA
SUBBASIN CHARACTERISTICS
TAREA 0.05 SUBBASIN AREA
PRECIPITATION DATA

..... HYDRO-35 TP-40 TP-49
5-MIN 15-MIN 60-MIN 2-HR 3-HR 4-HR 6-HR 12-HR 24-HR 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

SCS LOSS RATE
STRTL 0.25 INITIAL ABSTRACTION
CYMNR 89.00 CURVE NUMBER
RTIMP 0.00 PERCENT INTERVIOUS AREA
TLAG 0.63 LAG
STORM AREA = 0.03

UNIT HYDROGRAPH
53 END-OF-PERIOD ORDINATES

HYDROGRAPH AT STATION S19
TOTAL RAINFALL = 12.30, TOTAL LOSS = 1.37, TOTAL EXCESS = 10.93
PEAK FLOW TIME 6-HR 24-HR 72-HR 28.90-HR
(CFS) (HR) (CFS) (HR) (CFS) (HR) (CFS) (HR)
36 33.70 (CFS) 37 36 13
(INCHES) 6.243 10.889 10.910 10.910
(AC-FT) 18 32 32
CUMULATIVE AREA = 0.05 50 MI

.....
32 KK S20
.....

45 EO OUTPUT CONTROL VARIABLES
IPRNT 3 PRINT CONTROL
IPLOT 0 PLOT CONTROL
OSCAL 0 HYDROGRAPH PLOT SCALE

.....
SUBBASIN RUMOFF DATA
SUBBASIN CHARACTERISTICS
TAREA 0.05 SUBBASIN AREA
PRECIPITATION DATA

..... HYDRO-35 TP-40 TP-49
5-MIN 15-MIN 60-MIN 2-HR 3-HR 4-HR 6-HR 12-HR 24-HR 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

.....
 U.S. ARMY CORPS OF ENGINEERS
 HYDROLOGIC ENGINEERING CENTER
 809 SECOND STREET
 DAVIS, CALIFORNIA 95616
 (916) 551-1749

.....
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 JUN 09 1992
 VERSION 4.0.3E
 RUN DATE 09/12/97 TIME 10:25:38

X X XXXXXX XXXX X
 X X X X X X X
 X X X X X X X
 XXXXX XXXX X XXXX X
 X X X X X X X
 X X X XXXXX XXXX XXX

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1DS, HEC1DSB, AND HEC1DIA.
 THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTION- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
 THE DEFINITION OF -JACKS- ON IN-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTIETH VERSION.
 NEW OPTIONS: DAMAGED OUTFLOW SUBMERGENCE, SINGLE EVENT DAMAGE CALCULATION, DISMANTLE STAGE FREQUENCY,
 DESIRED TIME SERIES AT DESIRED CALCULATION INTERVAL, LOSS RATE/SCREEN AND AMPIT INFILTRATION
 KINEMATIC WAVES, NEW FINITE DIFFERENCE ALGORITHM

| UNIT HYDROGRAPH | 33 END-OF-PERIOD ORIGINATES |
|-----------------------------------|-----------------------------|
| 1. 3. 7. 11. 15. 19. 23. 27. 31. | 13. |
| 2. 4. 8. 12. 16. 20. 24. 28. 32. | 1. 0. |
| 3. 5. 9. 13. 17. 21. 25. 29. 33. | 0. 0. |
| 4. 6. 10. 14. 18. 22. 26. 30. 34. | 0. 0. |
| 5. 7. 11. 15. 19. 23. 27. 31. | 0. 0. |
| 6. 8. 12. 16. 20. 24. 28. 32. | 0. 0. |
| 7. 9. 13. 17. 21. 25. 29. 33. | 0. 0. |
| 8. 10. 14. 18. 22. 26. 30. 34. | 0. 0. |
| 9. 11. 15. 19. 23. 27. 31. | 0. 0. |
| 10. 12. 16. 20. 24. 28. 32. | 0. 0. |

.....
 HYDROGRAPH AT STATION 821
 TOTAL RAINFALL = 12.30, TOTAL LOSS = 1.17, TOTAL EXCESS = 10.93
 PEAK FLOW TIME 12.70
 (CFS) 6431
 (INCHES) 6.431
 (AC-FT) 9.
 CUMULATIVE AREA = 0.03 SQ MI

.....
 RUSBY 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 PERIOD | 24-HOUR PERIOD | 72-HOUR PERIOD | BASIN AREA | MULTIPLY STAGE | TIME OF MAX STAGE |
|---------------|---------|-----------|--------------|---------------------------------|---------------|----------------|----------------|------------|----------------|-------------------|
| HYDROGRAPH AT | 827 | 810. | 14.40 | 697. | 279. | 231. | 0.34 | | | |
| HYDROGRAPH AT | 818 | 108. | 14.40 | 79. | 35. | 29. | 0.12 | | | |
| HYDROGRAPH AT | 819 | 58. | 13.70 | 37. | 16. | 13. | 0.05 | | | |
| HYDROGRAPH AT | 820 | 61. | 13.10 | 37. | 16. | 13. | 0.05 | | | |
| HYDROGRAPH AT | 821 | 39. | 12.70 | 17. | 7. | 6. | 0.03 | | | |

..... NORMAL END OF HEC-1

MEC-1 INPUT
 10.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
 1 ID EAST KAPOLEI FLOOD (100-YEAR STORM)
 2 ID FIN HYDRO-DAT
 3 ID PROJECT CONDITIONS: EAST KAPOLEI - EXISTING CONDITIONS
 4 ID FLOW TO KAPOLEI AND WARDNA
 5 ID KALOJ - WRENAME NETWORK MODEL
 6 ID NO. OF STATIONS 1200 300
 7 ID 1 5
 8 ID 1 5
 9 ID 1 5
 10 ID 1 5
 11 ID 1 5
 12 ID 1 5
 13 ID 1 5
 14 ID 1 5
 15 ID 1 5
 16 ID 1 5
 17 ID 1 5
 18 ID 1 5
 19 ID 1 5
 20 ID 1 5
 21 ID 1 5
 22 ID 1 5
 23 ID 1 5
 24 ID 1 5
 25 ID 1 5
 26 ID 1 5
 27 ID 1 5

SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT LINE (V) DIVERSION OR PUMP FLOW (C) CONNECTION (---) RETURN OF DIVERTED OR PUMPED FLOW

PRECIPITATION DATA

13 PH DEPTH FOR 0-PERCENT HYPOTHEMETICAL STORM

| | | | | |
|--------------|--------|------|-------|------|
| HYDRO-35 | 1P-40 | 0.00 | 1P-49 | 0.00 |
| 5-MIN 15-MIN | 30-MIN | 1.32 | 2.45 | 3.55 |
| 60-MIN | 12-HR | 2.45 | 3.55 | 4.60 |
| 24-HR | 7-DAY | 9.20 | 12.30 | 0.00 |
| 10-DAY | 0.00 | 0.00 | 0.00 | 0.00 |

STORM AREA = 0.17

14 LS SCS LOSS RATE

0.25 INITIAL ABSTRACTION

0.00 PERCENT IMPERVIOUS AREA

15 LD SCS DIMENSIONLESS UNITGRAPH

1.37 LAG

UNIT HYDROGRAPH

| 96 END-OF-PERIOD ORDINATES | 17. | 21. | 24. |
|----------------------------|-----|-----|-----|
| 1. | 2. | 3. | 4. |
| 5. | 6. | 7. | 8. |
| 9. | 10. | 11. | 12. |
| 13. | 14. | 15. | 16. |
| 17. | 18. | 19. | 20. |
| 21. | 22. | 23. | 24. |
| 25. | 26. | 27. | 28. |
| 29. | 30. | 31. | 32. |
| 33. | 34. | 35. | 36. |
| 37. | 38. | 39. | 40. |
| 41. | 42. | 43. | 44. |
| 45. | 46. | 47. | 48. |
| 49. | 50. | 51. | 52. |
| 53. | 54. | 55. | 56. |
| 57. | 58. | 59. | 60. |
| 61. | 62. | 63. | 64. |
| 65. | 66. | 67. | 68. |
| 69. | 70. | 71. | 72. |
| 73. | 74. | 75. | 76. |
| 77. | 78. | 79. | 80. |
| 81. | 82. | 83. | 84. |
| 85. | 86. | 87. | 88. |
| 89. | 90. | 91. | 92. |
| 93. | 94. | 95. | 96. |

HYDROGRAPH AT STATION ZAP

TOTAL RAINFALL = 12.30, TOTAL LOSS = 1.37, TOTAL EXCESS = 10.93

PEAK FLOW TIME

| | | | |
|-------|-------|----------|----------|
| 6-HR | 24-HR | 72-HR | 24-92-HR |
| 176 | 13.67 | 114 | 47 |
| (CFS) | (CFS) | (INCHES) | (AC-FT) |
| | | 10.670 | 10.670 |
| | | 57 | 97 |

CUMULATIVE AREA = 0.17 SQ MI

16 KX

19 ED

20 BA

21 PH

OUTPUT CONTROL VARIABLES

PRINT CONTROL

PLOT CONTROL

SCALE

0. HYDROGRAPH PLOT SCALE

SUBBASIN RUNOFF DATA

SUBBASIN CHARACTERISTICS

TAREA

0.17 SUBBASIN AREA

PRECIPITATION DATA

DEPTHS FOR 0-PERCENT HYPOTHEMETICAL STORM

| | | | | |
|--------------|--------|------|-------|------|
| HYDRO-35 | 1P-40 | 0.00 | 1P-49 | 0.00 |
| 5-MIN 15-MIN | 30-MIN | 1.32 | 2.45 | 3.55 |
| 60-MIN | 12-HR | 2.45 | 3.55 | 4.60 |
| 24-HR | 7-DAY | 9.20 | 12.30 | 0.00 |
| 10-DAY | 0.00 | 0.00 | 0.00 | 0.00 |

U.S. ARMY CORPS OF ENGINEERS

HYDROLOGIC ENGINEERING CENTER

609 SECOND STREET

DAVIS, CALIFORNIA 95616

(916) 551-1748

EAST KAPOLEI FLOOD (100-YEAR STORM)

FBI XIDIC-DAT

PROJECT CONDITIONS: EAST KAPOLEI - EXISTING CONDITIONS

FLOW TO KAPOLEI AND WAIKONA

KALO1 - WAIKONA NETWORK MODEL

7 10 OUTPUT CONTROL VARIABLES

PRINT CONTROL

PLOT CONTROL

SCALE

0. HYDROGRAPH PLOT SCALE

HYDROGRAPH TIME DATA

| | |
|--------------------------------|---------|
| MIN | 5 |
| STARTING DATE | 27JAN97 |
| STARTING TIME | 1200 |
| NUMBER OF HYDROGRAPH ORDINATES | 300 |
| ENDING DATE | 28JAN97 |
| ENDING TIME | 1255 |
| CERTainty MARK | 19 |

COMPUTATION INTERVAL 0.08 HOURS

TOTAL TIME BASE 24.92 HOURS

ENGLISH UNITS

DRAINAGE AREA SQUARE MILES

PRECIPITATION DEPTH INCHES

LENGTH, ELEVATION FEET

FLOW CURVIC FEET PER SECOND

STORAGE VOLUME ACRES-FEET

SURFACE AREA ACRES

TEMPERATURE DEGREES FAHRENHEIT

8 KX

11 ED

12 BA

OUTPUT CONTROL VARIABLES

PRINT CONTROL

PLOT CONTROL

SCALE

0. HYDROGRAPH PLOT SCALE

SUBBASIN RUNOFF DATA

SUBBASIN CHARACTERISTICS

TAREA

0.17 SUBBASIN AREA

STORM AREA = 0.17

22 LS SES LOSS RATE 0.25 INITIAL ABSTRACTION
 STRIL 89.00 CURVE NUMBER
 CYNBA 0.00 PERCENT IMPERVIOUS AREA
 ATIMP

23 UD SES DIMENSIONLESS UNITGRAPH 0.92 LAG

UNIT HYDROGRAPH
 57 END-OF-PERIOD ORDINATES

| | | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| 2. | 7. | 13. | 21. | 31. | 43. | 57. | 77. | 114. | 176. | 221. | 375. |
| 84. | 84. | 82. | 77. | 69. | 57. | 43. | 31. | 21. | 13. | 7. | 4. |
| 32. | 27. | 24. | 21. | 18. | 16. | 14. | 12. | 10. | 9. | 8. | 7. |
| 8. | 7. | 6. | 5. | 4. | 4. | 4. | 3. | 3. | 3. | 3. | 3. |
| 2. | 2. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |

HYDROGRAPH AT STATION VIA

TOTAL RAINFALL = 12.30, TOTAL LOSS = 1.37, TOTAL EXCESS = 10.93

| | | | | |
|-----------|-------|----------------|--------|--------|
| PEAK FLOW | TIME | 6-HR | 24-HR | 72-HR |
| (CFS) | (HR) | | | |
| 221. | 13.00 | 115. | 49. | 47. |
| | | (INCHES) 6.390 | 10.844 | 10.844 |
| | | (AC-FI) 57. | 97. | 97. |

CUMULATIVE AREA = 0.17 SQ MI

*** NORMAL END OF REC-1 ***

 24 KX * SECS *

25 KO OUTPUT CONTROL VARIABLES 3 PRINT CONTROL
 IPLOT 0 PLOT CONTROL
 GSCALE 0. HYDROGRAPH PLOT SCALE

26 KC HYDROGRAPH COMBINATION 2 NUMBER OF HYDROGRAPHS TO COMBINE

UNITZ NPLAN, NSTM 1 0

HYDROGRAPH AT STATION SECS

| | | | | |
|-----------|-------|----------------|--------|--------|
| PEAK FLOW | TIME | 6-HR | 24-HR | 72-HR |
| (CFS) | (HR) | | | |
| 375. | 13.17 | 226. | 97. | 94. |
| | | (INCHES) 6.266 | 10.756 | 10.756 |
| | | (AC-FI) 113. | 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 | 72-HOUR | 24-HOUR | 6-HOUR | BASEIN AREA | MAXIMUM STAGE | TIME OF MAX STAGE |
|---------------|---------|-----------|--------------|---------------------------------|---------|---------|--------|-------------|---------------|-------------------|
| HYDROGRAPH AT | KAP | 176. | 13.87 | 114. | 49. | 47. | 47. | 0.17 | | |
| HYDROGRAPH AT | VIA | 221. | 13.00 | 115. | 49. | 47. | 47. | 0.17 | | |
| 2 COMBINED AT | SECS | 375. | 13.17 | 226. | 97. | 94. | 94. | 0.34 | | |

6/17/98
 EAST KAPOLEI DRAINAGE MASTER PLAN
 SUMMARY OF HEC-1 CALCULATIONS
 file: sumdev.wk3

HEC-1 RUNOFF SUMMARY

DEVELOPED KALOIGULCH (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 KALOIGULCH (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 KALOIGULCH (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. | | |

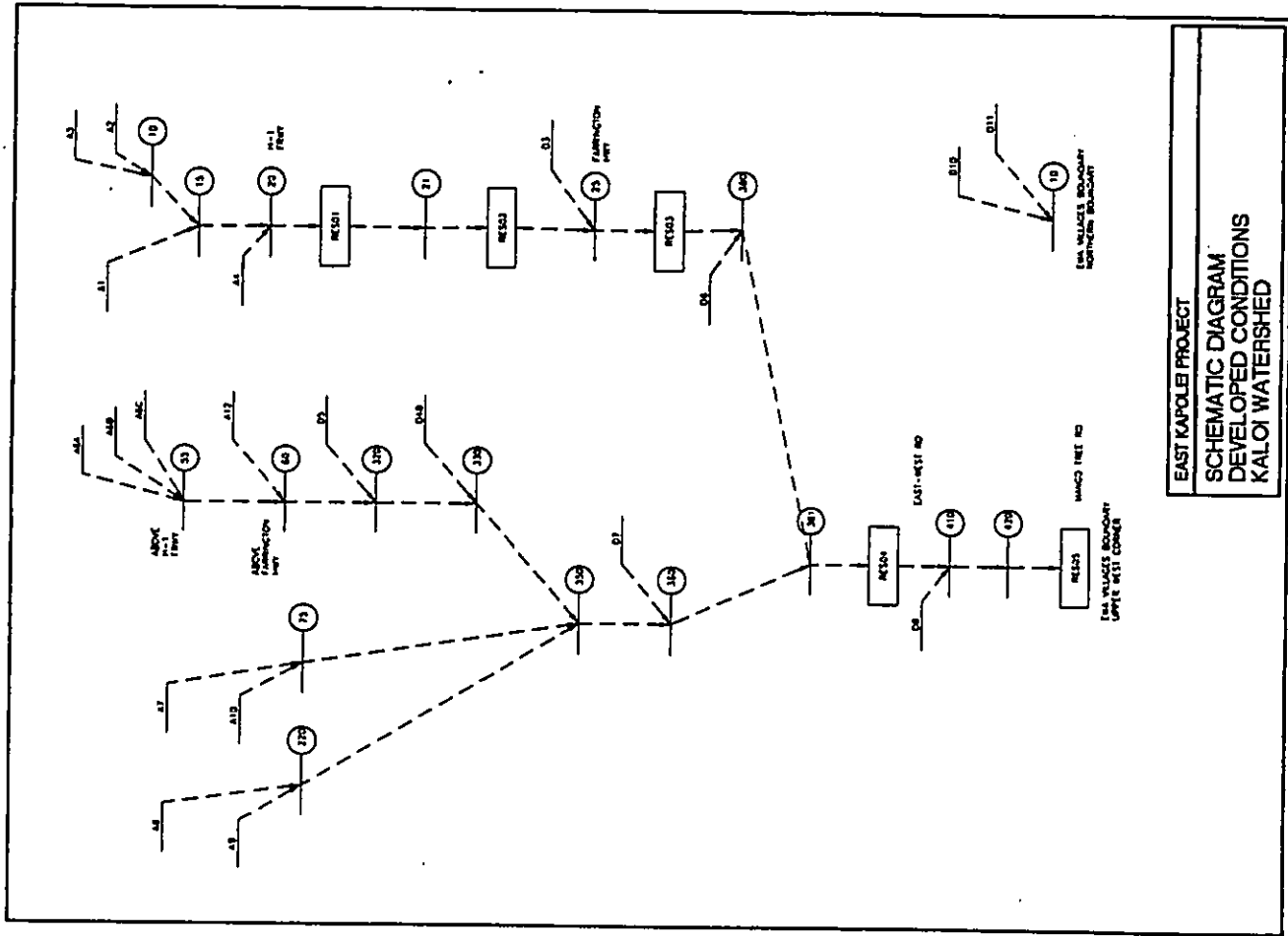
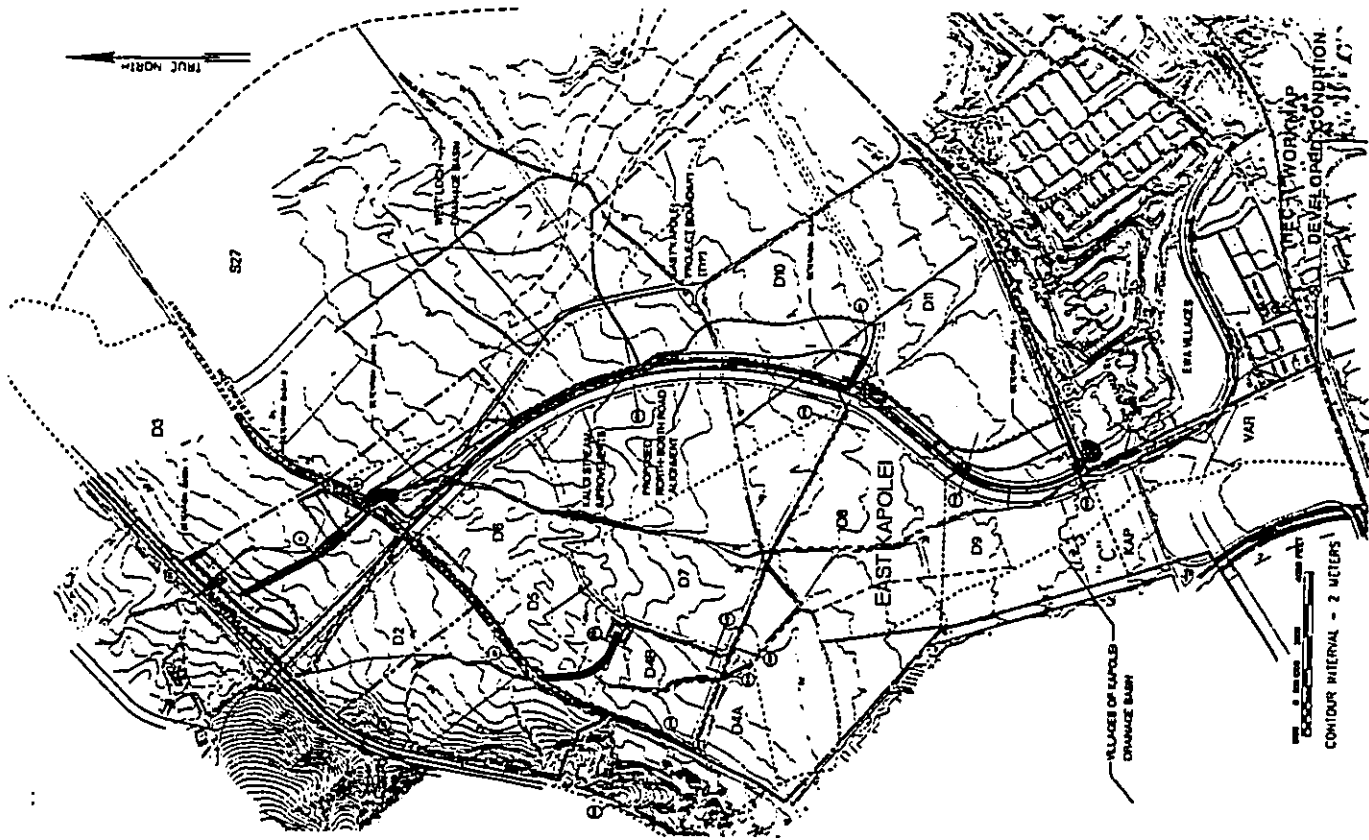
DEVELOPED WEST LOCH

| 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 | 58 |
| | S20 | 0.054 | 31 | 68 |
| | S21 | 0.025 | 15 | 39 |
| | | 1,192 | 696 | 1,105 |
| | | 763 Ac. | | |

APPENDIX B

REGIONAL HYDROLOGY FOR DEVELOPED CONDITIONS

- ▶ HEC-1 Summary for Developed Conditions
- ▶ 100-Year, 24-hour HEC-1 Computations (Kaloii Watershed)
- ▶ 100-Year, 24-hour HEC-1 Computations (West Loch Watershed)
- ▶ 100-Year, 24-hour HEC-1 Computations (Kapolei Villages Watershed)



1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

| | | SOIL GROUP | | | | | | Comp_CN | |
|--------|-------|------------|-------|-------|-------|-------|-------|---------|---------|
| | | AREA | A | B | C | D | CN | A x CN | Comp_CN |
| AREAD1 | 28.56 | 24.00 | 3.60 | 3.00 | 20.40 | | | | |
| SF | | 3.00 | 3.00 | | | | | | |
| PARK | | 12.00 | 4.80 | 7.20 | | | | | |
| SCHOOL | | 4.56 | 4.56 | | | | | | |
| ROADS | | 43.56 | 0.00 | 15.96 | 0.00 | 27.60 | 43.56 | | |
| TOTAL | | | | | | | | | |
| 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 | | | | 43.56 | 3735.00 | 86 |

| | | SOIL GROUP | | | | | | Comp_CN | |
|----------|------|------------|-------|-------|-------|--------|--------|----------|---------|
| | | AREA | A | B | C | D | CN | A x CN | Comp_CN |
| AREAD1 | 95.9 | 88.31 | 8.63 | 77.68 | | | | | |
| SF | | 47.20 | 14.16 | 33.04 | | | | | |
| MF | | 6.50 | | 6.50 | | | | | |
| CRM CHAN | | 20.00 | 10.00 | 10.00 | | | | | |
| BASIN | | 26.50 | 13.25 | 13.25 | | | | | |
| PARK | | 7.00 | 7.00 | | | | | | |
| COM | | 28.59 | 28.59 | | | | | | |
| ROADS | | 222.10 | 0.00 | 64.63 | 10.00 | 147.47 | 222.10 | | |
| TOTAL | | | | | | | | | |
| 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 | 2718.05 | |
| BASIN | | | 10.00 | | | | 74.00 | 740 | |
| PARK | | | | | | | 80.00 | 1060 | |
| SF | | | 77.68 | | | | 92.00 | 7148.56 | |
| 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 | | | | 222.10 | 19530.19 | 88 |

| | | SOIL GROUP | | | | | | Comp_CN | |
|--------|---|------------|-------|-------|------|-------|-------|---------|---------|
| | | AREA | A | B | C | D | CN | A x CN | Comp_CN |
| AREAD1 | 3 | 3.00 | | | | | | | |
| PARK | | 15.50 | 7.75 | | | | | | |
| SF | | 68.76 | 13.75 | | | | | | |
| COM | | 1.00 | | | | | | | |
| ROADS | | 10.84 | 10.84 | | | | | | |
| TOTAL | | 98.10 | 0.00 | 32.34 | 0.00 | 66.76 | 99.10 | | |
| SF | | | 13.75 | | | | 85.00 | 1168.75 | |
| MF | | | 7.75 | | | | 85.00 | 656.75 | |
| ROADS | | | 10.84 | | | | 95.00 | 1029.8 | |
| PARK | | | | | | | 80.00 | 240 | |
| SF | | | | | | | 92.00 | 5060.92 | |
| MF | | | | | | | 92.00 | 713 | |
| COM | | | | | | | 95.00 | 95 | |
| TOTALS | | | 32.34 | | | | 99.10 | 8966.22 | 90 |

| | | SOIL GROUP | | | | | | Comp_CN | |
|----------|---|------------|-------|-------|------|--------|--------|---------|----------|
| | | AREA | A | B | C | D | CN | A x CN | Comp_CN |
| AREAD1 | 3 | 3.00 | | | | | | | |
| PARK | | 2.00 | | | | | | | |
| COM | | 12.00 | | | | | | | |
| ES | | 1.30 | | | | | | | |
| CRM CHAN | | 4.80 | | | | | | | |
| CHAN | | 10.44 | | | | | | | |
| ROADS | | 31.00 | | | | | | | |
| MF | | 98.68 | 1.55 | 19.94 | | | | | |
| SF | | 175.30 | 0.00 | 21.49 | 0.00 | 153.81 | 175.30 | | |
| TOTAL | | | | | | | | | |
| SF | | | 19.94 | | | | 85.00 | 1694.9 | |
| MF | | | 1.55 | | | | 85.00 | 131.75 | |
| PARK | | | | | | | 80.00 | 240 | |
| SF | | | | | | | 92.00 | 7337 | |
| MF | | | | | | | 92.00 | 2709.4 | |
| ROADS | | | | | | | 95.00 | 2044.4 | |
| COM | | | | | | | 95.00 | 190 | |
| CRM CHAN | | | | | | | 95.00 | 123.5 | |
| CHAN | | | | | | | 80.00 | 384 | |
| ES | | | | | | | 12.00 | 1008 | |
| TOTALS | | | 21.49 | | | | 153.82 | 175.31 | 15862.95 |

| | | SOIL GROUP | | | | | | Comp_CN | |
|--------|------|------------|-------|---|---|---|-------|---------|---------|
| | | AREA | A | B | C | D | CN | A x CN | Comp_CN |
| AREAD1 | 8.60 | 8.60 | | | | | | | |
| PARK | | 54.06 | | | | | | | |
| SF | | 11.74 | | | | | | | |
| ROAD | | 8.50 | | | | | | | |
| BASIN | | 82.90 | | | | | | | |
| TOTALS | | | | | | | | | |
| PARK | | | 8.60 | | | | 80.00 | 688 | |
| SF | | | 54.06 | | | | 92.00 | 4358.96 | |
| ROAD | | | 11.74 | | | | 95.00 | 1749.9 | |
| BASIN | | | 8.50 | | | | 80.00 | 680 | |
| TOTALS | | | 82.90 | | | | 82.90 | 7476.86 | 90 |

U.S. ARMY CORPS OF ENGINEERS
 HYDROLOGIC ENGINEERING CENTER
 609 SECOND STREET
 DAVIS, CALIFORNIA 95616
 (916) 551-1748

FLOOD HYDROGRAPH PACKAGE (REC-1)
 JAN 09 1982
 VERSION 4.0.3E
 RUN DATE 06/06/78 TIME 08:33:06

| AREA/DI | SOIL GROUP | | | | | | COMP_CN |
|----------|------------|---|---|--------|--------|----------|---------|
| | A | B | C | D | CN | AXCN | |
| AREA D10 | 95.5 | | | | | | 91 |
| SF | 85.85 | | | 85.95 | 92.00 | 7907.4 | |
| EXIST | 23.30 | | | 23.30 | 89.00 | 2073.7 | |
| PARK | 6.50 | | | 6.50 | 80.00 | 520 | |
| ROADS | 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 | | | | | | | 91 |
| ES | 12.00 | | | 12.00 | 84.00 | 1008 | |
| INT | 20.00 | | | 20.00 | 84.00 | 1680 | |
| SF | 98.37 | | | 98.37 | 92.00 | 9050.04 | |
| MF | 31.00 | | | 31.00 | 92.00 | 2852 | |
| ROADS | 14.63 | | | 14.63 | 95.00 | 1389.85 | |
| TOTALS | 176.00 | | | 176.00 | 176.00 | 15979.89 | 91 |
| "KAP" | | | | | | | 95 |
| SF | 10.3 | | | 9.27 | 92.00 | 852.84 | |
| PARK | 37.3 | | | 37.30 | 80.00 | 2984 | |
| ROADS | 4.63 | | | 4.63 | 95.00 | 439.85 | |
| MF | 10.5 | | | 10.50 | 92.00 | 966 | |
| TOTALS | 61.70 | | | 61.70 | 61.70 | 5242.69 | 95 |
| "VAR" | | | | | | | 88 |
| SF | 37.0 | | | 25.80 | 80.00 | 2072 | |
| PARK | 3.40 | | | 3.06 | 92.00 | 281.52 | |
| COMM | 8.0 | | | 8.00 | 95.00 | 760 | |
| ROADS | 17.44 | | | 17.44 | 95.00 | 1656.8 | |
| TOTALS | 54.40 | | | 54.40 | 54.40 | 4770.32 | 88 |

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 XXXXX XXX X XXXX
 X X X X X X X
 X X X X X X X
 X X XXXXXX XXXX XXX

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF REC-1 KNOWN AS REC1 (JAN 73), REC1GS, REC1GR, AND REC1GR.
 THE DEFINITIONS OF VARIABLES -ITIM- AND -RTIM- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
 THE DEFINITION OF -MMSK- ON IN-GRID WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION.
 NEW OPTIONS: DAMBRK OUTFLOW SUBMERGENCE, SINGLE EVENT DAMAGE CALCULATION, DISINTEGRATE STAGE FREQUENCY,
 OSH-HEAD TIME SERIES AT DESIGN CALCULATION INTERVAL, LOSS RATE/SCREEN AND AWT INFILTRATION,
 KINEMATIC WAVE: REV FINITE DIFFERENCE ALGORITHM

REC-1 INPUT
 ID 1.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
 10 EAST KAPOLEI FLOOD (100-YEAR STORM)
 10 FFI: NEVIAZ.DAT
 10 PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
 10 EAST KAPOLEI - DEV. COND. - NO BASINS - ADD 47 AC. EUP.
 10 ID KALO1 - WAREHOUSE NETWORK MODEL
 10 7 05MAY78 1200 300
 10 5
 KK A3
 10 9 GENERATE HYDROGRAPH FROM SUBBASIN A3 TO SECOS
 10 10 UPPERMOST WATERSHED PRECIPITATION DATA
 10 11
 10 12 PH 1.701 .69 1.40 2.60 3.70 4.75 6.85 9.30 12.70
 10 13 LS 0 .66
 10 14 LD 1.206

KK SEC10
 10 15 ROUTE KALO1 TRIBUTARY FLOW FROM SECOS TO SEC10
 10 16 KALO1 STREAM ABOVE CONFLUENCE OF MAIN AND TRIBUTARY
 10 17 FLOW
 10 18 0
 10 19 RC 0.035 0.035 0.035 2250 0.024 220
 10 20 AX 0 150 155 165 180 190 195 520
 10 21 RT 220 218 215 208 208 218 218 220
 10 22 KK A2
 10 23 GENERATE HYDROGRAPH FROM SUBBASIN A2 TO SEC10
 10 24 UPPERMOST WATERSHED PRECIPITATION DATA
 10 25 0.167 0.167 .69 1.40 2.60 3.70 4.75 6.85 9.30 12.70
 10 26 LS 0 .66
 10 27 LD 0.339

KK SEC10
 10 29 COMBINE HYDROGRAPHS AT SEC10
 10 30
 10 31
 10 32 KK A1
 10 33 GENERATE HYDROGRAPH FROM SUBBASIN A1 TO SEC10
 10 34 UPPERMOST WATERSHED PRECIPITATION DATA

35 BA 2.036 2.036 .69 1.40 2.60 3.70 4.75 6.85 9.30 12.70
 36 LS 0 70
 37 LD 1.634
 38
 39 KK SEC15 COMBINE HYDROGRAPHS AT SEC15
 40 KM 2
 41 KC 2
 42 KK SEC20
 43 KM 2
 44 RS 2
 45 RC .035 .035 200 0.025 207
 46 RK 0 160 190 205 240 400 550
 47 RY 215 215 194 194 207 210 215
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 LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

94 KM 0.347 MID-WATERSHED PRECIPITATION DATA
 95 RA 0
 96 LS 0 86
 97 LD 0.45
 98
 99 KK SEC30 COMBINE HYDROGRAPHS AT SEC30
 100 KM 2
 101 KC 2
 102 KK ALA
 103 KM ALA
 104 RC ALA
 105 RK ALA
 106 RY ALA
 107 LS 0 74
 108 LD 0.168
 109
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 LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

139 KK SEC40
 140 KM 2
 141 RS 2
 142 RC 0.035 0.035 3041 0.036 158
 143 RK 0 216 317 401 472 445
 144 RY 162.6 157.48 154.53 150.92 154.20 154.20 137.48
 145
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 156
 LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

92 KK SEC30
 93 KM 2
 94 KC 2
 95 KK ALA
 96 KM ALA
 97 RC ALA
 98 RK ALA
 99 RY ALA
 100 LS 0 74
 101 LD 0.168
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 LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

139 KK SEC40
 140 KM 2
 141 RS 2
 142 RC 0.035 0.035 3041 0.036 158
 143 RK 0 216 317 401 472 445
 144 RY 162.6 157.48 154.53 150.92 154.20 154.20 137.48
 145
 146
 147
 148
 149
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 154
 155
 156
 LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218

```

    2  FLOW 0
    0.035 0.025 0.005 1019 0.002 136.4
    0 100 200 218 248 266 306 486
    RT 138.26 138.26 138.26 179.26 179.26 138.26 138.26 138.26

    DS
    0.068
    0.65 1.32 2.45 3.55 4.60 6.75 9.20 12.30

    0 88
    0.450

    2
    0.007 116.00 116.00 106.00 106.00 116.0 116.0 116.0

    0 88
    0.450
  
```

ROUTE FLOW FROM SUBBASIN D5 TO SEC320
 MID-WATERSHED PRECIPITATION DATA
 0.068
 0.65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
 0 88
 0.450

ROUTE FLOW FROM SEC320 TO SEC330
 0
 0.015 0.015 0.015 1627 0.005 112.0
 0 100 200 206.001 218.001 218.002 352 452
 116.00 116.00 116.00 106.00 106.00 116.0 116.0 116.0

GENERATE HYDROGRAPH FROM SUBBASIN D4B TO SEC330
 UPPER WATERSHED PRECIPITATION DATA
 0.097
 0.66 1.35 2.50 3.60 4.65 6.80 9.25 12.50
 0 88
 0.450

1. 2. 3. 4. 5. 6. 7. 8. 9.

PAGE 5

184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218

```

    2  FLOW 0
    0.168 0.168
    0.65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
    0 76
    0.312

    0.009 193.41 199.48 196.85 190.29 190.29 196.85 203.41 209.97

    0 88
    0.450
  
```

ROUTE FLOW FROM SUBBASIN A6 TO SEC30
 MID-WATERSHED PRECIPITATION DATA
 0.168
 0.65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
 0 76
 0.312

GENERATE HYDROGRAPH FROM SUBBASIN A7 TO SEC30
 UPPER WATERSHED PRECIPITATION DATA
 0.009
 193.41 199.48 196.85 190.29 190.29 196.85 203.41 209.97
 0 88
 0.450

ROUTE FLOW FROM SEC320 TO SEC310
 0
 0.035 0.035 0.035 1 0.055 198
 0 60 83 105 122 141 170 180
 203.41 199.48 196.85 190.29 190.29 196.85 203.41 209.97

GENERATE HYDROGRAPH FROM SUBBASIN D1 TO SEC310
 0.075
 0.64 1.35 2.5 3.6 4.65 6.8 9.25 12.5
 0 88
 0.450

1. 2. 3. 4. 5. 6. 7. 8. 9.

PAGE 6

219 220 221 222 223 224

```

    2  FLOW 0
    0.015 0.015 0.015 1247 0.018 130
    0 100 200 200.001 210.001 210.002 310 410
    RT 131.7 131.7 131.7 124.7 124.7 131.7 131.7 131.7

    REC-1 INPUT
  
```

ROUTE WATERSHED FLOW FROM SEC310 TO SEC340
 MID-WATERSHED PRECIPITATION DATA
 0.015
 0.015 0.015 0.015 1247 0.018 130
 0 100 200 200.001 210.001 210.002 310 410
 131.7 131.7 131.7 124.7 124.7 131.7 131.7 131.7

REC-1 INPUT

1. 2. 3. 4. 5. 6. 7. 8. 9.

PAGE 6

225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277

```

    D4A
    0.036
    0.65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
    0 88
    0.450

    2
    0.015 0.015 0.015 2417 0.011
    0 100 200 200.001 215.002 315 415
    RT 81 81 81 73 73 81 81 81

    0.155
    0.65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
    0 90
    0.450

    2
    0.015 0.015 0.015 1400 0.0065
    0 100 130 260 300 490 590
    RT 66 66 66 51 51 66 66 66

    D8
    0.273
    0.65 1.32 2.45 3.55 4.60 6.75 9.2 12.3
    0 90
    0.450
  
```

GENERATE HYDROGRAPH FROM SUBBASIN D4A TO SEC340
 MID-WATERSHED PRECIPITATION DATA
 0.036
 0.65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
 0 88
 0.450

COMBINE HYDROGRAPHS AT SEC340

COMBINE HYDROGRAPHS AT SEC350

ROUTE FLOW FROM SEC350 TO SEC360
 0
 0.015 0.015 0.015 2417 0.011
 0 100 200 200.001 215.002 315 415
 81 81 81 73 73 81 81 81

GENERATE HYDROGRAPH FROM SUBBASIN D7 TO SEC340
 MID-WATERSHED PRECIPITATION DATA
 0.155
 0.65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
 0 90
 0.450

COMBINE HYDROGRAPHS AT SEC360

COMBINE HYDROGRAPHS AT SEC300

ROUTE FLOW FROM SEC400 TO SEC610
 0
 0.035 0.035 0.035 1400 0.0065
 0 100 130 260 300 490 590
 66 66 66 51 51 66 66 66

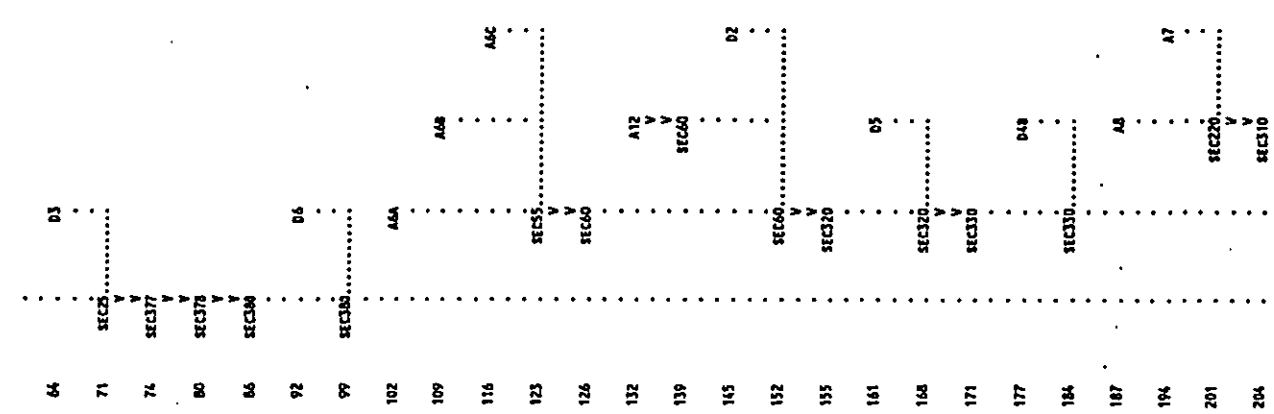
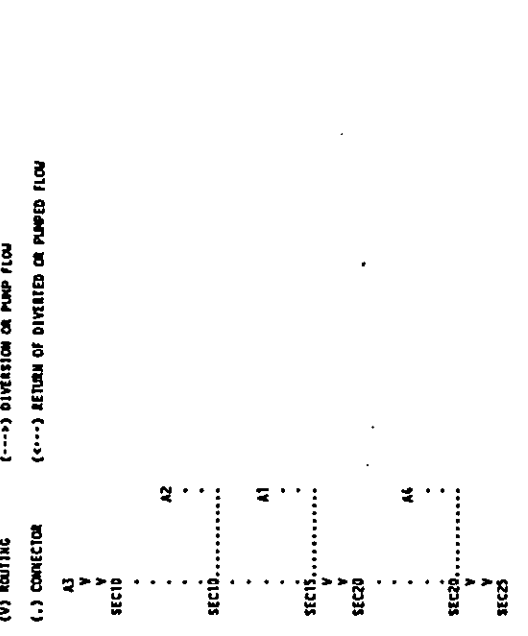
GENERATE HYDROGRAPH FROM SUBBASIN D8 TO SEC410
 MID-WATERSHED PRECIPITATION DATA
 0.273
 0.65 1.32 2.45 3.55 4.60 6.75 9.2 12.3
 0 90
 0.450

1. 2. 3. 4. 5. 6. 7. 8. 9.

PAGE 7

| | | | | | | | | |
|-----|----|--|--|------|-------|------|------|-------|
| 278 | RY | 66 | 66 | 51 | 51 | 66 | 66 | 66 |
| 279 | KK | D9 | GENERATE HYDROGRAPH FROM SUBBASIN D9 TO SEC20 | | | | | |
| 280 | KH | MID-WATERSHED PRECIPITATION DATA | | | | | | |
| 281 | KI | 0.130 | | | | | | |
| 282 | KA | 0 | 89 | 0.65 | 1.32 | 2.45 | 3.55 | 4.60 |
| 283 | KB | | | | | | | 6.75 |
| 284 | PC | | | | | | | 9.2 |
| 285 | LD | | | | | | | 12.3 |
| 286 | KK | SEC20 | COMBINE HYDROGRAPHS AT SEC20 | | | | | |
| 287 | KD | 3 | | | | | | |
| 288 | KE | 2 | | | | | | |
| 289 | KK | D10 | GENERATE HYDROGRAPH FROM SUBBASIN D10 TO SEC05 | | | | | |
| 290 | KH | UPPERMOST WATERSHED PRECIPITATION DATA | | | | | | |
| 291 | KI | 0.232 | | | | | | |
| 292 | KA | | 91 | .65 | 1.32 | 2.50 | 3.60 | 4.65 |
| 293 | KB | | | | | | | 6.80 |
| 294 | PC | | | | | | | 9.25 |
| 295 | LD | | | | | | | 12.30 |
| 296 | KK | SEC10 | ROUTE FLOW FROM SEC05 TO SEC10 | | | | | |
| 297 | KM | 1 | | | | | | |
| 298 | KN | 0 | | | | | | |
| 299 | KS | 0.015 | 0.015 | 3040 | 0.010 | 54 | | |
| 300 | KL | 0 | 100 | 200 | 220 | 220 | 320 | 420 |
| 301 | KJ | 55 | 55 | 47 | 47 | 55 | 55 | 55 |
| 302 | KI | | | | | | | |
| 303 | KK | D11 | GENERATE HYDROGRAPH FROM SUBBASIN D11 TO SEC10 | | | | | |
| 304 | KH | UPPERMOST WATERSHED PRECIPITATION DATA | | | | | | |
| 305 | KI | 0.275 | | | | | | |
| 306 | KA | | 91 | .65 | 1.32 | 2.50 | 3.60 | 4.65 |
| 307 | KB | | | | | | | 6.80 |
| 308 | PC | | | | | | | 9.25 |
| 309 | LD | | | | | | | 12.30 |
| 310 | KK | SEC10 | COMBINE HYDROGRAPHS AT SEC10 | | | | | |
| 311 | KM | 3 | | | | | | |
| 312 | KO | 2 | | | | | | |
| 313 | HC | | | | | | | |
| 314 | ZZ | | | | | | | |

SCHEMATIC DIAGRAM OF STREAM NETWORK





PROJECT CONDITIONS: UPPER WATERBEDS - EXISTING CONDITIONS
 EAST KAPOLEI - DEV. COND. NO BASINS - ADJ 47 AC. KAP.
 CALOI - WAREHOUSE NETWORK MODEL

7 10 OUTPUT CONTROL VARIABLES
 IPLOT 5 PRINT CONTROL
 IPLOT 0 PLOT CONTROL
 GSCALE 0. HYDROGRAPH PLOT SCALE

11 HYDROGRAPH TIME DATA 7 MINUTES IN COMPUTATION INTERVAL
 DATE 5/4/78 STARTING DATE
 TIME 1200 STARTING TIME
 NO 300 NUMBER OF HYDROGRAPH ORIGINATES
 MODATE 6/4/78 ENDING DATE
 MOTIME 2233 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 ACRES-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 |
| MAXEZ MPLAN, MSTH 1 0 | | | |
| VALUE EXCEEDS TABLE IN LOGLOG | 24.03336 | 0.01667 | 24.00000 |
| VALUE EXCEEDS TABLE IN LOGLOG | 24.03336 | 0.01667 | 24.00000 |
| MAXEZ MPLAN, MSTH 1 0 | | | |

WARNING --- ROUTED OUTFLOW (1817.) 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 (3158.) IS GREATER THAN MAXIMUM OUTFLOW (1720.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (3006.) IS GREATER THAN MAXIMUM OUTFLOW (1720.) IN STORAGE-OUTFLOW TABLE

210 01

 216 SEC310.....
 Y
 219 SEC340.....
 Y
 225 04A

 232 SEC340.....

 235 SEC350.....
 Y
 238 SEC360.....

 244 07

 251 SEC360.....

 254 SEC400.....
 Y
 257 SEC410.....

 263 08

 270 SEC410.....
 Y
 273 SEC420.....

 279 09

 286 SEC420.....

 290 010
 Y
 297 SEC10.....

 303 011

 310 SEC10.....

 U.S. ARMY CORPS OF ENGINEERS
 HYDROLOGIC ENGINEERING CENTER
 609 SECOND STREET
 DAVIS, CALIFORNIA 95616
 (916) 551-1748

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

 FLOOD HYDROGRAPH PACKAGE (REC-1)
 JUN 09 1992
 VERSION 4.0.3E
 RUN DATE 06/06/98 TIME 08:33:06

EAST KAPOLEI FLOOD (100-YEAR STORM)
 FN: HEUTAZ.DAT

289 JC HYDROGRAPH COMBINATION 2 NUMBER OF HYDROGRAPHS TO COMBINE
ICOMP ***

NAME2 NPLAM,NSTIM 1 0 ***

HYDROGRAPH AT STATION SECC20
 PEAK FLOW TIME 6-HR 24-HR 72-HR 34.08-HR
 (CFS) (HR) (CFS) (INCHES) (AC-FT) (AC-FT)
 * 5507. 12.72 3644. 1517. 1070. 1070.
 5.319 9.075 9.156 1070.
 1082. 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 * SECTO *

312 KO OUTPUT CONTROL VARIABLES
 IPRINT 3 PRINT CONTROL
 IPLOT 0 PLOT CONTROL
 DISCAL 0. HYDROGRAPH PLOT SCALE

313 KC HYDROGRAPH COMBINATION 2 NUMBER OF HYDROGRAPHS TO COMBINE
ICOMP ***

NAME2 NPLAM,NSTIM 1 0 ***

HYDROGRAPH AT STATION SECC10
 PEAK FLOW TIME 6-HR 24-HR 72-HR 34.08-HR
 (CFS) (HR) (CFS) (INCHES) (AC-FT) (AC-FT)
 * 941. 12.48 360. 153. 105. 105.
 6.515 11.184 11.184 11.184
 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 | BASEIN AREA | MAXIMUM STAGE | TIME OF MAX STAGE |
|---------------|---------|-----------|--------------|---------------------------------|--------|---------|---------|-------------|---------------|-------------------|
| HYDROGRAPH AT | A3 | 1621. | 13.30 | 939. | 364. | 263. | 263. | 1.70 | | |
| ROUTED TO | SECC10 | 1621. | 13.42 | 939. | 384. | 263. | 263. | 1.70 | 213.07 | 13.42 |
| HYDROGRAPH AT | | | | | | | | | | |

| OPERATION | STATION | PEAK FLOW | TIME OF PEAK | AVERAGE FLOW FOR MAXIMUM PERIOD | 6-HOUR | 24-HOUR | 72-HOUR | BASEIN AREA | MAXIMUM STAGE | TIME OF MAX STAGE |
|---------------|---------|-----------|--------------|---------------------------------|--------|---------|---------|-------------|---------------|-------------------|
| 2 COMBINED AT | A2 | 270. | 12.48 | 91. | 34. | 25. | 0.17 | | | |
| HYDROGRAPH AT | SECC10 | 1726. | 13.30 | 1028. | 421. | 288. | 1.87 | | | |
| HYDROGRAPH AT | A1 | 1846. | 13.45 | 1168. | 476. | 326. | 2.04 | | | |
| 2 COMBINED AT | SECC15 | 3546. | 13.42 | 2174. | 896. | 615. | 3.90 | | | |
| ROUTED TO | SECC20 | 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 | SECC20 | 3467. | 13.42 | 2273. | 934. | 642. | 4.09 | | | |
| ROUTED TO | SECC25 | 3468. | 13.53 | 2272. | 934. | 642. | 4.09 | 199.02 | 13.53 | |
| HYDROGRAPH AT | D3 | 595. | 12.48 | 221. | 90. | 62. | 0.34 | | | |
| 2 COMBINED AT | SECC25 | 3900. | 13.53 | 2480. | 1025. | 704. | 4.43 | | | |
| ROUTED TO | SECC377 | 3895. | 13.65 | 2479. | 1025. | 704. | 4.43 | 155.53 | 13.65 | |
| ROUTED TO | SECC378 | 3895. | 13.65 | 2479. | 1025. | 704. | 4.43 | 102.89 | 13.65 | |
| ROUTED TO | SECC380 | 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 | SECC380 | 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 | SECC55 | 489. | 12.25 | 149. | 61. | 42. | 0.23 | | | |
| ROUTED TO | SECC60 | 489. | 12.37 | 149. | 61. | 42. | 0.23 | 188.57 | 12.37 | |
| HYDROGRAPH AT | A12 | 145. | 12.95 | 73. | 30. | 21. | 0.11 | | | |
| ROUTED TO | SECC60 | 142. | 13.07 | 73. | 30. | 21. | 0.11 | 151.66 | 13.07 | |
| HYDROGRAPH AT | D2 | 307. | 12.48 | 146. | 61. | 42. | 0.22 | | | |
| 3 COMBINED AT | SECC60 | 918. | 12.37 | 367. | 152. | 104. | 0.56 | | | |

.....
 * U.S. ARMY CORPS OF ENGINEERS
 * HYDROLOGIC ENGINEERING CENTER
 * 609 SECOND STREET
 * DAVIS, CALIFORNIA 95616
 * (916) 551-1748
 *

.....
 * FLOOD HYDROGRAPH PACKAGE (HEC-1)
 * JAN 09 1992
 * VERSION 4.0.3E
 *

.....
 * X XXXXXXX XXXXX X
 * X X X X X X X X
 * XXXXXXX XXXX X XXXX X
 * X X X X X X X X
 * X X X X X XXXXX XXXX
 *

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1G, HEC1D, AND HEC1CV.
 THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOM- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
 THE DEFINITION OF -ANXK- ON IN-CHANNEL WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE PORTLAND7 VERSION.
 NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE - SINGLE EVENT DAMAGE CALCULATION, OBTAINITE STAGE FREQUENCY,
 OSS-READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE-GREEN AND AMPT INFILTRATION
 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

HEC-1 INPUT

```

1  ID 10.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
2  ID 10 EAST KAPOLEI FLOOD (100-YEAR STORM)
3  ID 10 FH: EASTCAPS.OAT
4  ID 10 PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
5  ID 10 PROJECT CONDITIONS: EAST KAPOLEI - DEVELOPED CONDITIONS - ADD 47.0 AC LAP
6  ID 10 RUN WITH BASINS IN - DROP ELEV BAS. 445
7  ID 10 KALO1 - WAIWAIWANE NETWORK MODEL
8  ID 10 7 05MAY98 1200 300
9  ID 10
10 ID 10
11 ID 10
12 ID 10
13 ID 10
14 ID 10
15 ID 10
16 ID 10
17 ID 10
18 ID 10
19 ID 10
20 ID 10
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22 ID 10
23 ID 10
24 ID 10
25 ID 10
26 ID 10
27 ID 10
28 ID 10
29 ID 10
30 ID 10
31 ID 10
32 ID 10
33 ID 10
34 ID 10

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HEC-1 INPUT

```

1  ID 10.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
2  ID 10 EAST KAPOLEI FLOOD (100-YEAR STORM)
3  ID 10 FH: EASTCAPS.OAT
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10 ID 10
11 ID 10
12 ID 10
13 ID 10
14 ID 10
15 ID 10
16 ID 10
17 ID 10
18 ID 10
19 ID 10
20 ID 10
21 ID 10
22 ID 10
23 ID 10
24 ID 10
25 ID 10
26 ID 10
27 ID 10
28 ID 10
29 ID 10
30 ID 10
31 ID 10
32 ID 10
33 ID 10
34 ID 10

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.....
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.....
 * FLOOD HYDROGRAPH PACKAGE (HEC-1)
 * JAN 09 1992
 * VERSION 4.0.3E
 *

.....
 * X XXXXXXX XXXXX X
 * X X X X X X X X
 * XXXXXXX XXXX X XXXX X
 * X X X X X X X X
 * X X X X X XXXXX XXXX
 *

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1G, HEC1D, AND HEC1CV.
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 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

HEC-1 INPUT

```

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27 ID 10
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30 ID 10
31 ID 10
32 ID 10
33 ID 10
34 ID 10

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HEC-1 INPUT

```

1  ID 10.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
2  ID 10 EAST KAPOLEI FLOOD (100-YEAR STORM)
3  ID 10 FH: EASTCAPS.OAT
4  ID 10 PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS
5  ID 10 PROJECT CONDITIONS: EAST KAPOLEI - DEVELOPED CONDITIONS - ADD 47.0 AC LAP
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10 ID 10
11 ID 10
12 ID 10
13 ID 10
14 ID 10
15 ID 10
16 ID 10
17 ID 10
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27 ID 10
28 ID 10
29 ID 10
30 ID 10
31 ID 10
32 ID 10
33 ID 10
34 ID 10

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1

95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157

HC 2 COMBINE HYDROGRAPHS AT SECS

KC RES03 ROUTE FLOW FROM SECS THROUGH RES03

KS 1 ELEV 115.47 27.60 34.50 82.93 108.59 137.97

KR 0 6.90 13.00 119.47 120.47 125.47 129.47

KA 115.47 116.47 117.47 118.47 119.47 120.47 121.47

KL 50 3 1.5

KM 115.47 0.785 0.6 0.5

KK SEC380 ROUTE RES03 TO SEC380

KL 2 FLOW 0

KM 0.035 0.025 0.035 1657 0.012 130.47

KN 0 100 200 250 260 290 300 300

KO 130.47 130.47 130.47 115.47 115.47 130.47 130.47 130.47

KK SEC06 GENERATE HYDROGRAPH FROM SUBBASIN D6 TO SEC380

KL 2 FLOW 0

KM 0.361 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30

KN 0 60 60

KO 0.45

KK SEC380 COMBINE HYDROGRAPHS AT SEC380

KL 2

158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179

KC SEC60 ROUTE A12 TO SEC60

KL 2 FLOW 0

KM 0.035 0.035 3041 0.026 156

KN 0 216 347 401 432 445 452 749

KA 182.4 157.48 154.53 150.92 150.92 154.20 154.20 157.48

KK SEC07 GENERATE HYDROGRAPH FROM SUBBASIN D2 TO SEC60

KL 2 FLOW 0

KM 0.215 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30

KN 0 84 84

KO 0.45

KK SEC60 COMBINE HYDROGRAPHS AT SEC60

KL 3

KK SEC320 ROUTE FLOW FROM SEC60 TO SEC320

KL 2 FLOW 0

KM 0.025 0.025 0.025 1616 0.010 139.3

KN 0 100 200 216 266 282 326 420

KA 139.3 139.30 139.30 131.30 131.30 139.30 139.30 139.3

KO REC-1 INPUT

180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220

HC 2 COMBINE HYDROGRAPHS AT SECS

KC RES03 ROUTE FLOW FROM SECS THROUGH RES03

KS 1 ELEV 115.47 27.60 34.50 82.93 108.59 137.97

KR 0 6.90 13.00 119.47 120.47 125.47 129.47

KA 115.47 116.47 117.47 118.47 119.47 120.47 121.47

KL 50 3 1.5

KM 115.47 0.785 0.6 0.5

KK SEC380 ROUTE RES03 TO SEC380

KL 2 FLOW 0

KM 0.035 0.025 0.035 1657 0.012 130.47

KN 0 100 200 250 260 290 300 300

KO 130.47 130.47 130.47 115.47 115.47 130.47 130.47 130.47

KK SEC06 GENERATE HYDROGRAPH FROM SUBBASIN D6 TO SEC380

KL 2 FLOW 0

KM 0.361 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30

KN 0 60 60

KO 0.45

KK SEC380 COMBINE HYDROGRAPHS AT SEC380

KL 2

180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220

HC 2 COMBINE HYDROGRAPHS AT SECS

KC RES03 ROUTE FLOW FROM SECS THROUGH RES03

KS 1 ELEV 115.47 27.60 34.50 82.93 108.59 137.97

KR 0 6.90 13.00 119.47 120.47 125.47 129.47

KA 115.47 116.47 117.47 118.47 119.47 120.47 121.47

KL 50 3 1.5

KM 115.47 0.785 0.6 0.5

KK SEC380 ROUTE RES03 TO SEC380

KL 2 FLOW 0

KM 0.035 0.025 0.035 1657 0.012 130.47

KN 0 100 200 250 260 290 300 300

KO 130.47 130.47 130.47 115.47 115.47 130.47 130.47 130.47

KK SEC06 GENERATE HYDROGRAPH FROM SUBBASIN D6 TO SEC380

KL 2 FLOW 0

KM 0.361 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30

KN 0 60 60

KO 0.45

KK SEC380 COMBINE HYDROGRAPHS AT SEC380

KL 2

180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220

HC 2 COMBINE HYDROGRAPHS AT SECS

KC RES03 ROUTE FLOW FROM SECS THROUGH RES03

KS 1 ELEV 115.47 27.60 34.50 82.93 108.59 137.97

KR 0 6.90 13.00 119.47 120.47 125.47 129.47

KA 115.47 116.47 117.47 118.47 119.47 120.47 121.47

KL 50 3 1.5

KM 115.47 0.785 0.6 0.5

KK SEC380 ROUTE RES03 TO SEC380

KL 2 FLOW 0

KM 0.035 0.025 0.035 1657 0.012 130.47

KN 0 100 200 250 260 290 300 300

KO 130.47 130.47 130.47 115.47 115.47 130.47 130.47 130.47

KK SEC06 GENERATE HYDROGRAPH FROM SUBBASIN D6 TO SEC380

KL 2 FLOW 0

KM 0.361 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30

KN 0 60 60

KO 0.45

KK SEC380 COMBINE HYDROGRAPHS AT SEC380

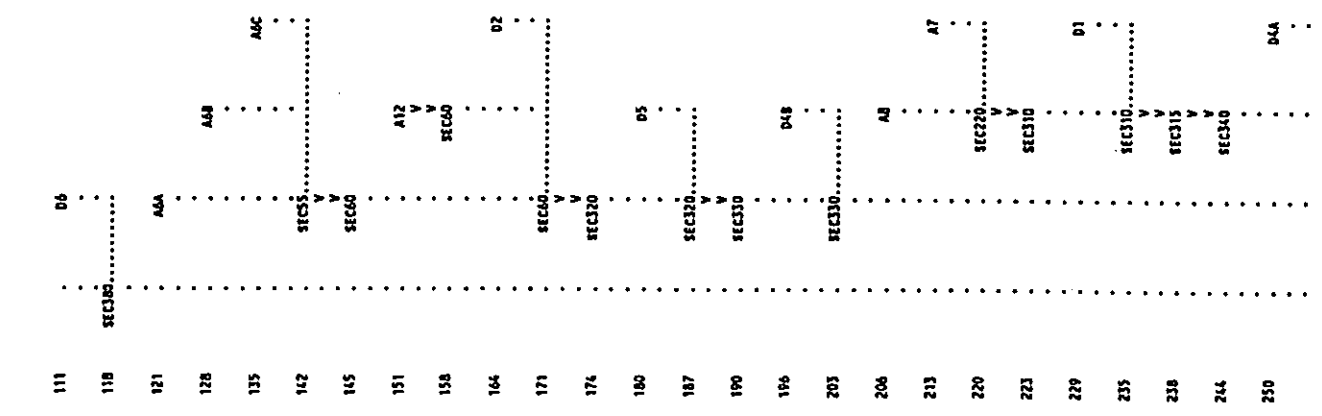
KL 2



KK SEC10 ROUTE FLOW FROM SEC05 TO SEC10
 KN FLOW 0
 KC 0.015 0.015 3040 0.010 54
 KB 0 100 200 200 220 420
 KA 55 55 47 47 55 55
 AT 55 55 47 47 55 55
 KK SEC10 D11
 KN GENERATE HYDROGRAPH FROM SUBBASIN D11 TO SEC10
 KC UPPERMOST WATERSHED PRECIPITATION DATA
 KB 0.275
 KA 0 91
 LA 0 91
 LB 0 91
 LC 0 91
 LD 0.450
 KK SEC10 COMBINE HYDROGRAPHS AT SEC10
 KN 3
 KC 2
 KB 2
 KA 2
 LA 2
 LB 2
 LC 2
 LD 2

SCHEMATIC DIAGRAM OF STREAM NETWORK

INPUT LINE (V) ROUTING (----) DIVERSION OR PUMP FLOW
 (.) CONNECTOR (-----) RETURN OF DIVERTED OR PUMPED FLOW



0. HYDROGRAPH PLOT SCALE

HYDROGRAPH TIME DATA
 7 MINUTES IN COMPUTATION INTERVAL
 5MAY78 STARTING DATE
 1200 STARTING TIME
 500 NUMBER OF HYDROGRAPH ORDINATES
 6MAY78 ENDING DATE
 2255 ENDING TIME
 19 CENTURY HOUR
 ICENT

COMPUTATION INTERVAL 0.12 HOURS
 TOTAL TIME BASE 34.56 HOURS

ENGLISH UNITS
 DRAINAGE AREA SQUARE MILES
 PRECIPITATION DEPTH INCHES
 LENGTH, ELEVATION FEET
 FLOW CURVIC 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
 VALUE EXCEEDS TABLE IN LOGLOG 24.03336 0.01667 24.00000
 VALUE EXCEEDS TABLE IN LOGLOG 24.03336 0.01667 24.00000

.....

59 EK
 RES01

61 KD
 OUTPUT CONTROL VARIABLES
 IPLOT 3 PRINT CONTROL
 IPLOT 0 PLOT CONTROL
 BSICAL 0. HYDROGRAPH PLOT SCALE

HYDROGRAPH ROUTING DATA

62 RS
 STORAGE ROUTING
 TRIPS 1 NUMBER OF SUBREACHES
 ITPP ELEV TYPE OF INITIAL CONDITION
 170.00 INITIAL CONDITION
 RSVVIC 0.00 WORKING R AND D COEFFICIENT
 X
 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
 65 SI
 LOW-LEVEL OUTLET
 ELEV 170.00 ELEVATION AT CENTER OF OUTLET
 CANEA 0.79 CROSS-SECTIONAL AREA
 COOL 0.40 COEFFICIENT
 EXPL 0.50 EXPONENT OF HEAD

65 SS
 SPILLWAY
 CHEL 175.00 SPILLWAY CREST ELEVATION
 SPWID 40.00 SPILLWAY WIDTH
 COOIN 3.40 WEIR COEFFICIENT
 EXPW 1.50 EXPONENT OF HEAD

COMPUTED OUTFLOWS-ELEVATION DATA

257
 SEC310.....
 260
 SEC310.....
 263
 SEC335.....
 269
 SEC360.....
 275
 D7
 282
 SEC360.....
 285
 SEC381.....
 288
 RES04.....
 296
 SEC410.....
 302
 D8
 309
 SEC410.....
 312
 D9
 319
 SEC420.....
 322
 RES05.....
 330
 D10
 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
 409 SECOND STREET
 DAVIS, CALIFORNIA 95616
 (916) 551-1728

EAST KAPOLEI FLOOD (100-YEAR STORM)
 FH: EASTKAP.041
 PROJECT CONDITIONS: UPPER WATERSHED - EXISTING CONDITIONS - ADD 47.0 AC MAP
 EAST KAPOLEI - DEVELOPED CONDITIONS - ADD 47.0 AC MAP
 RUN WITH BASINS IN - DROP ELEV BAS. 455

KALOI - INHERENT NETWORK MODEL

OUTPUT CONTROL VARIABLES
 IPLOT 3 PRINT CONTROL
 IPLOT 0 PLOT CONTROL

WARNING --- ROUTED OUTFLOW (3442.) IS GREATER THAN MAXIMUM OUTFLOW (3266.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (3344.) IS GREATER THAN MAXIMUM OUTFLOW (3266.) IN STORAGE-OUTFLOW TABLE

| OUTFLOW ELEVATION | 0.00 | 2.67 | 3.22 | 3.59 | 4.05 | 4.66 | 5.48 | 6.65 | 8.45 |
|-------------------|--------|--------|--------|--------|--------|---------|---------|---------|---------|
| 170.00 | 170.50 | 170.60 | 170.72 | 170.90 | 171.15 | 171.52 | 172.10 | 173.00 | 175.00 |
| OUTFLOW ELEVATION | 15.63 | 64.51 | 106.07 | 151.30 | 196.49 | 2368.82 | 3528.37 | 5016.95 | 6874.95 |
| 175.16 | 175.55 | 176.23 | 177.10 | 178.42 | 179.92 | 181.69 | 183.74 | 186.06 | 188.65 |

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

| STORAGE OUTFLOW ELEVATION | 0.00 | 2.89 | 3.45 | 4.20 | 5.23 | 6.67 | 8.82 | 11.59 | 12.18 |
|---------------------------|--------|---------|---------|---------|---------|---------|---------|--------|--------|
| 170.00 | 170.50 | 170.60 | 170.72 | 170.90 | 171.15 | 171.52 | 172.10 | 173.00 | 175.00 |
| STORAGE OUTFLOW ELEVATION | 6.54 | 17.94 | 23.18 | 28.98 | 32.83 | 37.17 | 42.24 | 43.51 | 51.46 |
| 173.00 | 173.09 | 174.00 | 175.00 | 175.14 | 175.55 | 176.23 | 177.00 | 177.19 | 178.42 |
| STORAGE OUTFLOW ELEVATION | 61.61 | 1496.68 | 1532.47 | 2368.82 | 3528.37 | 5016.95 | 6874.95 | | |
| 179.92 | 180.00 | 181.69 | 183.74 | 186.06 | 188.65 | | | | |

HYDROGRAPH AT STATION RES01

| PEAK FLOW TIME | (CFS) | 6-HR | 24-HR | 72-HR | 34.88-HR |
|----------------|-------|----------|-------|-------|----------|
| 3605. | 13.65 | 2270. | 922. | 633. | 633. |
| | | (INCHES) | 5.115 | 8.366 | 8.366 |
| | | (AC-FT) | 1116. | 1826. | 1826. |

MAXIMUM AVERAGE STORAGE

| PEAK STORAGE TIME | (AC-FT) | 6-HR | 24-HR | 72-HR | 34.88-HR |
|-------------------|---------|------|-------|-------|----------|
| 102. | 13.65 | 77. | 51. | 38. | 38. |

MAXIMUM AVERAGE STAGE

| PEAK STAGE TIME | (FEET) | 6-HR | 24-HR | 72-HR | 34.88-HR |
|-----------------|--------|--------|--------|--------|----------|
| 183.86 | 13.65 | 181.39 | 176.10 | 176.12 | 176.12 |

CUMULATIVE AREA = 4.09 SQ MI

WARNING --- ROUTED OUTFLOW (3365.) IS GREATER THAN MAXIMUM OUTFLOW (3266.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (3479.) IS GREATER THAN MAXIMUM OUTFLOW (3266.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (3558.) IS GREATER THAN MAXIMUM OUTFLOW (3266.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (3600.) IS GREATER THAN MAXIMUM OUTFLOW (3266.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (3602.) IS GREATER THAN MAXIMUM OUTFLOW (3266.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (3567.) IS GREATER THAN MAXIMUM OUTFLOW (3266.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (3594.) IS GREATER THAN MAXIMUM OUTFLOW (3266.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (3670.) IS GREATER THAN MAXIMUM OUTFLOW (3266.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (3318.) IS GREATER THAN MAXIMUM OUTFLOW (3266.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (3330.) IS GREATER THAN MAXIMUM OUTFLOW (3266.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (3453.) IS GREATER THAN MAXIMUM OUTFLOW (3266.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (3541.) IS GREATER THAN MAXIMUM OUTFLOW (3266.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (3592.) IS GREATER THAN MAXIMUM OUTFLOW (3266.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (3604.) IS GREATER THAN MAXIMUM OUTFLOW (3266.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (3578.) IS GREATER THAN MAXIMUM OUTFLOW (3266.) IN STORAGE-OUTFLOW TABLE
 WARNING --- ROUTED OUTFLOW (3521.) IS GREATER THAN MAXIMUM OUTFLOW (3266.) IN STORAGE-OUTFLOW TABLE

73 EX RES02
 75 RO
 76 RS
 77 SV
 78 SE
 80 SL
 79 SS

STORAGE ROUTING
 NSTPS
 ITPP
 RSTRIC
 STORAGE
 ELEVATION

NUMBER OF SUBREACHES
 ELEV TYPE OF INITIAL CONDITION
 162.00 INITIAL CONDITION
 0.00 WORKING R AND D COEFFICIENT
 0.0 1.9 3.8 7.7 11.5 15.3 19.1 33.1 50.1 69.3

LOW-LEVEL OUTLET
 ELEV
 AREA
 COEF
 EDPL

SPILLWAY
 CHEL
 SPWID
 CDWY
 EDPL

ELEVATION AT CENTER OF OUTLET
 CROSS-SECTIONAL AREA
 COEFFICIENT
 ELEVATION OF HEAD

SPILLWAY CHEST ELEVATION
 SPILLWAY WIDTH
 WEIR COEFFICIENT
 ELEVATION OF HEAD

COMPUTED OUTFLOW-ELEVATION DATA

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

HYDROGRAPH AT STATION RES02

| PEAK FLOW TIME | 6-HR | 24-HR | 72-HR | 34.88-HR |
|----------------|------|-------|-------|----------|
| | | | | |

STORAGE
OUTFLOW
ELEVATION

STORAGE
OUTFLOW
ELEVATION

21.35 27.60 34.50 35.39 38.02 42.59 45.94 56.35 68.50 77.26
 6.65 7.55 8.45 12.71 41.64 119.42 270.25 518.33 887.84 1602.98
 118.56 119.47 120.47 120.56 120.83 121.28 121.72 122.73 123.72 124.88

82.93 92.73 106.59 112.85 137.97
 2087.94 2791.12 2966.92 4064.13
 125.47 126.23 127.47 127.76 129.47

3584. 13.88 (CFS) 2268. 913. 627. 627.
 (INCHES) 5.111 8.289 8.277 8.277
 (AC-FT) 1115. 1865. 1866. 1866.

PEAK STORAGE TIME 6-HR 24-HR 72-HR 34.88-HR
 (AC-FT) (HR) 51. 33. 24. 24.
 65. 13.88

PEAK STAGE TIME 6-HR 24-HR 72-HR 34.88-HR
 (FEET) (HR) 152.99 169.88 167.74 167.74
 155.25 13.88

CUMULATIVE AREA = 4.09 SQ MI

VALUE EXCEEDS TABLE IN LOGLOG 24.03336 0.01667 24.00000
 MAKE2 MPLAM, NSIM 1 0

97 EK * RESOS *

99 ED OUTPUT CONTROL VARIABLES
 PRINT 3 PRINT CONTROL
 PLOT 0 PLOT CONTROL
 OSCAL 0. HYDROGRAPH PLOT SCALE

HYDROGRAPH ROUTING DATA

100 RS STORAGE ROUTING
 NSIPS 1 NUMBER OF SUBREACHES
 ITPP 1 ELEV TYPE OF INITIAL CONDITION
 RSYNTR 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
 ELEV 115.47 ELEVATION AT CENTER OF OUTLET
 CAREA 0.79 CROSS-SECTIONAL AREA
 COOL 0.60 COEFFICIENT
 ERPL 0.50 EXPONENT OF HEAD

103 SS SPILLWAY
 CREL 120.47 SPILLWAY CREST ELEVATION
 SPWD 50.00 SPILLWAY WIDTH
 COOV 3.00 WEIR COEFFICIENT
 ERPV 1.50 EXPONENT OF HEAD

COMPUTED OUTFLOW-ELEVATION DATA

OUTFLOW 0.00 2.67 2.92 3.22 3.59 4.05 4.68 5.48 6.45 8.45
 ELEVATION 115.47 115.97 116.07 116.19 116.37 116.62 116.99 117.37 118.56 120.47

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

STORAGE 0.00 3.44 4.11 5.00 6.22 6.90 7.94 10.49 13.80 18.51
 OUTFLOW 0.00 2.67 2.92 3.22 3.59 4.05 4.68 5.48 6.45 8.45
 ELEVATION 115.47 115.97 116.07 116.19 116.37 116.62 116.99 117.37 118.56 120.47

HYDROGRAPH AT STATION RESDS

PEAK FLOW TIME 6-HR 24-HR 72-HR 34.88-HR

PEAK STAGE TIME 6-HR 24-HR 72-HR 34.88-HR

PEAK STORAGE TIME 6-HR 24-HR 72-HR 34.88-HR

MAXIMUM AVERAGE FLOW

MAXIMUM AVERAGE STAGE

MAXIMUM AVERAGE STORAGE

VALUE EXCEEDS TABLE IN LOGLOG

MAKE2 MPLAM, NSIM

CUMULATIVE AREA = 4.43 SQ MI

COMPUTED OUTFLOW-ELEVATION DATA

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

* (FEET) (HR) 66.17 62.21 60.27 60.27
 67.93 14.23
 CUMULATIVE AREA = 5.93 SQ MI

VALUE EXCEEDS TABLE IN LOGLOG 24.03336 0.01667 24.00000
 MAKEZ WPLAM,ASTM 1 0
 VALUE EXCEEDS TABLE IN LOGLOG 24.03336 0.01667 24.00000
 MAKEZ WPLAM,ASTM 1 0

 322 RK * REIOS *

 324 KO OUTPUT CONTROL VARIABLES 3 PRINT CONTROL
 IPLOT 0 PILOT CONTROL
 OSCAL 0 HYDROGRAPH PLOT SCALE

HYDROGRAPH ROUTING DATA
 STORAGE ROUTING
 NSIPS 1 NUMBER OF SUBREACHES
 ITPP ELEV TYPE OF INITIAL CONDITION
 ASYRIC 51.50 INITIAL CONDITION
 X 0.00 WORKING R AND D COEFFICIENT
 STORAGE 0.0 8.1 16.5 44.1 55.2 78.8 108.0 138.9
 ELEVATION 51.50 52.50 53.50 56.50 57.40 59.00 60.70 62.30

LOW-LEVEL OUTLET
 ELEV 51.50 ELEVATION AT CENTER OF OUTLET
 CAREA 0.79 CROSS-SECTIONAL AREA
 COOL 0.60 COEFFICIENT
 EXPL 0.50 EXPONENT OF HEAD
 SPILLWAY
 CREL 54.50 SPILLWAY CREST ELEVATION
 SPWD 110.00 SPILLWAY WIDTH
 COCW 3.00 WEIR COEFFICIENT
 EXPW 1.50 EXPONENT OF HEAD

 326 RV

 328 VE

 329 VE

 328 VE

COMPUTED OUTFLOW-ELEVATION DATA
 OUTFLOW ELEVATION 0.00 2.64 2.85 3.10 3.40 3.76 4.21 4.78 5.32 6.56
 OUTFLOW ELEVATION 51.50 51.99 52.07 52.17 52.31 52.49 52.74 53.10 53.64 54.50
 OUTFLOW ELEVATION 13.97 64.93 202.44 449.51 909.13 1564.34 2478.13 3693.32 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 OUTFLOW ELEVATION 0.00 3.95 4.61 5.45 6.55 8.02 10.11 13.11 16.48 17.74
 STORAGE OUTFLOW ELEVATION 0.00 2.64 2.85 3.10 3.40 3.76 4.21 4.78 5.34 5.52
 STORAGE OUTFLOW ELEVATION 25.69 26.62 28.58 32.18 37.21 43.48 44.11 44.10 45.20 48.87
 STORAGE OUTFLOW ELEVATION 6.34 13.97 64.93 202.44 449.51 909.14 1564.34 2478.13 3693.32 5253.54
 STORAGE OUTFLOW ELEVATION 78.85 87.32 108.01 110.31 138.95 164.8 183.89 2178.13 3693.32 5253.54
 STORAGE OUTFLOW ELEVATION 3180.51 3893.52 5105.94 5253.54 7201.20 8230.00 9249.00 10249.00 11249.00 12249.00

288 KK * REIOS *

 290 KO OUTPUT CONTROL VARIABLES 3 PRINT CONTROL
 IPLOT 0 PILOT CONTROL
 OSCAL 0 HYDROGRAPH PLOT SCALE

HYDROGRAPH ROUTING DATA
 STORAGE ROUTING
 NSIPS 1 NUMBER OF SUBREACHES
 ITPP ELEV TYPE OF INITIAL CONDITION
 ASYRIC 51.50 INITIAL CONDITION
 X 0.00 WORKING R AND D COEFFICIENT
 STORAGE 0.0 58.7 68.3 88.5 127.4 185.1 228.9 276.4 374.7
 ELEVATION 51.51 61.51 62.33 63.98 64.31 68.90 70.54 72.18 75.46

LOW-LEVEL OUTLET
 ELEV 51.51 ELEVATION AT CENTER OF OUTLET
 CAREA 0.79 CROSS-SECTIONAL AREA
 COOL 0.60 COEFFICIENT
 EXPL 0.50 EXPONENT OF HEAD
 SPILLWAY
 CREL 59.31 SPILLWAY CREST ELEVATION
 SPWD 50.00 SPILLWAY WIDTH
 COCW 3.00 WEIR COEFFICIENT
 EXPW 1.50 EXPONENT OF HEAD

 292 SV

 293 SE

 295 SL

 294 SS

COMPUTED OUTFLOW-ELEVATION DATA
 OUTFLOW ELEVATION 0.00 2.67 2.92 3.22 3.59 4.05 4.66 5.48 6.45 8.45
 OUTFLOW ELEVATION 53.31 53.81 53.91 54.03 54.21 54.46 54.83 55.41 56.40 58.31
 OUTFLOW ELEVATION 19.51 299.14 695.12 1346.81 2317.94 3672.20 5473.34 7785.08 10471.16 13977.75
 ELEVATION 58.40 59.00 59.86 61.06 62.61 64.49 66.72 69.29 72.20 75.46

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA
 STORAGE OUTFLOW ELEVATION 0.00 3.66 4.37 5.32 6.62 8.45 11.16 15.43 22.72 34.70
 STORAGE OUTFLOW ELEVATION 0.00 2.67 2.92 3.22 3.59 4.05 4.66 5.48 6.45 8.45
 STORAGE OUTFLOW ELEVATION 37.98 41.77 48.08 56.90 68.72 84.29 104.08 128.36 157.64 192.82
 STORAGE OUTFLOW ELEVATION 19.51 299.14 695.12 1346.81 2317.94 3672.20 5473.34 7785.08 10471.16 13977.75
 STORAGE OUTFLOW ELEVATION 136.55 185.10 248.92 328.38 428.71 543.19 674.70 824.70 994.70 1184.70
 STORAGE OUTFLOW ELEVATION 3672.20 5184.26 6473.34 7785.08 9249.00 10949.00 12949.00 15249.00 17849.00 20749.00

HYDROGRAPH AT STATION RESON
 PEAK FLOW TIME (HR) 6-HR 24-HR 72-HR 34.00-HR
 4513. 16.23 (CFS) 3369. 1379. 949. 647. 2733.
 (INCHES) 3.242 8.421 6.647 8.647 2733.
 (AC-FT) 1657. 2725.
 PEAK STORAGE TIME (HR) 6-HR 24-HR 72-HR 34.00-HR
 164. 128. 75. 57. 57.
 PEAK STAGE TIME (HR) 6-HR 24-HR 72-HR 34.00-HR

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---------------|--------|-------|-------|------|------|------|--------|-------|---|---------------|--------|-------|-------|-------|-------|-------|------|---|
| • | • | SEC60 | 142. | 13.07 | 73. | 30. | 21. | 0.11 | 151.66 | 13.07 | • | 2 COMBINED AT | SEC381 | 4616. | 13.68 | 3180. | 1389. | 961. | 5.93 | • |
| • | • | HYDROGRAPH AT | D2 | 387. | 12.48 | 146. | 61. | 0.22 | • | • | • | ROUTED TO | RES04 | 4513. | 14.23 | 3169. | 1379. | 948. | 3.93 | • |
| • | • | 3 COMBINED AT | SEC60 | 919. | 12.37 | 367. | 152. | 0.56 | • | • | • | ROUTED TO | SEC410 | 4512. | 14.35 | 3169. | 1379. | 948. | 5.93 | • |
| • | • | ROUTED TO | SEC320 | 913. | 12.37 | 367. | 152. | 0.56 | 133.17 | 12.37 | • | HYDROGRAPH AT | • | • | • | • | • | • | • | • |
| • | • | HYDROGRAPH AT | D5 | 122. | 12.48 | 46. | 19. | 0.07 | • | • | • | 2 COMBINED AT | SEC410 | 4681. | 14.23 | 3544. | 1435. | 1004. | 6.20 | • |
| • | • | 2 COMBINED AT | SEC320 | 1024. | 12.48 | 413. | 171. | 0.43 | • | • | • | HYDROGRAPH AT | D9 | 239. | 12.48 | 91. | 38. | 26. | 0.13 | • |
| • | • | ROUTED TO | SEC330 | 1035. | 12.48 | 413. | 171. | 0.43 | 94.91 | 12.48 | • | 2 COMBINED AT | SEC420 | 4753. | 14.23 | 3629. | 1491. | 1030. | 6.33 | • |
| • | • | HYDROGRAPH AT | D6 | 106. | 12.48 | 40. | 17. | 0.06 | • | • | • | ROUTED TO | RES05 | 4733. | 14.47 | 3620. | 1466. | 1021. | 6.33 | • |
| • | • | 2 COMBINED AT | SEC330 | 1141. | 12.48 | 433. | 188. | 0.69 | • | • | • | HYDROGRAPH AT | D10 | 436. | 12.48 | 165. | 70. | 48. | 0.23 | • |
| • | • | HYDROGRAPH AT | A5 | 326. | 12.37 | 103. | 42. | 0.17 | • | • | • | ROUTED TO | SEC10 | 432. | 12.60 | 165. | 70. | 48. | 0.23 | • |
| • | • | HYDROGRAPH AT | A7 | 19. | 12.15 | 4. | 1. | 0.01 | • | • | • | HYDROGRAPH AT | D11 | 517. | 12.48 | 195. | 83. | 57. | 0.28 | • |
| • | • | 2 COMBINED AT | SEC220 | 333. | 12.37 | 107. | 43. | 0.18 | • | • | • | 2 COMBINED AT | SEC10 | 941. | 12.48 | 360. | 153. | 105. | 0.51 | • |
| • | • | ROUTED TO | SEC310 | 327. | 12.37 | 107. | 43. | 0.18 | 192.10 | 12.37 | • | • | • | • | • | • | • | • | • | • |
| • | • | HYDROGRAPH AT | D1 | 186. | 12.25 | 53. | 22. | 0.08 | • | • | • | • | • | • | • | • | • | • | • | • |
| • | • | 2 COMBINED AT | SEC310 | 507. | 12.37 | 159. | 65. | 0.25 | • | • | • | • | • | • | • | • | • | • | • | • |
| • | • | ROUTED TO | SEC315 | 507. | 12.37 | 159. | 65. | 0.25 | 91.96 | 12.37 | • | • | • | • | • | • | • | • | • | • |
| • | • | ROUTED TO | SEC340 | 507. | 12.37 | 159. | 65. | 0.25 | 92.22 | 12.37 | • | • | • | • | • | • | • | • | • | • |
| • | • | HYDROGRAPH AT | D6A | 66. | 12.48 | 25. | 10. | 0.04 | • | • | • | • | • | • | • | • | • | • | • | • |
| • | • | 2 COMBINED AT | SEC340 | 567. | 12.37 | 184. | 76. | 0.29 | • | • | • | • | • | • | • | • | • | • | • | • |
| • | • | 2 COMBINED AT | SEC350 | 1679. | 12.48 | 637. | 244. | 0.98 | • | • | • | • | • | • | • | • | • | • | • | • |
| • | • | ROUTED TO | SEC355 | 1700. | 12.48 | 637. | 244. | 0.98 | 89.73 | 12.48 | • | • | • | • | • | • | • | • | • | • |
| • | • | ROUTED TO | SEC360 | 1711. | 12.48 | 637. | 244. | 0.98 | 82.67 | 12.48 | • | • | • | • | • | • | • | • | • | • |
| • | • | HYDROGRAPH AT | D7 | 266. | 12.48 | 109. | 46. | 0.16 | • | • | • | • | • | • | • | • | • | • | • | • |
| • | • | 2 COMBINED AT | SEC360 | 1997. | 12.48 | 745. | 310. | 1.13 | • | • | • | • | • | • | • | • | • | • | • | • |

*** NORMAL END OF REC-1 ***



```
.....
FLOOD HYDROGRAPH PACKAGE (HEC-1)
JUN 09 1992
VERSION 4.0.3E
RUN DATE 05/14/78 TIME 10:45:58
.....
```

```
.....
U.S. ARMY CORPS OF ENGINEERS
HYDROLOGIC ENGINEERING CENTER
609 SECOND STREET
DAVIS, CALIFORNIA 95616
(916) 551-1748
.....
```

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X X XXXXXX XXXXX X
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X X X XXXXXX XXXXX
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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1DS, HEC1DR, AND HEC1DV.
THE DEFINITIONS OF VARIABLES 'RTIMP' AND 'RTION' HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF 'WSEK' ON HEC-CAD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTYSEVENTH VERSION
NEW OPTIONS: DRAINAGE OUTFLOW SUBMERGENCE, SINGLE EVENT DAMAGE CALCULATION, DESIRED STAGE FREQUENCY,
DESIRED TIME SERIES AT DESIRED CALCULATION INTERVAL, LOSS RATE:GREEN AND AMPT INFILTRATION
SCHEMATIC CURVE: NEW FINITE DIFFERENCE ALGORITHM

```
.....
U.S. ARMY CORPS OF ENGINEERS
HYDROLOGIC ENGINEERING CENTER
609 SECOND STREET
DAVIS, CALIFORNIA 95616
(916) 551-1748
.....
```

```
.....
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 RESO1
32 SECS
(***). RUMOFF ALSO COMPUTED AT THIS LOCATION
FLOOD HYDROGRAPH PACKAGE (HEC-1)
JUN 09 1992
VERSION 4.0.3E
RUN DATE 05/14/78 TIME 10:45:58
.....
```

```
.....
EAST KAPOLEI FLOOD (100-YEAR STORM)
PRE: HEC1Z.DAT
PROJECT CONDITIONS: EAST KAPOLEI - DEVELOPED CONDITIONS
FLOW TO KAPOLEI AND VARONA (SP COMP. BASIN)
KAL01 - HAWAIIAN NETWORK MODEL
.....
```

| LINE | ID | HEC-1 INPUT | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------|-------|---|---|---|---|---|---|---|---|---|---|----|
| 1 | ID | EAST KAPOLEI FLOOD (100-YEAR STORM) | | | | | | | | | | |
| 2 | ID | PRE: HEC1Z.DAT | | | | | | | | | | |
| 3 | ID | PROJECT CONDITIONS: EAST KAPOLEI - DEVELOPED CONDITIONS | | | | | | | | | | |
| 4 | ID | FLOW TO KAPOLEI AND VARONA (SP COMP. BASIN) | | | | | | | | | | |
| 5 | ID | KAL01 - HAWAIIAN NETWORK MODEL | | | | | | | | | | |
| 6 | ID | DIAGRAM 5 14MAY78 1200 300 | | | | | | | | | | |
| 7 | ID | | | | | | | | | | | |
| 8 | KAP | GENERATE HYDROGRAPH FROM SUBBASIN KAP TO SECT | | | | | | | | | | |
| 9 | EN | UPPERMOST WATERSHED PRECIPITATION DATA | | | | | | | | | | |
| 10 | EN | | | | | | | | | | | |
| 11 | EN | | | | | | | | | | | |
| 12 | EN | | | | | | | | | | | |
| 13 | EN | | | | | | | | | | | |
| 14 | EN | | | | | | | | | | | |
| 15 | EN | | | | | | | | | | | |
| 16 | VAR | GENERATE HYDROGRAPH FROM SUBBASIN VAR TO SECT | | | | | | | | | | |
| 17 | EN | UPPERMOST WATERSHED PRECIPITATION DATA | | | | | | | | | | |
| 18 | EN | | | | | | | | | | | |
| 19 | EN | | | | | | | | | | | |
| 20 | EN | | | | | | | | | | | |
| 21 | EN | | | | | | | | | | | |
| 22 | EN | | | | | | | | | | | |
| 23 | EN | | | | | | | | | | | |
| 24 | RESO1 | ROUTE VAR THROUGH RESO1 | | | | | | | | | | |
| 25 | EN | SPORTS COMPLEX SUMP - NO OUTLET | | | | | | | | | | |
| 26 | EN | | | | | | | | | | | |
| 27 | EN | | | | | | | | | | | |
| 28 | EN | | | | | | | | | | | |
| 29 | EN | | | | | | | | | | | |
| 30 | EN | | | | | | | | | | | |
| 31 | EN | | | | | | | | | | | |
| 32 | SECS | | | | | | | | | | | |
| 33 | EN | | | | | | | | | | | |
| 34 | EN | | | | | | | | | | | |
| 35 | EN | | | | | | | | | | | |

```
.....
OUTPUT CONTROL VARIABLES
IPRINT 5 PRINT CONTROL
IPLOT 0 PLOT CONTROL
ISCAL 0 HYDROGRAPH PLOT SCALE
.....
HYDROGRAPH TIME DATA 5 MINUTES IN COMPUTATION INTERVAL
IDATE 14MAY78 STARTING DATE
ITIME 1200 STARTING TIME
IPI 300 NUMBER OF HYDROGRAPH ORDINATES
IWDATE 15MAY78 ENDING DATE
IWDTIME 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 KC
.....
11 KO OUTPUT CONTROL VARIABLES 3 PRINT CONTROL
.....
```

PILOT CONTROL
0. HYDROGRAPH PLOT SCALE

SUBBASIN RUNOFF DATA

SUBBASIN CHARACTERISTICS
TIMEA 0.10 SUBBASIN AREA

PRECIPITATION DATA

DEPKS FOR 0-PERCENT HYPOTHEMETICAL STORM
..... 1P-40 1P-49
5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 48-HR 72-HR 96-HR 192-HR
0.65 1.32 2.45 4.60 6.75 9.20 12.30 0.00 0.00 0.00 0.00 0.00

SCS LOSS RATE
STRIAL 0.17 INITIAL ABSTRACTION
CMBR 92.00 CURVE NUMBER
RTIMP 0.00 PERCENT IMPERVIOUS AREA
STORM AREA = 0.10

SCS DIMENSIONLESS UNITGRAPH
TLAG 0.45 LAG

UNIT HYDROGRAPH
29 END-OF-PERIOD ORIGINATES
7. 22. 66. 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. 0.

HYDROGRAPH AT STATION KAP
TOTAL RAINFALL = 12.30, TOTAL LOSS = 0.99, TOTAL EXCESS = 11.31

PEAK FLOW TIME
(CFS) (HR) 6-HR 24-HR 72-HR 24-92-HR
* 185. 12.50 60. 29. 28. 28.
(INCHES) 6.565 11.304 11.304 11.304
(AC-FT) 34. 58. 58. 58.
CUMULATIVE AREA = 0.10 SQ MI

OUTPUT CONTROL VARIABLES
PRINT CONTROL
PILOT CONTROL
0. HYDROGRAPH PLOT SCALE

SUBBASIN RUNOFF DATA
SUBBASIN CHARACTERISTICS
TIMEA 0.09 SUBBASIN AREA

PRECIPITATION DATA

DEPKS FOR 0-PERCENT HYPOTHEMETICAL STORM
..... 1P-40 1P-49
5-MIN 15-MIN 60-MIN 2-HR 3-HR 6-HR 12-HR 24-HR 48-HR 72-HR 96-HR 192-HR
0.65 1.32 2.45 4.60 6.75 9.20 12.30 0.00 0.00 0.00 0.00 0.00

STORM AREA = 0.09

SCS LOSS RATE
STRIAL 0.17 INITIAL ABSTRACTION
CMBR 92.00 CURVE NUMBER
RTIMP 0.00 PERCENT IMPERVIOUS AREA

SCS DIMENSIONLESS UNITGRAPH
TLAG 0.22 LAG

UNIT HYDROGRAPH
15 END-OF-PERIOD ORIGINATES
32. 108. 153. 139. 1. 1. 0.
6. 3. 2. 1. 0. 0.

HYDROGRAPH AT STATION VAR
TOTAL RAINFALL = 12.30, TOTAL LOSS = 0.99, TOTAL EXCESS = 11.31

PEAK FLOW TIME
(CFS) (HR) 6-HR 24-HR 72-HR 24-92-HR
* 222. 12.25 60. 26. 25. 25.
(INCHES) 6.565 11.313 11.313 11.313
(AC-FT) 30. 51. 51. 51.
CUMULATIVE AREA = 0.09 SQ MI

OUTPUT CONTROL VARIABLES
PRINT CONTROL
PILOT CONTROL
0. HYDROGRAPH PLOT SCALE

HYDROGRAPH ROUTING DATA

STORAGE ROUTING
NUMBER OF SUBREACHES
ELEV TIME OF INITIAL CONDITION
43.00 INITIAL CONDITION
0.00 WORKING R AND D COEFFICIENT

STORAGE ELEVATION 43.00 44.00 45.00 46.00 47.00 48.00 49.00 50.00 51.00
ELEVATION 43.00 44.00 45.00 46.00 47.00 48.00 49.00 50.00 51.00
SPILLWAY CREST ELEVATION 50.00
SPILLWAY WIDTH 400.00
WEIR COEFFICIENT 3.00
EXPONENT OF HEAD 1.50

COMPUTED OUTFLOW-ELEVATION DATA

OUTFLOW ELEVATION 0.00 0.00 0.21 1.65 5.56 13.17 25.72 44.44 70.58 105.35
OUTFLOW ELEVATION 43.00 50.00 50.00 50.01 50.03 50.05 50.08 50.11 50.15 50.20
OUTFLOW ELEVATION 150.00 205.76 273.87 355.56 452.04 564.61 694.44 842.80 1010.91 1200.00
OUTFLOW 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
OUTFLOW
ELEVATION | 0.00
0.00
43.00 | 0.97
0.00
44.00 | 2.80
0.00
45.00 | 6.12
0.00
46.00 | 11.00
0.00
47.00 | 17.47
0.00
48.00 | 25.29
0.00
49.00 | 35.74
0.00
50.00 | 35.79
1.65
50.01 | 35.86
5.56
50.03 |
|---------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| STORAGE | 35.95 | 36.07 | 36.21 | 36.38 | 36.58 | 36.81 | 37.05 | 37.33 | 37.63 | 37.96 |
| OUTFLOW | 15.17 | 25.72 | 44.44 | 70.58 | 105.35 | 150.00 | 205.74 | 273.87 | 355.55 | 452.06 |
| ELEVATION | 50.95 | 50.98 | 50.11 | 50.15 | 50.20 | 50.25 | 50.31 | 50.37 | 50.44 | 50.52 |
| STORAGE | 38.32 | 38.70 | 39.11 | 39.55 | 40.00 | | | | | |
| OUTFLOW | 564.43 | 696.44 | 842.00 | 1010.91 | 1200.00 | | | | | |
| ELEVATION | 50.60 | 50.69 | 50.79 | 50.89 | 51.00 | | | | | |

*** WARNING *** MODIFIED PEAK ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN 35% TO 120%
 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 RE001

| PEAK FLOW
(CFS) | 37. | 16.75 |
|--------------------|-------|-------|
| TIME (HR) | 22. | 8. |
| (INCHES) | 2.421 | 3.421 |
| (AC-FT) | 11. | 16. |
| PEAK STORAGE TIME | 6-HR | 24-HR |
| (AC-FT) | 36. | 21. |
| TIME | 16.75 | 21. |
| PEAK STAGE TIME | 6-HR | 24-HR |
| (FEET) | 50.07 | 47.83 |
| 50.10 | 16.75 | 47.65 |

CUMULATIVE AREA = 0.09 SQ MI

| OPERATION | STATION | PEAK FLOW | TIME OF PEAK | RURCEFF SUMMARY | | | BASIN AREA | MAXIMUM STAGE | TIME OF MAX STAGE |
|---------------|---------|-----------|--------------|-------------------------------|-------------------------------------|---------------------------------|------------|---------------|-------------------|
| | | | | FLOW IN CUBIC FEET PER SECOND | TIME IN HOURS, AREA IN SQUARE MILES | AVERAGE FLOW FOR MAXIMUM PERIOD | | | |
| HYDROGRAPH AT | REP | 183. | 12.50 | 68. | 29. | 28. | 0.10 | | |
| HYDROGRAPH AT | VAR | 222. | 12.25 | 60. | 26. | 25. | 0.09 | | |
| ROUTED TO | RE001 | 37. | 16.75 | 22. | 8. | 8. | 0.09 | 16.75 | |
| 2 COMBINED AT | SECS | 183. | 12.50 | 77. | 37. | 36. | 0.18 | | |

*** NORMAL END OF REC-1 ***

32 KK * SECS *

33 NO OUTPUT CONTROL VARIABLES
 IPRT 3 PRINT CONTROL
 IPLOT 0 PLOT CONTROL
 OSCAL 0. HYDROGRAPH PLOT SCALE

34 NC HYDROGRAPH COMBINATION 2 NUMBER OF HYDROGRAPHS TO COMBINE
 ICOMP ***

4402 NPLAN,NSIM 1 0

| PEAK FLOW
(CFS) | 183. |
|--------------------|------------|
| TIME (HR) | 12.50 |
| (INCHES) | 3.960 |
| (AC-FT) | 38. |
| CUMULATIVE AREA = | 0.18 SQ MI |

.....
 * FLOOD HYDROGRAPH PACKAGE (REC-1) *
 * JAN 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 XXXXXX XXXX X
 X X X X X X X X
 XXXXXX XXXX X
 X X X X X X X X
 X X X X X X X X
 X X XXXXXX XXXX XXX

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF REC-1 KNOWN AS REC1 (JUN 73), REC1G, REC1DB, AND REC1D.
 THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIMP- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
 THE DEFINITION OF -AMSK- ON IN-CAO WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTNIGHTLY VERSION.
 NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE, SINGLE EVENT DAMAGE CALCULATION, ASSISTIVE STAGE FREQUENCY,
 DISSEMINATION TIME SERIES AT DESIRED CALCULATION INTERVAL, LOSS WATERGAIN AND DAMP INFILTRATION
 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

```

LINE  ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
1  ID EAST KAPOLEI FLOOD (100-YEAR STORM)
2  FN: REVIB.DAT
3  ID PROJECT CONDITIONS: EAST KAPOLEI - DEVELOPED CONDITIONS
4  ID FLOW TO WEST LOCH
5  ID KALO1 - MAINEARNE NETWORK MODEL
6  ID 6 27JAN97 1200 300
7  ID 5
8  KX AZ7
9  KX GENERATE HYDROGRAPH FROM SUBBASIN AZ7 TO SECT
10  KX
11  KX UPPERMOST WATERSHED PRECIPITATION DATA
12  BA 0.939
13  PK 0
14  LS .64 1.30 2.45 3.50 4.55 6.70 9.10 12.30
15  LD 2.174
16  KX S19
17  KX GENERATE HYDROGRAPH FROM SUBBASIN S19 TO SECT
18  KX
19  KX UPPERMOST WATERSHED PRECIPITATION DATA
20  BA 0.119
21  PK 0
22  LS .65 1.32 2.45 3.55 4.60 6.75 9.2 12.30
23  LD 2.174
24  KX S20
25  KX GENERATE HYDROGRAPH FROM SUBBASIN S20 TO SECT
26  KX
27  KX UPPERMOST WATERSHED PRECIPITATION DATA
28  BA 0.053
29  PK 0
30  LS .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
31  LD 1.595
32  KX S20
33  KX GENERATE HYDROGRAPH FROM SUBBASIN S20 TO SECT
34  KX UPPERMOST WATERSHED PRECIPITATION DATA

```

```

35  KO 3
36  BA 0.056
37  PK 0
38  LS .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
39  LD 1.019
40  KX S21
41  KX GENERATE HYDROGRAPH FROM SUBBASIN S21 TO SECT
42  KX UPPERMOST WATERSHED PRECIPITATION DATA
43  BA 3
44  PK .025
45  LS .65 1.32 2.45 3.55 4.60 6.75 9.2 12.3
46  LD 0.627
47
48  ZI

```

SCHEMATIC DIAGRAM OF STREAM NETWORK
 (V) ROUTING (->->) DIVERSION OR PUMP FLOW
 (.) CONNECTOR (->->) RETURN OF DIVERTED OR PUMPED FLOW

```

NO.  (.) CONNECTOR (->->) RETURN OF DIVERTED OR PUMPED FLOW
0  AZ7
16  . 818
24  . 819
32  . 820
40  . 821

```

.....
 * U.S. ARMY CORPS OF ENGINEERS *
 * HYDROLOGIC ENGINEERING CENTER *
 * 609 SECOND STREET *
 * DAVIS, CALIFORNIA 95616 *
 * (916) 551-1748 *
 *

7 10 OUTPUT CONTROL VARIABLES
 IPART 5 PRINT CONTROL
 IPLOT 0 PLOT CONTROL
 BECAL 0. HYDROGRAPH PLOT SCALE

11 HYDROGRAPH TIME DATA
 MMIN 6 MINUTES IN COMPUTATION INTERVAL
 IDATE 27JAN97 STARTING DATE
 ITIME 1200 STARTING TIME
 NQ 300 NUMBER OF HYDROGRAPH ORDINATES
 MDATE 28JAN97 ENDING DATE
 MTIME 1754 ENDING TIME
 ICEBT 19 CENTURY MARK

COMPUTATION INTERVAL 0.10 HOURS
 TOTAL TIME RATE 29.90 HOURS
 ENGLISH UNITS
 DRAINAGE AREA SQUARE MILES
 PRECIPITATION DEPTH INCHES

LENGTH, ELEVATION FEET
FLOW CUBIC FEET PER SECOND
STORAGE VOLUME ACRES-FEET
SURFACE AREA ACRES
TEMPERATURE DEGREES FAHRENHEIT

.....
16 KK
.....

.....
8 KK
.....

.....
19 KO
.....

.....
11 KO
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.....
20 BA
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12 BA
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21 PH
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13 PH
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22 LS
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14 LS
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23 LD
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15 LD
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23 LD
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.....
TOTAL RAINFALL = 12.78, TOTAL LOSS = 1.24, TOTAL EXCESS = 11.04
PEAK FLOW TIME (CFS) (MG) (INCHES) (AC-FT) CUMULATIVE AREA = 0.94 SQ MI

.....
TOTAL RAINFALL = 12.30, TOTAL LOSS = 1.24, TOTAL EXCESS = 11.06
PEAK FLOW TIME (CFS) (MG) (INCHES) (AC-FT) CUMULATIVE AREA = 0.12 SQ MI

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HYDROGRAPH AT STATION A27
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HYDROGRAPH AT STATION S18
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* S1P *
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24 KK

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* S1P *
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27 KO

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* S1P *
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28 BA

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* S1P *
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29 PH

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* S1P *
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30 LS

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* S1P *
.....

31 UD

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* S1P *
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32 KK

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* S1P *
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* S1P *
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33 LS

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* S1P *
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34 UD

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* S1P *
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35 KO

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36 BA

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37 PH

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38 LS

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39 UD

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40 KK

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43 KO

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44 BA

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45 PH

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45 PH

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46 BA

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47 PH

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48 LS

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49 UD

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50 KK

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51 KO

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52 BA

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53 PH

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54 LS

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55 UD

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56 KK

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57 KO

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58 BA

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59 PH

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60 LS

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61 UD

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62 KK

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63 KO

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64 BA

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65 PH

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66 LS

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67 UD

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68 KK

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69 KO

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70 BA

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71 PH

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72 LS

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73 UD

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74 KK

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75 KO

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76 BA

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77 PH

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78 LS

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79 UD

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80 KK

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81 KO

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* S1P *
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82 BA

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83 PH

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84 LS

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* S1P *
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85 UD

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* S1P *
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86 KK

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* S1P *
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87 KO

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* S1P *
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88 BA

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* S1P *
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89 PH

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* S1P *
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90 LS

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* S1P *
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***** HEC-2 ***** TP-40 ***** TP-49 *****
 5-MIN 15-MIN 60-MIN 2-HR 4-HR 12-HR 24-HR 4-DAY 7-DAY 10-DAY
 0.65 1.32 2.43 3.55 4.60 6.75 9.20 12.30 0.00 0.00 0.00 0.00

SCS LOSS RATE 0.25 INITIAL ABSTRACTION
 STRAL 69.00 CURVE NUMBER
 CVOBR 0.00 PERCENT IMPERVIOUS AREA
 RTIMP
 SCS DIMENSIONLESS UNITGRAPH 0.65 LAG
 TLAG

UNIT HYDROGRAPH
 33 END-OF-PERIOD COORDINATES
 1. 3. 7. 11. 15. 19. 23. 27. 31. 35.
 10. 7. 6. 5. 4. 3. 2. 1. 0. 0.
 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 6-HR 24-HR 72-HR 29.90-HR
 (CFS) (HR) (CFS) (HR)
 * 39. 12.70 17. 7. 6. 6.
 (INCHES) 6.631 10.927 10.931 10.931
 (AC-FT) 9. 15. 15. 15.
 CUMULATIVE AREA = 0.03 SQ MI

| OPERATION | STATION | PEAK FLOW | TIME OF PEAK | RUNOFF SUMMARY | | | BASIN AREA | MAXIMUM STAGE | TIME OF MAX STAGE |
|---------------|---------|-----------|--------------|----------------|--------|---------|------------|---------------|-------------------|
| | | | | AVERAGE FLOW | 6-HOUR | 24-HOUR | | | |
| HYDROGRAPH AT | A27 | 635. | 16.40 | 611. | 277. | 226. | 0.94 | | |
| HYDROGRAPH AT | S18 | 107. | 16.40 | 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 REC-1 ***

APPENDIX C
 REGIONAL DRAINAGE SYSTEM HYDRAULIC SIZING

- ▶ HEC-2 Computations
- ▶ Kaloj 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

```

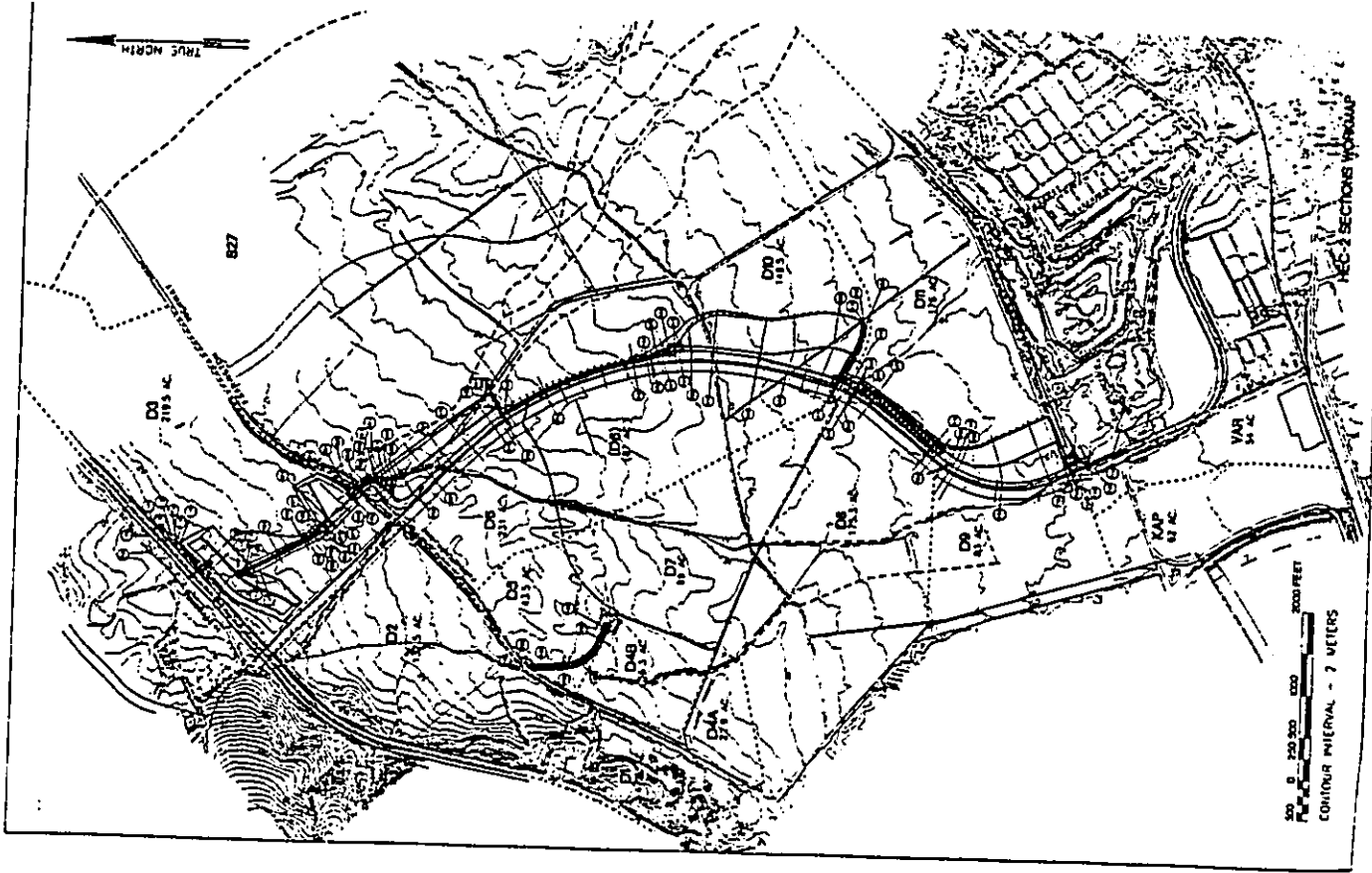
X X XXXX XXXX XXXX XX XXX
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```

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:
 Kalo Channel Realignment - Eas, Oahu, Hawaii
 Kalo Channel Realignment -
 Lower Basin & HGI

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 Multiple Openings = 0
 Culverts = 4 In-line Weirs = 0
 Bridges = 4

Computational Information
 Water surface calculation tolerance = 0.01
 Critical depth calculation tolerance = 0.01
 Maximum number of iterations = 20
 Maximum difference tolerance = 0.5
 Flow tolerance factor = 0.001

Computational Flow Regime: Mixed Flow



KALOI CHANNEL IMPROVEMENTS - PLATE 6 FLOOD PROFILE
 SECTIONS 140 TO 730 FROM ENA VILLAGES DRAINAGE MASTER PLAN, Rev. 3/777
 SUMMARY OF CROSS SECTIONS

| | |
|-------|---|
| C 114 | CENTRE SUBDIVISION (0+8000) |
| C 115 | DOWNSTR. FACE OF BRIDGE AT ORL ROW |
| C 116 | DOWNSTR. FACE OF BRIDGE AT ORL ROW |
| C 117 | UPSTR. FACE OF BRIDGE AT ORL ROW |
| C 118 | UPSTR. FACE OF BRIDGE AT ORL ROW (CHANNEL) |
| C 119 | CHANNEL SECTION |
| C 120 | SECTION LEFT TRANSITION FROM CONC TO COR RIGHT C&M (0+8500) |
| C 121 | SECTION LEFT CONC RIGHT FROM CONC TO C&M |
| C 122 | SECTION LEFT FROM CONC TO C&M RIGHT CONC |
| C 123 | SECTION LEFT C&M RIGHT CONC TO C&M |
| C 124 | SECTION COR LEFT AND RIGHT |
| C 125 | SECTION CHANNEL WIDEST POINT C&M LEFT AND RIGHT |
| C 126 | DOWNSTR. FACE OF BRIDGE AT R-S ROAD (CHANNEL) |
| C 127 | DOWNSTR. FACE OF BRIDGE AT R-S ROAD |
| C 128 | UPSTR. FACE OF BRIDGE AT R-S ROAD (CHANNEL) |
| C 129 | UPSTR. FACE OF BRIDGE AT R-S ROAD |
| C 130 | DOWNSTR. FACE OF BRIDGE AT RERTON ROAD (CHANNEL) |
| C 131 | DOWNSTR. FACE OF BRIDGE AT RERTON ROAD (0+8550) |
| C 132 | UPSTR. FACE OF BRIDGE AT RERTON ROAD |
| C 133 | UPSTR. FACE OF BRIDGE AT RERTON ROAD (GOLF COURSE) |
| C 134 | GOLF COURSE CHANNEL |
| C 135 | GOLF COURSE CHANNEL |
| C 136 | BASIN #4 CULVERT OUTLET |
| C 137 | BASIN #4 CULVERT INLET |
| C 138 | GOLF COURSE CHANNEL |
| C 139 | GOLF COURSE CHANNEL |
| C 140 | #4 TA |
| C 141 | GOLF COURSE CHANNEL |
| C 142 | GOLF COURSE CHANNEL |
| C 143 | BASIN #3 CULVERT OUTLET |
| C 144 | BASIN #3 CULVERT INLET |
| C 145 | GOLF COURSE CHANNEL |
| C 146 | GOLF COURSE CHANNEL |
| C 147 | GOLF COURSE CHANNEL (0+8000) |
| C 148 | GOLF COURSE CHANNEL (0+7700) |
| C 149 | GOLF COURSE CHANNEL |
| C 150 | GOLF COURSE CHANNEL |
| C 151 | GOLF COURSE CHANNEL |
| C 152 | GOLF COURSE CHANNEL |
| C 153 | GOLF COURSE CHANNEL |
| C 154 | GOLF COURSE CHANNEL |
| C 155 | #4 GREEN |
| C 156 | GOLF COURSE CHANNEL (0+7600) |
| C 157 | BASIN #2 CULVERT OUTLET |
| C 158 | BASIN #2 CULVERT INLET |
| C 159 | #5 TA |
| C 160 | #6 GREEN |
| C 161 | GOLF COURSE CHANNEL |
| C 162 | GOLF COURSE CHANNEL |
| C 163 | #6 TB |
| C 164 | BASIN #1 CULVERT OUTLET (0+7550) |
| C 165 | BASIN #1 CULVERT INLET |
| C 166 | #5 GREEN |
| C 167 | GOLF COURSE CHANNEL |
| C 168 | DRIVING RANGE TB |
| C 169 | GOLF COURSE CHANNEL (0+7400) |
| C 170 | GOLF COURSE CHANNEL |
| C 171 | DOWNSTREAM OF BRIDGE AT CURVE "A" |
| C 172 | UPSTREAM OF BRIDGE AT CURVE "A" |
| C 173 | C&M CHANNEL SECTION |
| C 174 | SECTION AT BOTTOM OF BEEM |
| C 175 | SECTION TOP OF BEEM |
| C 176 | SECTION AT FULL WIDTH CHANNEL W/ 2.5% PARK |
| C 177 | SECTION AT FULL WIDTH CHANNEL W/ 2.5% PARK |
| C 178 | TRANSITION CHANNEL SECTION |

| | |
|--------|--|
| C 790 | TRANSITION CHANNEL SECTION |
| C 800 | CHANNEL SECTION TO POND |
| C 810 | END C&M CHANNEL SECTION |
| C 820 | C&M CHANNEL SECTION |
| C 830 | DOWNSTREAM FACE OF BRIDGE |
| C 840 | UPSTREAM FACE OF BRIDGE |
| C 850 | SECTION THROUGH C&M |
| C 855 | SECTION AT BOTTOM OF BEEM, C&M |
| C 860 | SECTION AT TOP OF BEEM, C&M |
| C 870 | SECTION THROUGH WIDEST POND SECTION W/ 2.5% PARK (0+6150) |
| C 880 | SECTION THROUGH TYPICAL CHANNEL SECTION W/ 2.5% PARK |
| C 890 | SECTION THROUGH CHANNEL SECTION W/ 2.5% PARK |
| C 900 | CHANNEL SECTION THROUGH 2.5% PARK |
| C 910 | CHANNEL SECTION THROUGH 2.5% PARK |
| C 920 | TYPICAL CHANNEL SECTION, C&M |
| C 930 | TYPICAL CHANNEL SECTION, C&M |
| C 940 | END NARROW C&M SECTION |
| C 950 | SECTION NARROW C&M CHANNEL |
| C 960 | BEGIN NARROW C&M SECTION (BOTTOM OF BEEM) (0+6000) |
| C 970 | TOP OF BEEM (RESERVOIR 3) |
| C 980 | SECTION TRANSITION FROM PARK SECTION TO NARROW C&M SECTION |
| C 990 | TYPICAL PARK SECTION, END C&M |
| C 1000 | TYPICAL PARK SECTION AT BOTTOM OF BEEM |
| C 1010 | TYPICAL PARK SECTION AT TOP OF BEEM, BEGIN C&M |
| C 1020 | TYPICAL PARK SECTION |
| C 1030 | BEGIN TYPICAL PARK SECTION |
| C 1040 | SECTION THROUGH POND AND PARK |
| C 1050 | SECTION THROUGH POND AND PARK |
| C 1060 | SECTION THROUGH WIDEST PART OF POND AND PARK |
| C 1070 | SECTION END C&M |
| C 1080 | TYPICAL CHANNEL SECTION, C&M |
| C 1090 | DOWNSTREAM FACE OF BRIDGE (0+5900) |
| C 1100 | SECTION AT BOTTOM OF BEEM |
| C 1110 | SECTION AT TOP OF BEEM |
| C 1120 | SECTION THROUGH POND |
| C 1130 | SECTION THROUGH C&M SECTION |
| C 1140 | SECTION THROUGH TYPICAL C&M SECTION |
| C 1150 | SECTION THROUGH TYPICAL C&M SECTION |
| C 1160 | SECTION THROUGH BOTTOM OF BEEM |
| C 1170 | SECTION THROUGH PARK SECTION, TOP OF BEEM |
| C 1180 | SECTION THROUGH PARK SECTION |
| C 1190 | SECTION THROUGH C&M CHANNEL |
| C 1200 | SECTION THROUGH C&M CHANNEL |
| C 1210 | SECTION AT DOWNSTREAM FACE OF DUL 12412 BOX |
| C 1220 | SECTION AT UPSTREAM FACE OF DUL 12412 BOX |
| C 1230 | SECTION ABOVE INT |

FLOW DATA
 Flow Title: Imported Flow 01
 Flow file : c:\hvc\res\vanstap2.f01

Flow Data (cfs)

| Reach | RS | PIFI |
|-------|------|------|
| 1 | 1160 | 5300 |
| 1 | 1135 | 5900 |
| 1 | 1045 | 5900 |
| 1 | 1020 | 6000 |
| 1 | 960 | 6000 |
| 1 | 950 | 6000 |
| 1 | 945 | 7400 |
| 1 | 870 | 7550 |
| 1 | 680 | 7600 |
| 1 | 630 | 7700 |
| 1 | 550 | 8000 |
| 1 | 470 | 8350 |
| 1 | 460 | 8500 |
| 1 | 310 | 8500 |
| 1 | 190 | 8600 |

Boundary Conditions

| River | Reach | Profile | Upstream | Downstream |
|-------|-------|---------|----------|-----------------|
| 1 | 1 | PIFI | Critical | Known US = 33.0 |

GEOMETRY DATA
 Geometry Title: Imported Geom 01
 Geometry File : c:\hvc\res\vanstap2.g01

CROSS SECTION RIVER: 1
 REACH: 1

INPUT Description: 1160 ABOVE N-1 FREEWAY
 Station Elevation Data num 10
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 28.48 218.54 273.83 209.97 466.78 203.41 490.34 200.70 528.02 203.41
 580.67 205.05 659.86 207.5 738.59 209.97 952.59 211.61 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.
 273.83 738.59 149 185 241 .1 .3

CROSS SECTION RIVER: 1
 REACH: 1

INPUT Description: 1150 UPSTREAM FACE OF DUL 12N12 CULV
 Station Elevation Data num 10
 Sta Elev 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 REACH: 1 RIVER: 1
 RS: 1165

INPUT Description: Bridge # 11

Distance from Upstream XS = 0
 Deck/Roadway Width = 131.82
 Weir Coefficient = 2.6
 Bridge Deck/Roadway Stew =
 Upstream Deck/Roadway Coordinates num 12

Sta MI Cord Lo Cord Sta MI Cord Lo Cord Sta MI Cord Lo Cord
 75.24 209.77 209.77 526.85 206.24 659 204.84 204.84 204.84
 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 num 10
 Station Elevation Data num 10
 Sta Elev 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 MI Cord Lo Cord Sta MI Cord Lo Cord Sta MI Cord Lo Cord
 41.35 209.97 209.97 591.66 206.24 206.24 763.2 204.74 204.74
 763.21 204.74 189 763.21 204.74 201 776.39 204.74 201
 776.39 204.74 189 777.29 204.74 189 777.29 204.74 201
 790.22 204.74 201 790.22 204.74 189 790.22 204.74 204.74
 912.98 206.24 206.24 1279.54 209.97 209.97

Downstream Bridge Cross Section Data num 12
 Station Elevation Data num 12
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 41.35 209.97 591.66 206.24 763.2 204.74 763.21 189 776.29 189
 776.3 189 777.28 189 777.29 189 790.22 189 790.22 204.74

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 E Elev Sta E 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 side-slope 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 height 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: 1160

INPUT Description: 1160 DOWNSTREAM FACE OF DBL. 12X12 CURV num= 12
 Station Elevation Data num= 12
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 41.35 209.97 591.66 206.26 763.2 204.74 763.21 189 776.29 189
 776.3 189 777.28 189 777.29 189 790.22 189 790.23 204.74
 912.98 206.26 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 Length: Left Channel Right Coeff Contr. Expan.
 763.2 790.23 25.4 25.4 25.4 25.4 .3 .5

Ineffective Elev num= 2
 Sta L Elev 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 CBM CHANNEL AT TOP SLOPE num= 6
 Station Elevation Data num= 6
 Sta Elev Sta Elev Sta Elev Sta Elev
 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 Length: Left Channel Right Coeff Contr. Expan.
 73.36 191.92 25.4 25.4 25.4 25.4 .2 .4

CROSS SECTION RIVER: 1
 REACH: 1 RS: 1134

INPUT Description: 1134 CBM MID-SLOPE num= 6
 Station Elevation Data num= 6
 Sta Elev Sta Elev Sta Elev Sta Elev
 200.13 22.96 186.65 22.96 183.72 56.96 183.72 56.96 186.65
 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 Length: Left Channel Right Coeff Contr. Expan.
 79.92 183.72 50.8 50.8 50.8 50.8 .1 .3

CROSS SECTION RIVER: 1
 REACH: 1 RS: 1132

INPUT Description: 1132 CBM MID-SLOPE num= 6
 Station Elevation Data num= 6
 Sta Elev Sta Elev Sta Elev Sta Elev
 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 Length: Left Channel Right Coeff Contr. Expan.
 112.74 177.16 56.75 56.75 56.75 56.75 .1 .3

CROSS SECTION RIVER: 1
 REACH: 1 RS: 1130

INPUT Description: 1130 BOTTOM SLOPE INTO BASIN 1 num= 4
 Station Elevation Data num= 4
 Sta Elev Sta Elev Sta Elev Sta Elev
 400 190 440 170 474 170 516 190

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 400 .025 400 .025 516 .025

Bank Sta: Left Right Length: Left Channel Right Coeff Contr. Expan.
 400 516 20 20 20 20 .1 .3

CROSS SECTION RIVER: 1
 REACH: 1 RS: 1125

INPUT Description: 1125 RETARD BOTTOM SLOPE BASIN 1 num= 4
 Station Elevation Data num= 4
 Sta Elev Sta Elev Sta Elev Sta Elev
 0 190 40 170 105 170 165 190

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .035 0 .035 165 .035

Bank Sta: Left Right Length: Left Channel Right Coeff Contr. Expan.
 0 165 500 108 20 20 .1 .3

CROSS SECTION RIVER: 1
 REACH: 1 RS: 1120

INPUT Description: 1120 TYPICAL SECTION BASIN 1 num= 9
 Station Elevation Data num= 9
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 190 2 189 182 180 175 202 170
 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 Length: Left Channel Right Coeff Contr. Expan.
 182 384 240 240 240 240 .1 .3

CROSS SECTION RIVER: 1
 REACH: 1 RS: 1119

INPUT Description: 1119 BASIN 1 SECTION num= 5
 Station Elevation Data num= 5
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 189 180 180 200 170 362 170 426.82 203.4

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .035 180 .035 426.82 .035

Bank Sta: Left Right Length: Left Channel Right Coeff Contr. Expan.
 180 426.82 30 118 350 350 .1 .3

CROSS SECTION RIVER: 1
 REACH: 1 RS: 1117

INPUT Description: 1117 BASIN 1 CHANNEL SECTION num= 6
 Station Elevation Data num= 6
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 419.47 185.36 187 164 181.26 187.28 169.62 207.28 169.62 228.04 180

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 Length: Left Channel Right Coeff Contr. Expan.
 164 228.04 85 85 85 85 .1 .3

CROSS SECTION RIVER: 1
 REACH: 1 RS: 1115

INPUT Description: 1115 UPSTREAM BOTTOM WEIR

INPUT
 Description: 1090 CDM SECTION TOP OF SLOPE
 Station Elevation Data num
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 177 20 172 48 150 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
 CROSS SECTION RIVER: 1
 REACH: 1 RS: 1088

INPUT
 Description: 1048 CDM MID-SLOPE INTO BASIN 2
 Station Elevation Data num 4
 Sta Elev Sta Elev Sta Elev Sta Elev
 0 170.0 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
 CROSS SECTION RIVER: 1
 REACH: 1 RS: 1087

INPUT
 Description: 1087 CDM MID-SLOPE INTO BASIN 2
 Station Elevation Data num 4
 Sta Elev Sta Elev Sta Elev Sta Elev
 0 170.0 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
 CROSS SECTION RIVER: 1
 REACH: 1 RS: 1085

INPUT
 Description: 1085 CDM 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
 CROSS SECTION RIVER: 1
 REACH: 1 RS: 1084

INPUT
 Description: 1084 CDM 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 97.21 147.64 160 169
 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.
 0 160 60 60 60

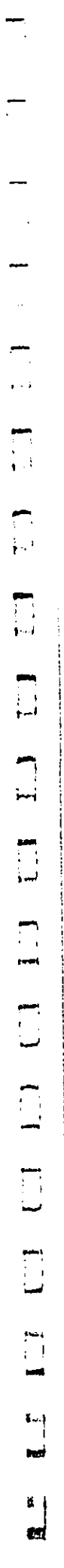
Station Elevation Data num 5
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 185.36 33.65 168.53 53.65 168.53 84.03 183.72 207 187
 Manning's n Values num 3
 Sta n Val Sta n Val Sta n Val
 0 .035 0 .025 84.03 .035
 Bank Sta: Left Right Lengths Left Channel Right Coeff Contr. Expan.
 0 84.03 10 10 10

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

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

CROSS SECTION RIVER: 1
 REACH: 1 RS: 1100
 INPUT
 Description: 1100 CDM 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

CROSS SECTION RIVER: 1
 REACH: 1 RS: 1095
 INPUT
 Description: 1095 CDM 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



576 164
 Manning's n Values
 Sta n Val Sta n Val
 0 .035 430 .025 556 .035

Bank Sta: Left Right Lengths: Left Channel Right
 430 556 10 10
 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 - CDM SLOPE
 Station Elevation Data num 6
 Sta Elev Sta Elev Sta Elev Sta Elev
 0 172.49 40 153 470 167 480 142
 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
 470 604 235 235
 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 4
 Sta Elev Sta Elev Sta Elev Sta Elev
 0 172.2 60 171.04 118 142 672 706 159
 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
 60 716.42 128 128
 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 Sta Elev
 0 157.48 28 157.48 28 150.91 50 162 120 142
 162 150.91 162 157.48 170 157.48

Manning's n Values num 3
 Sta n Val Sta n Val Sta n Val
 0 .035 28 .025 162 .035

Bank Sta: Left Right Lengths: Left Channel Right
 28 162 10 10
 Ineffective Flow num 1
 Sta L Sta R Elev
 0 142 170

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 Sta Elev
 0 157.48 30 157.48 30 157.48 80 167 80 157.48
 160 157.48

CROSS SECTION RIVER: 1
 REACH: 1 RS: 1082

INPUT Description: 1082 CDM 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
 44 44 44

CROSS SECTION RIVER: 1
 REACH: 1 RS: 1080

INPUT Description: 1080 CDM BOTTOM SLOPE BASIN 2
 Station Elevation Data num 6
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 168.96 32 153 69.73 152.55 90.66 162 170.86 142
 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
 40 20 20

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 Sta Elev
 0 169 169 8.84 164.58 32 153 83.84 150.92 101.69 162
 181.69 142 232.35 167.32

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
 100 70 70

CROSS SECTION RIVER: 1
 REACH: 1 RS: 1077

INPUT Description: 1077 UPSTREAM BOTTOM BERM - CDM SLOPE
 Station Elevation Data num 6
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 170.6 35.2 153 237.7 147.96 269.7 162 329.7 142
 360.34 167.32

Manning's n Values num 3
 Sta n Val Sta n Val Sta n Val
 0 .035 237.7 .025 360.34 .035

Bank Sta: Left Right Lengths: Left Channel Right
 100 10 10

CROSS SECTION RIVER: 1
 REACH: 1 RS: 1075

INPUT Description: 1075 TOP OF BERM BASIN 2 - CDM SLOPE
 Station Elevation Data num 6
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 172 40 153 430 167 550 167 556 160

19.68 105.76 100 76 50 .3 .5

CROSS SECTION RIVER: 1
REACH: 1
RS: 1005

INPUT Description: 1025 CHN MID-SLOPE INTO BASIN 3
Station Elevation Data num
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
0 150.92 25 138.45 25 132.87 64 132.87 84 132.87 130 155.84

Manning's n Values num
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 CHN MID-SLOPE INTO BASIN 3
Station Elevation Data num
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
0 149.28 29.5 134.5 29.5 129.25 97.1 129.25 146.97 156.2

Manning's n Values num
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 66 46 .1 .3

CROSS SECTION RIVER: 1
REACH: 1
RS: 1015

INPUT Description: 1015 CHN MID-SLOPE INTO BASIN 3
Station Elevation Data num
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
0 149.28 34.77 131.89 34.77 126.31 108.46 126.31 164.23 156.2

Manning's n Values num
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 CHN MID-SLOPE INTO BASIN 3
Station Elevation Data num
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

Manning's n Values num
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 CHN SLOPE
Station Elevation Data num
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
0 149.28 39.37 129.47 118.77 124.67 118.77 256.48 118.9

Manning's n Values num
328.56 155.84

Manning's n Values num
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
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
0 157.48 30 157.48 30 142 80 142 80 137.40

Manning's n Values num
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 CHN CHANNEL UNDER FARR. HWY
Station Elevation Data num
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

Manning's n Values num
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
Sta L Sta R Elev
62.37 66.37 160.76

CROSS SECTION RIVER: 1
REACH: 1
RS: 1035

INPUT Description: 1035 CHN CHANNEL UNDER FARR. HWY
Station Elevation Data num
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
0 160.76 62.65 139.44 65.65 139.44 69.65 139.44 92.65 139.44

Manning's n Values num
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
Sta L Sta R Elev
65.65 69.65 162.4

CROSS SECTION RIVER: 1
REACH: 1
RS: 1030

INPUT Description: 1030 CHN CHANNEL UNDER FARR. HWY
Station Elevation Data num
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
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 62.33 62.33 62.33 .1 .3

Sta n Val 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
CROSS SECTION RIVER: 1
REACH: 1 RS: 1005

INPUT
Description: 1005 BASIN 3 BOTTOM SLOPE CRN 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
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 CRN SLOPE
Station Elevation Data num 6
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
0 149.28 39.66 129.47 185.47 122.21 198.99 115.47 422.55 115.47
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 40 105 425
CROSS SECTION RIVER: 1
REACH: 1 RS: 990

INPUT
Description: 990 FULL WIDTH BASIN 3 (SX PAIR)
Station Elevation Data num 6
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
0 151.2 108.76 150.97 162.86 142.85 189.44 129.47 389.44 120.47
379.44 115.47 604.44 115.47 632.44 127.47 782.5 159.9
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
CROSS SECTION RIVER: 1
REACH: 1 RS: 985

INPUT
Description: 985 BASIN 3 SECTION (SX PAIR)
Station Elevation Data num 6
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
CROSS SECTION RIVER: 1
REACH: 1 RS: 958

REACH: 1 RS: 990
INPUT
Description: 990 BASIN 3 SECTION (SX PAIR)
Station Elevation Data num 6
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
CROSS SECTION RIVER: 1
REACH: 1 RS: 975

INPUT
Description: 975 BASIN 3 SECTION (SX PAIR)
Station Elevation Data num 6
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
0 145.9 96.99 134.00 106.25 129.47 266.25 120.47 296.25 115.47
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
CROSS SECTION RIVER: 1
REACH: 1 RS: 970

INPUT
Description: 970 BASIN 3 SECTION (SX PAIR)
Station Elevation Data num 6
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
129 139.5 149 129.47 329 129.47 339 120.47 431.5 115.47
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
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 6
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
0 137.47 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
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
0 139.47 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
Ineffective Flow num 1
Sta L Sta R Elev
0 200 139.47
CROSS SECTION RIVER: 1
REACH: 1 RS: 958

Station Elevation Data num 6 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
0 .035 0 .025 118.2 .035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
Sta 1 Sta 8 Elev num 1 10 10 10 10
90.2 118.2 136.15

CROSS SECTION RIVER: 1 RS: 957
REACH: 1

INPUT Description: 957 TOP WEIR num 4 Sta Elev Sta Elev
0 136 0 120.47 50 120.47 50 136

Manning's n Values num 3 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 10

CROSS SECTION RIVER: 1 RS: 955
REACH: 1

INPUT Description: 955 DOWNSTREAM BOTTOM WEIR num 7 Sta Elev Sta Elev Sta Elev Sta Elev
0 136 120 134 120 120.47 130 115.47 160 115.47
170 120.47 170 134

Manning's n Values num 3 Sta n Val Sta n Val
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

CROSS SECTION RIVER: 1 RS: 950
REACH: 1

INPUT Description: 950 CEM CHANNEL JUST BELOW WEIR num 4 Sta Elev Sta Elev Sta Elev
0 136.15 40.5 116.83 70.5 116.83 121.00 136.43

Manning's n Values num 3 Sta n Val Sta n Val
0 .035 0 .025 121.00 .035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
0 121.00 526.7 526.7 526.7

CROSS SECTION RIVER: 1 RS: 945
REACH: 1

INPUT Description: 945 CEM CHANNEL SECTION num 4 Sta Elev Sta Elev Sta Elev
0 129.59 30.75 109.26 68.75 109.26 117.21 129.59

Manning's n Values num 3 Sta n Val Sta n Val
0 .035 0 .025 117.21 .035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
0 117.21 129.59

CROSS SECTION RIVER: 1 RS: 940
REACH: 1

INPUT Description: 940 CEM CHANNEL SECTION num 4 Sta Elev Sta Elev Sta Elev
0 114.6 34.55 95.96 66.55 95.96 112.40 114.6

Manning's n Values num 3 Sta n Val Sta n Val
0 .035 0 .025 112.40 .035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
0 112.40 180 180

CROSS SECTION RIVER: 1 RS: 930
REACH: 1

INPUT Description: 930 CEM CHANNEL TOP SLOPE num 4 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
0 .035 0 .025 104.64 .035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
0 104.64 60 60

CROSS SECTION RIVER: 1 RS: 929
REACH: 1

INPUT Description: 929 CEM MID-SLOPE INTO BASIN 4 num 4 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
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

CROSS SECTION RIVER: 1 RS: 928
REACH: 1

INPUT Description: 928 CEM CHANNEL MID-SLOPE num 4 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
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

CROSS SECTION RIVER: 1 RS: 927
REACH: 1

INPUT Description: 927 CEM MID-SLOPE INTO BASIN 4 num 4 Sta Elev Sta Elev Sta Elev
0 106.27 65.62 75.5 124.28 75.5 193.18 109.91

Manning's n Values num 3 Sta n Val Sta n Val
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

Bank Sta: Left Right Length: Left Channel Right Coeff Contr. Expan.
0 193.10 70.75 70.75 70.75 .1 .3

CROSS SECTION REACH: 1
Manning's n Values RIVER: 1 RS: 926
Sta n Val Sta n Val Sta n Val Sta n Val
0 106.63 75.5 66.9 144.4 68.9 223.16 108.27

INPUT Description: 926 CRN MID-SLOPE INTO BASIN 4
Station Elevation Data num
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 .025 223.16 .035

Bank Sta: Left Right Length: Left Channel Right Coeff Contr. Expan.
0 223.14 81.43 81.43 81.43 .1 .3

CROSS SECTION REACH: 1
Manning's n Values RIVER: 1 RS: 925
Sta n Val Sta n Val Sta n Val
0 .035 0 .025 261.26 .035

INPUT Description: 925 CRN CHANNEL BOTTOM SLOPE
Station Elevation Data num
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 Length: Left Channel Right Coeff Contr. Expan.
0 261.26 55 50 50 .1 .3

CROSS SECTION REACH: 1
Manning's n Values RIVER: 1 RS: 923
Sta n Val Sta n Val Sta n Val
0 .035 0 .025 322 .035

INPUT Description: 923 BOTTOM SLOPE INTO BASIN 4
Station Elevation Data num
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 Length: Left Channel Right Coeff Contr. Expan.
0 322 200 154 150 .1 .3

CROSS SECTION REACH: 1
Manning's n Values RIVER: 1 RS: 920
Sta n Val Sta n Val Sta n Val
0 .035 0 .025 404 .035

INPUT Description: 920 EMO CRN (GUESS) TOP OF BASIN 4
Station Elevation Data num
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 Length: Left Channel Right Coeff Contr. Expan.
0 404 416 300 270 .1 .3

Bank Sta: Left Right Length: Left Channel Right Coeff Contr. Expan.
0 532.66 53.31 532.66 81.31 .1 .3

CROSS SECTION REACH: 1
Manning's n Values RIVER: 1 RS: 900
Sta n Val Sta n Val Sta n Val Sta n Val
0 .035 0 .035 532.66 .035

INPUT Description: 900 BASIN 4 (2.5% PARK)
Station Elevation Data num
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 Length: Left Channel Right Coeff Contr. Expan.
0 535 331 381 381 .1 .3

CROSS SECTION REACH: 1
Manning's n Values RIVER: 1 RS: 890
Sta n Val Sta n Val Sta n Val
0 .035 0 .035 721.2 .035

INPUT Description: 890 BASIN 4 (2.5% PARK)
Station Elevation Data num
Sta Elev Sta Elev Sta Elev Sta Elev
0 81.31 10 72.31 410 61.31 426 53.31 793 53.31
672.95 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
0 .035 0 .035 721.2 .035

Bank Sta: Left Right Length: Left Channel Right Coeff Contr. Expan.
0 721.2 518 426.11 426.11 .1 .3

CROSS SECTION REACH: 1
Manning's n Values RIVER: 1 RS: 880
Sta n Val Sta n Val Sta n Val
0 .035 0 .035 851 .035

INPUT Description: 880 FULL WIDTH OF BASIN 4 (2.5% PARK)
Station Elevation Data num
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 68.98

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 Length: Left Channel Right Coeff Contr. Expan.
0 851 290 199.27 187 .1 .3

CROSS SECTION REACH: 1
Manning's n Values RIVER: 1 RS: 875
Sta n Val Sta n Val Sta n Val
0 .035 0 .025 862.3 .035

INPUT Description: 875 UPSTREAM BOTTOM MEIR
Station Elevation Data num
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 Length: Left Channel Right Coeff Contr. Expan.
0 862.3 426 311 270 .1 .3

CROSS SECTION RIVER: 1
 REACH: 1 RS: 835

INPUT
 Description: 835 CAN CHANNEL ABOVE DROP
 Station Elevation Data num
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 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
 0 .035 100 .015 286.96 .035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 100 286.96 .5 .5

CROSS SECTION RIVER: 1
 REACH: 1 RS: 830

INPUT
 Description: 830 CAN CHANNEL BELOW DROP
 Station Elevation Data num
 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

CROSS SECTION RIVER: 1
 REACH: 1 RS: 829

INPUT
 Description: 829 BETOND DROP TOP OF BASIN 5
 Station Elevation Data num
 Sta Elev 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

CROSS SECTION RIVER: 1
 REACH: 1 RS: 827

INPUT
 Description: 827 BETOND DROP TOP OF BASIN 5
 Station Elevation Data num
 Sta Elev 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

CROSS SECTION RIVER: 1
 REACH: 1 RS: 820

INPUT
 Description: 820 CAN CHANNEL
 Station Elevation Data num
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 72.16 327.85 78.74 371.83 56.47 471.83 56.47 512.13 77.1

Manning's n Values num 3
 Sta n Val Sta n Val Sta n Val
 0 .035 327.85 .025 512.13 .035

0 862.3 10 10 10 10 .5
 Ineffective flow num
 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
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 81.31 120 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

CROSS SECTION RIVER: 1
 REACH: 1 RS: 860

INPUT
 Description: 860 DOWNSTREAM BOTTOM OF WEIR
 Station Elevation Data num
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 265 80.38 309.46 58.2 347.46 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

CROSS SECTION RIVER: 1
 REACH: 1 RS: 850

INPUT
 Description: 850 CHANNEL UNDER EAST-WEST RD
 Station Elevation Data num
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 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

Blocked obstructions num 1
 Sta L Sta R Elev
 755.7 759.7 60.38

CROSS SECTION RIVER: 1
 REACH: 1 RS: 840

INPUT
 Description: 840 CHANNEL UNDER EAST-WEST RD
 Station Elevation Data num
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 82.84 726.67 60.38 773.59 56.8 799.59 56.8 803.59 56.8

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

Blocked obstructions num 1
 Sta L Sta R Elev
 779.59 803.59 60.38



Bank Sta: Left Right Length: Left Channel Right Coeff Contr. Expan.
 327.85 512.13 940 940 .1 .3

CROSS SECTION RIVER: 1
 REACH: 1
 INPUT
 Description: 810 CRK CHANNEL
 Station Elevation Data num
 Sta Elev Sta Elev Sta Elev Sta Elev
 0 78 251.5 77.1 294.7 55.5 390.7 77.1
 456.75 80.26

Manning's n Values num
 Sta n Val Sta n Val Sta n Val
 0 .035 251.5 .025 433.9 .035

Bank Sta: Left Right Length: Left Channel Right Coeff Contr. Expan.
 251.5 433.9 100 100 .1 .3

CROSS SECTION RIVER: 1
 REACH: 1
 INPUT
 Description: 805 GRASSED CHANNEL
 Station Elevation Data num
 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
 Sta n Val Sta n Val Sta n Val
 100 .035 100 .035 312 .035

Bank Sta: Left Right Length: Left Channel Right Coeff Contr. Expan.
 100 312 128 168 .1 .3

CROSS SECTION RIVER: 1
 REACH: 1
 INPUT
 Description: 800 TRANSITION CHANNEL SECTION
 Station Elevation Data num
 Sta Elev Sta Elev Sta Elev Sta Elev
 170.62 71.5 181.62 60.5 280 56.5
 400 56.5 440 71.5 462.13 77.58

Manning's n Values num
 Sta n Val Sta n Val Sta n Val
 170.62 .035 170.62 .035 440 .035

Bank Sta: Left Right Length: Left Channel Right Coeff Contr. Expan.
 170.62 440 72 76.51 83 .1 .3

CROSS SECTION RIVER: 1
 REACH: 1
 INPUT
 Description: 790 TRANSITION CHANNEL SECTION
 Station Elevation Data num
 Sta Elev Sta Elev Sta Elev Sta Elev
 100.22 71.5 111.22 60.5 248 56.5
 398 71.5 426.2 76.5 448.42 77.5

Manning's n Values num
 Sta n Val Sta n Val Sta n Val
 100.22 .035 100.22 .035 426.2 .035

Bank Sta: Left Right Length: Left Channel Right Coeff Contr. Expan.
 100.22 426.2 60 62.72 67 .1 .3

CROSS SECTION RIVER: 1
 REACH: 1
 INPUT
 Description: 780 TRANSITION CHANNEL SECTION
 Station Elevation Data num
 Sta Elev Sta Elev Sta Elev Sta Elev

Bank Sta: Left Right Length: Left Channel Right Coeff Contr. Expan.
 83.97 71.5 112 60.5 248.58 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
 Sta n Val Sta n Val Sta n Val
 83.97 .035 83.97 .035 428.58 .035

Bank Sta: Left Right Length: Left Channel Right Coeff Contr. Expan.
 83.97 428.58 438 556.7 599 .1 .3

CROSS SECTION RIVER: 1
 REACH: 1
 INPUT
 Description: 770 FULL WIDTH OF BASIN 5 (2.5X PARK)
 Station Elevation Data num
 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 71.52 700.53 71.99

Manning's n Values num
 Sta n Val Sta n Val Sta n Val
 66 .035 66 .035 667.18 .035

Bank Sta: Left Right Length: Left Channel Right Coeff Contr. Expan.
 66 667.18 556 537.89 591 .1 .3

CROSS SECTION RIVER: 1
 REACH: 1
 INPUT
 Description: 760 FULL WIDTH OF BASIN 5 (2.5X PARK)
 Station Elevation Data num
 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
 Sta n Val Sta n Val Sta n Val
 66 .035 66 .035 796.5 .035

Bank Sta: Left Right Length: Left Channel Right Coeff Contr. Expan.
 66 796.5 257 255.7 257 .1 .3

CROSS SECTION RIVER: 1
 REACH: 1
 INPUT
 Description: 755 BOTTOM OF WEIR - UPSTREAM
 Station Elevation Data num
 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
 Sta n Val Sta n Val Sta n Val
 0 .035 495 .035 681.45 .035

Bank Sta: Left Right Length: Left Channel Right Coeff Contr. Expan.
 495 681.45 10 10 .3 .5

CROSS SECTION RIVER: 1
 REACH: 1
 INPUT
 Description: 750 TOP OF WEIR
 Station Elevation Data num
 Sta Elev Sta Elev Sta Elev Sta Elev
 0 66.44 49.0 66.5 51.9 65.5 495.3 63.5 495.3 63.5
 605.3 54.5 605.3 66.5 635.3 71.5

Manning's n Values num
 Sta n Val Sta n Val Sta n Val
 0 .035 495.3 .025 605.3 .035

Bank Sta: Left Right Length: Left Channel Right Coeff Contr. Expan.
 495.3 605.3 10 10 .3 .5

495.3 605.3 RIVER: 1 RS: 740
CROSS SECTION REACH: 1
INPUT
Description: 740 BOTTOM OF WEIR
Station Elevation Data
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
0 66.44 43.45 64.5 45.35 45.5 379.08 64.85 473.11 64.45
500.31 50.85 590.31 50.85 618.09 64.74 667.52 65.7

Manning's n Values
Sta n Val Sta n Val
0 .033 45.35 .025 618.09 .035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
45.35 618.09 16 20.85 24 .3 .3 .5

CROSS SECTION REACH: 1
INPUT
Description: 720
Station Elevation Data
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
0 66.4 42.43 66.57 44.6 44.75 64 493.05 50.85 583.66 50.85
609.86 64.25 666.24 65.39

Manning's n Values
Sta n Val Sta n Val
0 .035 44.6 0.025 609.86 .035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
44.6 609.86 16 41.04 71 .3 .3 .5

CROSS SECTION REACH: 1
INPUT
Description: 720
Station Elevation Data
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
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 .3 .5

CROSS SECTION REACH: 1
INPUT
Description: 710
Station Elevation Data
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
0 66.11 137 65.94 331.41 65.42 468.51 64.5 495 50.5
575 50.5 601 63.65 701.93 64.02 750.44 63.75

Manning's n Values
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 .6 .8

CROSS SECTION REACH: 1
INPUT
Description: 700
Station Elevation Data
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
20 64 30 62 50 60 70 50 100 50

195 54 320 52 340 50 370 48.5 425 50
435 52 480 54 565 56 585 60 645 62
655 64

Manning's n Values
Sta n Val Sta n Val
20 .055 320 .035 480 .055

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
320 480 120 160 160 .6 .6 .8

CROSS SECTION REACH: 1
INPUT
Description: 690
Station Elevation Data
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
20 64 40 62 60 60 80 50 100 56
110 54 240 52 315 50 400 48 430 47
520 48 535 50 546 52 585 54 630 56
635 58 640 60 695 62 700 64 785 64

Manning's n Values
Sta n Val Sta n Val
20 .055 240 .035 540 .055

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
240 580 130 150 160 .6 .6 .8

CROSS SECTION REACH: 1
INPUT
Description: 680
Station Elevation Data
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
26 64 40 62 40 60 80 50 100 56
110 54 240 52 315 50 400 48 430 47
445 50 480 48 490 48 510 48 530 48
545 50 515 52 520 54 545 54 585 56 640 58 675 58

Manning's n Values
Sta n Val Sta n Val
26 .055 380 .035 675 .055

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
380 675 670 150 160 .6 .6 .8

CROSS SECTION REACH: 1
INPUT
Description: 670
Station Elevation Data
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
30 62 15 60 35 58 50 56 65 54
75 52 125 50 200 48 280 46 310 44
415 40 660 44 670 46 675 48 690 50
705 52 720 54 745 56 750 58 760 60
825 66 835 66 840 64 870 62 880 62

Manning's n Values
Sta n Val Sta n Val
30 .055 280 .035 675 .055

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
280 675 120 125 80 .6 .6 .8

CROSS SECTION REACH: 1
INPUT
Description: 660
Station Elevation Data
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
27 64 30 62 50 60 70 50 100 50

Table with columns: Station Elevation Data, Manning's n Values, Bank Sta: Left, Right, Lengths, Left Channel, Right, Coeff Contr., Expan. Includes data for stations 0 to 790.

Table with columns: Station Elevation Data, Manning's n Values, Bank Sta: Left, Right, Lengths, Left Channel, Right, Coeff Contr., Expan. Includes data for stations 0 to 1615.

Table with columns: Station Elevation Data, Manning's n Values, Bank Sta: Left, Right, Lengths, Left Channel, Right, Coeff Contr., Expan. Includes data for stations 0 to 1315.

Table with columns: Station Elevation Data, Manning's n Values, Bank Sta: Left, Right, Lengths, Left Channel, Right, Coeff Contr., Expan. Includes data for stations 0 to 1415.

Table with columns: Station Elevation Data, Manning's n Values, Bank Sta: Left, Right, Lengths, Left Channel, Right, Coeff Contr., Expan. Includes data for stations 0 to 1415.

Table with columns: Station Elevation Data, Manning's n Values, Bank Sta: Left, Right, Lengths, Left Channel, Right, Coeff Contr., Expan. Includes data for stations 0 to 790.

Table with columns: Station Elevation Data, Manning's n Values, Bank Sta: Left, Right, Lengths, Left Channel, Right, Coeff Contr., Expan. Includes data for stations 0 to 1615.

Table with columns: Station Elevation Data, Manning's n Values, Bank Sta: Left, Right, Lengths, Left Channel, Right, Coeff Contr., Expan. Includes data for stations 0 to 1315.

Table with columns: Station Elevation Data, Manning's n Values, Bank Sta: Left, Right, Lengths, Left Channel, Right, Coeff Contr., Expan. Includes data for stations 0 to 1415.

Table with columns: Station Elevation Data, Manning's n Values, Bank Sta: Left, Right, Lengths, Left Channel, Right, Coeff Contr., Expan. Includes data for stations 0 to 1415.

Table with columns: Station Elevation Data, Manning's n Values, Bank Sta: Left, Right, Lengths, Left Channel, Right, Coeff Contr., Expan. Includes data for stations 0 to 790.

Table with columns: Station Elevation Data, Manning's n Values, Bank Sta: Left, Right, Lengths, Left Channel, Right, Coeff Contr., Expan. Includes data for stations 0 to 1615.

Table with columns: Station Elevation Data, Manning's n Values, Bank Sta: Left, Right, Lengths, Left Channel, Right, Coeff Contr., Expan. Includes data for stations 0 to 1315.

Table with columns: Station Elevation Data, Manning's n Values, Bank Sta: Left, Right, Lengths, Left Channel, Right, Coeff Contr., Expan. Includes data for stations 0 to 1415.

Table with columns: Station Elevation Data, Manning's n Values, Bank Sta: Left, Right, Lengths, Left Channel, Right, Coeff Contr., Expan. Includes data for stations 0 to 1415.

INPUT Description: Culvert # 4 (4 1.5' pipes)
Distance from Upstream XS = 0
Deck/Roadway Width = 38
Weir Coefficient = 2.64
Bridge Deck/Roadway Slope =
Upstream Deck/Roadway Coordinates
Downstream Bridge Cross Section Data
Station Elevation Data
Manning's n Values
Bank Sta: Left Right Lengths Left Channel Right Coeff Contr. Expan.
Upstream Embankment side slope
Downstream Embankment side slope
Maximum allowable submergence for weir flow = .95
Elevation at which weir flow begins
Energy head used in spillway design
Weir crest height used in design
Weir crest shape
o Broad crested

Back Sta: Left Right Height Coeff. Contr. Expan.
 Ineffective Flow num Sta L Sta R Elev
 120 55 158 54 165 53 197 53 206 52
 255 51.5 300 47 332.3 43 345.7 43 378 47
 308 49 758 49 783 51.5 808 52 898 54
 995 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 Length: Left Channel Right Coeff. Contr. Expan.
 Ineffective Flow num Sta L Sta R Elev
 0 300 47 378 917 47

CULVERT RIVER: 1
 REACH: 1 RS: 378
 Description: Culvert # 3 (4 1.5' Pipes)
 Distance from Upstream XS = 30
 Deck/Roadway Width = 30
 Weir Coefficient = 2.64
 Bridge Deck/Roadway Skew =
 Upstream Deck/Roadway Coordinates
 num 20 Sta n Val Cord to Cord Sta n Val Cord to Cord
 0 68 42.6 25 42 42.6 50 66 42.6
 80 56 42.6 45 55 42.6 120 55 42.6
 158 34 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 42.6 758 49 42.6 808 52 42.6
 995 56 42.6 917 58 42.6

INPUT Description: 570 Station Elevation Data num 22
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 68 25 62 165 53 332.3 43 345.7 43 378 47
 120 55 300 47 332.3 43 345.7 43 378 47
 255 51.5 300 47 783 51.5 808 52 898 54
 308 49 758 49 783 51.5 808 52 898 54
 995 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.
 Ineffective Flow num Sta L Sta R Elev
 0 300 47 378 917 47

Downstream Deck/Roadway Coordinates
 num 20 Sta n Val Cord to Cord Sta n Val Cord to Cord
 0 68 42.6 25 42 42.6 50 66 42.6
 80 56 42.6 45 55 42.6 120 55 42.6
 158 34 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 42.6 758 49 42.6 808 52 42.6
 995 56 42.6 917 58 42.6
 Downstream Bridge Cross Section Data num 22
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 68 25 62 165 53 332.3 43 345.7 43 378 47
 120 55 300 47 332.3 43 345.7 43 378 47
 255 51.5 300 47 783 51.5 808 52 898 54
 308 49 758 49 783 51.5 808 52 898 54
 995 56 917 58
 Manning's n Values num 3
 Sta n Val Sta n Val Sta n Val
 0 .035 300 .025 378 .035

Back Sta: Left Right Height Coeff. Contr. Expan.
 Ineffective Flow num Sta L Sta R Elev
 0 300 47 378 917 47
 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 Length: Left Channel Right Coeff. Contr. Expan.
 Ineffective Flow num Sta L Sta R Elev
 0 300 47 378 917 47

CULVERT RIVER: 1
 REACH: 1 RS: 378
 Description: Culvert # 1 - Concrete Pipe Culvert
 Distance from Upstream XS = 30
 Deck/Roadway Width = 30
 Weir Coefficient = 2.64
 Bridge Deck/Roadway Skew =
 Upstream Deck/Roadway Coordinates
 num 20 Sta n Val Cord to Cord Sta n Val Cord to Cord
 0 68 42.6 25 42 42.6 50 66 42.6
 80 56 42.6 45 55 42.6 120 55 42.6
 158 34 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 42.6 758 49 42.6 808 52 42.6
 995 56 42.6 917 58 42.6

INPUT Description: 570 Station Elevation Data num 22
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 68 25 62 165 53 332.3 43 345.7 43 378 47
 120 55 300 47 332.3 43 345.7 43 378 47
 255 51.5 300 47 783 51.5 808 52 898 54
 308 49 758 49 783 51.5 808 52 898 54
 995 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.
 Ineffective Flow num Sta L Sta R Elev
 0 300 47 378 917 47

Downstream Deck/Roadway Coordinates
 num 20 Sta n Val Cord to Cord Sta n Val Cord to Cord
 0 68 42.6 25 42 42.6 50 66 42.6
 80 56 42.6 45 55 42.6 120 55 42.6
 158 34 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 42.6 758 49 42.6 808 52 42.6
 995 56 42.6 917 58 42.6
 Downstream Bridge Cross Section Data num 22
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 68 25 62 165 53 332.3 43 345.7 43 378 47
 120 55 300 47 332.3 43 345.7 43 378 47
 255 51.5 300 47 783 51.5 808 52 898 54
 308 49 758 49 783 51.5 808 52 898 54
 995 56 917 58
 Manning's n Values num 3
 Sta n Val Sta n Val Sta n Val
 0 .035 300 .025 378 .035

REACH: 1 AS: 550

INPUT
Description: 550
Station Elevation Data
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
1 46 15 62 25 64 30 62 45 58
35 60 45 58 55 65 60 65 75 75
200 50 215 48 225 48 235 48 245 48
265 38 280 38 290 38 300 38
310 44 315 44 325 48 335 50 340 52
350 54 360 56

Manning's n Values
Sta n Val Sta n Val
1 .055 235 .035 310 .055

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
255 310 110 110 110 110 .6 .8

CROSS SECTION
REACH: 1 RIVER: 1
RS: 510

INPUT
Description: 510
Station Elevation Data
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 34 290 38
295 40 305 42 310 44 315 44 320 48

Manning's n Values
Sta n Val Sta n Val
1 .055 70 .035 290 .055

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
70 290 210 210 210 210 .6 .8

CROSS SECTION
REACH: 1 RIVER: 1
RS: 500

INPUT
Description: 500
Station Elevation Data
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
10 64 35 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 34 265 40
270 42 275 44 280 46 290 48 295 50
315 52 325 54

Manning's n Values
Sta n Val Sta n Val
10 .055 85 .035 255 .055

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
85 255 120 110 110 110 .6 .8

CROSS SECTION
REACH: 1 RIVER: 1
RS: 490

INPUT
Description: 490
Station Elevation Data
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 32 210 31 250 32 260 36
265 38 270 40 275 42 280 44 285 46
290 48 295 50

Manning's n Values
Sta n Val Sta n Val
15 .055 150 .035 270 .055

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
150 270 120 120 120 120 .6 .8

CROSS SECTION
REACH: 1 RIVER: 1
RS: 480

INPUT
Description: 480
Station Elevation Data
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
0 50 5 48 10 46 15 44 20 42
40 40 50 38 60 36 70 34 80 32
90 30 120 30 300 30 310 32 320 32
340 34 350 36 355 38 370 40 380 42
390 44 400 46 415 48 430 50 460 50

REACH: 1 AS: 550

INPUT
Description: 550
Station Elevation Data
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
1 46 15 62 25 64 30 62 45 58
35 60 45 58 55 65 60 65 75 75
200 50 215 48 225 48 235 48 245 48
265 38 280 38 290 38 300 38
310 44 315 44 325 48 335 50 340 52
350 54 360 56

Manning's n Values
Sta n Val Sta n Val
1 .055 235 .035 310 .055

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
255 310 110 110 110 110 .6 .8

CROSS SECTION
REACH: 1 RIVER: 1
RS: 540

INPUT
Description: 540
Station Elevation Data
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
1 66 5 64 10 62 15 62 20 62 25 62
30 60 40 58 50 56 60 54 70 52 80 50
100 50 130 48 160 46 200 44 240 42 280 40
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
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 45 45 45 .6 .8

CROSS SECTION
REACH: 1 RIVER: 1
RS: 530

INPUT
Description: 530
Station Elevation Data
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
Sta n Val Sta n Val
5 .055 100 .035 290 .055

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
100 290 190 190 200 200 .6 .8

CROSS SECTION
REACH: 1 RIVER: 1
RS: 520

INPUT
Description: 520
Station Elevation Data
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
Sta n Val Sta n Val
10 .055 90 .035 280 .055

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
 REACH: 1 RIVER: 1
 RS: 470
 INPUT
 Description: 470
 Station Elevation Data num 29
 Sta Elev 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 30 260 30
 275 28 290 27 560 20 620 20 680 20
 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.
 170 120 30 .6 .8

CROSS SECTION
 REACH: 1 RIVER: 1
 RS: 460
 INPUT
 Description: 460
 Station Elevation Data num 26
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 5 46 25 44 30 42 40 40
 68 36 95 34 130 32 150 30 160 30
 185 28 200 27 480 27 500 28 520 30
 540 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 .055 580 .055
 Bank Sta: Left Right Lengths Left Channel Right Coeff Contr. Expan.
 170 130 130 .6 .8

CROSS SECTION
 REACH: 1 RIVER: 1
 RS: 450
 INPUT
 Description: 450
 Station Elevation Data num 25
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 10 46 20 44 30 42 40 40
 190 40 200 38 215 36 225 35 235 34
 245 32 255 30 265 28 275 27 370 27
 340 28 370 27 406 22 486 24 498 26
 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.
 70 70 70 .6 .8

CROSS SECTION
 REACH: 1 RIVER: 1
 RS: 440
 INPUT
 Description: 440
 Station Elevation Data num 26
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 5 48 12 46 25 44 30 42 40 40
 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 31.6 285.3 35.5 31.6 311 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 num 26
 Station Elevation Data num 26
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 5 48 12 46 25 44 30 42 40 40
 65 51 31.6 75 50 31.6 85 48 31.6
 140 44 190 42 206 40 225 41.5 258 36.5
 275.3 36.5 285.3 35.5 299 32 327.6 41.5 317.6 42 580.6 46
 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 .6 .8

Ineffective Flow num 2
 Sta L Sta R Elev Sta L Elev Sta R Elev
 5 285.3 35.5 341.3 604.6 35.5
 Downstream Deck/Roadway Coordinates num 21
 Sta MI Cord Lo Cord Sta MI Cord Lo Cord
 5 46 31.6 12 44 31.6 25 44 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 31.6 285.3 35.5 31.6 311 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 num 26
 Station Elevation Data num 26
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 5 48 12 46 25 44 30 42 40 40
 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 31.6 285.3 35.5 31.6 311 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

Manning's n Values num 26
 Sta n Val Sta n Val 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 .6 .8

Ineffective Flow num 2
 Sta L Sta R Elev Sta L Elev Sta R Elev
 5 285.3 35.5 341.3 604.6 35.5
 Downstream Deck/Roadway Coordinates num 21
 Sta MI Cord Lo Cord Sta MI Cord Lo Cord
 5 46 31.6 12 44 31.6 25 44 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 31.6 285.3 35.5 31.6 311 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 num 26
 Station Elevation Data num 26
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 5 48 12 46 25 44 30 42 40 40
 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 31.6 285.3 35.5 31.6 311 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

Manning's n Values num 26
 Sta n Val Sta n Val 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 .6 .8

Ineffective Flow num 2
 Sta L Sta R Elev Sta L Elev Sta R Elev
 5 285.3 35.5 341.3 604.6 35.5
 Downstream Deck/Roadway Coordinates num 21
 Sta MI Cord Lo Cord Sta MI Cord Lo Cord
 5 46 31.6 12 44 31.6 25 44 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 31.6 285.3 35.5 31.6 311 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

Manning's n Values
 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 2 .6 .8

Ineffective flow num 2
 Sta L Elev Sta R Elev
 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 = Broad Crested
 Weir crest shape =

Number of Culverts = 1
 Culvert Name Shape Rise Span
 Culvert # 1 Circular 1.5 1.5
 FRMA Chart # 1 - Concrete Pipe Culvert
 FRMA Scale # 1 - Square edge entrance with headwall
 Solution Criteria = Highest U.S. EG
 Culvert Upstream 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. 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. Sta.
 308.05 309.55 311.05 312.55 314.05 315.55 317.05 318.55

CROSS SECTION RIVER: 1
 REACH: 1
 INPUT
 Description: 430
 Station Elevation Data num Elev Sta Elev Sta Elev Sta Elev Sta Elev
 5 46 12 44 25 44 25 44 25 44 25 44 25 44 25 44 25 44 25 44
 55 50 65 51 75 50 85 48 100 46 46
 140 44 190 42 206 40 225 41.5 258.3 34.5
 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 2 .6 .8

Ineffective flow num 2
 Sta L Elev Sta R Elev
 285.3 35.5 341.3 604.6 35.5

CROSS SECTION RIVER: 1
 REACH: 1
 INPUT
 Description: 420
 Station Elevation Data num Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 46 10 44 25 44 25 44 25 44 25 44 25 44 25 44 25 44
 90 46 100 44 105 42 115 40 120 38 130 36 140 34 150 32
 160 30 175 28 195 28 200 30 210 32 215 35
 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.
 50 215 160 100 110 .6 .8

CROSS SECTION RIVER: 1
 REACH: 1
 INPUT
 Description: 410
 Station Elevation Data num Elev Sta Elev Sta Elev Sta Elev Sta Elev
 5 44 20 42 35 42 35 42 35 42 35 42 35 42 35 42 35 42 35 42
 45 34 70 32 80 30 85 28 90 27 200 25 210 23 220 21 230 19
 240 28 250 30 260 32 265 34 270 36 280 38 290 40 300 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
 INPUT
 Description: 400
 Station Elevation Data num Elev Sta Elev Sta Elev Sta Elev Sta Elev
 5 44 20 44 20 44 20 44 20 44 20 44 20 44 20 44 20 44 20 44
 90 36 100 34 110 32 118 30 125 28 28 28 35 30 365 32 402 42
 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
 INPUT
 Description: 390
 Station Elevation Data num Elev Sta Elev Sta Elev Sta Elev Sta Elev
 5 44 12 42 20 40 20 40 20 40 20 40 20 40 20 40 20 40 20 40
 55 34 65 32 70 31 80 30 92 28 28 28 28 28 28 28 28 28 28 28 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
 INPUT
 Description: 380
 Station Elevation Data num Elev Sta Elev Sta Elev Sta Elev Sta Elev
 6 44 15 42 22 41 22 41 22 41 22 41 22 41 22 41 22 41 22 41
 125 35 138.7 31.5 147.3 31.5 181 35 191 35 191 35 191 35 191 35
 241 36 294 41 300 42 308 44

Manning's n Values num 3
 Sta n Val Sta n Val Sta n Val
 6 .055 125 .025 181 .035

Bank Sta: Left 125 Right 181 Lengths: Left Channel 38 Right 38 Coeff Contr. .6 Expan. .0
 Ineffective Flow num 2
 Sta L Sta R Elev Sta L Sta R Elev
 4 125 35 181 308 35

CUVERT
 REACH: 1 RIVER: 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

name 12
 Sta MI Cord Lo Cord Sta MI Cord Lo Cord
 4 44 31.1 15 42 31.1 22 41 31.1
 5 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 num 14
 Station Elevation Data num
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 4 44 15 42 22 41 167.3 31.5 181 35 191 36
 261 36 294 41 300 42

Manning's n Values num 3
 Sta n Val Sta n Val Sta n Val
 4 .035 125 .025 181 .035

Bank Sta: Left 125 Right 181 Coeff Contr. .6 Expan. .0
 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 MI Cord Lo Cord Sta MI Cord Lo Cord
 4 44 31.1 15 42 31.1 22 41 31.1
 5 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 num 16
 Station Elevation Data num
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 4 44 15 42 22 41 167.3 31.5 181 35 191 36
 261 36 294 41 300 42

Manning's n Values num 3
 Sta n Val Sta n Val Sta n Val
 4 .035 125 .025 181 .035

Bank Sta: Left 125 Right 181 Coeff Contr. .6 Expan. .0
 Ineffective Flow num 2
 Sta L Sta R Elev Sta L Sta R Elev
 4 125 35 181 308 35

Upstream Embankment side slope =
 Downstream Embankment side slope =
 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
 PMA Chart # 1 - Concrete Pipe Culvert

FAHA Chart # 1 - Square edge entrance with headwall
 Solution Criteria = Highest U.S. EG
 Culvert Upstream Dist Length n Value Entrance Loss Coef Exit Loss Coef
 0 38 .015 .1

Number of barrels = 8
 Upstream Elevation = 31.5
 Centerline Stations
 Sta. Sta. Sta. Sta. Sta. Sta. Sta.
 167.75 169.25 150.75 152.25 153.75 155.25 156.75 158.25

Downstream Elevation = 31
 Centerline Stations
 Sta. Sta. Sta. Sta. Sta. Sta. Sta.
 167.75 169.25 150.75 152.25 153.75 155.25 156.75 158.25

CROSS SECTION
 REACH: 1 RIVER: 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 41 167.3 31.5 181 35 191 36
 261 36 294 41 300 42

Manning's n Values num 3
 Sta n Val Sta n Val Sta n Val
 4 .035 125 .025 181 .035

Bank Sta: Left 125 Right 181 Lengths: Left Channel 38 Right 38 Coeff Contr. .6 Expan. .0
 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 MI Cord Lo Cord Sta MI Cord Lo Cord
 4 44 31.1 15 42 31.1 22 41 31.1
 5 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 num 16
 Station Elevation Data num
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 4 44 15 42 22 41 167.3 31.5 181 35 191 36
 261 36 294 41 300 42

Manning's n Values num 3
 Sta n Val Sta n Val Sta n Val
 4 .035 125 .025 181 .035

Bank Sta: Left 125 Right 181 Coeff Contr. .6 Expan. .0
 Ineffective Flow num 2
 Sta L Sta R Elev Sta L Sta R Elev
 4 125 35 181 308 35

Upstream Embankment side slope =
 Downstream Embankment side slope =
 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
 PMA Chart # 1 - Concrete Pipe Culvert

FAHA Chart # 1 - Square edge entrance with headwall
 Solution Criteria = Highest U.S. EG
 Culvert Upstream Dist Length n Value Entrance Loss Coef Exit Loss Coef
 0 38 .015 .1

Number of barrels = 8
 Upstream Elevation = 31.5
 Centerline Stations
 Sta. Sta. Sta. Sta. Sta. Sta. Sta.
 167.75 169.25 150.75 152.25 153.75 155.25 156.75 158.25

Downstream Elevation = 31
 Centerline Stations
 Sta. Sta. Sta. Sta. Sta. Sta. Sta.
 167.75 169.25 150.75 152.25 153.75 155.25 156.75 158.25

CROSS SECTION
 REACH: 1 RIVER: 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 41 167.3 31.5 181 35 191 36
 261 36 294 41 300 42

Manning's n Values num 3
 Sta n Val Sta n Val Sta n Val
 4 .035 125 .025 181 .035

Bank Sta: Left 125 Right 181 Lengths: Left Channel 38 Right 38 Coeff Contr. .6 Expan. .0
 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 MI Cord Lo Cord Sta MI Cord Lo Cord
 4 44 31.1 15 42 31.1 22 41 31.1
 5 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 num 16
 Station Elevation Data num
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 4 44 15 42 22 41 167.3 31.5 181 35 191 36
 261 36 294 41 300 42

Manning's n Values num 3
 Sta n Val Sta n Val Sta n Val
 4 .035 125 .025 181 .035

Bank Sta: Left 125 Right 181 Coeff Contr. .6 Expan. .0
 Ineffective Flow num 2
 Sta L Sta R Elev Sta L Sta R Elev
 4 125 35 181 308 35

Upstream Embankment side slope =
 Downstream Embankment side slope =
 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
 PMA Chart # 1 - Concrete Pipe Culvert

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 Length: 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 Length: 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 HS = 0
 Deck/Roadway Width = 83.25
 Weir Coefficient = 2.6
 Bridge Deck/Roadway Slope =
 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 num 8
 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 num 8
 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 =
 Downstream Embankment side slope =
 Maximum allowable submergence for weir flow = .95

Elevation at which weir flow begins = 46.16
 Entry 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
 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 Length: 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 Length: 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 Length: 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 40.88 46.5 40.88

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 Length: Left Channel Right Coeff Contr. Expan.
 0 91.5 20 20 20 .3 .5

Upstream Embankment side slope =
 Downstream Embankment side slope =
 Maximum allowable submergence for weir flow = .95



CROSS SECTION RIVER: 1
 REACH: 1 RS: 260

INPUT
 Description: 260
 Station Elevation Data num 8
 Sta Elev 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 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 28.18 162 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 27.75 162 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: 260

INPUT
 Description: 260
 Station Elevation Data num 5
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 43.56 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

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 = 121.86
 Deck/Roadway Width = 2.6
 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 num 8
 Station Elevation Data num 8
 Sta Elev 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 num 8
 Station Elevation Data num 8
 Sta Elev 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 = Broad Crested
 Weir crest shape =
 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

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
0 .018 0 .018 167.92 .018
0 167.92 33.94 26.66 25.2

CROSS SECTION RIVER: 1
REACH: 1 RS: 160

INPUT
Description: 160
Station Elevation Data num 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 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 0 169 20 20 .3 .5

CROSS SECTION RIVER: 1
REACH: 1 RS: 170

INPUT
Description: 170
Station Elevation Data num Sta Elev Sta Elev Sta Elev Sta Elev
0 42.1 6.8 36.7 45 27.01 110 27.01 110 43.01

Manning's n Values num 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

CROSS SECTION RIVER: 1
REACH: 1 RS: 210

INPUT
Description: 210
Station Elevation Data num 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 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

CROSS SECTION RIVER: 1
REACH: 1 RS: 200

INPUT
Description: 200
Station Elevation Data num 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 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

CROSS SECTION RIVER: 1
REACH: 1 RS: 190

INPUT
Description: 190
Station Elevation Data num 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 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 0 169 20 20 .3 .5

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
0 110 78.85 93.87 101.5

CROSS SECTION RIVER: 1
REACH: 1 RS: 230

INPUT
Description: 230
Station Elevation Data num 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 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

CROSS SECTION RIVER: 1
REACH: 1 RS: 220

INPUT
Description: 220
Station Elevation Data num 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 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

CROSS SECTION RIVER: 1
REACH: 1 RS: 210

INPUT
Description: 210
Station Elevation Data num 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 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

CROSS SECTION RIVER: 1
REACH: 1 RS: 200

INPUT
Description: 200
Station Elevation Data num 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 Sta n Val Sta n Val Sta n Val
0 .015 0 .015 118 .015

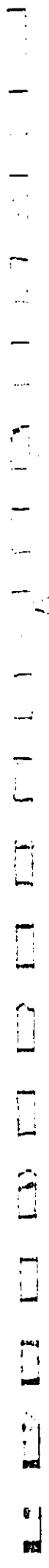
Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
0 118 178.95 121.02 72.15

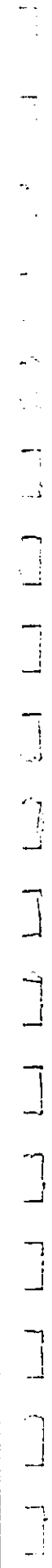
CROSS SECTION RIVER: 1
REACH: 1 RS: 190

INPUT
Description: 190
Station Elevation Data num 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 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 0 169 20 20 .3 .5





Downstream Deck/Roadway Coordinates
 num 2 Sta M Cord Lo Cord Sta M Cord To Cord
 0 42.03 40 169 42.83 40

Downstream Bridge Cross Section Data
 num 45
 Sta Elev Sta Elev Sta Elev Sta Elev
 0 42.1 6.8 38.7 6.8 40 24.8 40 24.8 29.7 32 26.1
 23.3 34.5 23.3 40 24.8 40 41.4 40 41.4 26.1 56.3 26.1
 37.9 28.1 39.9 40 41.4 40 57.8 40 57.8 26.1 72.7 40
 56.3 40 74.2 26.1 87 26.1 89.1 40 89.1 40
 74.2 40 94.6 26.1 105.4 40 106.9 40
 90.6 40 111.8 26.1 121.5 40 123 40
 106.9 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
 0 .018 0 .018 169 .018

Bank Sta: Left Right Lengths Left Channel Right Coeff Contr. Expan.
 0 169 .3 .5

Upstream Embankment side slope = horiz. to 1.0 vertical
 Downstream Embankment side slope = 95
 Maximum allowable submergence for weir flow = 42.03
 Elevation at which weir flow begins =
 Energy head used in spillway design =
 Spillway height used in design = Broad Crested
 Weir crest shape

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
 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

Station Elevation Data
 num 5
 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
 0 .033 0 .033 169 .033

Bank Sta: Left Right Lengths Left Channel Right Coeff Contr. Expan.
 0 169 .3 .5

CROSS SECTION
 REACH: 1
 RIVER: 1
 RS: 140

INPUT
 Description: 140
 Station Elevation Data
 num 76
 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 41.6 455 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 41.1 1130 40 1165 40 1210 40.6
 1235 40.9 1290 41.1 1400 42 1600 42 1690 41
 1580 42 1620 43.2 1730 42 1820 41.9 1920 41
 1945 43 2000 41 2050 42 2135 44 2190 44.5
 2270 43 2400 43.5 2480 43 2600 42 2670 42
 2798 42 2816 44 2820 34 2738 32 2774 32
 2878 26 2882 26 2898 26 2905 26 2915 26
 2945 26 3045 26 3065 26 3210 26 3220 40
 3280 35 3360 40 3400 40 3470 42
 3770 41.8

Manning's n Values
 num 3
 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

Ineffective Flow
 num 2
 Sta L Sta R Elev Sta L Elev Sta R Elev
 30 2820 44 3220 3970 40

Station Elevation Data
 num 45
 Sta Elev Sta Elev Sta Elev Sta Elev
 0 42.1 6.8 38.7 6.8 40 24.8 40 24.8 29.7 32 26.1
 23.3 30.55 23.3 40 24.8 40 41.4 40 41.4 26.1 56.3 26.1
 39.9 26.1 39.9 40 41.4 40 57.8 40 57.8 26.1 72.7 40
 56.3 40 74.2 26.1 87 26.1 89.1 40 89.1 40
 74.2 40 90.6 26.1 105.4 40 106.9 40
 90.6 40 90.6 26.1 121.5 40 123 40
 106.9 26.1 121.5 40 123 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
 0 .018 0 .018 169 .018

Bank Sta: Left Right Lengths Left Channel Right Coeff Contr. Expan.
 0 169 .3 .5

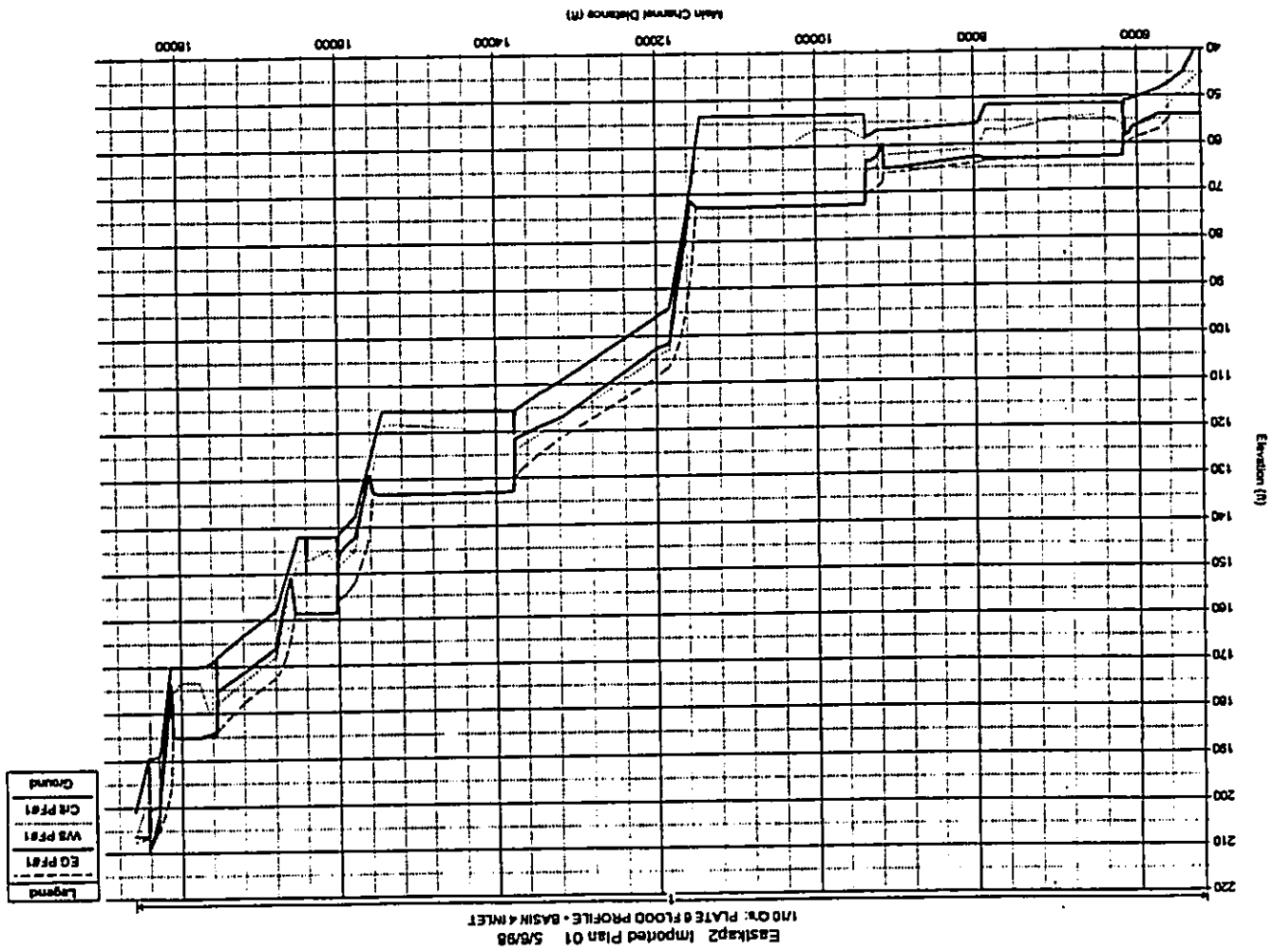
CROSS SECTION
 REACH: 1
 RIVER: 1
 RS: 150

INPUT
 Description: 150

Hydrological data table with columns for Reach, River Sta, Q Total, Man Ch E, W.S. Elev, Crt W.S., E.G. Elev, E.G. Slope, Vel Chd, Flow Area, Top Width, Froude # Ch. Rows 1-810.

EASTKAPZ.PRJ PLATE 6 FLOWS: MIXED FLOW REGIMES 5-5-08

HECRAS Plus, Kuba River: 1 Reach: 1



Eastkap2 Imported Plan 01 5/6/98
 1/10 CR: PLATE 8 FLOOD PROFILE - BASIN 4 INLET

| Reach | EC-RAS Plan: Kadi River: 1 Reach: 1 | Min Ch El (ft) | Length Chl (ft) | W.S. Elev (ft) | CR W.S. (ft) | E.O. Elev (ft) | E.O. Slope (ft/ft) | Vel Chd (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # |
|-------|-------------------------------------|----------------|-----------------|----------------|--------------|----------------|--------------------|----------------|-------------------|----------------|----------|
| 1 | 287.5 | 28.74 | 80.00 | 35.26 | 35.26 | 38.52 | 0.002485 | 14.48 | 644.77 | 80.00 | 1.01 |
| 1 | 290 | 28.85 | 154.96 | 33.42 | 34.70 | 34.07 | 0.001860 | 17.20 | 481.28 | 119.43 | 1.45 |
| 1 | 270 | 28.00 | 180.81 | 35.68 | 33.68 | 36.95 | 0.000990 | 9.07 | 878.89 | 131.84 | 0.82 |
| 1 | 260 | 27.75 | 108.03 | 35.56 | 33.25 | 36.72 | 0.000802 | 8.68 | 871.72 | 140.55 | 0.58 |
| 1 | 250 | 27.49 | 93.87 | 34.80 | 31.15 | 36.43 | 0.010206 | 10.87 | 711.53 | 110.00 | 0.72 |
| 1 | 240 | 27.27 | 115.81 | 34.55 | 31.96 | 36.20 | 0.000962 | 10.82 | 800.25 | 110.00 | 0.88 |
| 1 | 230 | 27.01 | 180.40 | 34.49 | 31.71 | 36.15 | 0.000841 | 10.33 | 822.78 | 110.00 | 0.87 |
| 1 | 220 | 26.58 | 32.77 | 34.42 | 32.28 | 35.83 | 0.000781 | 9.88 | 841.80 | 110.00 | 0.82 |
| 1 | 210 | 26.50 | 121.02 | 34.41 | 32.22 | 35.82 | 0.000717 | 8.72 | 874.07 | 112.95 | 0.82 |
| 1 | 200 | 26.22 | 28.66 | 34.40 | 32.04 | 35.67 | 0.000665 | 8.91 | 987.78 | 136.87 | 0.58 |
| 1 | 190 | 26.15 | 20.00 | 34.43 | 31.94 | 35.62 | 0.000623 | 8.74 | 1007.04 | 138.14 | 0.52 |
| 1 | 180 | 26.10 | 0.00 | 33.82 | 31.28 | 35.41 | 0.000320 | 10.72 | 820.00 | 123.09 | 0.72 |
| 1 | 170 | 26.10 | 80.00 | 33.25 | 32.28 | 35.25 | 0.003744 | 11.37 | 774.29 | 121.80 | 0.78 |
| 1 | 160 | 26.00 | 80.00 | 33.03 | 31.84 | 34.78 | 0.040888 | 10.81 | 829.56 | 123.90 | 0.75 |
| 1 | 150 | 26.00 | 26.00 | 33.80 | 28.55 | 33.83 | 0.000323 | 2.83 | 3002.83 | 437.42 | 0.18 |
| 1 | 140 | 26.00 | 26.00 | 33.80 | 28.55 | 33.83 | 0.000323 | 2.83 | 3002.83 | 437.42 | 0.18 |

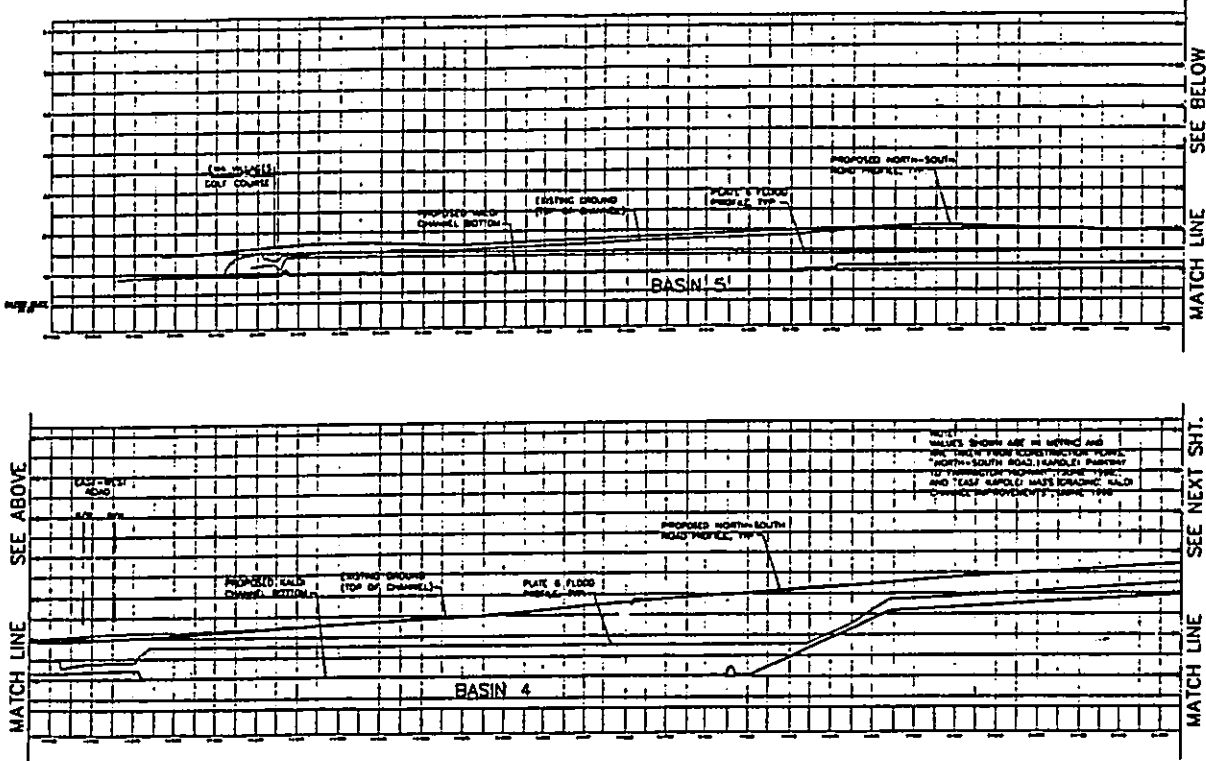
SEALO CHANNEL IMPROVEMENTS - PLATE 6 FLOOD PROFILE
(SECTIONS 140 TO 730 FROM RMA VILLAGES DRAINAGE MASTER PLAN, Rev. 3/1973)
SUMMARY OF CROSS SECTIONS - NO RR BRIDGE

C 114 GENTRY SUBDIVISION (0=65000)
C 140 DOWNSTR. FACE OF BRIDGE AT ORL ROW
C 140 DOWNSTR. FACE OF BRIDGE AT ORL ROW
C 140 DOWNSTR. FACE OF BRIDGE AT ORL ROW
C 140 DOWNSTR. FACE OF BRIDGE AT ORL ROW
C 140 DOWNSTR. FACE OF BRIDGE AT ORL ROW
C 180 CHANNEL SECTION
C 180 CHANNEL SECTION FROM CONC TO CEM RIGHT CEM (0=8500)
C 190 SECTION LEFT CONC RIGHT TRAM FROM CONC TO CEM
C 200 SECTION LEFT TRAM FROM CONC TO CEM RIGHT CONC
C 210 SECTION LEFT CONC RIGHT CONC
C 220 SECTION LEFT CONC RIGHT CONC TO CEM
C 230 SECTION CEM LEFT AND RIGHT
C 240 SECTION CHANNEL WIDEST POINT CEM LEFT AND RIGHT
C 250 DOWNSTR. FACE OF BRIDGE AT N-S ROAD (CHANNEL)
C 260 DOWNSTR. FACE OF BRIDGE AT N-S ROAD
C 270 UPSTR. FACE OF BRIDGE AT N-S ROAD (CHANNEL)
C 280 DOWNSTR. FACE OF BRIDGE AT RENTON ROAD (0=8350)
C 290 DOWNSTR. FACE OF BRIDGE AT RENTON ROAD
C 300 UPSTR. FACE OF BRIDGE AT RENTON ROAD (GOLF COURSE)
C 310 GOLF COURSE CHANNEL
C 320 GOLF COURSE CHANNEL
C 330 BASIN #4 CURVE INLET
C 340 BASIN #4 CURVE INLET
C 350 GOLF COURSE CHANNEL
C 360 GOLF COURSE CHANNEL
C 370 GOLF COURSE CHANNEL
C 380 BASIN #5 CURVE INLET
C 390 BASIN #5 CURVE INLET
C 400 GOLF COURSE CHANNEL (0=8200)
C 410 GOLF COURSE CHANNEL (0=7700)
C 420 GOLF COURSE CHANNEL
C 430 GOLF COURSE CHANNEL
C 440 GOLF COURSE CHANNEL
C 450 GOLF COURSE CHANNEL
C 460 GOLF COURSE CHANNEL
C 470 GOLF COURSE CHANNEL
C 480 GOLF COURSE CHANNEL
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 (0=7600)
C 570 BASIN #2 CURVE INLET
C 580 BASIN #2 CURVE 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 CURVE INLET (0=7550)
C 650 BASIN #1 CURVE INLET
C 660 #5 GREEN
C 670 GOLF COURSE CHANNEL
C 680 DRIVING RANGE TB
C 690 GOLF COURSE CHANNEL (0=7400)
C 700 GOLF COURSE CHANNEL
C 710 DOWNSTREAM OF BRIDGE AT CURVE "A"
C 720 UPSTREAM OF BRIDGE AT CURVE "A"
C 730 CEM CHANNEL SECTION
C 740 SECTION AT BOTTOM OF BEEM
C 750 SECTION TOP OF BEEM
C 760 SECTION AT FULL WIDTH CHANNEL W/ 2.5% PAKE
C 770 SECTION AT FULL WIDTH CHANNEL W/ 2.5% PAKE
C 780 TRANSITION CHANNEL SECTION

C 770 TRANSITION CHANNEL SECTION
C 800 CHANNEL SECTION TO POND
C 810 END CEM CHANNEL SECTION
C 820 CEM CHANNEL SECTION
C 830 DOWNSTREAM FACE OF BRIDGE
C 840 SECTION THROUGH CEM
C 850 SECTION AT BOTTOM OF BEEM, CEM
C 860 SECTION AT TOP OF BEEM, CEM
C 870 SECTION THROUGH WIDEST POND SECTION W/ 2.5% PAKE (0=6150)
C 880 SECTION THROUGH TYPICAL CHANNEL SECTION W/ 2.5% PAKE
C 890 CHANNEL SECTION THROUGH 2.5% PAKE
C 900 CHANNEL SECTION THROUGH 2.5% PAKE
C 910 TYPICAL CHANNEL SECTION, END CEM & BEGIN PAK
C 920 TYPICAL CHANNEL SECTION, CEM
C 930 BEGIN TYP CHANNEL SECTION, CEM
C 940 END NARROW CEM SECTION
C 945 SECTION, NARROW CEM CHANNEL
C 950 BEGIN NARROW CEM SECTION (BOTTOM OF BEEM) (0=6000)
C 955 TOP OF BEEM (RESERVOIR 3)
C 960 SECTION, TRANSITION FROM PAK SECTION TO NARROW CEM SECTION
C 970 TYPICAL PAK SECTION, END CEM
C 975 TYPICAL PAK SECTION AT BOTTOM OF BEEM
C 980 TYPICAL PAK SECTION AT TOP OF BEEM, BEGIN CEM
C 985 BEGIN TYPICAL PAK SECTION
C 990 SECTION THROUGH POND AND PAK
C 1000 SECTION THROUGH WIDEST PART OF POND AND PAK
C 1010 SECTION END CEM
C 1020 TYPICAL CHANNEL SECTION, CEM
C 1030 DOWNSTREAM FACE OF BRIDGE (0=5900)
C 1040 SECTION AT TOP OF BEEM
C 1045 SECTION AT BOTTOM OF BEEM
C 1050 SECTION THROUGH POND
C 1060 SECTION AT BEGINNING OF CEM
C 1070 SECTION THROUGH CEM SECTION
C 1080 SECTION THROUGH TYPICAL CEM SECTION
C 1090 SECTION THROUGH TYPICAL CEM SECTION
C 1100 SECTION THROUGH BOTTOM OF BEEM
C 1105 SECTION THROUGH PAK SECTION, TOP OF BEEM
C 1110 SECTION THROUGH PAK SECTION
C 1120 SECTION THROUGH CEM CHANNEL
C 1130 SECTION THROUGH CEM CHANNEL AT HEADWALL
C 1135 SECTION THROUGH CEM CHANNEL
C 1140 SECTION AT DOWNSTREAM FACE OF DIL 12X12 BOX (0=5300)
C 1150 SECTION AT UPSTREAM FACE OF DIL 12X12 BOX
C 1160 SECTION ABOVE WY

EC-RAS Plan Kaloj River 1 Reach: 1

| Reach | River Sta | Q Total (cfs) | Min Ch E (ft) | Length Ch E (ft) | W/S Elev (ft) | Ch W/S (ft) | E.O. Elev (ft) | E.G. Slope (ft/ft) | Vel Chd (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Ch |
|-------|-----------|---------------|---------------|------------------|---------------|-------------|----------------|--------------------|----------------|-------------------|----------------|-------------|
| - | 280 | 8500.00 | 28.74 | 60.00 | 45.84 | 33.28 | 48.31 | 0.000137 | 8.50 | 1548.88 | 81.50 | 0.24 |
| - | 270 | 8500.00 | 28.55 | 186.86 | 48.05 | 34.70 | 48.28 | 0.000270 | 3.17 | 2187.82 | 154.28 | 0.18 |
| - | 260 | 8500.00 | 28.18 | 100.81 | 48.07 | 33.88 | 48.24 | 0.000416 | 3.27 | 2801.22 | 174.00 | 0.15 |
| - | 250 | 8500.00 | 27.75 | 109.03 | 48.07 | 33.25 | 48.23 | 0.000443 | 3.18 | 2883.30 | 174.00 | 0.16 |
| - | 240 | 8500.00 | 27.48 | 93.87 | 48.81 | 33.18 | 48.18 | 0.000554 | 4.18 | 2650.54 | 110.00 | 0.17 |
| - | 230 | 8500.00 | 27.27 | 111.81 | 48.81 | 32.84 | 48.18 | 0.000550 | 4.98 | 2078.81 | 110.00 | 0.17 |
| - | 220 | 8500.00 | 27.01 | 182.40 | 48.81 | 32.71 | 48.17 | 0.000547 | 4.00 | 2123.87 | 110.00 | 0.18 |
| - | 210 | 8500.00 | 26.88 | 32.77 | 48.81 | 32.28 | 48.15 | 0.000441 | 3.84 | 2710.85 | 110.00 | 0.18 |
| - | 200 | 8500.00 | 26.50 | 121.02 | 48.81 | 32.04 | 48.14 | 0.000441 | 3.14 | 2788.85 | 187.82 | 0.14 |
| - | 190 | 8500.00 | 26.22 | 75.00 | 48.81 | 32.04 | 48.10 | 0.000358 | 8.05 | 1073.88 | 500.00 | 1.01 |
| - | 180 | 8500.00 | 42.80 | 20.00 | 44.83 | 44.83 | 45.84 | 0.007390 | 28.08 | 302.80 | 113.86 | 3.17 |
| - | 150 | 8500.00 | 26.08 | 50.00 | 33.80 | 31.84 | 41.83 | 0.117254 | 2.83 | 3002.83 | 437.42 | 0.18 |
| - | 140 | 8500.00 | 26.00 | 28.00 | 33.80 | 28.55 | 33.83 | 0.000223 | | | | |



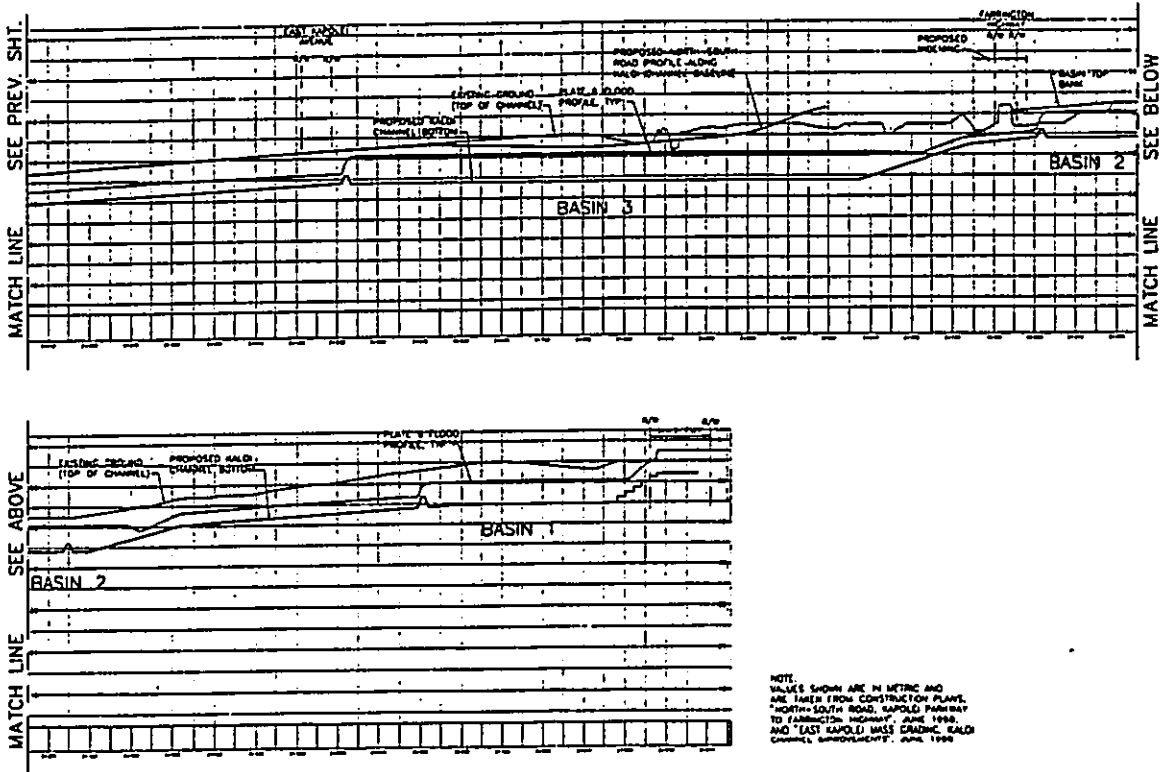
KALOJ CHANNEL -- PLATE 6 HYDRAULIC GRADES

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

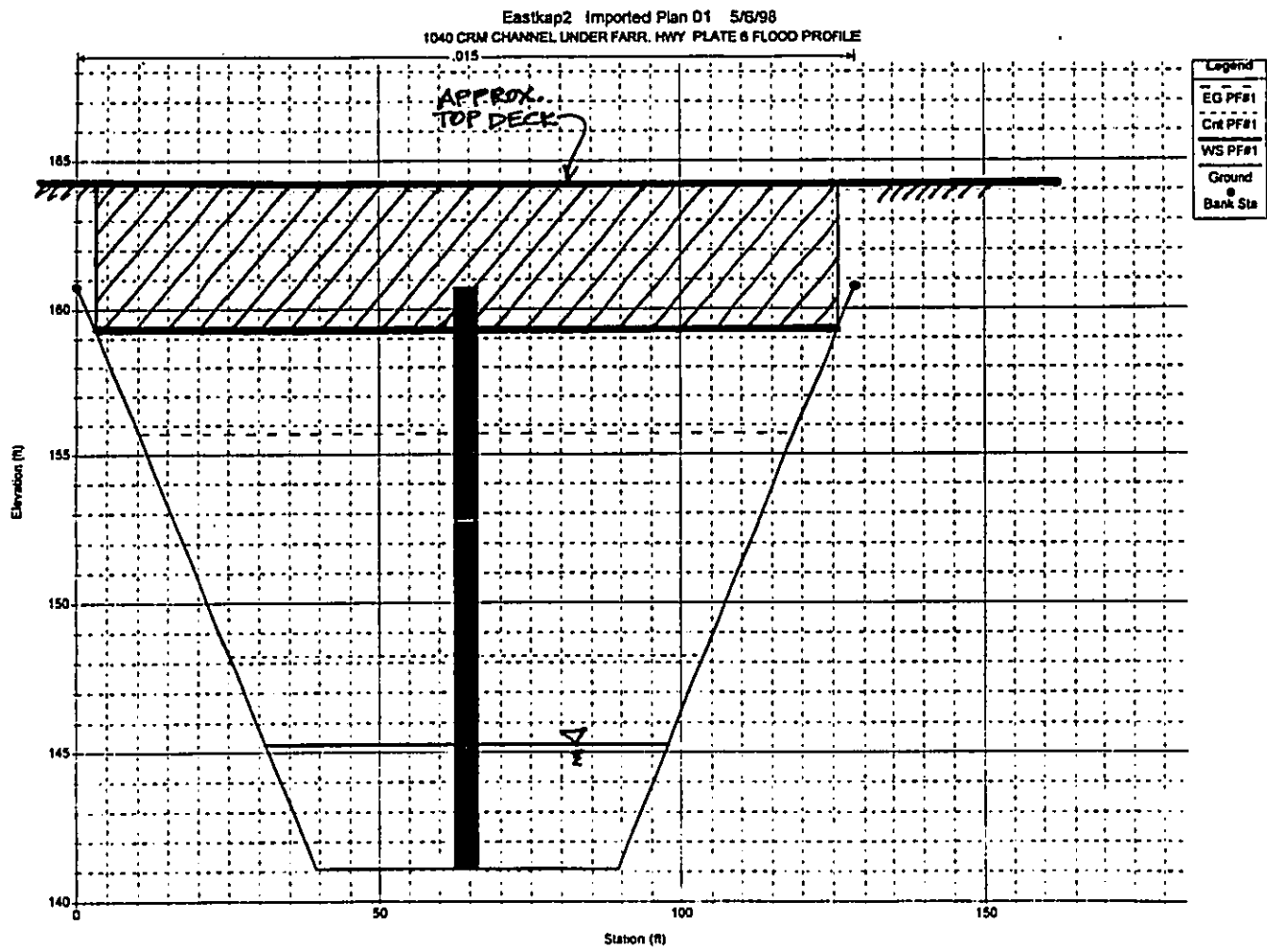
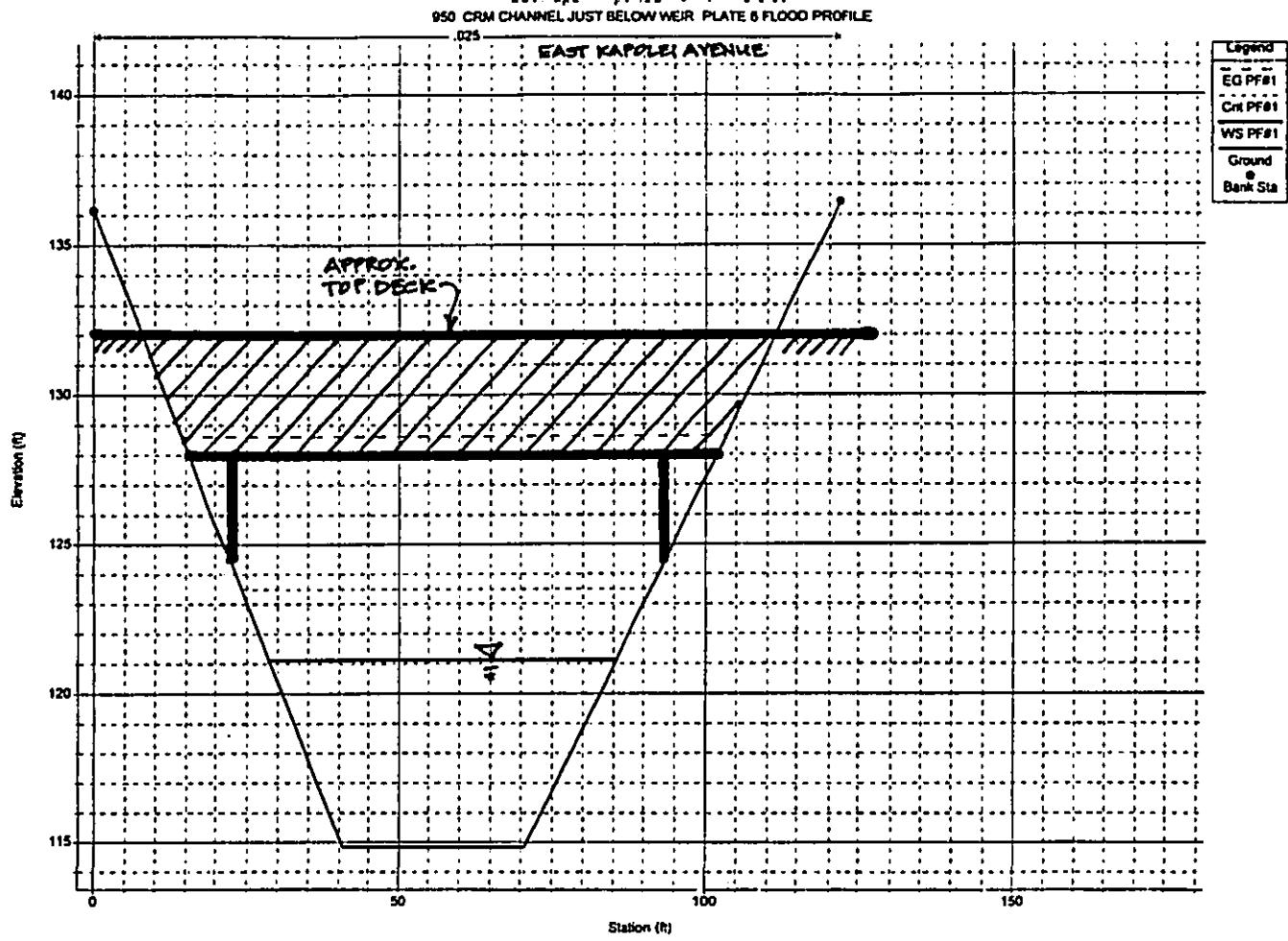
6/17/98
 FILE: brdgsum.wk3
 EAST KAPOLEI DRAINAGE MASTER PLAN
 BRIDGE SUMMARY (HEC-2 RESULTS)

HEC-2 BRIDGE SUMMARY

| | TOP ROAD | BOT. DECK | CHAN. INVERT | CWSEL | F.B. |
|--|----------|-----------|--------------|--------|-------|
| BRIDGE AT RESERVOIR 2
(FARRINGTON HIGHWAY) | 164.2 | 159.2 | 141 | 145.28 | 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 |



KALO'I CHANNEL --- PLATE 6 HYDRAULIC GRADES



5/14/98 Use with New1C2.dwg

| Depth | Elev | Area (sq) | Vol (cu-ft) | Cumulative Vol (cu-ft) |
|-------|------|-----------|-------------|------------------------|
| 0 | 43 | 0.67 | 0.67 | 0.67 |
| 1 | 44 | 1.27 | 1.84 | 2.51 |
| 1 | 45 | 2.38 | 4.22 | 4.80 |
| 1 | 46 | 4.28 | 8.50 | 12.70 |
| 1 | 47.0 | 5.64 | 14.14 | 18.34 |
| 1 | 48.0 | 7.17 | 21.31 | 25.51 |
| 1 | 49 | 8.47 | 29.78 | 34.00 |
| 1 | 50 | 12.43 | 42.21 | 46.43 |

Basin 2.xls Chan between 4 and 5 at elev. 56
5/5/98 Use with eastkap2.dwg
East Kapode - Kodo Channel Detention Basin Storage

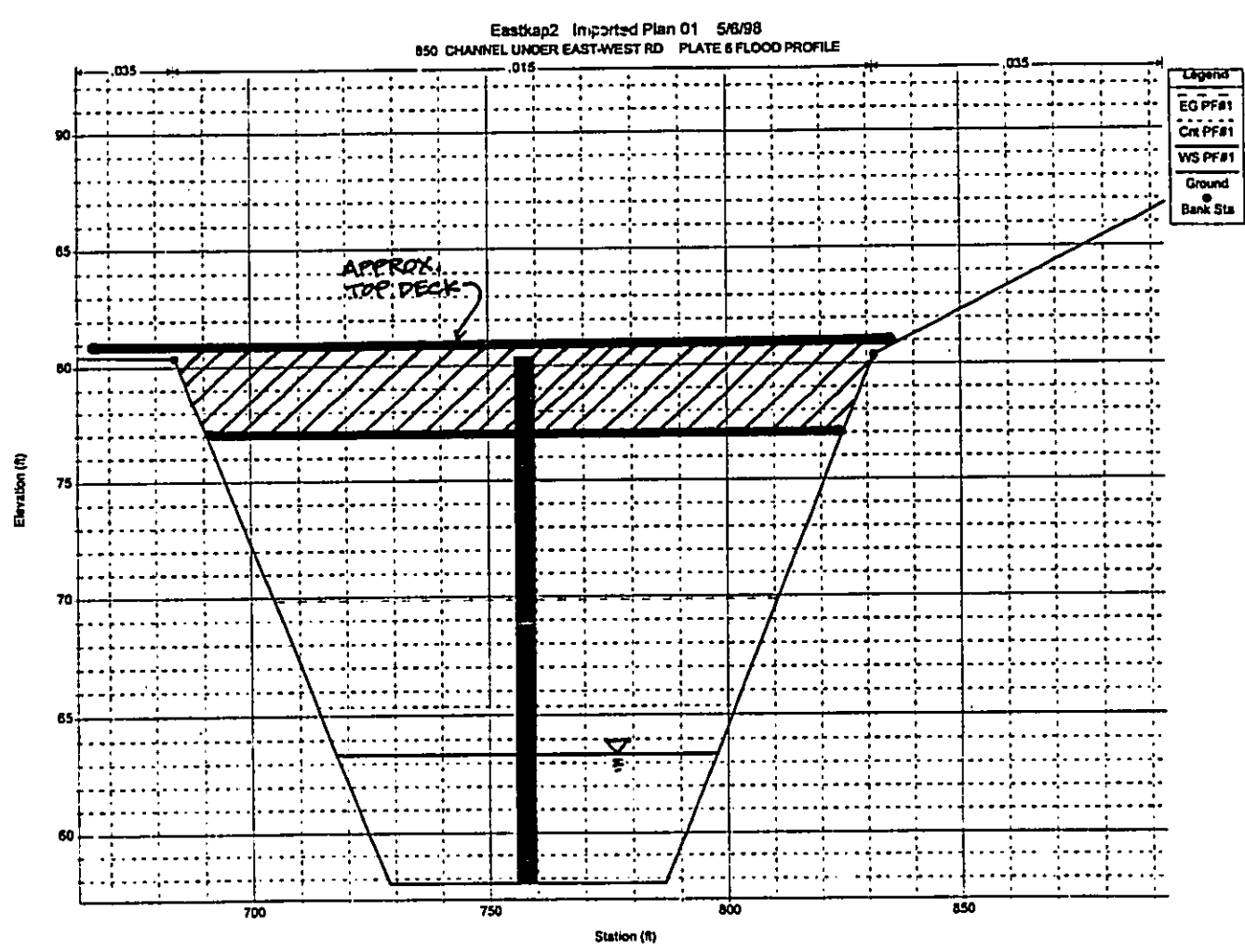
| Depth | Elev | Area (sq) | Vol (cu-ft) | Cumulative Vol (cu-ft) |
|-------|------|-----------|-------------|------------------------|
| 0 | 51.5 | 8.01 | 8.01 | 8.01 |
| 1 | 52.5 | 8.17 | 16.18 | 16.18 |
| 1 | 53.5 | 8.61 | 24.79 | 24.79 |
| 2 | 55.5 | 8.97 | 33.76 | 33.76 |
| 1 | 58.5 | 11.12 | 44.88 | 44.88 |
| 0.9 | 57.4 | 13.53 | 58.41 | 58.41 |
| 1.6 | 59 | 19.04 | 77.45 | 77.45 |
| 1.7 | 60.7 | 18.26 | 95.71 | 95.71 |
| 1.6 | 62.3 | 20.42 | 116.13 | 116.13 |

| Depth | Elev | Area (sq) | Vol (cu-ft) | Cumulative Vol (cu-ft) |
|-------|-------|-----------|-------------|------------------------|
| 0 | 53.31 | 6.46 | 6.46 | 6.46 |
| 5 | 56.31 | 7.52 | 35 | 35 |
| 3 | 61.31 | 8.29 | 23.715 | 58.72 |
| 1.02 | 62.33 | 10.49 | 9.5778 | 68.29 |
| 1.65 | 63.98 | 13.98 | 20.166 | 88.46 |
| 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 | 276.36 |
| 3.28 | 75.46 | 30.43 | 98.3508 | 374.73 |

| Depth | Elev | Area (sq) | Vol (cu-ft) | Cumulative Vol (cu-ft) |
|-------|--------|-----------|-------------|------------------------|
| 0 | 115.47 | 6.32 | 6.32 | 6.32 |
| 5 | 120.47 | 7.48 | 34.50 | 34.50 |
| 10 | 125.47 | 11.89 | 48.43 | 82.93 |
| 12 | 127.47 | 13.77 | 25.06 | 108.59 |
| 14 | 129.47 | 15.61 | 29.38 | 137.97 |

| Depth | Elev | Area (sq) | Vol (cu-ft) | Cumulative Vol (cu-ft) |
|-------|--------|-----------|-------------|------------------------|
| 0 | 142.00 | 3.51 | 3.51 | 3.51 |
| 5 | 147.00 | 4.14 | 19.13 | 19.13 |
| 8 | 150.00 | 5.18 | 33.08 | 33.08 |
| 11 | 153.00 | 6.21 | 17.06 | 50.13 |
| 14 | 156.00 | 6.59 | 19.20 | 69.33 |

| Depth | Elev | Area (sq) | Vol (cu-ft) | Cumulative Vol (cu-ft) |
|-------|--------|-----------|-------------|------------------------|
| 0 | 170 | 5.37 | 5.37 | 5.37 |
| 5 | 175.00 | 6.22 | 28.975 | 28.975 |
| 5 | 180.00 | 7.04 | 33.15 | 62.13 |
| 3.73 | 183.73 | 10.22 | 32.1889 | 94.31 |
| 4.92 | 188.05 | 13.41 | 56.1288 | 152.44 |



035 015 035

90

85

80

75

70

65

60

Elevation (ft)

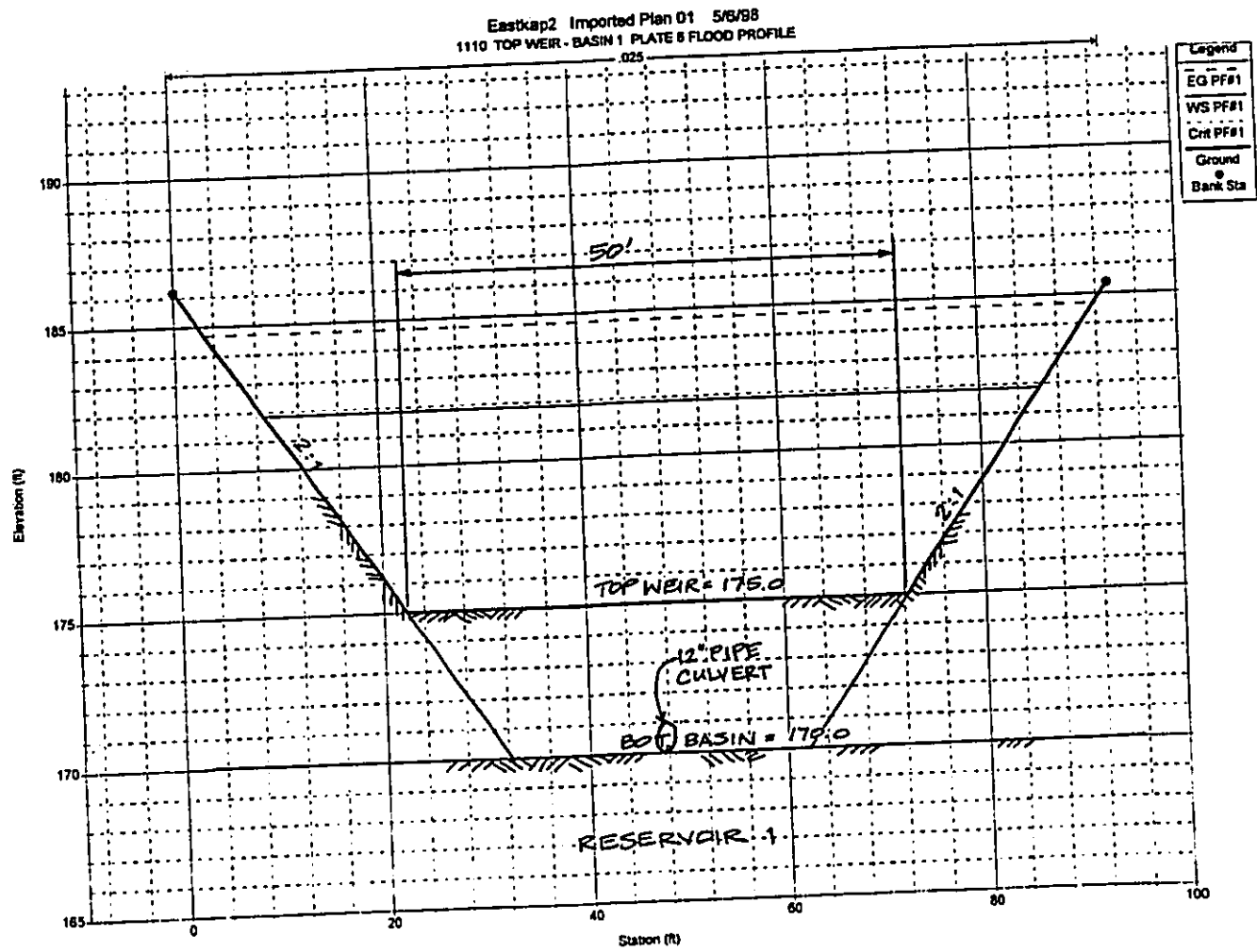
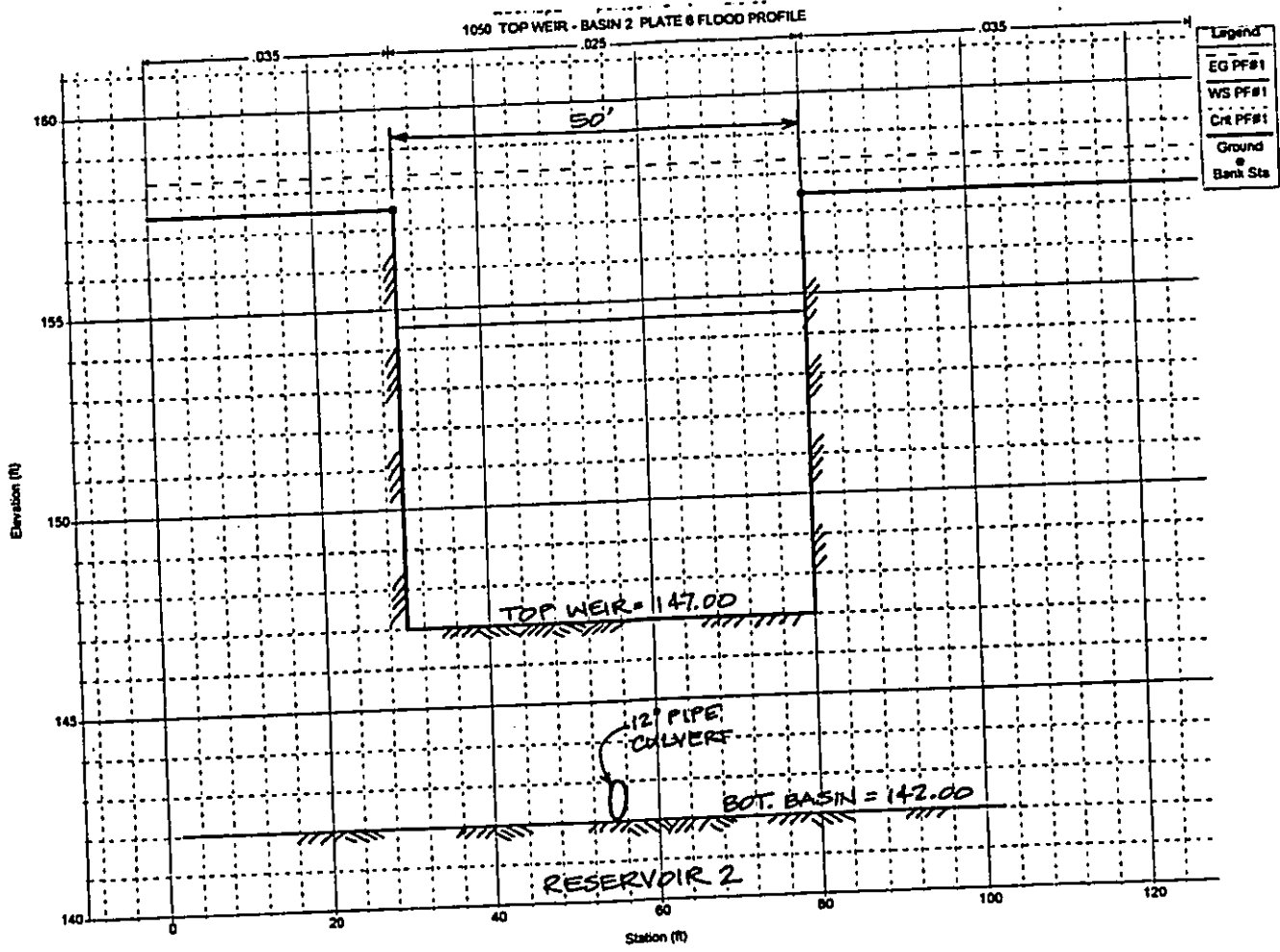
700 750 800 850

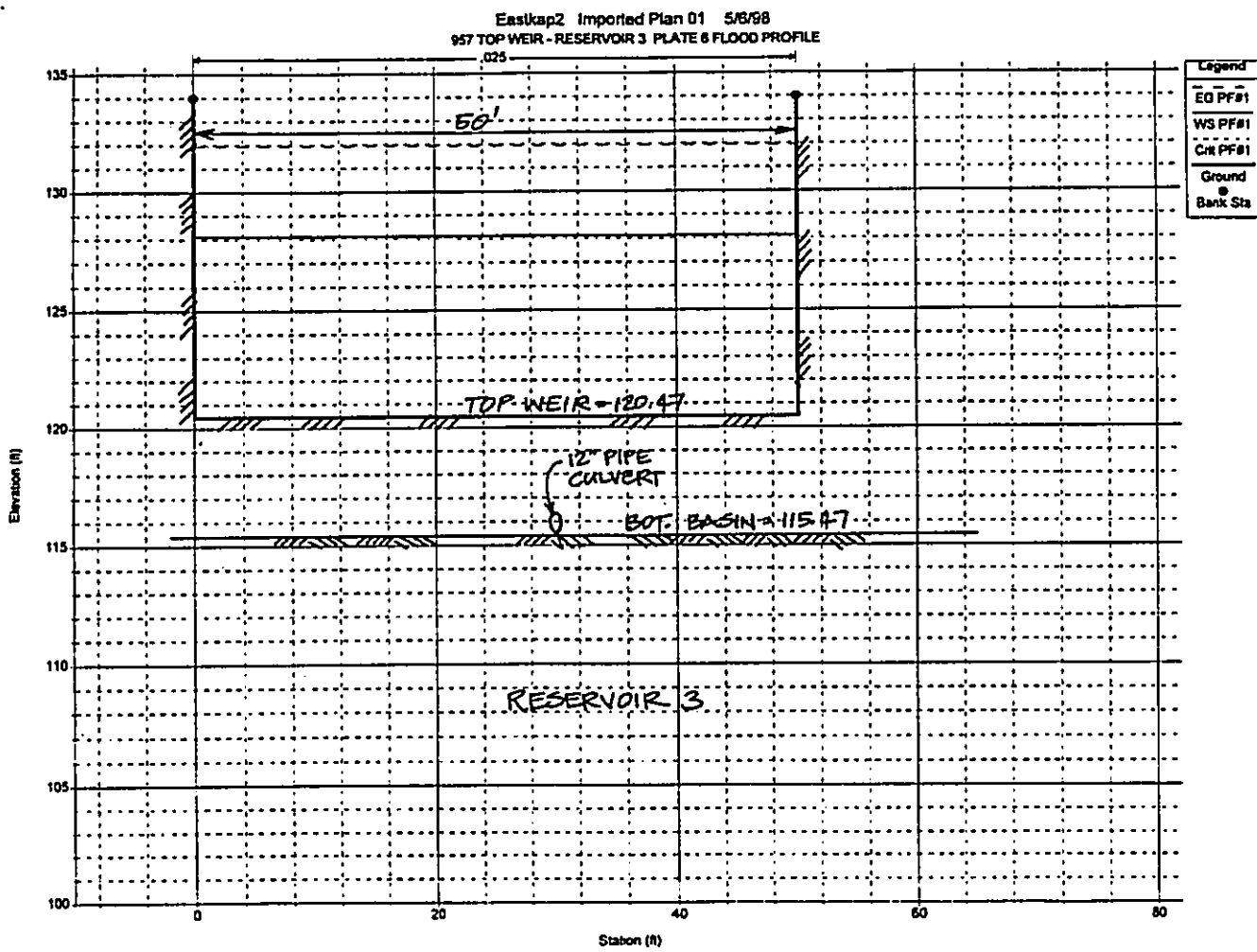
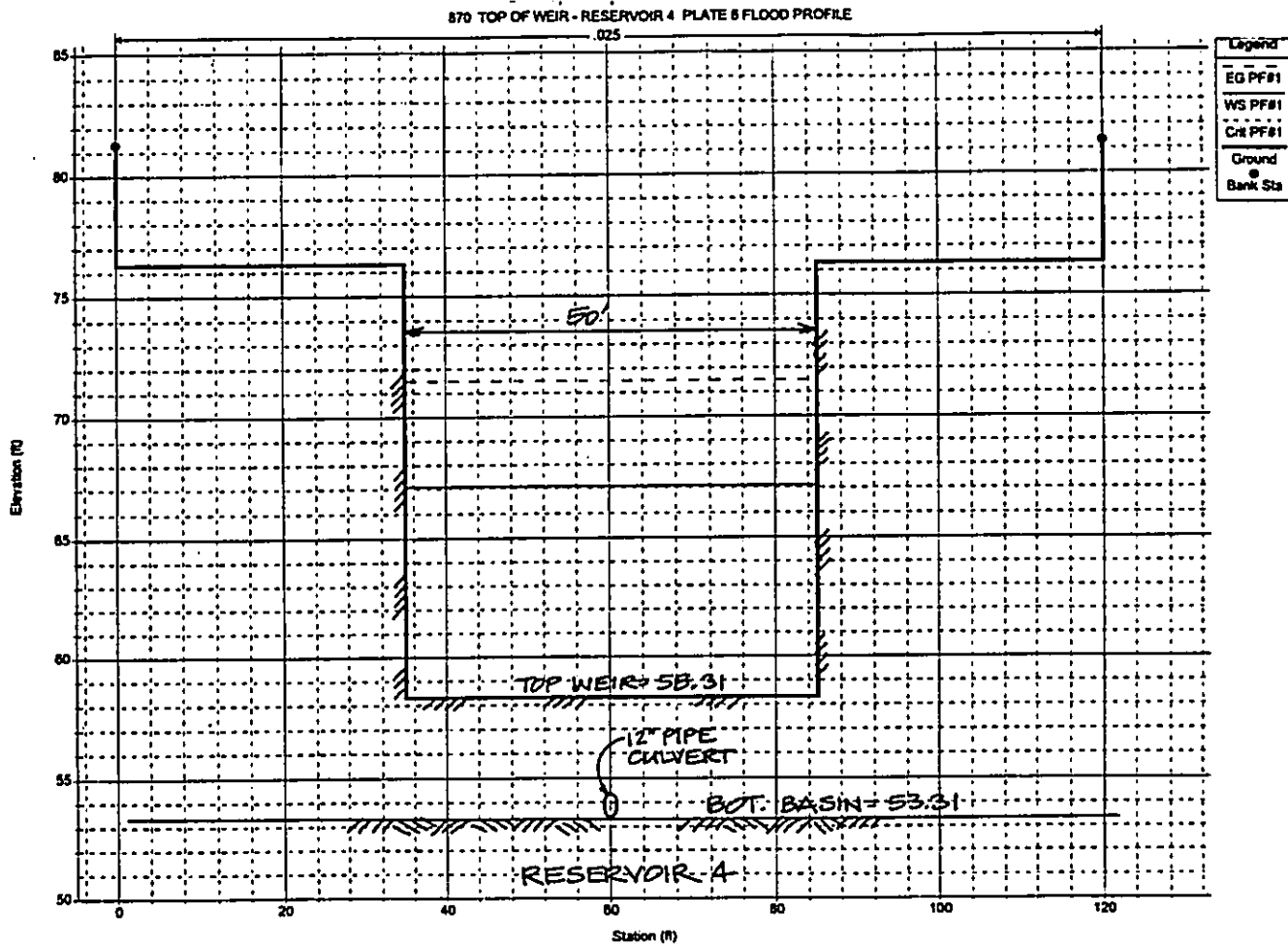
Station (ft)

Legend

- EG PF#1
- Cx PF#1
- WS PF#1
- Ground
- Bank Sta

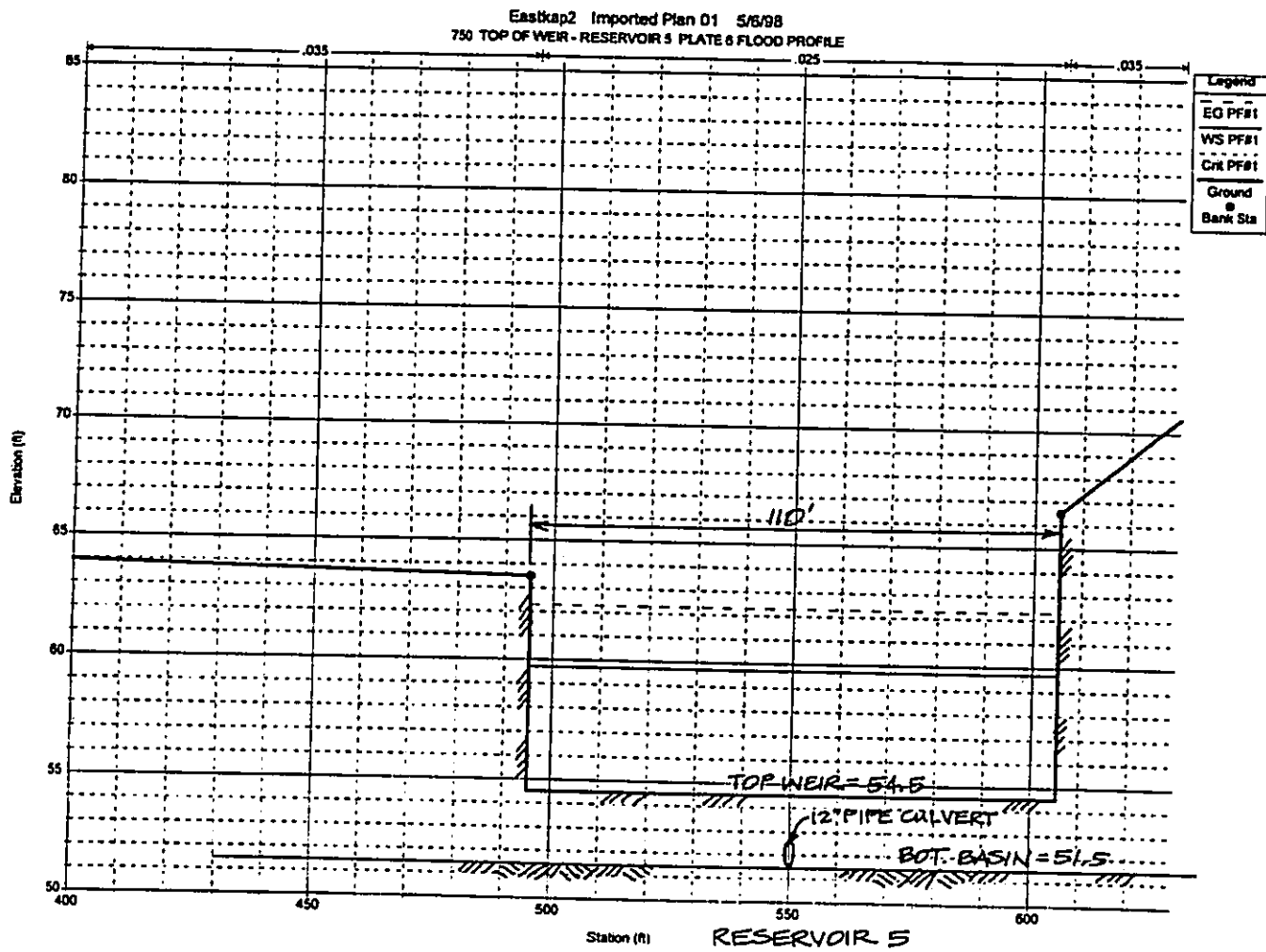
APPROX. TOP DECK

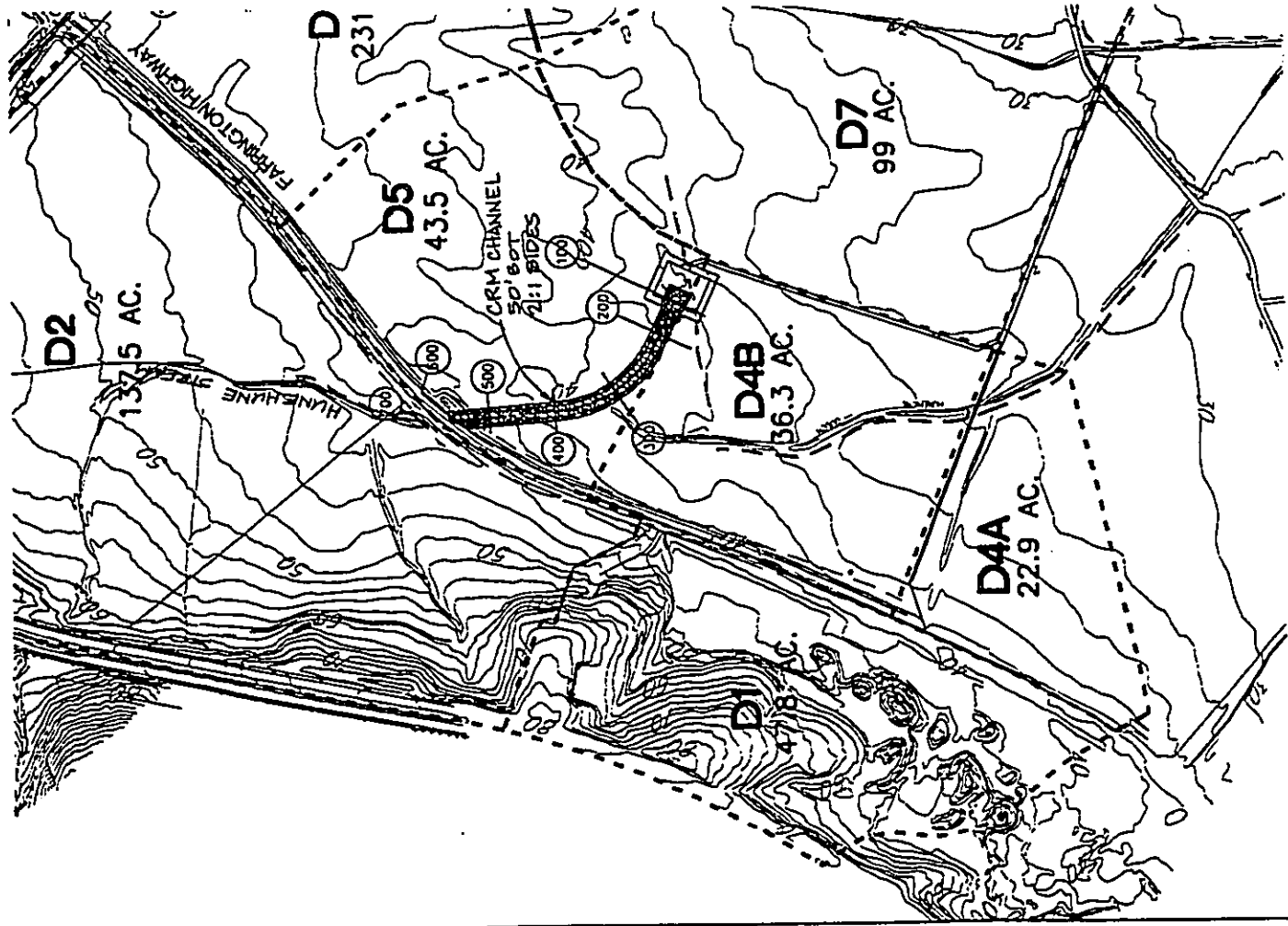




APPENDIX D
BACKBONE DRAINAGE SYSTEM HYDRAULIC SIZING

- ▲ HEC-2 Computations for CRM Channel
- ▲ Hunchue 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 XXXXX XXXX XXXX XX XXXX
 X X X X X X X X X X X X X X
 X X X X X X X X X X X X X X
 XXXXXX XXX XXX XXXX XXXX
 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: NAMEHERE
 Project File: namehere.prj
 Run Date and Time: 6/10/98 10:34:06 AM
 Project in English units
 Project Description:
 NAMEHERE STREAM-CON CHANNEL CONNECTING FARMINGTON RD AND BOX GRAIN
 PLATE 6 FLOOD PROFILE - (STARTING VELOCITY = 105.13, PER BOX DRAIN 1 HDR. CALC'S: (K-BODY.XLS)

PLAN DATA
 Plan Title: Imported Plan 01
 Plan File: c:\hrcras2\namehere.p01
 Geometry Title: Imported Geom 01
 Geometry File: c:\hrcras2\namehere.p01
 Flow Title: Imported Flow 01
 Flow File: c:\hrcras2\namehere.f01

Plan Summary Information:
 Number of: Cross Sections = 7 Multiple Openings = 0
 Culverts = 0 In-line Weirs = 0
 Bridges = 1

Computational Information
 Water surface calculation tolerance = 0.01
 Critical depth calculation tolerance = 0.01
 Maximum number of iterations = 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:\hrcras2\namehere.f01

Flow Data (cfs)

| River | Reach | SS | PF#1 |
|---------|---------|-----|------|
| RIVER-1 | Reach-1 | 700 | 1250 |
| RIVER-1 | Reach-1 | 100 | 1370 |

Boundary Conditions

| River | Reach | Profile | Upstream | Downstream |
|---------|---------|---------|----------|-------------------|
| RIVER-1 | Reach-1 | PF#1 | Critical | Known US = 105.13 |

Spillway height used in design
 Weir crest shape = Broad Crested

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data

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

| Sta | Elev | Sta | Elev | num | Sta | Elev | Sta | Elev |
|-----|-------|-----|-------|-----|-------|------|-------|-------|
| 0 | 163.7 | 0 | 139.3 | 6 | 131.3 | 66 | 131.3 | 82 |
| 82 | 163.7 | | | | | | | 139.3 |

Manning's n Values

| Sta | n Val | Sta | n Val | num | Sta | n Val |
|-----|-------|-----|-------|-----|------|-------|
| 0 | .025 | 0 | .025 | 82 | .025 | |

Bank Sta: Left 0 Right 82 Lengths: Left Channel 160 Right 100 Coeff Contr. .1 Expan. .3

CROSS SECTION RIVER: RIVER-1
 REACH: Reach-1 RS: 500

INPUT

Description: 500

Station Elevation Data

| Sta | Elev | Sta | Elev | num | Sta | Elev | Sta | Elev |
|-----|--------|-----|--------|-----|--------|------|--------|------|
| 0 | 137.18 | 16 | 129.18 | 66 | 129.18 | 82 | 137.18 | |

Manning's n Values

| Sta | n Val | Sta | n Val | num | Sta | n Val |
|-----|-------|-----|-------|-----|------|-------|
| 0 | .025 | 0 | .025 | 82 | .025 | |

Bank Sta: Left 0 Right 82 Lengths: Left Channel 275 Right 275 Coeff Contr. .1 Expan. .3

CROSS SECTION RIVER: RIVER-1
 REACH: Reach-1 RS: 400

INPUT

Description: 400

Station Elevation Data

| Sta | Elev | Sta | Elev | num | Sta | Elev | Sta | Elev |
|-----|--------|-----|--------|-----|--------|------|--------|------|
| 0 | 133.02 | 16 | 125.02 | 66 | 125.02 | 82 | 133.02 | |

Manning's n Values

| Sta | n Val | Sta | n Val | num | Sta | n Val |
|-----|-------|-----|-------|-----|------|-------|
| 0 | .025 | 0 | .025 | 82 | .025 | |

Bank Sta: Left 0 Right 82 Lengths: Left Channel 220 Right 260 Coeff Contr. .1 Expan. .3

CROSS SECTION RIVER: RIVER-1
 REACH: Reach-1 RS: 300

INPUT

Description: 300

Station Elevation Data

| Sta | Elev | Sta | Elev | num | Sta | Elev | Sta | Elev |
|-----|--------|-----|--------|-----|--------|------|--------|------|
| 0 | 129.39 | 16 | 121.39 | 66 | 121.39 | 82 | 129.39 | |

Manning's n Values

| Sta | n Val | num |
|-----|-------|-----|
| | | 3 |

GEOMETRY DATA

Geometry Title: Imported Geom 01

Geometry File: c:\hrcra2\hrcra2\geom01.g01

CROSS SECTION RIVER: RIVER-1
 REACH: Reach-1 RS: 700

INPUT

Description: 700

Station Elevation Data

| Sta | Elev | Sta | Elev | num | Sta | Elev | Sta | Elev |
|-----|-------|-----|--------|-----|--------|------|--------|--------|
| 0 | 163.7 | 0 | 139.44 | 16 | 131.44 | 66 | 131.44 | 82 |
| 82 | 163.7 | | | | | | | 139.44 |

Manning's n Values

| Sta | n Val | Sta | n Val | num | Sta | n Val |
|-----|-------|-----|-------|-----|------|-------|
| 0 | .025 | 0 | .025 | 82 | .025 | |

Bank Sta: Left 0 Right 82 Lengths: Left Channel 40 Right 40 Coeff Contr. .1 Expan. .3

BRIDGE REACH: Reach-1 RIVER: RIVER-1
 RS: 650

INPUT

Description: Bridge #1

Distance from Upstream XS = 0

Deck/Roadway Width = 40

Weir Coefficient = 2.6

Bridge Deck/Roadway Skew = 0

Upstream Deck/Roadway Coordinates

| Sta | MI Cord | Lo Cord | Sta | MI Cord | Lo Cord |
|-----|---------|---------|-----|---------|---------|
| 0 | 163.7 | 139.44 | 16 | 163.7 | 131.44 |
| 66 | 163.7 | 139.44 | 66 | 163.7 | 131.44 |
| 82 | 163.7 | 139.44 | 82 | 163.7 | 139.44 |

Downstream Bridge Cross Section Data

| Sta | Elev | Sta | Elev | num | Sta | Elev | Sta | Elev |
|-----|-------|-----|--------|-----|--------|------|--------|--------|
| 0 | 163.7 | 0 | 139.44 | 16 | 131.44 | 66 | 131.44 | 82 |
| 82 | 163.7 | | | | | | | 139.44 |

Manning's n Values

| Sta | n Val | Sta | n Val | num | Sta | n Val |
|-----|-------|-----|-------|-----|------|-------|
| 0 | .025 | 0 | .025 | 82 | .025 | |

Bank Sta: Left 0 Right 82 Coeff Contr. .1 Expan. .3

Downstream Deck/Roadway Coordinates

| Sta | MI Cord | Lo Cord | Sta | MI Cord | Lo Cord |
|-----|---------|---------|-----|---------|---------|
| 0 | 163.7 | 139.3 | 16 | 163.7 | 131.3 |
| 66 | 163.7 | 139.3 | 66 | 163.7 | 131.3 |
| 82 | 163.7 | 139.3 | 82 | 163.7 | 139.3 |

Downstream Bridge Cross Section Data

| Sta | Elev | Sta | Elev | num | Sta | Elev | Sta | Elev |
|-----|-------|-----|-------|-----|-------|------|-------|-------|
| 0 | 163.7 | 0 | 139.3 | 16 | 131.3 | 66 | 131.3 | 82 |
| 82 | 163.7 | | | | | | | 139.3 |

Manning's n Values

| Sta | n Val | Sta | n Val | num | Sta | n Val |
|-----|-------|-----|-------|-----|------|-------|
| 0 | .025 | 0 | .025 | 82 | .025 | |

Bank Sta: Left 0 Right 82 Coeff Contr. .1 Expan. .3

Downstream Embankment side slope

Downstream Embankment side slope = 0 horiz. to 1.0 vertical

Minimum allowable submergence for weir flow = .95

Elevation at which weir flow begins =

Energy head used in spillway design =



| Reach | River Sta. | Contr. | Expn. |
|---------|------------|--------|-------|
| Reach-1 | 700 | .1 | .3 |
| Reach-1 | 650 | Bridge | .3 |
| 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 |

Sta n Val sta n Val Sta n Val
 0 .025 0 .025 82 .025
 Bank Sta: Left Right Length: Left Channel Right Coeff Contr. Expn.
 0 82 280 290 300 .1 .3

CROSS SECTION
 REACH: Reach-1
 RIVER: RIVER-1
 RS: 200

INPUT
 Description: 200
 Station Elevation Data
 Sta Elev Sta Elev Sta Elev Sta Elev
 0 125 15 117 66 117 82 125
 Manning's n Values
 Sta n Val Sta n Val Sta n Val
 0 .025 0 .025 82 .025
 Bank Sta: Left Right Length: Left Channel Right Coeff Contr. Expn.
 0 82 150 150 150 .1 .3

CROSS SECTION
 REACH: Reach-1
 RIVER: RIVER-1
 RS: 100

INPUT
 Description: 100
 Station Elevation Data
 Sta Elev Sta Elev Sta Elev Sta Elev
 0 114 0 89.58 195 89.58 195 114
 Manning's n Values
 Sta n Val Sta n Val Sta n Val
 0 .025 0 .025 195 .025
 Bank Sta: Left Right Length: Left Channel Right Coeff Contr. Expn.
 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 | .025 | .025 |
| 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 |
| Reach-1 | 650 | Bridge | 100 |
| Reach-1 | 600 | 180 | 375 |
| Reach-1 | 500 | 275 | 540 |
| Reach-1 | 400 | 220 | 290 |
| Reach-1 | 300 | 280 | 150 |
| Reach-1 | 200 | 150 | 0 |
| Reach-1 | 100 | 0 | 0 |

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
 RIVER: RIVER-1

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 | | |
| D7 | 193.05 | |
| TOTAL | <u>98.91</u> | |
| | <u>700.32</u> | |
| BOX DRAIN #2 | | |
| A8 | 99.84 | |
| A7 | 8.96 | |
| D1 | 48.00 | |
| D4B | 36.25 | |
| TOTAL | <u>193.05</u> | |
| BOX DRAIN #3 | | |
| D4A | 22.89 | |
| D8 (NO ROAD, CHANNEL) | 152.30 | |
| TOTAL | <u>175.19</u> | |
| BOX DRAIN #4 | 34.00 | |
| D9 (NO ROAD, CHANNEL) | | |
| BOX DRAIN #5 | 26.00 | |
| D9 (NO ROAD, CHANNEL) | | |
| BOX DRAIN #6 | | |
| D6 (ABOVE COLL. RD. A) | 50.00 | |

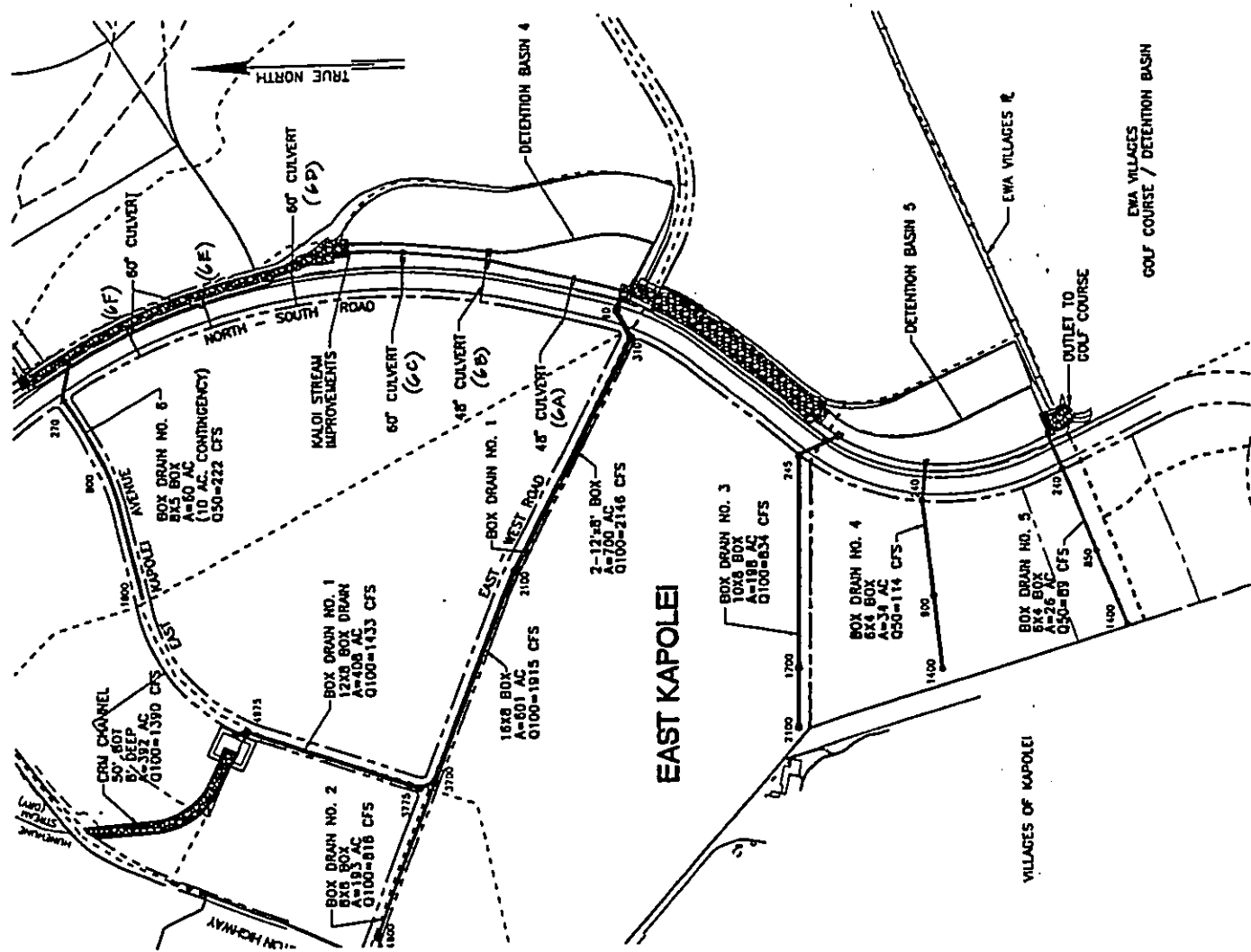
HUNEHUNE CRM CHANNEL PLATE 6 FLOOD PROFILE

6-18-98

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 | 0.002732 | 6.44 | 193.96 | 63.65 | 0.85 |
| Reach-1 | 650 | Bridge | | | | | | | | | | |
| Reach-1 | 600 | 1250.00 | 131.30 | 140.00 | 133.36 | 133.00 | 135.31 | 0.015329 | 11.22 | 111.43 | 58.24 | 1.43 |
| Reach-1 | 500 | 1250.00 | 129.16 | 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 NO. ROAD JLS | DATE | BY | AREA | TYPE | NAME | FE | LC | (10-YR) | (50-YR) | Peak | Over | Total | Cumulative | Phase | Page |
|-------------------------------|------|----|--------|------|----------------------------|------|------|---------|---------|-------|-------|-------|------------|--------|-------|
| FILE | DATE | BY | AREA | TYPE | NAME | FE | LC | (10-YR) | (50-YR) | (CFS) | (CFS) | (CFS) | (CFS) | (CFS) | (CFS) |
| BOX DRAIN #1 (East West Road) | | | | | | | | | | | | | | | |
| 0 | | | 700.26 | | | | | | | 0.0 | 0.0 | 0.0 | 2148.4 | 2148.4 | 5.5 |
| 90 | | | 700.26 | | | | | | | 0.0 | 0.0 | 0.0 | 2148.4 | 2148.4 | 5.5 |
| 210 | | | 700.26 | | DI | | | | WU | 0.0 | 0.0 | 0.0 | 2148.4 | 2148.4 | 8.0 |
| 2100 | | | 807.26 | | FROM BOX DRAIN #2 | | | | | 0.0 | 0.0 | 0.0 | 1915.0 | 1915.0 | 3.0 |
| 2700 | | | 808.26 | | | | | | | 0.0 | 0.0 | 0.0 | 1433.4 | 1433.4 | 8.0 |
| 2775 | | | 408.26 | | | | | | | 0.0 | 0.0 | 0.0 | 1433.4 | 1433.4 | 8.7 |
| 2975 | | | 408.26 | | | | | | | 0.0 | 0.0 | 0.0 | 1433.4 | 1433.4 | 8.7 |
| 3075 | | | 408.26 | | INLET AT CHANNEL | | | | | 0.0 | 0.0 | 0.0 | 1433.4 | 1433.4 | 8.7 |
| BOX DRAIN #2 (East West Road) | | | | | | | | | | | | | | | |
| 2700 | | | 133.00 | | ADD TO BOX DRAIN #1 | | | | | 26.2 | 0.0 | 0.0 | 818.0 | 818.0 | 7.0 |
| 2800 | | | 138.75 | | DRAIN | | | | | 138.8 | 0.0 | 0.0 | 700.1 | 700.1 | 4.8 |
| 3020 | | | | | DROP STRIKE INLET | | | | | | | | | | |
| BOX DRAIN #3 | | | | | | | | | | | | | | | |
| 0 | | | 108.00 | | OUTLET INTO KALOJI CHANNEL | | | | | 0.0 | 0.0 | 0.0 | 833.1 | 833.1 | 3.5 |
| 215 | | | 108.00 | | DATA FOR PROPOSED CULVERTS | | | | | 178.0 | 0.0 | 0.0 | 833.1 | 833.1 | 7.2 |
| 1700 | | | 21.00 | | (Kaloji Waterway) | 15.0 | 0.70 | 2.3 | 2.0 | 23.0 | 74.1 | 74.1 | 8.0 | 74.1 | 1.8 |
| 2100 | | | | | BEGIN CULVERT | | | | | | | | | | |



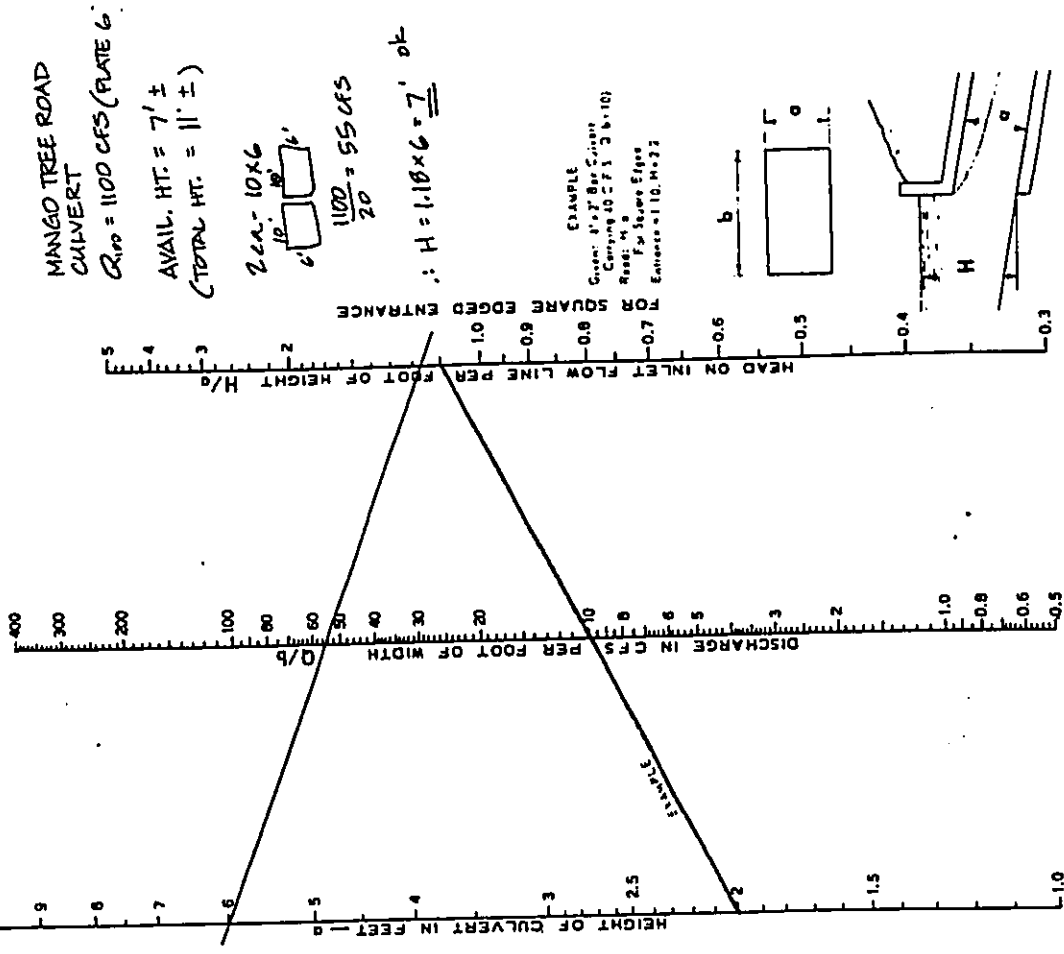
| FILE: EX-BOOKS.XLS | AREA | Total Area (sq) | DRY Flow Rate | TC | C | (30-YR) | A | Runoff | Over | Total | Cont'd | Phase 6 | Pipe | Ln | V | |
|---------------------|-------------------|-----------------|--|------|------|---------|------|--------|-------|-------|--------|---------|-------|------|------|--|
| DATE: 01/20/08 | NAME | (sq) | Rate | | | (CFS) | (sq) | (CFS) | (CFS) | (CFS) | (CFS) | (CFS) | (CFS) | (ft) | (ft) | |
| BOX DRAIN #1 | | | | | | | | | | | | | | | | |
| 0 | | 24.00 | OUTLET INTO KALDI CHANNEL | | | | | 0.0 | 0.0 | 112.4 | 0.0 | 112.4 | 2.7 | 27 | | |
| 240 | | 24.00 | PORT OF HWY ROAD CHANNEL | 15.0 | 0.70 | 2.3 | 2.0 | 25.0 | 30.3 | 30.3 | 112.4 | 0.0 | 112.4 | 2.8 | 27 | |
| 300 | (Kaldi Watershed) | 8.00 | PORT OF | 10.0 | 0.70 | 2.3 | 2.2 | 9.0 | 31.9 | 31.9 | 31.9 | 0.0 | 31.9 | 1.8 | 20 | |
| 3400 | (Kaldi Watershed) | | BEGIN CULVERT | | | | | | | | | | | | | |
| BOX DRAIN #2 | | | | | | | | | | | | | | | | |
| 0 | | 26.00 | OUTLET INTO KALDI CHANNEL | | | | | 0.0 | 0.0 | 88.6 | 0.0 | 88.6 | 1.7 | 37 | | |
| 240 | (Kaldi Watershed) | 26.00 | PORT OF HWY ROAD CHANNEL | 15.0 | 0.70 | 2.3 | 2.8 | 11.0 | 35.4 | 36.4 | 88.6 | 0.0 | 88.6 | 2.8 | 37 | |
| 320 | | 15.00 | PORT OF | 10.0 | 0.70 | 2.3 | 2.2 | 10.0 | 33.1 | 33.1 | 33.1 | 0.0 | 33.1 | 2.2 | 27 | |
| 3400 | (Kaldi Watershed) | | BEGIN CULVERT | | | | | | | | | | | | | |
| BOX DRAIN #3 | | | | | | | | | | | | | | | | |
| 0 | (Kaldi Watershed) | 80.00 | OUTLET INTO KALDI CHANNEL
(TOTAL ADDED FOR CONTINGENCY) | 10.0 | 0.70 | 2.3 | 2.3 | 16.7 | 61.7 | 61.7 | 222.2 | 0.0 | 222.2 | 2.8 | 38 | |
| 270 | (Kaldi Watershed) | 43.33 | | 10.0 | 0.70 | 2.3 | 2.3 | 21.7 | 30.2 | 30.2 | 100.5 | 0.0 | 100.5 | 3.3 | 32 | |
| 300 | | 21.67 | | 10.0 | 0.70 | 2.3 | 2.3 | 21.7 | 30.2 | 30.2 | 30.2 | 0.0 | 30.2 | 2.3 | 33 | |
| 3400 | (Kaldi Watershed) | | BEGIN CULVERT | | | | | | | | | | | | | |

| FILE: EX-BOOKS.XLS | Pipe Diam. or | Man. Dia. | L | n | SI | S | HW | HW | TR | MANHOLE LOSSES | | | | ENT. | H.C.L. | | FIN | FB |
|---------------------|---------------|-----------|------|-------|-------|-------|--------|--------|------|----------------|------|-------|-------|-------|--------|--------|-------------|---------------|
| DATE: 01/20/08 | (IN) | (IN) | NO | | | | ELEV | ELEV | IN | A | B | C | D | DOWN | DOWN | UP | CHL | (ft) |
| INLET | | | | | | | DOWN | UP | IN | | | | | DOWN | DOWN | UP | CHL | (ft) |
| BOX DRAIN #1 | | | | | | | | | | | | | | | | | | |
| 0 | | | | | | | 63.00 | | 0.27 | | | | | | 73.00 | 73.00 | 60.3 | |
| 30 | 2" | 12" X 8" | 80 | 0.013 | 0.005 | 0.005 | 62.34 | 62.34 | 0.83 | | | | 0.786 | | 73.36 | 73.36 | 60.3 | FOR 27 FB |
| 310 | 2" | 12" X 8" | 210 | 0.013 | 0.005 | 0.005 | 63.30 | 63.30 | 0.83 | | | | 1.221 | | 75.74 | 75.74 | 60.3 | FOR 36 FB |
| 2100 | 2" | 10" X 8" | 1780 | 0.013 | 0.005 | 0.005 | 72.00 | 72.00 | 0.50 | | | | | | 84.24 | 84.24 | 62.0 | FOR 67 FB |
| 2700 | 1" | 18" X 8" | 1800 | 0.013 | 0.005 | 0.004 | 72.00 | 72.00 | 7.41 | 0.068 | Open | | | | 81.72 | 84.31 | 62.0 | FOR 67 FB |
| 3700 | 1" | 12" X 8" | 70 | 0.013 | 0.005 | 0.005 | 82.71 | 82.71 | 0.40 | 0.001 | Open | 1.872 | 1.420 | | 95.10 | 94.70 | 105.0 | FOR 10 30 FB |
| 3775 | 1" | 12" X 8" | 75 | 0.013 | 0.005 | 0.005 | 83.08 | 83.08 | 0.37 | | | | 1.383 | | 96.88 | 96.88 | 105.0 | FOR 10 30 FB |
| 4375 | 1" | 12" X 8" | 1200 | 0.013 | 0.005 | 0.005 | 89.08 | 89.08 | 0.35 | | | | 1.361 | | 103.00 | 104.80 | 114.5 | FOR 9 87 FB |
| 5075 | 1" | 12" X 8" | 100 | 0.013 | 0.005 | 0.005 | 89.38 | 89.38 | 0.35 | | | | | 13.80 | 105.13 | 105.13 | 118.8 | FOR 11 48 FB |
| BOX DRAIN #2 | | | | | | | | | | | | | | | | | | |
| 3700 | | | | | | | 82.71 | | 3.48 | 0.064 | Open | | | | 94.70 | 94.70 | 105.0 | FOR 10 31 FB |
| 4800 | 1" | 8" X 8" | 1100 | 0.013 | 0.005 | 0.010 | 100.00 | 102.00 | 1.75 | 0.077 | Open | 0.497 | | | 104.22 | 106.58 | 121.7 | Open 15 14 FB |
| 5020 | | | | | | | 104.20 | 104.20 | | | | | | 13.80 | 118.00 | 126.8 | FOR 8 81 FB | |
| BOX DRAIN #3 | | | | | | | | | | | | | | | | | | |
| 0 | | | | | | | 58.30 | | 0.70 | | | | | | 63.18 | 74.9 | | |
| 245 | 1" | 10" X 8" | 1233 | 0.013 | 0.003 | 0.003 | 57.85 | 57.85 | 4.17 | | | | 0.672 | | 64.95 | 64.95 | 74.8 | Open 8 93 FB |
| 1700 | 1" | 8" X 8" | 400 | 0.013 | 0.000 | 0.005 | 61.00 | 63.00 | 0.08 | 0.162 | Open | | | | 68.20 | 76.0 | FOR 6 72 FB | |
| 2100 | | | | | | | 63.00 | 63.00 | | | | | | | 68.28 | 77.0 | FOR 7 84 FB | |

| FILE NO./DATE | AREA | Total Area | Flow | TE | L | (SQ-FT) | A | Flow | Flow | Total | Area | Area | Pipe | Flow | Flow |
|-------------------------------------|------------------------------|------------|------|----|------|---------|------|------|------|-------|------|------|------|------|------|
| DATE, M/S/YR | NAME | (SQ) | Name | | | (SQ) | (SQ) | (SQ) | (SQ) | (SQ) | (SQ) | (SQ) | (SQ) | (SQ) | (SQ) |
| DRAINAGE AREA, CULVERT, IN PROGRESS | | | | | | | | | | | | | | | |
| OUTLET | | 8.70 | | 10 | 0.80 | 2.3 | 2.3 | 2.3 | 12.3 | 12.3 | 26.9 | | 26.9 | 1.5 | 2.9 |
| ORBIT | HYPOTHETICAL | | | 10 | 0.80 | 2.3 | 2.3 | 2.3 | 12.3 | 11.2 | 24.3 | | 24.3 | 2.0 | 2.9 |
| ORBIT | LENGTH OF PIPE AND MANHOLES | 2.80 | | 10 | 0.80 | 2.3 | 2.3 | 2.3 | 12.3 | 12.3 | 22.3 | | 22.3 | 1.5 | 1.7 |
| ORBIT | FOR ESTIMATING PURPOSES ONLY | | | | | | | | | | | | | | |
| DRAINAGE AREA, CULVERT, IN PROGRESS | | | | | | | | | | | | | | | |
| OUTLET | | 8.70 | | 10 | 0.80 | 2.3 | 2.3 | 2.3 | 12.3 | 12.3 | 26.9 | | 26.9 | 1.5 | 2.9 |
| ORBIT | HYPOTHETICAL | | | 10 | 0.80 | 2.3 | 2.3 | 2.3 | 12.3 | 12.3 | 24.3 | | 24.3 | 2.0 | 2.9 |
| ORBIT | LENGTH OF PIPE AND MANHOLES | 2.80 | | 10 | 0.80 | 2.3 | 2.3 | 2.3 | 12.3 | 12.3 | 22.3 | | 22.3 | 1.5 | 1.7 |
| ORBIT | FOR ESTIMATING PURPOSES ONLY | | | | | | | | | | | | | | |
| DRAINAGE AREA, CULVERT, IN PROGRESS | | | | | | | | | | | | | | | |
| OUTLET | | 17.40 | | 10 | 0.80 | 2.3 | 2.3 | 2.3 | 24.3 | 24.3 | 72.8 | | 72.8 | 2.5 | 3.4 |
| ORBIT | HYPOTHETICAL | | | 10 | 0.80 | 2.3 | 2.3 | 2.3 | 24.3 | 24.3 | 48.1 | | 48.1 | 2.0 | 3.4 |
| ORBIT | LENGTH OF PIPE AND MANHOLES | 3.80 | | 10 | 0.80 | 2.3 | 2.3 | 2.3 | 24.3 | 24.3 | 48.1 | | 48.1 | 2.0 | 3.4 |
| ORBIT | FOR ESTIMATING PURPOSES ONLY | | | | | | | | | | | | | | |

| FILE NO./DATE | Pipe Dia. or | Box Dia. | L | A | B | S | RV. | RV. | IR | MANHOLE LOSSES | | | | ENT. | ENT. | ENT. | FB |
|---------------|--------------|----------|------|------|-------|-------|------------|----------|--------|----------------|---|---|---|--------------|--------|-------|-------------|
| DATE, M/S/YR | (IN) | (IN) | (FT) | (SQ) | (SQ) | (SQ) | ELEV. DOWN | ELEV. UP | (%) | A | B | C | D | CORR. | DOWN | UP | (%) |
| BOX DRAIN #4 | | | | | | | | | | | | | | | | | |
| 0 | | | | | | | 83.50 | | | | | | | | 83.50 | 83.5 | |
| 740 | 1 - | 8 X 4 | 4 | 240 | 0.013 | 0.001 | 0.005 | 84.80 | 84.80 | 0.22 | | | | 0.016 | 84.56 | 84.5 | FOR 2.0778 |
| 800 | 1 - | 8 X 4 | 4 | 840 | 0.013 | 0.001 | 0.002 | 86.00 | 86.00 | 0.87 | | | | 0.028 Excess | 85.13 | 85.1 | FOR 2.2278 |
| 1400 | 1 - | 8 X 4 | 4 | 300 | 0.013 | 0.000 | 0.002 | 88.00 | 88.00 | 0.15 | | | | | 87.85 | 87.8 | FOR 2.0278 |
| BOX DRAIN #5 | | | | | | | | | | | | | | | | | |
| 0 | | | | | | | 81.50 | | | | | | | | 81.50 | 81.5 | |
| 740 | 1 - | 8 X 4 | 4 | 240 | 0.013 | 0.001 | 0.005 | 82.80 | 82.80 | 0.20 | | | | 0.020 Excess | 82.60 | 82.6 | FOR 2.0778 |
| 800 | 1 - | 8 X 4 | 4 | 610 | 0.013 | 0.001 | 0.001 | 83.00 | 83.00 | 0.30 | | | | 0.033 | 82.70 | 82.7 | FOR 2.1878 |
| 1400 | 1 - | 8 X 4 | 4 | 350 | 0.013 | 0.000 | 0.001 | 83.50 | 83.50 | 0.15 | | | | | 83.35 | 83.3 | FOR 2.1478 |
| BOX DRAIN #6 | | | | | | | | | | | | | | | | | |
| 0 | | | | | | | 112.00 | | | | | | | | 112.00 | 112.0 | |
| 270 | 1 - | 8 X 4 | 3 | 210 | 0.013 | 0.001 | 0.005 | 113.30 | 113.30 | 0.24 | | | | 0.024 Excess | 113.06 | 113.0 | FOR 12.2378 |
| 800 | 1 - | 8 X 4 | 3 | 330 | 0.013 | 0.001 | 0.002 | 114.30 | 114.30 | 0.77 | | | | 0.027 Excess | 113.53 | 113.5 | FOR 11.2278 |
| 1800 | 1 - | 8 X 4 | 4 | 1800 | 0.013 | 0.001 | 0.002 | 117.00 | 117.00 | 0.87 | | | | | 116.13 | 116.1 | FOR 10.7878 |

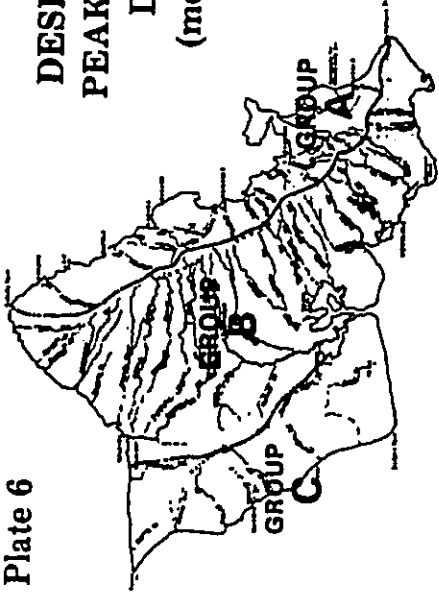
NOMOGRAPH FOR BOX CULVERTS WITH ENTRANCE CONTROL
PLATE 20



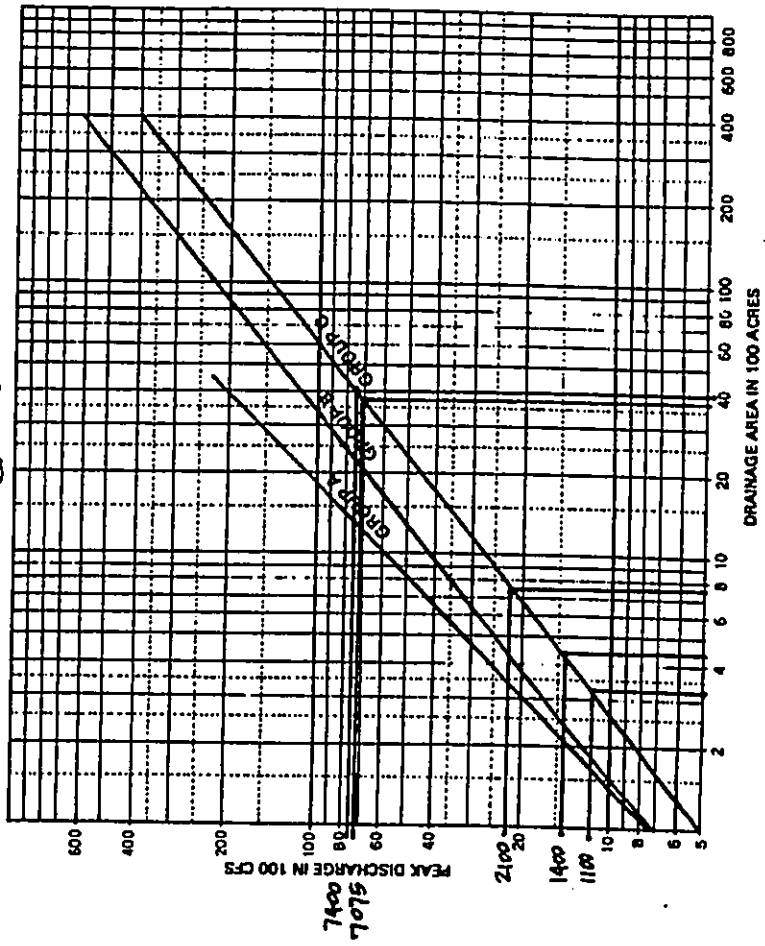
| PRE-EX-CULVERTS | Pipe Dia. or Section | L | n | S | R | K ₁ | K ₂ | K ₃ | K ₄ | MINOR LOSSES | | | | ENT. LOSS | CORR. LOSS | TOTAL LOSS | H ₁ | H ₂ |
|-----------------|----------------------|-----|-------|-------|-------|----------------|----------------|----------------|----------------|--------------|-------|-------|-------|-----------|------------|------------|----------------|----------------|
| | | | | | | | | | | A | B | C | D | | | | | |
| INLET | 1 | 100 | 1.49 | 0.015 | 1.49 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 112.4 | 112.4 |
| OUTLET | 1 | 60 | 0.015 | 0.001 | 0.001 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 112.4 | 112.4 |
| CHURN | 1 | 48 | 0.015 | 0.001 | 0.001 | 1.18 | 1.18 | 1.18 | 1.18 | 1.18 | 1.18 | 1.18 | 1.18 | 1.18 | 1.18 | 1.18 | 112.4 | 112.4 |
| CHURN | 1 | 36 | 0.015 | 0.001 | 0.001 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 112.4 | 112.4 |
| CHURN | 1 | 24 | 0.015 | 0.001 | 0.001 | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 | 112.4 | 112.4 |
| CHURN | 1 | 18 | 0.015 | 0.001 | 0.001 | 2.25 | 2.25 | 2.25 | 2.25 | 2.25 | 2.25 | 2.25 | 2.25 | 2.25 | 2.25 | 2.25 | 112.4 | 112.4 |
| CHURN | 1 | 12 | 0.015 | 0.001 | 0.001 | 2.70 | 2.70 | 2.70 | 2.70 | 2.70 | 2.70 | 2.70 | 2.70 | 2.70 | 2.70 | 2.70 | 112.4 | 112.4 |
| CHURN | 1 | 6 | 0.015 | 0.001 | 0.001 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 112.4 | 112.4 |
| CHURN | 1 | 3 | 0.015 | 0.001 | 0.001 | 10.80 | 10.80 | 10.80 | 10.80 | 10.80 | 10.80 | 10.80 | 10.80 | 10.80 | 10.80 | 10.80 | 112.4 | 112.4 |

Plate 6

**DESIGN CURVES FOR
PEAK DISCHARGE VS.
DRAINAGE AREA
(more than 100 acres)**



• CURVES ARE FOR
STREAM CHANNELS
AND DRAINAGE STRUCTURES.



**APPENDIX E
CITY & COUNTY PLATE 6 DISCHARGES**

PLATE 6

EWA VILLAGES
DRAINAGE MASTER PLAN

Ewa, Oahu, Hawaii



Kenneth I. Yamada
Kenneth I. 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

APPENDIX F

RELATED DRAINAGE MASTER PLANS

- ▶ Ewa Villages Drainage Master Plan
- ▶ Kapolei Village Drainage Master Plan

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.

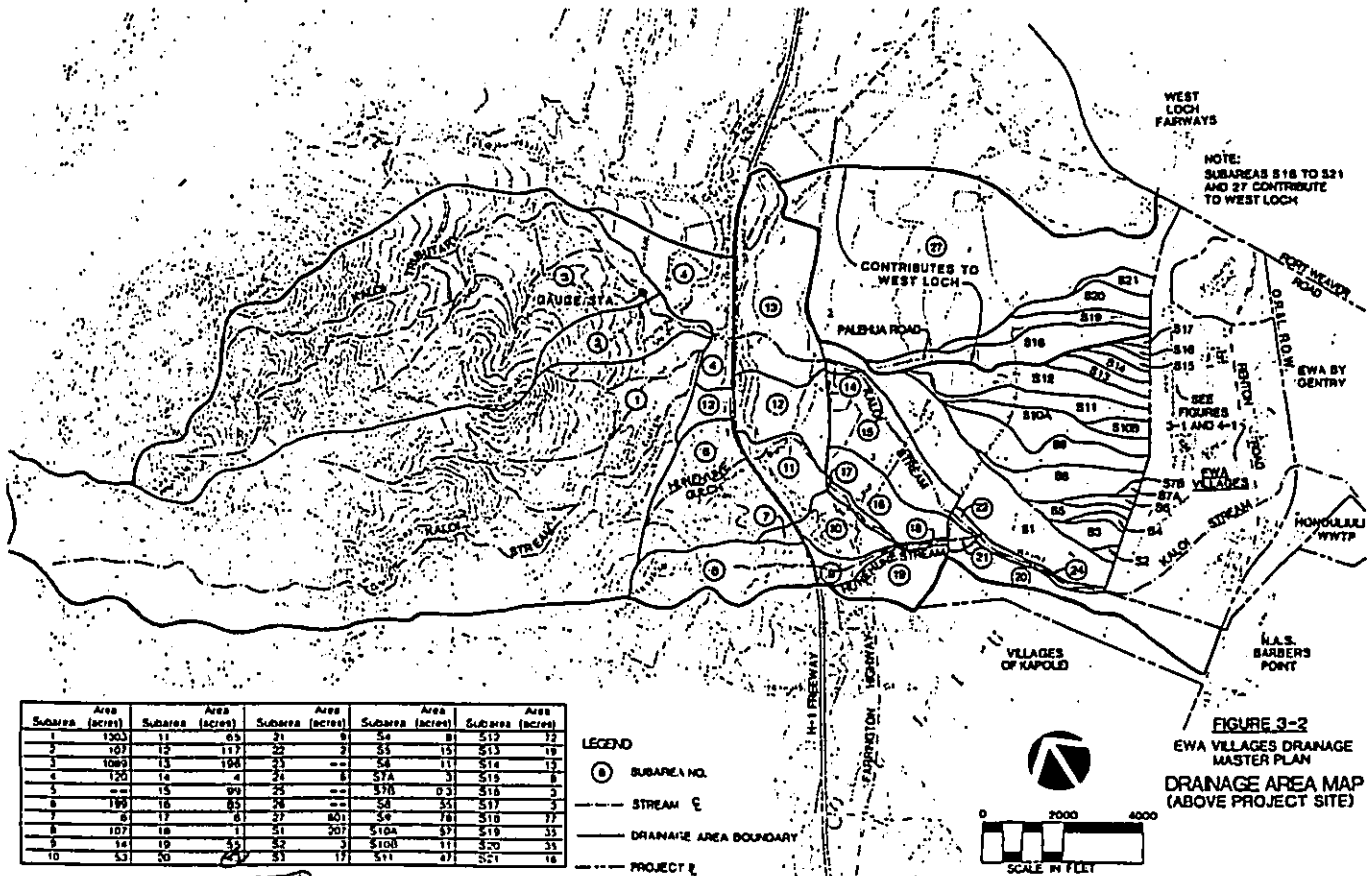
To carry out the plan, "regional" facilities are proposed to address off-site runoff and mitigate flooding from Kaloi Stream. "Backbone" facilities are proposed to address on-site generated runoff and feeds into the regional facilities. The street drainage systems within each of the development parcels 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.



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

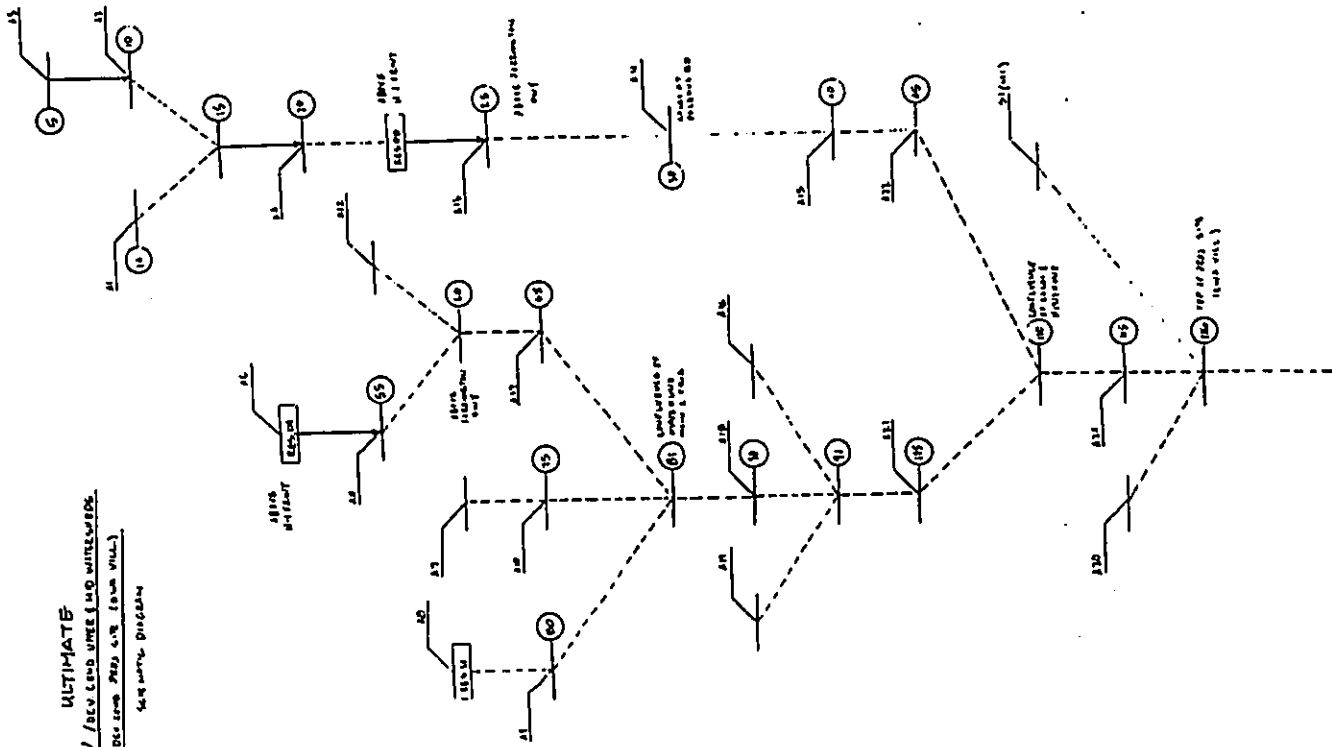
The backbone system consists of major pipe and box culverts which convey on-site generated runoff from the subdivision systems, as well as a portion of the golf course, to the OR&L Railroad bridge. The middle portion of the golf course below Subdivision "B" does not accept any off-site runoff and is 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.

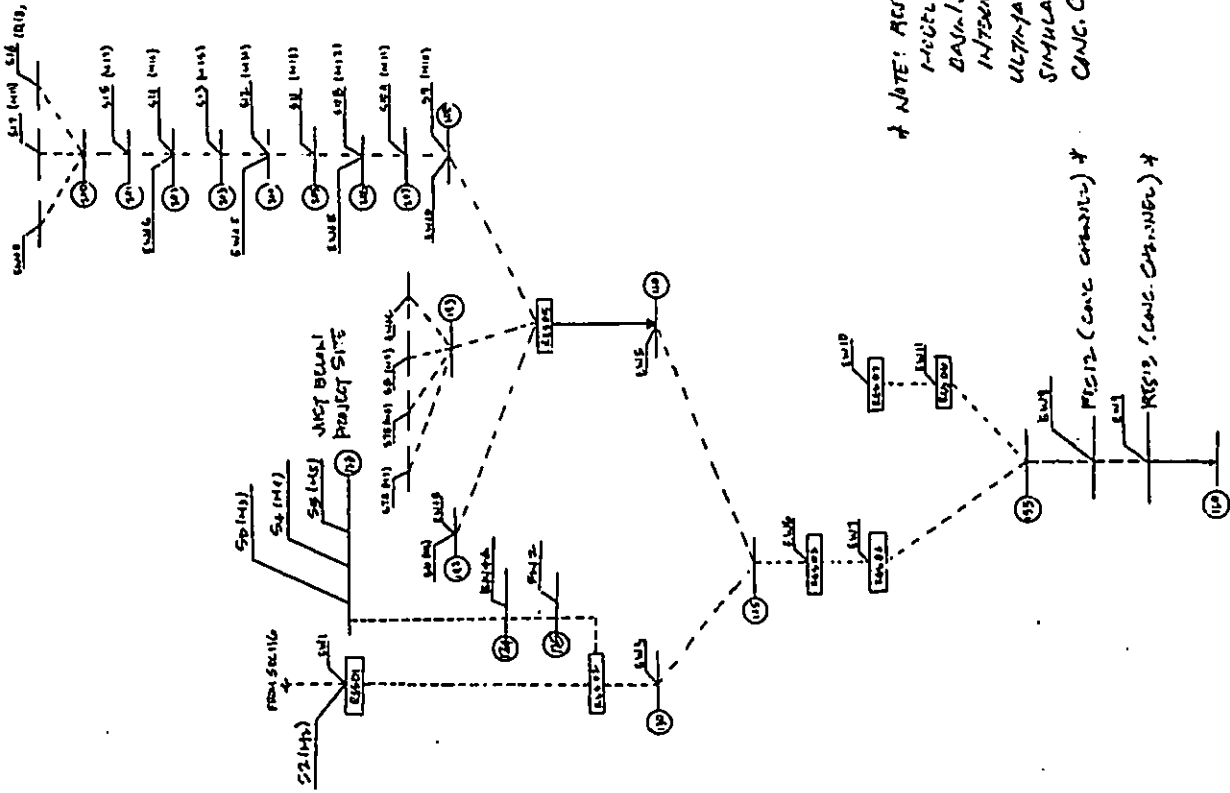
APPENDIX D

REGIONAL HYDROLOGY FOR ULTIMATE CONDITIONS

ULTIMATE
DCU / DCU END UNITS (NO WIRELAYS)
 DCU END UNITS (NO WIRELAYS)
 Sequence Diagram



10/12



* NOTE: ACQUISITION
 MODELED AS
 BASED ON
 INTERMEDIATE PHASE
 SIMULATED AS
 CONC. CHANNEL

10/24/93

MS12 (CONC. CHANNEL) *
 MS13 (CONC. CHANNEL) *

U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616

FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT SIZE VERSION) - FEB 1, 1985

HEC-1 ANALYSIS - KALO1
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

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10.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
ID EIA VILLAGES PROJECT FLOOD (100-YEAR STORM)
ID PM: 1100-HEC (BRIDGE AT ORAL ROW)
ID PROJECT CONDITIONS: UPPER WATERSHED - DEVELOPED CONDITIONS
ID (ULTIMATE) EIA VILLAGES - DEVELOPED CONDITIONS
ID KALO1 - MAINLINE NETWORK MODE (10/17/93)
DIAGRAM 5 01JAN93 1200 300
ID 5
ID 5
KC A3 GENERATE HYDROGRAPH FROM SUBBASIN A3 TO SEC05
UPPERMOST WATERSHED PRECIPITATION DATA
BA 1.701 .69 1.40 2.60 3.70 4.75 6.85 9.30 12.70
PH 0 .68
LS 1.206
UD 1.206
KC SEC10 ROUTE KALO1 TRIBUTARY FLOW FROM SEC05 TO SEC10
KALO1 STREAM ABOVE CONFLUENCE OF MAIN AND TRIBUTARY
KS 1 FLOW 0
RC 0.035 .035 0.035 220 0.024 220
RX 0 150 155 165 180 190 195 520
RY 220 218 215 208 208 218 218 220
KC A2 GENERATE HYDROGRAPH FROM SUBBASIN A2 TO SEC10
UPPERMOST WATERSHED PRECIPITATION DATA
BA 0.167 .69 1.40 2.60 3.70 4.75 6.85 9.30 12.70
PH 0 .66
LS 0.390
UD 0.390
KC SEC10 COMBINE HYDROGRAPHS AT SEC10
KC A1 GENERATE HYDROGRAPH FROM SUBBASIN A1 TO SEC16
UPPERMOST WATERSHED PRECIPITATION DATA
BA 2.036 .69 1.40 2.60 3.70 4.75 6.85 9.30 12.70
PH 0 .70
LS 1.434
UD 1.434
KC SEC15 COMBINE HYDROGRAPHS AT SEC15
KC SEC20 ROUTE KALO1 TRIBUTARY FLOW FROM SEC15 TO SEC20
KS 2 FLOW 0
RC .035 .035 200 0.025 207
RX 0 160 180 190 205 240 400 550
RY 215 215 215 194 194 207 210 215
UD MEC-1 INPUT

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PAGE 2

1

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48 KC A4 GENERATE HYDROGRAPH FROM SUBBASIN A4 TO SEC20
49 KC UPPER WATERSHED PRECIPITATION DATA
50 BA 0.188 .66 1.35 2.50 3.60 4.65 6.80 9.25 12.30
51 PH 0 .66
52 LS 0
53 UD 0.450

```

HEC-1 INPUT PAGE 2

```

58 KC RES06 ROUTE FLOW FROM SEC20 THROUGH RES06
59 KS 1 ELEV 193.5
60 SV 0 0.1 0.8 3.1 6.9 12.1 18.8 28.5 34.1
61 SE 193.5 200 202 204 206 208 210 212 215
62 SO 0 500 725 944 1285 2099 3121 3541 3904
63 SE 193.5 200 202 204 206 208 210 212 215
64 KC SEC25 ROUTE KALO1 TRIBUTARY FLOW FROM RES06 TO SEC25
65 KS 2 FLOW 0
66 RC .035 .035 2350 0.013 165
67 RX 0 270 330 340 355 640 700 900
68 RT 170 165 165 158 158 165 167 170
69 KC A13 GENERATE HYDROGRAPH FROM SUBBASIN A13 TO SEC25
70 KC UPPERMOST WATERSHED PRECIPITATION DATA
71 BA 0.307 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
72 PH 0 .79
73 LS 0
74 UD 0.290
75 KC SEC25 COMBINE HYDROGRAPHS AT SEC25
76 KC A16 GENERATE HYDROGRAPH FROM SUBBASIN A16 TO SEC30
77 KC UPPERMOST WATERSHED PRECIPITATION DATA
78 BA 0.007 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
79 PH 0 .78
80 LS 0.050
81 UD 0.050
82 KC SEC30 COMBINE HYDROGRAPHS AT SEC30
83 KC A22 GENERATE HYDROGRAPH FROM SUBBASIN A22 TO SEC45
84 KC UPPERMOST WATERSHED PRECIPITATION DATA
85 BA 0.155 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
86 PH 0 .68
87 LS 0.270
88 UD 0.270
89 KC SEC40 COMBINE HYDROGRAPHS AT SEC40
90 KC A22 GENERATE HYDROGRAPH FROM SUBBASIN A22 TO SEC45
91 KC UPPERMOST WATERSHED PRECIPITATION DATA
92 BA 0.003 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30
93 PH 0 .85
94 LS 0.050
95 UD 0.050

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PAGE 3

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LINE

229
230
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KK SEC01
KN
KC

COMBINE HYDROGRAPHS AT SEC01
3

232
233
234
235
236
237
238

KK A21
KN
KN
KN
KN
KN
KN
KN

GENERATE HYDROGRAPH FROM SUBBASIN A21 TO SEC105
MID-WATERSHED PRECIPITATION DATA
0.016
0.016
0.016
0.016
0.016
0.016
0.016

240
241
242
243
244
245

KK SEC105
KN
KN
KN
KN
KN
KN
KN

COMBINE HYDROGRAPHS AT SEC105
2
0.060
0.060
0.060
0.060
0.060
0.060
0.060

246
247
248
249
250
251
252

KK A24
KN
KN
KN
KN
KN
KN
KN

GENERATE HYDROGRAPH FROM SUBBASIN A24 TO SEC115
MID-WATERSHED PRECIPITATION DATA
0.010
0.010
0.010
0.010
0.010
0.010
0.010

253
254
255

KK SEC115
KN
KN
KN
KN
KN
KN
KN

COMBINE HYDROGRAPHS AT SEC115
2
0.100
0.100
0.100
0.100
0.100
0.100
0.100

256
257
258
259
260
261
262

KK A20
KN
KN
KN
KN
KN
KN
KN

GENERATE HYDROGRAPH FROM SUBBASIN A20 TO SEC125
MID-WATERSHED PRECIPITATION DATA
0.067
0.067
0.067
0.067
0.067
0.067
0.067

263
264
265
266
267
268
269

KK S1
KN
KN
KN
KN
KN
KN
KN

GENERATE HYDROGRAPH FROM SUBBASIN S1 TO SEC118
MID-WATERSHED PRECIPITATION DATA
0.324
0.324
0.324
0.324
0.324
0.324
0.324

270
271
272

KK SEC116
KN
KN
KN
KN
KN
KN
KN

COMBINE HYDROGRAPHS AT SEC116 (TOP OF PROJECT SITE - KALOJI DALCHI)
3
0.220
0.220
0.220
0.220
0.220
0.220
0.220

273
274
275
276
277
278
279

KK S2
KN
KN
KN
KN
KN
KN
KN

GENERATE HYDROGRAPH FROM SUBBASIN S2 TO RES01
MID-WATERSHED PRECIPITATION DATA
0.004
0.004
0.004
0.004
0.004
0.004
0.004

280
281
282
283
284
285
286

KK EV1
KN
KN
KN
KN
KN
KN
KN

GENERATE HYDROGRAPH FROM SUBBASIN EV1 TO RES01
EVA VILLAGES PRECIPITATION DATA
0.029
0.029
0.029
0.029
0.029
0.029
0.029

287
288
289

KK RES01
KN
KN
KN
KN
KN
KN
KN

COMBINE HYDROGRAPHS AT RES01
3
0.070
0.070
0.070
0.070
0.070
0.070
0.070

290
291
292
293
294
295
296

KK RES01
KN
KN
KN
KN
KN
KN
KN

ROUTE FLOW FROM SEC116 THROUGH RES01
1
ELEV
40
6.0
8.2
11.8
16.4
22.2
29.1
37.2
46.2
60.9

297
298
299
300
301
302
303

KK S3
KN
KN
KN
KN
KN
KN
KN

GENERATE HYDROGRAPH FROM SUBBASIN S3 TO SEC123
MID-WATERSHED PRECIPITATION DATA
0.027
0.027
0.027
0.027
0.027
0.027
0.027

304
305
306
307
308
309
310

KK S4
KN
KN
KN
KN
KN
KN
KN

GENERATE HYDROGRAPH FROM SUBBASIN S4 TO SEC123
MID-WATERSHED PRECIPITATION DATA
0.012
0.012
0.012
0.012
0.012
0.012
0.012

311
312
313
314
315
316

KK S5
KN
KN
KN
KN
KN
KN
KN

GENERATE HYDROGRAPH FROM SUBBASIN S5 TO SEC123
MID-WATERSHED PRECIPITATION DATA
0.023
0.023
0.023
0.023
0.023
0.023
0.023

317
318
319
320

KK SEC123
KN
KN
KN
KN
KN
KN
KN

COMBINE HYDROGRAPHS AT SEC123
3
0.140
0.140
0.140
0.140
0.140
0.140
0.140

321
322
323
324
325
326
327

KK EV2
KN
KN
KN
KN
KN
KN
KN

GENERATE HYDROGRAPH FROM SUBBASIN EV2 TO SEC124
EVA VILLAGES PRECIPITATION DATA
0.006
0.006
0.006
0.006
0.006
0.006
0.006

328
329
330

KK SEC124
KN
KN
KN
KN
KN
KN
KN

COMBINE HYDROGRAPHS AT SEC124
2
0.071
0.071
0.071
0.071
0.071
0.071
0.071

331
332
333
334
335
336
337

KK EV2
KN
KN
KN
KN
KN
KN
KN

GENERATE HYDROGRAPH FROM SUBBASIN EV2 TO SEC125
EVA VILLAGES PRECIPITATION DATA
0.030
0.030
0.030
0.030
0.030
0.030
0.030

338
339
340

KK SEC125
KN
KN
KN
KN
KN
KN
KN

COMBINE HYDROGRAPHS AT SEC125
2
0.134
0.134
0.134
0.134
0.134
0.134
0.134

341
342
343

KK RES02
KN
KN
KN
KN
KN
KN
KN

COMBINE HYDROGRAPHS AT RES02
2
0.029
0.029
0.029
0.029
0.029
0.029
0.029

344
345
346
347
348
349
350

KK RES02
KN
KN
KN
KN
KN
KN
KN

ROUTE FLOW FROM RES01 THROUGH RES02
1
ELEV
39
10.2
13.5
17.6
22.6
28.4
35.0
42.7
51.6
67.1

351
352
353

KK RES01
KN
KN
KN
KN
KN
KN
KN

COMBINE HYDROGRAPHS AT RES01
3
0.070
0.070
0.070
0.070
0.070
0.070
0.070

354
355
356
357
358
359
360

KK RES01
KN
KN
KN
KN
KN
KN
KN

COMBINE HYDROGRAPHS AT RES01
3
0.070
0.070
0.070
0.070
0.070
0.070
0.070

| LINE | CODE | DESCRIPTION | PRECIPITATION | TIME | PRECIPITATION | TIME | PRECIPITATION | TIME |
|------|------|---------------------------------------|---------------|------|---------------|------|---------------|----------------------|
| 351 | KK | EMC | | | | | | |
| 352 | KN | GENERATE HYDROGRAPH FROM SUBBASIN S17 | | | | | | |
| 353 | KN | MID-WATERSHED PRECIPITATION DATA | | | | | | |
| 354 | BA | 0.004 | 0.004 | 0.65 | 1.32 | 2.45 | 3.55 | 4.60 6.75 9.20 12.30 |
| 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 | | | | | | |
| 358 | UD | 0.040 | | | | | | |
| 359 | UD | 0.040 | | | | | | |
| 360 | UD | 0.040 | | | | | | |
| 361 | UD | 0.040 | | | | | | |
| 362 | UD | 0.040 | | | | | | |
| 363 | UD | 0.040 | | | | | | |
| 364 | UD | 0.040 | | | | | | |
| 365 | UD | 0.040 | | | | | | |
| 366 | UD | 0.040 | | | | | | |
| 367 | UD | 0.040 | | | | | | |
| 368 | UD | 0.040 | | | | | | |
| 369 | UD | 0.040 | | | | | | |
| 370 | UD | 0.040 | | | | | | |
| 371 | UD | 0.040 | | | | | | |
| 372 | UD | 0.040 | | | | | | |
| 373 | UD | 0.040 | | | | | | |
| 374 | UD | 0.040 | | | | | | |
| 375 | UD | 0.040 | | | | | | |
| 376 | UD | 0.040 | | | | | | |
| 377 | UD | 0.040 | | | | | | |
| 378 | UD | 0.040 | | | | | | |
| 379 | UD | 0.040 | | | | | | |
| 380 | UD | 0.040 | | | | | | |
| 381 | UD | 0.040 | | | | | | |
| 382 | UD | 0.040 | | | | | | |
| 383 | UD | 0.040 | | | | | | |
| 384 | UD | 0.040 | | | | | | |
| 385 | UD | 0.040 | | | | | | |
| 386 | UD | 0.040 | | | | | | |
| 387 | UD | 0.040 | | | | | | |
| 388 | UD | 0.040 | | | | | | |
| 389 | UD | 0.040 | | | | | | |
| 390 | UD | 0.040 | | | | | | |
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| 392 | UD | 0.040 | | | | | | |
| 393 | UD | 0.040 | | | | | | |
| 394 | UD | 0.040 | | | | | | |
| 395 | UD | 0.040 | | | | | | |
| 396 | UD | 0.040 | | | | | | |
| 397 | UD | 0.040 | | | | | | |
| 398 | UD | 0.040 | | | | | | |
| 399 | UD | 0.040 | | | | | | |
| 400 | UD | 0.040 | | | | | | |
| 401 | UD | 0.040 | | | | | | |
| 402 | UD | 0.040 | | | | | | |
| 403 | UD | 0.040 | | | | | | |
| 404 | UD | 0.040 | | | | | | |
| 405 | UD | 0.040 | | | | | | |
| 406 | UD | 0.040 | | | | | | |
| 407 | UD | 0.040 | | | | | | |
| 408 | UD | 0.040 | | | | | | |
| 409 | UD | 0.040 | | | | | | |

472
473
474
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```
BA 0.022 0.022 .64 1.30 2.41 3.50 4.55 6.70 9.10 12.20  
PH 0 80  
LS 0 80  
LD 0.167  
10.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
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534
535
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537

KK
KN
KW
MC

```
CC SEC206  
KN 3  
MC 3  
CC REE05  
KN 3  
MC 3  
CC REE05  
KN 3  
MC 3  
CC REE05  
KN 3  
MC 3  
CC REE05  
KN 3  
MC 3  
CC REE05  
KN 3  
MC 3  
CC REE05  
KN 3  
MC 3
```

534
535
536
537

KK
KN
KW
MC

```
CC SEC140  
KN 10 FLOW 0 950 0.012 50 300 330  
MC 0 .035 -.035 .205 255 285 300 50 60  
KN 0 90 180 32 40 50 60  
LD 0.098
```

534
535
536
537

KK
KN
KW
MC

```
CC SEC145  
KN 2  
MC 2  
CC SEC145  
KN 2  
MC 2  
CC SEC145  
KN 2  
MC 2  
CC SEC145  
KN 2  
MC 2  
CC SEC145  
KN 2  
MC 2
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534
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536
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KK
KN
KW
MC

```
CC SEC140  
KN 10 FLOW 0 950 0.012 50 300 330  
MC 0 .035 -.035 .205 255 285 300 50 60  
KN 0 90 180 32 40 50 60  
LD 0.098
```

534
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537

KK
KN
KW
MC

```
CC SEC140  
KN 10 FLOW 0 950 0.012 50 300 330  
MC 0 .035 -.035 .205 255 285 300 50 60  
KN 0 90 180 32 40 50 60  
LD 0.098
```

534
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536
537

KK
KN
KW
MC

```
CC SEC140  
KN 10 FLOW 0 950 0.012 50 300 330  
MC 0 .035 -.035 .205 255 285 300 50 60  
KN 0 90 180 32 40 50 60  
LD 0.098
```

534
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536
537

KK
KN
KW
MC

```
CC SEC140  
KN 10 FLOW 0 950 0.012 50 300 330  
MC 0 .035 -.035 .205 255 285 300 50 60  
KN 0 90 180 32 40 50 60  
LD 0.098
```

534
535
536
537

KK
KN
KW
MC

```
CC SEC140  
KN 10 FLOW 0 950 0.012 50 300 330  
MC 0 .035 -.035 .205 255 285 300 50 60  
KN 0 90 180 32 40 50 60  
LD 0.098
```

534
535
536
537

KK
KN
KW
MC

477
478
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482
483

```
KN 0.113 0.113 .65 1.32 2.45 3.55 4.60 6.75 9.20 12.30  
PH 0 80  
LS 0 80  
LD 0.340
```

538
539
540
541

KK
KN
KW
MC

```
CC SEC204  
KN 3  
MC 3  
CC SEC204  
KN 3  
MC 3  
CC SEC204  
KN 3  
MC 3  
CC SEC204  
KN 3  
MC 3  
CC SEC204  
KN 3  
MC 3
```

538
539
540
541

KK
KN
KW
MC

```
CC SEC206  
KN 3  
MC 3  
CC SEC206  
KN 3  
MC 3  
CC SEC206  
KN 3  
MC 3  
CC SEC206  
KN 3  
MC 3  
CC SEC206  
KN 3  
MC 3
```

538
539
540
541

KK
KN
KW
MC

```
CC SEC206  
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592 LS 0 B6
593 LD 0.001
594 RES04
595 KK COMBINE HYDROGRAPHS AT RES04
596 KN MC 2
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598 KK RES04
599 RN 1
600 RS 1 ELEV 23
601 SV 0 20.5 31.8 36.1 42.6 47.3 52.2 57.4 60.0 62.8
602 SE 23 31.5 35 36 37 38 39 40 40.5 41
603 SO 0 0 127 324 1164 2509 4199 6171 7251 8390
604 SE .23 31.5 35 36 37 38 39 40 40.5 41
605
606 KK EV10
607 RN 1
608 RS 1 ELEV 23
609 SV 0 20.5 31.8 36.1 42.6 47.3 52.2 57.4 60.0 62.8
610 SE 23 31.5 35 36 37 38 39 40 40.5 41
611 SO 0 0 127 324 1164 2509 4199 6171 7251 8390
612 SE .23 31.5 35 36 37 38 39 40 40.5 41
613
614 KK EV11
615 RN 1
616 RS 1 ELEV 43
617 SV 0 26.7 31.0 35.8 46.5 52.5
618 SE 30 43 44 45 47 48
619 SO 0 0 0 0 0 0 75
620 SE 30 43 44 45 47 48
621
622 KK EV12
623 RN 1
624 RS 1 ELEV 86
625 SV 0 0.123 .64 1.30 2.41 3.50 4.55 6.70 9.10 12.20
626 SE 30 0 0 0 0 0 0 0 0 0
627 SO 0 0 0 0 0 0 0 0 0 0
628 SE 30 0 0 0 0 0 0 0 0 0
629
630 KK EV13
631 RN 1
632 RS 1 ELEV 86
633 SV 0 0.123 .64 1.30 2.41 3.50 4.55 6.70 9.10 12.20
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635 SO 0 0 0 0 0 0 0 0 0 0
636 SE 30 0 0 0 0 0 0 0 0 0
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638 KK EV14
639 RN 1
640 RS 1 ELEV 86
641 SV 0 0.123 .64 1.30 2.41 3.50 4.55 6.70 9.10 12.20
642 SE 30 0 0 0 0 0 0 0 0 0
643 SO 0 0 0 0 0 0 0 0 0 0
644 SE 30 0 0 0 0 0 0 0 0 0
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646 KK EV15
647 RN 1
648 RS 1 ELEV 86
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652 SE 30 0 0 0 0 0 0 0 0 0
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REC-1 INPUT

REC-1 INPUT

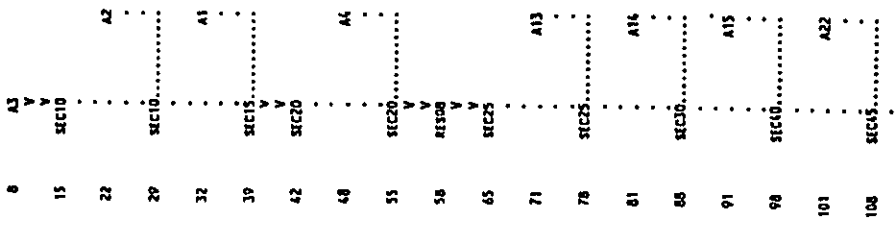
PAGE 15

REC-1 INPUT

654 LD 0.244
655 KK RES13
656 KN MC 2
657
658 KK RES16
659 RN 1
660 RS 10 FLOW 0
661 SV 0 100 105 105 105 195 200 297
662 SE 40 40 40 40 26 26 40 40
663 SO 0 0 0 0 0 0 0 0
664 SE 40 40 40 40 26 26 40 40

SCHEMATIC DIAGRAM OF STREAM NETWORK

(V) ROUTING
(-) CONNECTOR
(.....) DIVERSION OR PUMP FLOW
(-----) RETURN OF DIVERTED OR PUMPED FLOW



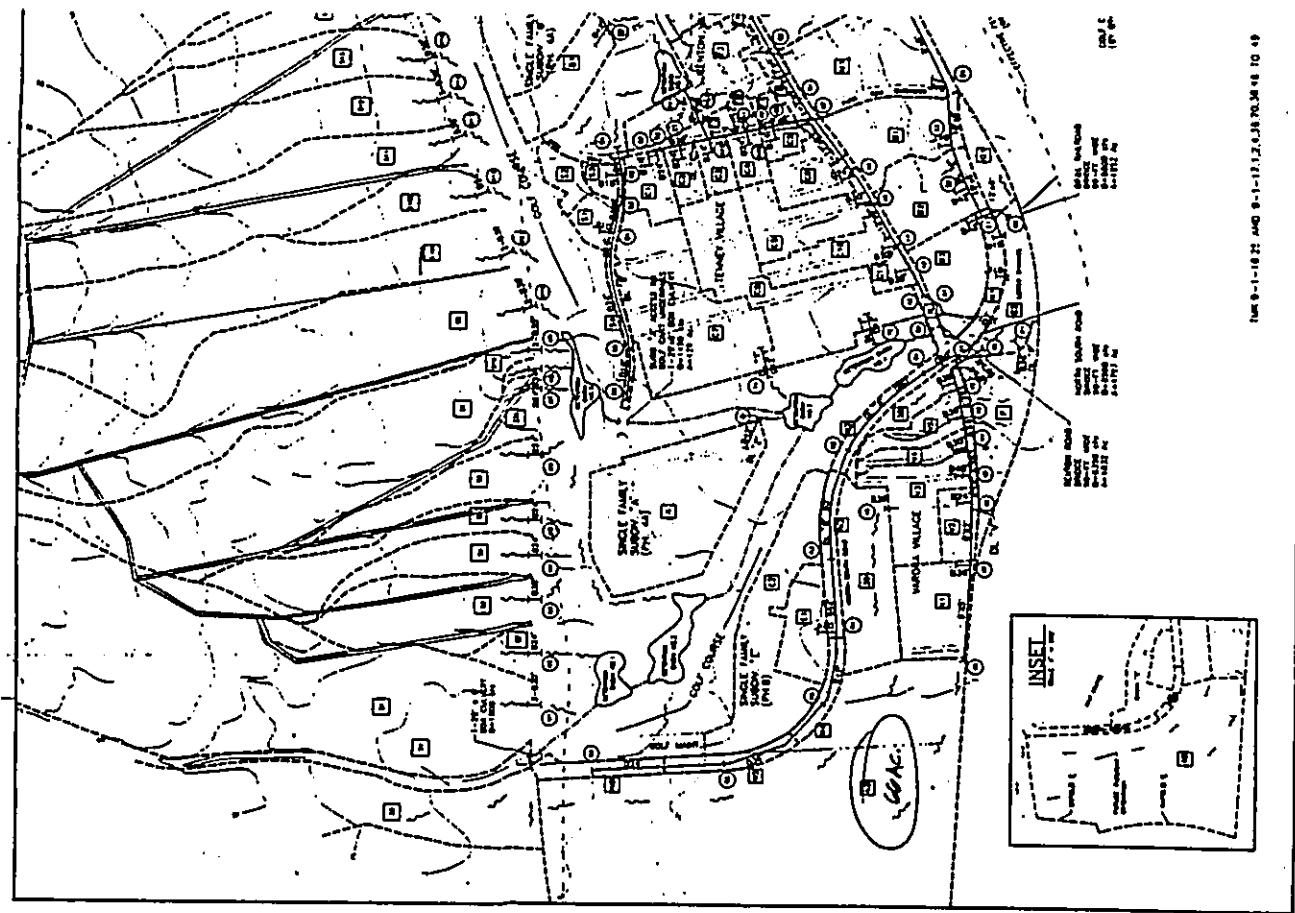
| RUNOFF SUMMARY | | | | | | | | | | | | | | | | |
|-------------------------------------|---------------|-----------|--------------|---------------------------------|---------|---------|------------|---------------|-------------------|-------|-------|-------|-------|-------|------|------|
| FLOW IN 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 | SECNO | 3668. | 13.67 | 2543. | 1034. | 998. | 4.56 |
| | | | | 6-HOUR | 24-HOUR | 72-HOUR | | | | | | | | | | |
| • | HYDROGRAPH AT | A3 | 1633. | 13.33 | 935. | 376. | 362. | 1.70 | | SEC50 | 3668. | 13.67 | 2543. | 1034. | 998. | 4.56 |
| • | ROUTED TO | SEC10 | 1632. | 13.33 | 935. | 375. | 361. | 1.70 | 213.09 | A22 | 12. | 12.08 | 2. | 1. | 1. | .00 |
| • | HYDROGRAPH AT | A2 | 275. | 12.42 | 91. | 36. | 35. | .17 | | SEC65 | 3669. | 13.67 | 2544. | 1037. | 999. | 4.56 |
| • | 2 COMBINED AT | SEC10 | 1738. | 13.33 | 1024. | 411. | 396. | 1.87 | | A6 | 623. | 12.25 | 187. | 66. | 64. | .31 |
| • | HYDROGRAPH AT | A1 | 1837. | 13.58 | 1144. | 462. | 445. | 2.04 | | REC09 | 622. | 12.25 | 187. | 66. | 64. | .31 |
| • | 2 COMBINED AT | SEC15 | 3568. | 13.42 | 2187. | 873. | 841. | 3.90 | | SEC55 | 607. | 12.33 | 187. | 66. | 64. | .31 |
| • | ROUTED TO | SEC20 | 3568. | 13.42 | 2187. | 873. | 841. | 3.90 | 201.36 | A11 | 254. | 12.25 | 43. | 25. | 24. | .10 |
| • | HYDROGRAPH AT | A4 | 277. | 12.50 | 100. | 40. | 38. | .19 | | SEC55 | 821. | 12.33 | 229. | 92. | 88. | .41 |
| • | 2 COMBINED AT | SEC20 | 3688. | 13.42 | 2284. | 913. | 879. | 4.09 | | A12 | 398. | 12.33 | 121. | 50. | 48. | .18 |
| • | ROUTED TO | REC08 | 3581. | 13.75 | 2283. | 913. | 879. | 4.09 | | SEC60 | 1219. | 12.33 | 350. | 142. | 136. | .60 |
| • | ROUTED TO | SEC25 | 3580. | 13.75 | 2283. | 910. | 877. | 4.09 | | A17 | 26. | 12.17 | 6. | 2. | 2. | .01 |
| • | HYDROGRAPH AT | A13 | 653. | 12.33 | 195. | 79. | 76. | .31 | | SEC65 | 1235. | 12.33 | 356. | 144. | 139. | .61 |
| • | 2 COMBINED AT | SEC25 | 3765. | 13.67 | 2442. | 989. | 953. | 4.40 | | A7 | 30. | 12.08 | 5. | 2. | 2. | .01 |
| • | HYDROGRAPH AT | A16 | 26. | 12.08 | 4. | 2. | 2. | .01 | | A10 | 232. | 12.17 | 50. | 20. | 20. | .08 |
| • | 2 COMBINED AT | SEC30 | 3769. | 13.67 | 2446. | 993. | 955. | 4.41 | | SEC75 | 255. | 12.17 | 55. | 22. | 21. | .09 |
| • | HYDROGRAPH AT | A15 | 365. | 12.33 | 107. | 45. | 43. | .16 | | A8 | 351. | 12.33 | 100. | 40. | 39. | .17 |
| • | ROUTED TO | SEC25 | 3580. | 13.75 | 2283. | 910. | 877. | 4.09 | | REC16 | 349. | 12.33 | 100. | 40. | 39. | .17 |
| • | ROUTED TO | SEC25 | 3580. | 13.75 | 2283. | 910. | 877. | 4.09 | | A9 | 55. | 12.17 | 13. | 5. | 5. | .02 |
| • | HYDROGRAPH AT | A13 | 653. | 12.33 | 195. | 79. | 76. | .31 | | SEC80 | 391. | 12.33 | 113. | 46. | 44. | .19 |
| • | 2 COMBINED AT | SEC25 | 3765. | 13.67 | 2442. | 989. | 953. | 4.40 | | SEC81 | 1781. | 12.33 | 524. | 212. | 204. | .68 |
| • | HYDROGRAPH AT | A16 | 26. | 12.08 | 4. | 2. | 2. | .01 | | A18 | 7. | 12.08 | 1. | 1. | 0. | .00 |
| • | 2 COMBINED AT | SEC30 | 3769. | 13.67 | 2446. | 993. | 955. | 4.41 | | SEC90 | 1783. | 12.33 | 525. | 212. | 204. | .69 |
| • | HYDROGRAPH AT | A15 | 365. | 12.33 | 107. | 45. | 43. | .16 | | A19 | 223. | 12.25 | 58. | 24. | 23. | .09 |
| • | ROUTED TO | SEC25 | 3580. | 13.75 | 2283. | 910. | 877. | 4.09 | | A16 | 334. | 12.25 | 89. | 37. | 35. | .13 |

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|---------------|-------|-------|-------|-------|-------|------|---------------|------|-------|------|-----|-----|-----|
| SEC01 | 2339. | 12.25 | 672. | 273. | 263. | 1.11 | 56 | 56. | 12.17 | 12. | 5. | 5. | .02 |
| HYDROGRAPH AT | | | | | | | HYDROGRAPH AT | | | | | | |
| A21 | 50. | 12.08 | 9. | 4. | 3. | .01 | EW49 | 31. | 12.08 | 5. | 2. | 2. | .01 |
| 2 COMBINED AT | | | | | | | 2 COMBINED AT | | | | | | |
| SEC105 | 2364. | 12.25 | 681. | 277. | 266. | 1.12 | SEC192 | 78. | 12.08 | 17. | 7. | 7. | .03 |
| 2 COMBINED AT | | | | | | | HYDROGRAPH AT | | | | | | |
| SEC110 | 5224. | 12.33 | 3192. | 1314. | 1265. | 5.69 | S7A | 21. | 12.08 | 3. | 1. | 1. | .00 |
| HYDROGRAPH AT | | | | | | | HYDROGRAPH AT | | | | | | |
| A24 | 28. | 12.25 | 7. | 3. | 3. | .01 | S7B | 4. | 12.08 | 1. | 0. | 0. | .00 |
| 2 COMBINED AT | | | | | | | HYDROGRAPH AT | | | | | | |
| SEC115 | 5247. | 12.33 | 3198. | 1316. | 1268. | 5.70 | S8 | 203. | 12.33 | 59. | 25. | 24. | .09 |
| HYDROGRAPH AT | | | | | | | HYDROGRAPH AT | | | | | | |
| A20 | 173. | 12.25 | 44. | 19. | 19. | .07 | EW4C | 59. | 12.08 | 10. | 4. | 4. | .01 |
| HYDROGRAPH AT | | | | | | | 4 COMBINED AT | | | | | | |
| S1 | 553. | 12.38 | 219. | 92. | 88. | .32 | SEC193 | 230. | 12.25 | 73. | 31. | 29. | .11 |
| 3 COMBINED AT | | | | | | | HYDROGRAPH AT | | | | | | |
| SEC116 | 5663. | 12.33 | 3455. | 1428. | 1375. | 6.09 | S17 | 17. | 12.08 | 3. | 1. | 1. | .00 |
| HYDROGRAPH AT | | | | | | | HYDROGRAPH AT | | | | | | |
| S2 | 17. | 12.08 | 3. | 1. | 1. | .00 | S16 | 17. | 12.08 | 3. | 1. | 1. | .00 |
| HYDROGRAPH AT | | | | | | | HYDROGRAPH AT | | | | | | |
| EU1 | 97. | 12.08 | 18. | 8. | 7. | .03 | EW4H | 12. | 12.17 | 3. | 1. | 1. | .00 |
| 3 COMBINED AT | | | | | | | 3 COMBINED AT | | | | | | |
| RES01 | 5993. | 12.33 | 3475. | 1436. | 1383. | 6.12 | SEC200 | 44. | 12.08 | 8. | 3. | 3. | .01 |
| ROUTED TO | | | | | | | HYDROGRAPH AT | | | | | | |
| RES01 | 5826. | 12.42 | 3474. | 1420. | 1368. | 6.12 | S15 | 40. | 12.17 | 8. | 3. | 3. | .01 |
| HYDROGRAPH AT | | | | | | | 2 COMBINED AT | | | | | | |
| S3 | 89. | 12.17 | 19. | 8. | 8. | .03 | SEC201 | 80. | 12.08 | 16. | 7. | 7. | .02 |
| HYDROGRAPH AT | | | | | | | HYDROGRAPH AT | | | | | | |
| S4 | 40. | 12.17 | 8. | 3. | 3. | .01 | S14 | 63. | 12.17 | 14. | 6. | 6. | .02 |
| HYDROGRAPH AT | | | | | | | HYDROGRAPH AT | | | | | | |
| S5 | 71. | 12.17 | 16. | 7. | 6. | .02 | EW4G | 18. | 12.17 | 4. | 2. | 1. | .01 |
| 3 COMBINED AT | | | | | | | 3 COMBINED AT | | | | | | |
| SEC123 | 200. | 12.17 | 43. | 18. | 17. | .06 | SEC202 | 155. | 12.17 | 34. | 14. | 14. | .05 |
| HYDROGRAPH AT | | | | | | | HYDROGRAPH AT | | | | | | |
| EW4A | 20. | 12.08 | 4. | 2. | 1. | .01 | S13 | 86. | 12.17 | 21. | 9. | 8. | .03 |
| 2 COMBINED AT | | | | | | | 2 COMBINED AT | | | | | | |
| SEC124 | 217. | 12.17 | 47. | 20. | 19. | .07 | SEC203 | 241. | 12.17 | 55. | 23. | 22. | .08 |
| HYDROGRAPH AT | | | | | | | HYDROGRAPH AT | | | | | | |
| EV2 | 86. | 12.17 | 19. | 8. | 7. | .03 | S12 | 239. | 12.42 | 78. | 33. | 32. | .11 |
| 2 COMBINED AT | | | | | | | HYDROGRAPH AT | | | | | | |
| SEC125 | 304. | 12.17 | 64. | 27. | 26. | .10 | EW4F | 31. | 12.17 | 6. | 3. | 2. | .01 |
| 2 COMBINED AT | | | | | | | 3 COMBINED AT | | | | | | |
| RES02 | 5985. | 12.33 | 3536. | 1448. | 1394. | 6.22 | SEC204 | 437. | 12.17 | 139. | 58. | 56. | .20 |
| ROUTED TO | | | | | | | HYDROGRAPH AT | | | | | | |
| RES02 | 5968. | 12.42 | 3535. | 1428. | 1376. | 6.22 | S11 | 153. | 12.42 | 50. | 21. | 20. | .07 |
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| EV3 | 52. | 12.25 | 13. | 5. | 5. | .02 | SEC205 | 569. | 12.25 | 189. | 80. | 77. | .28 |
| 2 COMBINED AT | | | | | | | HYDROGRAPH AT | | | | | | |
| SEC130 | 6005. | 12.42 | 3548. | 1434. | 1381. | 6.24 | S10B | 60. | 12.17 | 12. | 5. | 5. | .02 |
| HYDROGRAPH AT | | | | | | | HYDROGRAPH AT | | | | | | |
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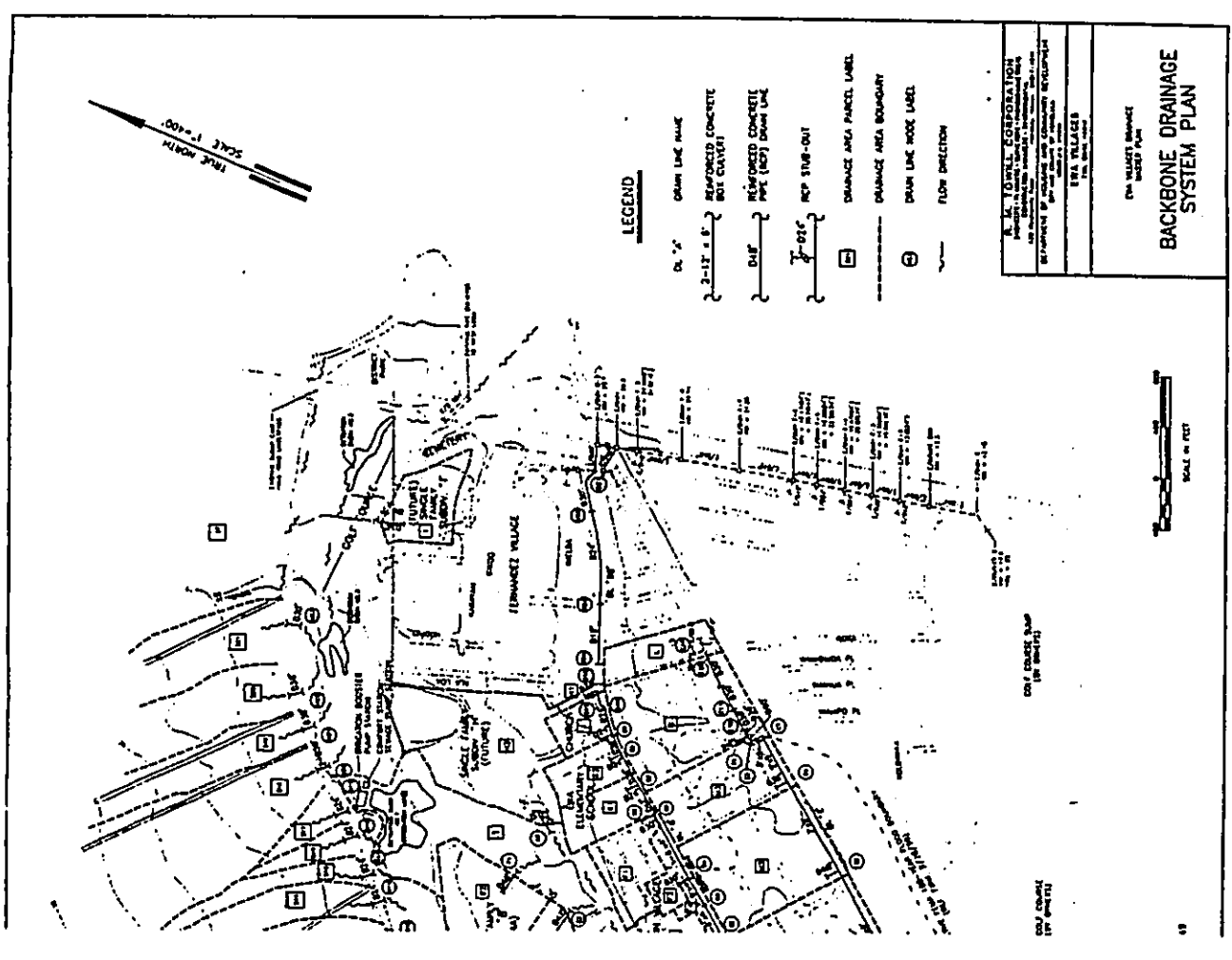
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| 2 COMBINED AT | SEC207 | 838. | 12.25 | 273. | 115. | 110. | .40 |
| HYDROGRAPH AT | S9 | 266. | 12.33 | 84. | 35. | 34. | .12 |
| HYDROGRAPH AT | EW4D | 61. | 12.17 | 14. | 6. | 5. | .02 |
| 3 COMBINED AT | SEC208 | 1135. | 12.25 | 371. | 156. | 150. | .54 |
| 3 COMBINED AT | RES05 | 1421. | 12.25 | 441. | 193. | 186. | .47 |
| ROUTED TO | RES05 | 1303. | 12.42 | 460. | 182. | 175. | .67 |
| ROUTED TO | SEC140 | 1309. | 12.42 | 460. | 182. | 175. | .67 |
| HYDROGRAPH AT | EW5 | 66. | 12.17 | 10. | 4. | 4. | .01 |
| 2 COMBINED AT | SEC140 | 1324. | 12.42 | 470. | 186. | 179. | .89 |
| 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 |
| HYDROGRAPH AT | EW7 | 104. | 12.08 | 34. | 14. | 14. | .05 |
| 2 COMBINED AT | RES04 | 7497. | 12.50 | 4200. | 1677. | 1615. | 7.26 |
| ROUTED TO | RES04 | 7476. | 12.50 | 4200. | 1654. | 1595. | 7.26 |
| HYDROGRAPH AT | EW10 | 71. | 12.08 | 11. | 5. | 4. | .02 |
| ROUTED TO | RES07 | 0. | .08 | 0. | 0. | 0. | .02 |
| HYDROGRAPH AT | EW11 | 309. | 12.25 | 83. | 35. | 33. | .12 |
| 2 COMBINED AT | RES06 | 309. | 12.25 | 83. | 35. | 33. | .16 |
| ROUTED TO | RES06 | 251. | 12.42 | 75. | 29. | 28. | .16 |
| 2 COMBINED AT | SEC155 | 7704. | 12.50 | 4274. | 1685. | 1623. | 7.38 |

*** MORALE END OF SEC-1 ***

01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50



DATE 9-1-1922 AND 9-1-17, 12, 13, 14, 15, 16, 17, 18 TO 19



**KAPOLEI VILLAGE
DRAINAGE MASTER PLAN**

Prepared for:
Housing Finance and Development Corporation
State of Hawaii

Prepared by:
R. M. Towill Corporation
420 Waikamilo Road, Suite 411
Honolulu, Hawaii 96817-4941

DECEMBER 1991

| FILE# MEMORANDUM DATE: 4-18-91 (1/15) | AREA NAME | Total Area (Ac) | Other Flow (cfs) | Yp | C | I (in/hr) | Y | A (sq) | Runoff | Other | Total | Cumul. (cfs) | Pipe A Group C (cfs) | Pipe B (cfs) | Pipe C (cfs) | |
|---|-----------|-----------------|-----------------------|-------|-------|-----------|-------|--------|--------|-------|-------|--------------|----------------------|--------------|--------------|--------------------|
| | | | | | | | | | (cfs) | (cfs) | (cfs) | | | | | |
| DRAIN LINE "V" (Various Villages/Manton Road) | | | | | | | | | | | | | | | | |
| U0 | DL-E | 157.70 | FROM DRAIN LINE "R" | | | | | | 0.0 | 157.8 | 157.8 | 481.8 | 562.5 | 653.1 | 7.3 | |
| U1 | U1 | 108.70 | | 10.0 | 0.35 | 2.2 | 1.4 | 2.2 | 5.7 | 113.5 | 124.2 | 595.3 | 677.7 | 771.7 | 7.1 | |
| U2 | U2 | 108.40 | | 12.7 | 0.70 | 2.2 | 2.2 | 4.4 | 14.9 | 128.3 | 252.5 | 723.6 | 803.9 | 893.9 | 7.0 | |
| U3 | U3 | 101.40 | | 12.7 | 0.70 | 2.2 | 2.2 | 4.4 | 14.9 | 143.3 | 405.8 | 820.4 | 905.2 | 995.2 | 6.7 | |
| U4 | U4 | 98.70 | FROM AREA "Y" | 12.7 | 0.70 | 2.2 | 2.0 | 4.0 | 13.4 | 157.1 | 562.9 | 878.3 | 963.5 | 1053.5 | 7.7 | |
| U5 | U5 | 78.70 | | 12.7 | 0.70 | 2.2 | 2.4 | 4.8 | 16.2 | 173.3 | 736.2 | 909.5 | 994.7 | 1084.7 | 7.4 | |
| U6 | U6 | 74.70 | | 12.8 | 0.70 | 2.2 | 2.2 | 4.4 | 14.9 | 188.2 | 825.4 | 910.3 | 995.5 | 1085.5 | 7.3 | |
| U7 | U7 | 65.70 | | 12.8 | 0.70 | 2.2 | 1.8 | 3.6 | 12.0 | 200.2 | 925.4 | 925.4 | 1010.6 | 1100.6 | 7.2 | |
| DRAIN LINE "R" (North-South Road) | | | | | | | | | | | | | | | | |
| V1 | TRANE | 37.10 | ADD TO DRAIN LINE "A" | | | | | | 0.0 | 0.0 | 157.8 | | 157.8 | 157.8 | 3.2 | |
| V2 | V2 | 37.10 | | 5.0 | 0.35 | 2.2 | 2.8 | 5.6 | 18.4 | 166.2 | 324.0 | | 324.0 | 324.0 | 3.3 | |
| V3 | V3 | 34.10 | | 7.0 | 0.35 | 2.2 | 2.8 | 5.6 | 17.5 | 183.7 | 497.7 | | 497.7 | 497.7 | 3.2 | |
| V4 | V4 | 20.70 | FROM R2 | 10.7 | 0.70 | 2.2 | 2.2 | 4.4 | 14.9 | 198.6 | 696.3 | | 696.3 | 696.3 | 3.1 | |
| V5 | V5 | 7.70 | | 5.0 | 0.35 | 2.2 | 2.8 | 5.6 | 18.4 | 207.0 | 803.3 | | 803.3 | 803.3 | 3.1 | |
| V6 | V6 | 5.00 | | 5.0 | 0.35 | 2.2 | 2.8 | 5.6 | 18.4 | 225.4 | 821.7 | | 821.7 | 821.7 | 3.1 | |
| V7 | V7 | 2.70 | | 5.0 | 0.35 | 2.2 | 2.8 | 5.6 | 18.4 | 243.8 | 840.1 | | 840.1 | 840.1 | 3.1 | |
| DRAIN LINE "A" (North-South Road) | | | | | | | | | | | | | | | | |
| A1 | A1 | 7.8 | | 7.8 | 0.13 | 0.002 | 0.014 | 0.28 | 0.363 | 0.326 | 0.380 | 0.30 | 38.47 | 38.47 | 44.3 | Full 4.46 FB |
| A2 | A2 | 8.0 | | 8.0 | 0.13 | 0.003 | 0.008 | 0.16 | 0.159 | 0.000 | 0.109 | 0.05 | 3.755 | 42.22 | 46.0 | Full 5.15 FB |
| A3 | A3 | 8.0 | | 8.0 | 0.13 | 0.003 | 0.005 | 0.10 | 0.161 | 0.189 | 0.108 | 0.05 | 3.265 | 45.48 | 48.0 | Full 3.89 FB |
| A4 | A4 | 7.5 | | 7.5 | 0.13 | 0.004 | 0.003 | 0.06 | 0.145 | 0.000 | 0.097 | 0.05 | 4.947 | 46.20 | 50.0 | Full 3.41 FB |
| A5 | A5 | 4.7 | | 4.7 | 0.13 | 0.003 | 0.003 | 0.06 | 0.145 | 0.289 | 0.097 | 0.00 | 4.773 | 48.78 | 52.0 | Full 3.88 FB |
| A6 | A6 | 7.0 | | 7.0 | 0.13 | 0.002 | 0.008 | 0.16 | 0.076 | 0.074 | 0.017 | 0.15 | 3.016 | 51.80 | 54.0 | Full 3.51 FB |
| A7 | A7 | 4.0 | | 4.0 | 0.13 | 0.003 | 0.003 | 0.06 | 0.087 | 0.000 | 0.016 | 0.30 | 2.808 | 54.61 | 58.0 | Ent. Cont. 3.88 FB |
| | | | | 55.00 | 55.00 | | | | | | | | 54.27 | 58.27 | 67.0 | Full 3.78 FB |

SECTION 3
EXISTING DRAINAGE CONDITIONS

3.1 GROUND COVER

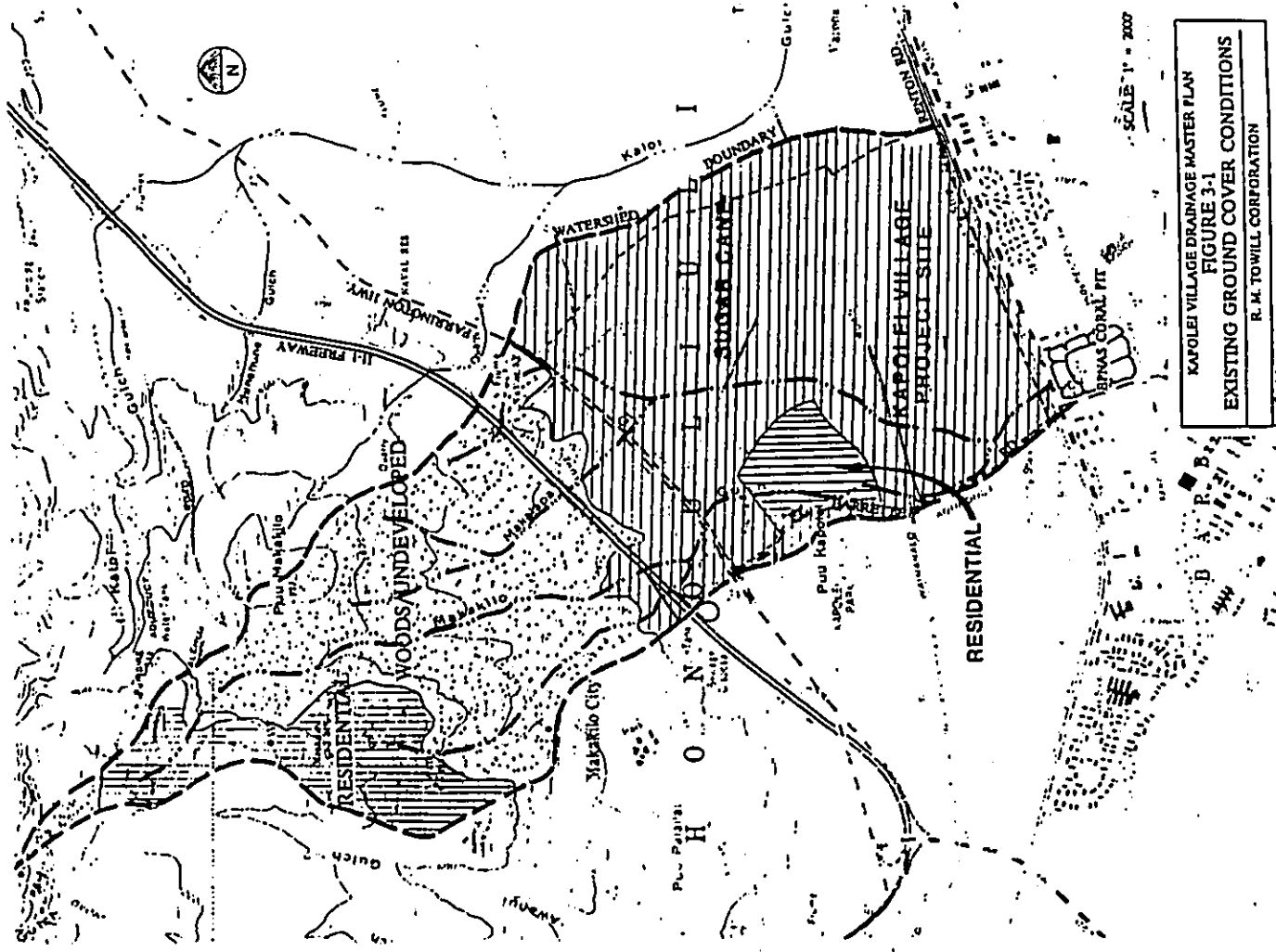
Between the NASBP and the H-1 Freeway, the ground cover consists mostly of sugarcane fallow. Near Farrington Highway, the early increments of the Kapolei Village residential development is under construction. Above the H-1 Freeway, the cover conditions vary from sparse vegetation on steep rocky slopes 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.

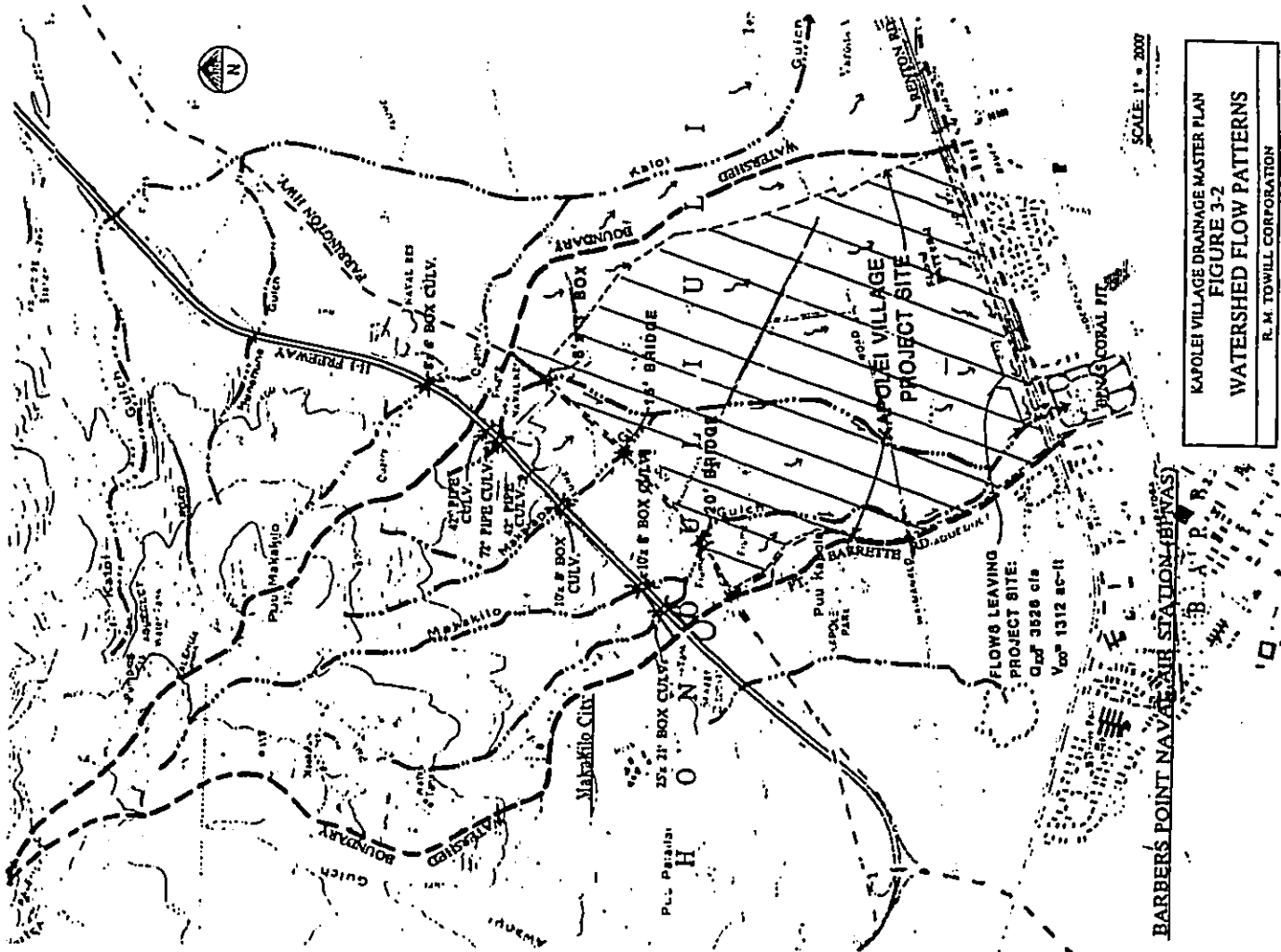
3.2 DRAINAGE PATTERNS

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





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 approximately 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.

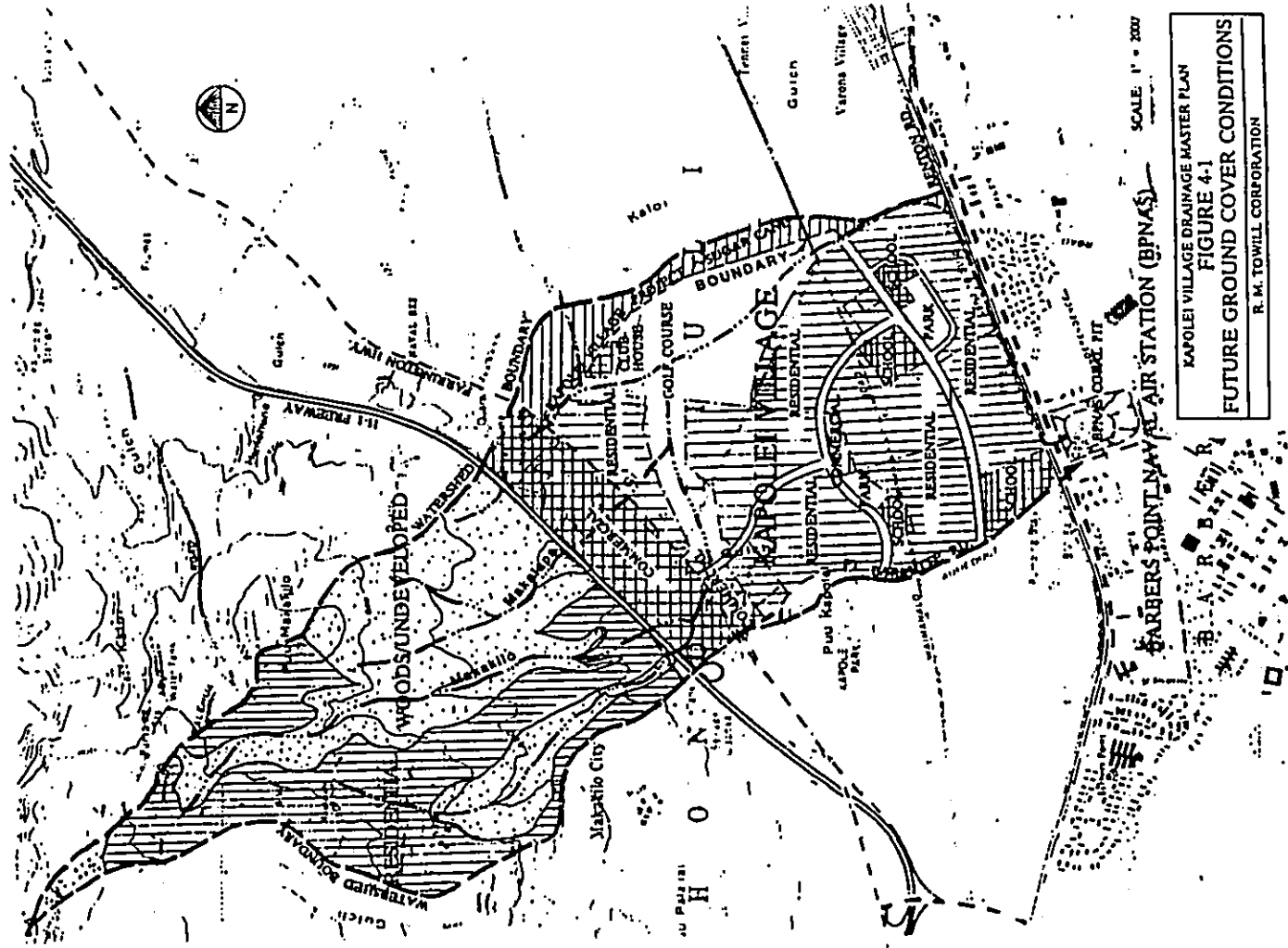


TABLE 4-1
RUNOFF INCREASE DUE TO KAPOLEI VILLAGE
(FOR COMPARISON PURPOSES -- NO FLOOD CONTROL PROJECTS IMPLEMENTED)
RUNOFF VOLUMES (AT LOWER BOUNDARY OF PROJECT SITE)

| 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

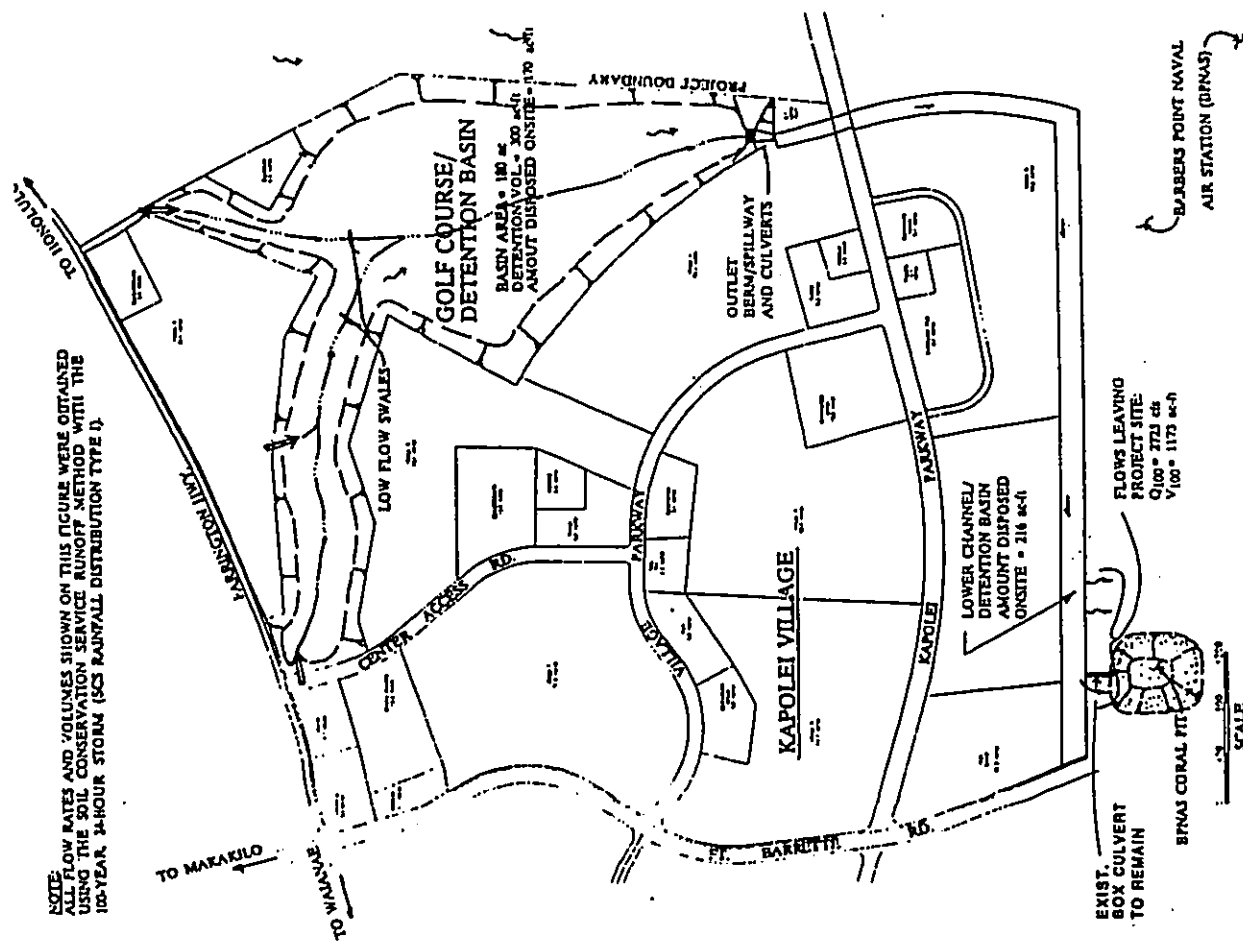
Two types of drainage systems are discussed in this plan: regional and subdivision. The regional system includes those facilities which will be used to limit runoff entering the NASBP. Three primary regional facilities are identified as: 1) the Kapolei Village Golf Course/detention basin, located along 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.



KAPOLEI VILLAGE DRAINAGE MASTER PLAN
 FIGURE 4-2
 REGIONAL DRAINAGE PLAN
 R. M. TOWILL CORPORATION

TABLE 4-2
 RUNOFF VALUES FOR THE REGIONAL DRAINAGE SYSTEM
 (ENTIRE WATERSHED DEVELOPED -- FLOOD CONTROL PROJECTS IMPLEMENTED)

RUNOFF VOLUMES

| RECURRENCE | GOLF COURSE/ DETENTION BASIN | | LOWER CHANNEL/BASIN | | NASBP CORAL PIT | | EXISTING RUNOFF ENTERING NASBP | CHANGE IN RUNOFF ENTERING NASBP |
|-------------|------------------------------|-----------|---------------------|-------------|-----------------|---------|--------------------------------|---------------------------------|
| | INFLOW | OUTFLOW | INFLOW | OUTFLOW | INFLOW | OUTFLOW | | |
| 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 | | LOWER CHANNEL/BASIN | | NASBP CORAL PIT | | EXISTING RUNOFF ENTERING NASBP | CHANGE IN RUNOFF ENTERING NASBP |
|-------------|------------------------------|---------|---------------------|-----------|-----------------|---------|--------------------------------|---------------------------------|
| | INFLOW | OUTFLOW | INFLOW | OUTFLOW | INFLOW | OUTFLOW | | |
| 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 Geolabs-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 as 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)

KAPOLEI VILLAGE DRAINAGE MASTER PLAN

 KAPOLEI VILLAGE
 ENA, OAHU, HAWAII
 PREPARED BY: GHH

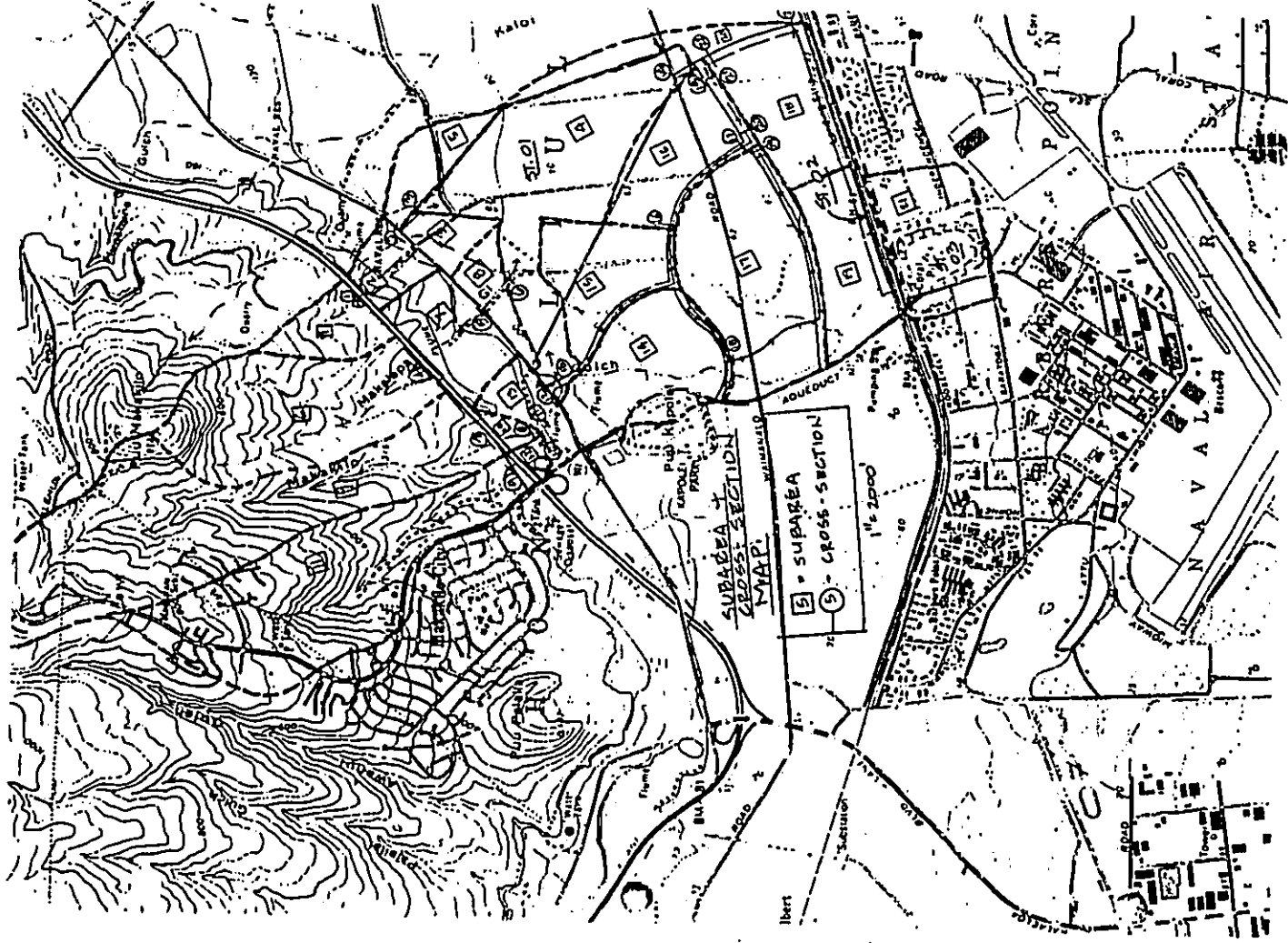
 JOB REF: J-15713-0E
 DATE: 8/28/89
 CHECKED BY:

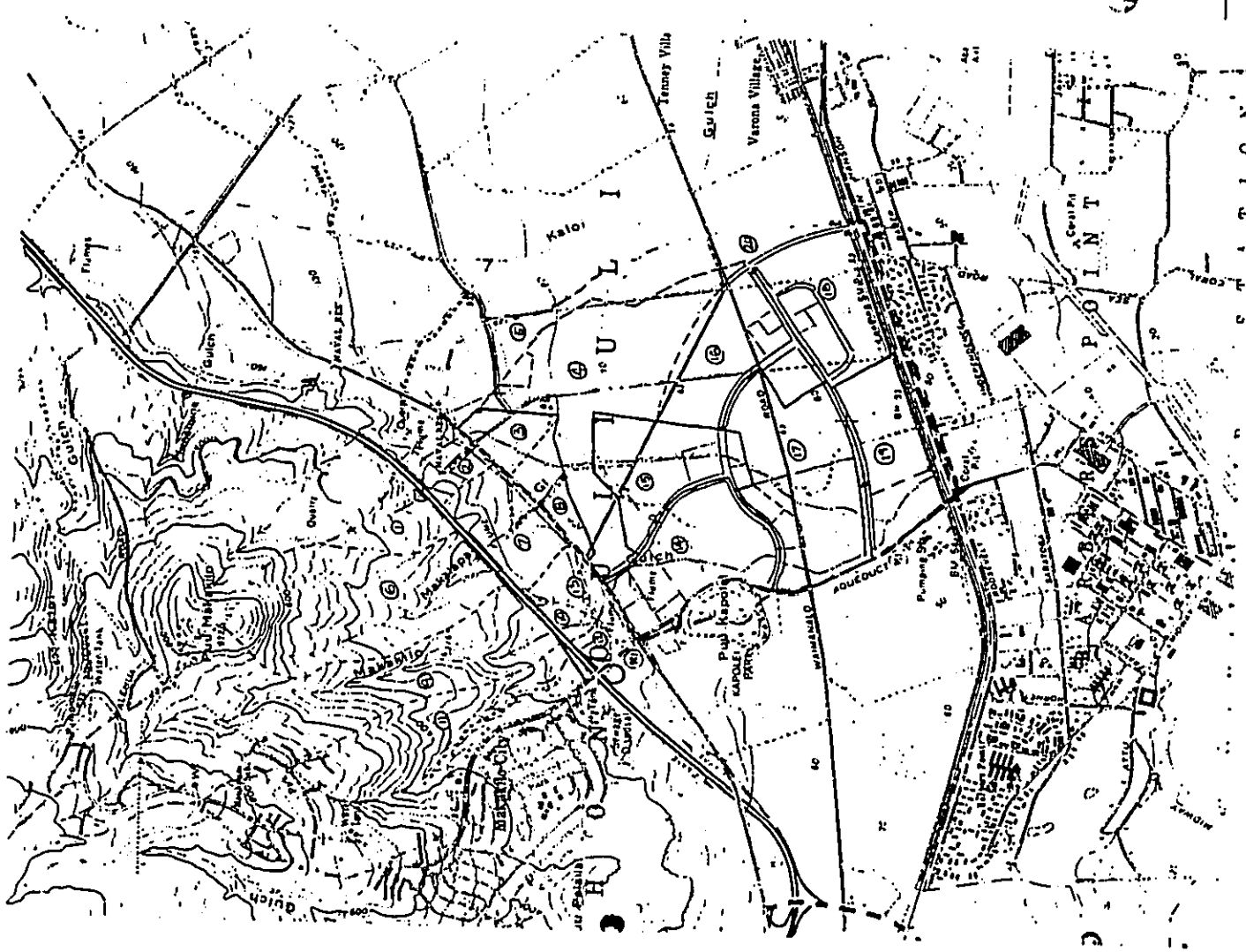
PURPOSE:

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.

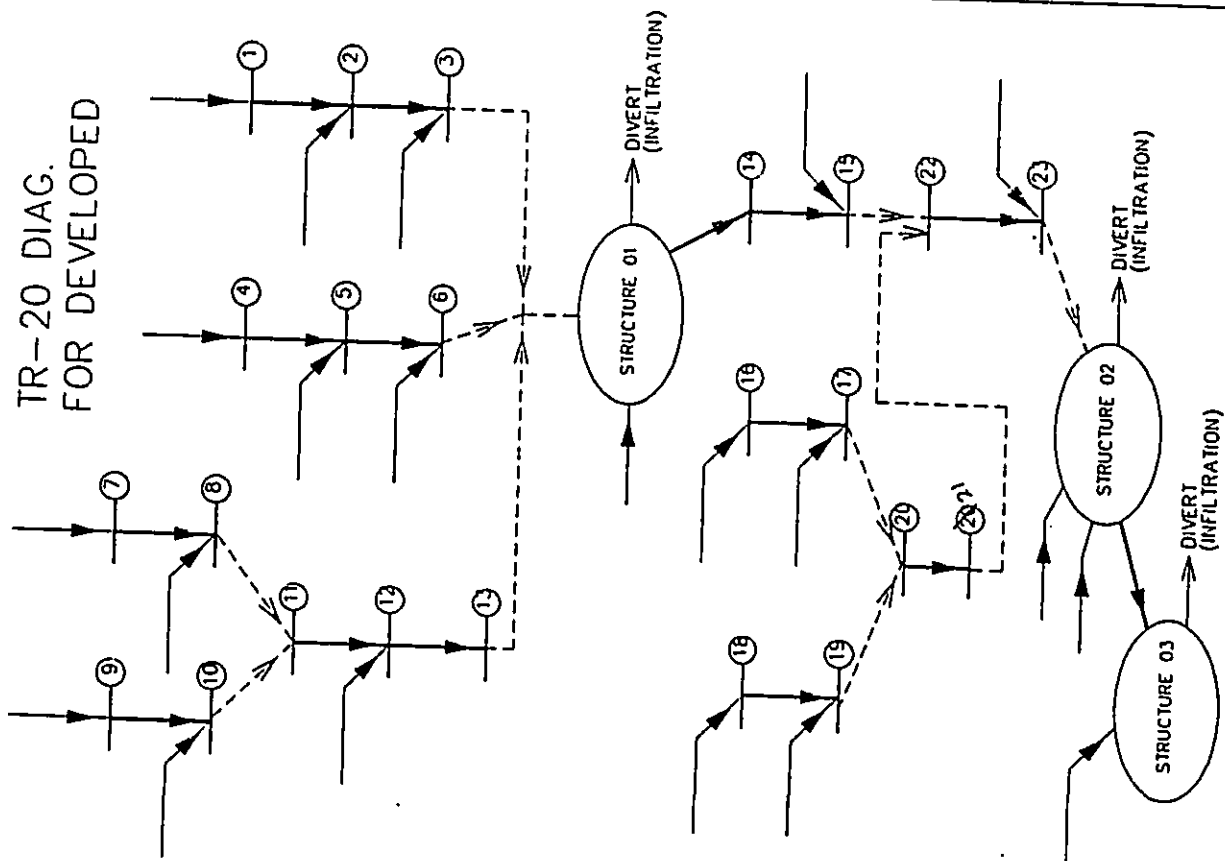
WATERSHED DATA:

| 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 |
| | <u>2206</u> | <u>3.447</u> |





TR-20 DIAG.
FOR DEVELOPED



KAPOLEI VILLAGE DRAINAGE MASTER PLAN
SCS RUNOFF CURVE NUMBERS - FULLY DEVELOPED WATERSHED

KAPOLEI VILLAGE
 SNA, 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.

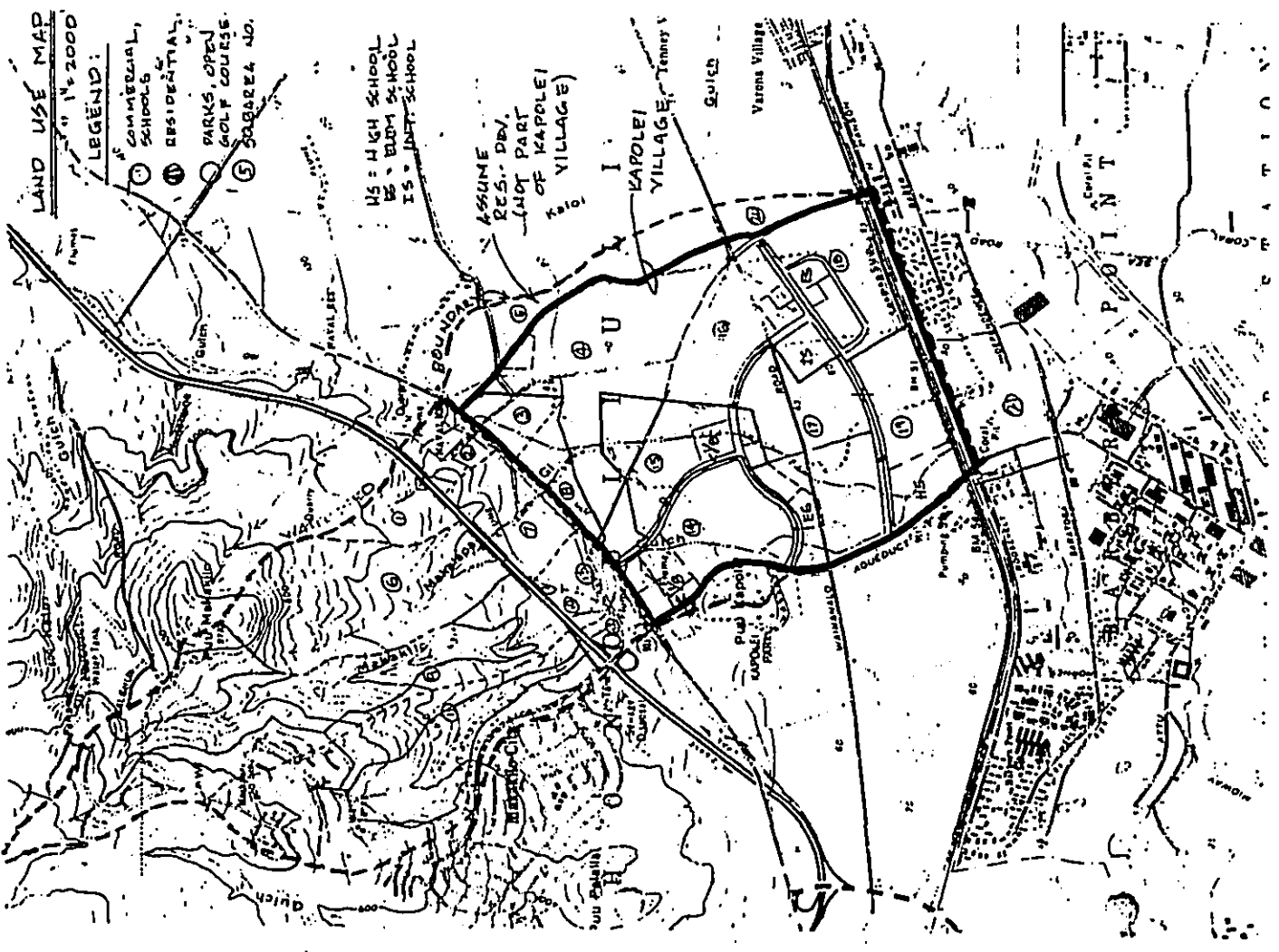
- REFERENCES:**
- McLuen, Richard H., A Guide to Hydrologic Analysis Using SCS Methods, Prentice-Hall, Inc., Englewood Cliffs, NJ c.1982
 - U.S. Department of Agriculture Soil Conservation Service, Urban Hydrology for Small Watersheds, Technical Release No. 55, Washington DC, Jan.1975

CALCULATIONS:

| Subarea | Soil Group | Acres | Land Use | CR | Acres*CR |
|---------|------------|-------|------------------|-----------------------|--------------|
| 1 | A | 28 | Woods | 45 | 1260 |
| | B | 14 | Woods | 66 | 924 |
| | | 42 | | | 2184 |
| | | | | total = | 3184 |
| | | | | Composite CR = | 52 |
| 2 | A | 16 | Commercial | 89 | 1424 |
| | B | 15 | Commercial | 92 | 1380 |
| | | 35 | | | 2804 |
| | | | | total = | 2804 |
| | | | | Composite CR = | 91 |
| 3 | B | 11 | Residential | 55 | 605 |
| | D | 15 | Residential | 92 | 1380 |
| | | 26 | | | 1985 |
| | | | | total = | 2315 |
| | | | | Composite CR = | 89 |
| 4 | B | 140 | Open/Golf Course | 61 | 8540 |
| | C | 59 | Open/Golf Course | 74 | 4366 |
| | D | 10 | Open/Golf Course | 80 | 800 |
| | | 209 | | | 13706 |
| | | | | total = | 13706 |
| | | | | Composite CR = | 65 |

| Subarea | Soil Group | Acres | Land Use | CR | Acres*CR |
|---------|------------|-------|------------------|-----------------------|--------------|
| 5 | B | 4 | Residential | 85 | 340 |
| | D | 120 | Residential | 92 | 11040 |
| | | 124 | | | 11380 |
| | | | | total = | 11380 |
| | | | | Composite CR = | 92 |
| 6 | A | 150 | Woods | 45 | 6750 |
| | B | 38 | Woods | 66 | 2508 |
| | | 188 | | | 9708 |
| | | | | total = | 9708 |
| | | | | Composite CR = | 45 |
| 7 | A | 19 | Commercial | 89 | 1681 |
| | B | 38 | Commercial | 92 | 3496 |
| | C | 10 | Commercial | 94 | 940 |
| | | 66 | | | 6038 |
| | | | | total = | 6038 |
| | | | | Composite CR = | 91 |
| 8 | B | 25 | Residential | 85 | 2125 |
| | | 35 | | | 2975 |
| | | | | total = | 2975 |
| | | | | Composite CR = | 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 | 72 | 7560 |
| | E | 110 | Residential | 85 | 9450 |
| | C | 21 | Residential | 90 | 1890 |
| | | | | total = | 21102 |
| | | | | Composite CR = | 72 |
| 10 | B | 8 | Commercial | 92 | 736 |
| | | 9 | | | 828 |
| | | | | total = | 1564 |
| | | | | Composite CR = | 92 |
| 11 | A | 160 | Residential | 77 | 12320 |
| | B | 20 | Residential | 85 | 1700 |
| | A | 102 | Open/Parks/Woods | 45 | 4590 |
| | | 282 | | | 18610 |
| | | | | total = | 18610 |
| | | | | Composite CR = | 67 |
| 12 | B | 9 | Commercial | 92 | 828 |
| | | 9 | | | 828 |
| | | | | total = | 1656 |
| | | | | Composite CR = | 92 |





| Subarea | Soil | Acres | Land Use | CR | Acres/CR |
|---------|------|-------|----------------|-------|----------|
| 13 | A | 3 | Commercial | 89 | 349 |
| | B | 3074 | Commercial | 92 | 3074 |
| | C | 211 | Commercial | 94 | 211 |
| | | 28 | Commercial | 94 | 2501 |
| | | | total = | 92 | |
| | | | Composite CR = | 92 | |
| 14 | B | 592 | Cons./Church | 92 | 592 |
| | P | 6426 | Residential | 85 | 6426 |
| | C | 118 | Cons./Church | 94 | 118 |
| | D | 349 | Residential | 90 | 349 |
| | D | 1187 | Cons./Church | 95 | 1187 |
| | D | 3318 | Residential | 92 | 3318 |
| | | | total = | 11056 | |
| | | | Composite CR = | 88 | |
| 15 | P | 97 | Residential | 85 | 7305 |
| | D | 5 | Residential | 92 | 437 |
| | D | 2 | CC | 92 | 276 |
| | | 95 | | 95 | 8165 |
| | | | total = | 86 | |
| | | | Composite CR = | 86 | |
| 16 | B | 76 | Residential | 85 | 4460 |
| | D | 16 | Residential | 92 | 1472 |
| | D | 15 | School | 92 | 1380 |
| | | 107 | | 92 | 9312 |
| | | | total = | 87 | |
| | | | Composite CR = | 87 | |
| 17 | B | 6 | Park | 61 | 366 |
| | B | 6 | School | 85 | 510 |
| | E | 37 | Residential | 85 | 3145 |
| | D | 105 | Residential | 92 | 9660 |
| | | 154 | | 92 | 13681 |
| | | | total = | 89 | |
| | | | Composite CR = | 89 | |
| 18 | F | 1 | Rec. Center | 85 | 85 |
| | D | 2 | Rec. Center | 92 | 154 |
| | D | 6 | School | 92 | 552 |
| | D | 65 | Residential | 92 | 5980 |
| | E | 14 | Commercial | 95 | 1330 |
| | | | total = | 5131 | |
| | | | Composite CR = | 92 | |
| 19 | B | 12 | School | 85 | 1020 |
| | P | 9 | Residential | 85 | 765 |
| | D | 17 | School | 85 | 1495 |
| | D | 49 | Residential | 92 | 4508 |
| | | 83 | | 92 | 7398 |
| | | | total = | 55 | |
| | | | Composite CR = | 55 | |
| 20 | D | 19 | Residential | 92 | 1746 |
| | | 19 | | 92 | 1746 |
| | | | total = | 92 | |
| | | | Composite CR = | 92 | |

END OF 1 JOBS IN THIS RUN

*****90-40 LIST OF INPUT DATA FOR TR-20 HYDROLOGY*****

JOB TR-20 EYELPRINT SUMMARY
TITLE 001 KVDES.DAT - ENTIRE WATCHED DEY. - W/PRODUCTS - REFINED

| 2 XSECTN | 002 | 1.0 | 97.0 | 0.0 |
|----------|-----|-------|--------|-------|
| 0 | 0 | 21.5 | 76.0 | 20.0 |
| 0 | 0 | 44.0 | 272.0 | 78.0 |
| 0 | 0 | 44.5 | 482.0 | 172.0 |
| 0 | 0 | 36.0 | 483.0 | 138.0 |
| 0 | 0 | 37.0 | 1873.0 | 248.0 |
| 9 ENDVAL | 003 | 1.0 | 108.0 | 0.0 |
| 2 XSECTN | 003 | 1.0 | 0.0 | 0.0 |
| 0 | 0 | 100.0 | 101.0 | 2.0 |
| 0 | 0 | 100.2 | 154.0 | 4.0 |
| 0 | 0 | 101.0 | 207.0 | 8.0 |
| 0 | 0 | 102.0 | 813.0 | 16.0 |
| 0 | 0 | 103.0 | 1839.0 | 40.0 |
| 0 | 0 | 106.0 | 3222.0 | 64.0 |
| 9 ENDVAL | 005 | 1.0 | 112.0 | 0.0 |
| 2 XSECTN | 005 | 1.0 | 0.0 | 0.0 |
| 0 | 0 | 107.0 | 47.0 | 7.0 |
| 0 | 0 | 107.3 | 84.0 | 14.0 |
| 0 | 0 | 107.5 | 153.0 | 26.0 |
| 0 | 0 | 108.0 | 332.0 | 54.0 |
| 0 | 0 | 109.0 | 473.0 | 80.0 |
| 0 | 0 | 110.0 | 1834.0 | 280.0 |
| 0 | 0 | 111.0 | 3204.0 | 480.0 |
| 9 ENDVAL | 006 | 1.0 | 113.0 | 0.0 |
| 2 XSECTN | 006 | 1.0 | 0.0 | 0.0 |
| 0 | 0 | 105.0 | 170.0 | 4.0 |
| 0 | 0 | 105.5 | 240.0 | 8.0 |
| 0 | 0 | 106.0 | 480.0 | 16.0 |
| 0 | 0 | 107.0 | 1477.0 | 40.0 |
| 0 | 0 | 110.0 | 2518.0 | 64.0 |
| 9 ENDVAL | 008 | 1.0 | 118.0 | 0.0 |
| 2 XSECTN | 008 | 1.0 | 0.0 | 0.0 |
| 0 | 0 | 111.0 | 68.0 | 12.0 |
| 0 | 0 | 112.0 | 199.0 | 35.0 |
| 0 | 0 | 113.0 | 888.0 | 120.5 |
| 0 | 0 | 115.5 | 1840.0 | 268.0 |
| 9 ENDVAL | 010 | 1.0 | 118.0 | 0.0 |
| 2 XSECTN | 010 | 1.0 | 0.0 | 0.0 |
| 0 | 0 | 111.0 | 19.0 | 0.0 |

DEVELOPED CONDITIONS
(File: KVDES.DAT)

*****90-40 LIST OF INPUT DATA (CONTINUED)*****

| | | | | |
|----------|-----|-------|--------|-------|
| 0 | 0 | 112.0 | 106.0 | 19.0 |
| 0 | 0 | 113.0 | 222.0 | 40.0 |
| 0 | 0 | 115.5 | 556.0 | 135.0 |
| 0 | 0 | 116.0 | 1720.0 | 230.0 |
| 9 ENDVAL | 012 | 1.0 | 93.0 | 0.0 |
| 2 XSECTN | 012 | 1.0 | 0.0 | 0.0 |
| 0 | 0 | 64.0 | 67.0 | 4.0 |
| 0 | 0 | 64.5 | 179.0 | 19.0 |
| 0 | 0 | 65.0 | 373.0 | 39.0 |
| 0 | 0 | 67.0 | 517.0 | 53.0 |
| 0 | 0 | 68.0 | 776.0 | 78.0 |
| 0 | 0 | 90.5 | 1741.0 | 155.0 |
| 0 | 0 | 93.0 | 2814.0 | 232.0 |
| 9 ENDVAL | 013 | 1.0 | 98.0 | 0.0 |
| 2 XSECTN | 013 | 1.0 | 0.0 | 0.0 |
| 0 | 0 | 90.3 | 139.0 | 5.0 |
| 0 | 0 | 90.5 | 278.0 | 10.0 |

*****80-80 LIST OF INPUT DATA (CONTINUED)*****

| | | | | | |
|---|---|-------|--------|------|-------|
| 3 | 1 | 20.0 | 557.0 | 81.0 | 20.0 |
| 3 | 2 | 40.0 | 1113.0 | 42.0 | 40.0 |
| 3 | 3 | 100.0 | 3847.0 | 85.0 | 100.0 |
| 3 | 4 | 160.0 | 6378.0 | 98.0 | 160.0 |
| 3 | 1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 2 | 50.0 | 52.0 | 43.0 | 50.0 |
| 3 | 3 | 108.0 | 163.0 | 44.0 | 108.0 |
| 3 | 4 | 404.0 | 358.0 | 48.0 | 404.0 |
| 3 | 5 | 700.0 | 2702.0 | 48.0 | 700.0 |
| 3 | 6 | 0.0 | 5672.0 | 52.0 | 0.0 |
| 3 | 1 | 0.0 | 52.0 | 1.0 | 0.0 |
| 3 | 2 | 50.0 | 0.0 | 42.0 | 50.0 |
| 3 | 3 | 108.0 | 163.0 | 43.0 | 108.0 |
| 3 | 4 | 404.0 | 358.0 | 44.0 | 404.0 |
| 3 | 5 | 700.0 | 2702.0 | 48.0 | 700.0 |
| 3 | 6 | 0.0 | 5672.0 | 52.0 | 0.0 |
| 3 | 1 | 0.0 | 51.0 | 1.0 | 0.0 |
| 3 | 2 | 10.0 | 0.0 | 45.0 | 10.0 |
| 3 | 3 | 20.0 | 65.0 | 46.0 | 20.0 |
| 3 | 4 | 40.0 | 130.0 | 47.0 | 40.0 |
| 3 | 5 | 80.0 | 256.0 | 49.0 | 80.0 |
| 3 | 6 | 160.0 | 466.0 | 51.0 | 160.0 |
| 3 | 1 | 50.0 | 50.0 | 1.0 | 50.0 |

*****80-80 LIST OF INPUT DATA (CONTINUED)*****

| | | | | | |
|---|---|-------|--------|------|-------|
| 3 | 1 | 0.0 | 0.0 | 42.0 | 0.0 |
| 3 | 2 | 14.0 | 52.0 | 43.0 | 14.0 |
| 3 | 3 | 30.0 | 104.0 | 44.0 | 30.0 |
| 3 | 4 | 75.0 | 315.0 | 47.0 | 75.0 |
| 3 | 5 | 120.0 | 541.0 | 50.0 | 120.0 |
| 3 | 1 | 0.0 | 46.0 | 40.0 | 0.0 |
| 3 | 2 | 30.0 | 152.0 | 41.0 | 30.0 |
| 3 | 3 | 60.0 | 294.0 | 42.0 | 60.0 |
| 3 | 4 | 150.0 | 947.0 | 45.0 | 150.0 |
| 3 | 5 | 240.0 | 1644.0 | 48.0 | 240.0 |
| 3 | 1 | 0.0 | 50.0 | 1.0 | 0.0 |
| 3 | 2 | 50.0 | 163.0 | 41.0 | 50.0 |
| 3 | 3 | 100.0 | 358.0 | 42.0 | 100.0 |
| 3 | 4 | 404.0 | 2702.0 | 48.0 | 404.0 |
| 3 | 5 | 700.0 | 5672.0 | 50.0 | 700.0 |
| 3 | 1 | 0.0 | 0.0 | 47.0 | 0.0 |
| 3 | 2 | 6.0 | 10.0 | 48.0 | 6.0 |
| 3 | 3 | 24.0 | 42.0 | 49.0 | 24.0 |
| 3 | 4 | 40.0 | 75.0 | 50.0 | 40.0 |
| 3 | 5 | 58.0 | 90.0 | 51.0 | 58.0 |
| 3 | 6 | 72.0 | 106.0 | 52.0 | 72.0 |
| 3 | 1 | 102.0 | 123.0 | 53.0 | 102.0 |
| 3 | 2 | 132.0 | 135.0 | 54.0 | 132.0 |
| 3 | 3 | 182.0 | 150.0 | 55.0 | 182.0 |
| 3 | 4 | 192.0 | 162.0 | 56.0 | 192.0 |
| 3 | 5 | 233.0 | 276.0 | 57.0 | 233.0 |
| 3 | 6 | 300.0 | 768.0 | 58.0 | 300.0 |
| 3 | 1 | 0.0 | 1776.0 | 59.0 | 0.0 |
| 3 | 2 | 24.0 | 0.0 | 44.0 | 24.0 |
| 3 | 3 | 51.0 | 46.0 | 46.0 | 51.0 |
| 3 | 4 | 82.0 | 85.0 | 48.0 | 82.0 |
| 3 | 5 | 93.0 | 140.0 | 50.0 | 93.0 |
| 3 | 6 | 103.0 | 220.0 | 50.5 | 103.0 |
| 3 | 1 | 107.0 | 511.0 | 51.5 | 107.0 |
| 3 | 2 | 110.0 | 5699.0 | 51.5 | 110.0 |
| 3 | 3 | 0.200 | 9875.0 | 52.0 | 0.200 |

*****80-80 LIST OF INPUT DATA (CONTINUED)*****

| | | | | |
|---|-------------|------------|--------|---|
| 6 | ADMTD 4 017 | 2 3 | 0.187 | 1 |
| 6 | REACH 1 018 | 5 | 80.0 | 1 |
| 6 | ADMTD 3 019 | 5 | 2100.0 | 1 |
| 6 | REACH 1 019 | 5 | 89.0 | 1 |
| 6 | ADMTD 4 019 | 6 7 | 0.241 | 1 |
| 6 | ADMTD 4 020 | 2 3 | 1100.0 | 1 |
| 6 | REACH 3 021 | 2 3 | 84.0 | 1 |
| 6 | ADMTD 4 022 | 1 3 | 1900.0 | 1 |
| 6 | REACH 3 023 | 2 3 | 84.0 | 1 |
| 6 | ADMTD 1 023 | 2 3 | 0.030 | 1 |
| 6 | ADMTD 4 023 | 1 2 3 | 0.138 | 1 |
| 6 | REACH 1 023 | 5 6 | 89.0 | 1 |
| 6 | ADMTD 4 024 | 2 3 5 6 | 0.130 | 1 |
| 6 | REACH 1 024 | 6 7 | 88.0 | 1 |
| 6 | ADMTD 4 025 | 2 3 4 5 6 | 0.73 | 1 |
| 6 | REACH 1 025 | 8 | 72.0 | 1 |
| 6 | ADMTD 4 026 | 02 3 4 5 6 | 0.23 | 1 |
| 6 | REACH 1 026 | 8 | 27.0 | 1 |
| 6 | ADMTD 4 027 | 03 1 2 3 4 | 0.08 | 1 |
| 6 | REACH 1 027 | 8 | 0.89 | 1 |
| 6 | ADMTD 4 028 | 03 3 4 5 6 | 0.69 | 1 |
| 6 | REACH 1 028 | 8 | 0.69 | 1 |

1820 XEQ 03-07-91 09:38 KYDES.DAT - ENTIRE WATERSHED DEV. - V/PROJECTS - REFINED REV PC 09/83(.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.)

Table with columns: SECTION/STRUCTURE ID, STANDARD CONTROL OPERATION, DRAINAGE AREA (SQ MI), RAIN ANTIC MOIST COND INCHEN (HR), PRECIPITATION AMOUNT (IN), RUMOFF AMOUNT (IN), ELEVATION (FT), PEAK DISCHARGE TIME (HR), RATE (CFS), RATE (CSM). Rows include sections 1 through 12.

1820 XEQ 03-07-91 09:38 KYDES.DAT - ENTIRE WATERSHED DEV. - V/PROJECTS - REFINED REV PC 09/83(.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.)

Table with columns: SECTION/STRUCTURE ID, STANDARD CONTROL OPERATION, DRAINAGE AREA (SQ MI), RAIN ANTIC MOIST COND INCHEN (HR), PRECIPITATION AMOUNT (IN), RUMOFF AMOUNT (IN), ELEVATION (FT), PEAK DISCHARGE TIME (HR), RATE (CFS), RATE (CSM). Rows include sections 1 through 12.

1820 XEQ 03-07-91 09:38 KYDES.DAT - ENTIRE WATERSHED DEV. - V/PROJECTS - REFINED REV PC 09/83(.1)

1820 XEQ 03-07-91 09:38 KYDES.DAT - ENTIRE WATERSHED DEV. - V/PROJECTS - REFINED REV PC 09/83(.1)

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Table with columns: SECTION/STRUCTURE ID, STANDARD CONTROL OPERATION, DRAINAGE AREA (SQ MI), RAIN ANTIC MOIST COND INCHEN (HR), PRECIPITATION AMOUNT (IN), RUMOFF AMOUNT (IN), ELEVATION (FT), PEAK DISCHARGE TIME (HR), RATE (CFS), RATE (CSM). Rows include sections 1 through 12.

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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.)

Table with columns: SECTION/STRUCTURE ID, STANDARD CONTROL OPERATION, DRAINAGE AREA (SQ MI), RAIN ANTIC MOIST COND INCHEN (HR), PRECIPITATION AMOUNT (IN), RUMOFF AMOUNT (IN), ELEVATION (FT), PEAK DISCHARGE TIME (HR), RATE (CFS), RATE (CSM). Rows include sections 1 through 12.

1820 XEQ 03-07-91 09:38 KYDES.DAT - ENTIRE WATERSHED DEV. - V/PROJECTS - REFINED REV PC 09/83(.1)

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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.)

Table with columns: SECTION/STRUCTURE ID, STANDARD CONTROL OPERATION, DRAINAGE AREA (SQ MI), RAIN ANTIC MOIST COND INCHEN (HR), PRECIPITATION AMOUNT (IN), RUMOFF AMOUNT (IN), ELEVATION (FT), PEAK DISCHARGE TIME (HR), RATE (CFS), RATE (CSM). Rows include sections 1 through 12.

1820 XEQ 03-07-91 09:38 KYDES.DAT - ENTIRE WATERSHED DEV. - V/PROJECTS - REFINED REV PC 09/83(.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.)

Table with columns: SECTION/STRUCTURE ID, STANDARD CONTROL OPERATION, DRAINAGE AREA (SQ MI), RAIN ANTIC MOIST COND INCHEN (HR), PRECIPITATION AMOUNT (IN), RUMOFF AMOUNT (IN), ELEVATION (FT), PEAK DISCHARGE TIME (HR), RATE (CFS), RATE (CSM). Rows include sections 1 through 12.

1820 XEQ 03-07-91 09:38 KYDES.DAT - ENTIRE WATERSHED DEV. - V/PROJECTS - REFINED REV PC 09/83(.1)

TRSD XEO 03-07-91 09:38 KYDES.DAT - ENTIRE WATERSHED DEV. - V/PROJECTS - REFINED
REV PC 09/83(1.1)

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A START*) 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.)

Table with 16 columns: SECTION/STRUCTURE ID, STANDARD CONTROL OPERATION, DRAINAGE AREA (SQ MI), RAIN ARTIC TABLE #, COND, INTRC, TIME, BEGIN, PRECIPITATION AMOUNT (IN), DURATION (HR), RUMOFF AMOUNT (IN), ELEVATION (FT), PEAK DISCHARGE TIME (HR), RATE (CFS), PEAK DISCHARGE RATE (CFSM).

Table with 16 columns: SECTION/STRUCTURE ID, STANDARD CONTROL OPERATION, DRAINAGE AREA (SQ MI), RAIN ARTIC TABLE #, COND, INTRC, TIME, BEGIN, PRECIPITATION AMOUNT (IN), DURATION (HR), RUMOFF AMOUNT (IN), ELEVATION (FT), PEAK DISCHARGE TIME (HR), RATE (CFS), PEAK DISCHARGE RATE (CFSM).

TRSD XEO 03-07-91 09:38 KYDES.DAT - ENTIRE WATERSHED DEV. - V/PROJECTS - REFINED
REV PC 09/83(1.1)

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A START*) 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.)

Table with 16 columns: SECTION/STRUCTURE ID, STANDARD CONTROL OPERATION, DRAINAGE AREA (SQ MI), RAIN ARTIC TABLE #, COND, INTRC, TIME, BEGIN, PRECIPITATION AMOUNT (IN), DURATION (HR), RUMOFF AMOUNT (IN), ELEVATION (FT), PEAK DISCHARGE TIME (HR), RATE (CFS), PEAK DISCHARGE RATE (CFSM).

ALTERNATE 1 STORM 4

Table with columns: SECTION, RUMPOFF, ADORNO, BEACH, DIVERT, etc. and rows for various sections like SECTION 6, SECTION 7, etc.

ALTERNATE 1 STORM 1

Table with columns: SECTION, RUMPOFF, ADORNO, BEACH, DIVERT, etc. and rows for various sections like SECTION 2, SECTION 3, etc.

ALTERNATE 2 STORM 1

Table with columns: SECTION, RUMPOFF, ADORNO, BEACH, DIVERT, etc. and rows for various sections like SECTION 2, SECTION 3, etc.

ALTERNATE 2 STORM 2

Table with columns: SECTION, RUMPOFF, ADORNO, BEACH, DIVERT, etc. and rows for various sections like SECTION 2, SECTION 3, etc.

HYDROGRAPH INFORMATION

ROUTING PARAMETERS

Summary text: SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED

Summary Table 1 with columns: SECTION/STRUCTURE ID, STANDARD CONTROL OPERATION, RAIN ANTICIPATION TABLE, etc.

ALTERNATE 1 STORM 4

Table with columns: SECTION/STRUCTURE ID, RUMPOFF, ADORNO, BEACH, DIVERT, etc.

ALTERNATE 1 STORM 1

Table with columns: SECTION/STRUCTURE ID, RUMPOFF, ADORNO, BEACH, DIVERT, etc.

ALTERNATE 2 STORM 1

Table with columns: SECTION/STRUCTURE ID, RUMPOFF, ADORNO, BEACH, DIVERT, etc.

ALTERNATE 2 STORM 2

Table with columns: SECTION/STRUCTURE ID, RUMPOFF, ADORNO, BEACH, DIVERT, etc.

ALTERNATE 1 STORM 1

Table with columns: SECTION/STRUCTURE ID, RUMPOFF, ADORNO, BEACH, DIVERT, etc.

ALTERNATE 1 STORM 2

Table with columns: SECTION/STRUCTURE ID, RUMPOFF, ADORNO, BEACH, DIVERT, etc.

ALTERNATE 2 STORM 1

Table with columns: SECTION/STRUCTURE ID, RUMPOFF, ADORNO, BEACH, DIVERT, etc.

ALTERNATE 2 STORM 2

Table with columns: SECTION/STRUCTURE ID, RUMPOFF, ADORNO, BEACH, DIVERT, etc.

ALTERNATE 1 STORM 1

Table with columns: SECTION/STRUCTURE ID, RUMPOFF, ADORNO, BEACH, DIVERT, etc.

ALTERNATE 1 STORM 2

Table with columns: SECTION/STRUCTURE ID, RUMPOFF, ADORNO, BEACH, DIVERT, etc.

ALTERNATE 2 STORM 1

Table with columns: SECTION/STRUCTURE ID, RUMPOFF, ADORNO, BEACH, DIVERT, etc.

ALTERNATE 2 STORM 2

Table with columns: SECTION/STRUCTURE ID, RUMPOFF, ADORNO, BEACH, DIVERT, etc.

Table with columns for EC REACH, INFLOW, OUTFLOW, etc. Includes data for EC 700, 800, 700, 300, 500, 4 50, 4 400, 7 2500, 9 5200, 1 1400, 3 1900. Includes section headers 'ALTERNATE 1 STORM 3' and 'ALTERNATE 1 STORM 4'.

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ROUTING PARAMETERS: VOLUME, MAIN TIER, Q AND A, PEAK S/Q, AT-T, TRAVEL TIME. HYDROGRAPH INFORMATION: EC REACH, INFLOW, OUTFLOW, INTERFL, etc.

Table with columns for EC REACH, INFLOW, OUTFLOW, INTERFL, etc. Includes data for EC 1200, 700, 800.

Table with columns for EC 10, 12, 13, 14, 15, 17, 19, 21, 23. Includes data for EC 10, 12, 13, 14, 15, 17, 19, 21, 23.

TR20 XEQ 03-07-91 09:38 KYDES.DAT - ENTIRE WATERSHED DEV. - W/PROJECTS - REFINED JOB 1 SUMMARY

REV PC 09/83(1.1)

SUMMARY TABLE 3 - DISCHARGE (CFS) AT SECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

| SECTION/
STRUCTURE
ID | DISCHARGE
AREA
(SQ MI) | STORM NUMBER..... 2 | 3 | 4 |
|-----------------------------|------------------------------|---------------------|---------|---------|
| STRUCTURE 3 | 3.45 | | | |
| ALTERNATE 1 | | .06 | .04 | .00 |
| STRUCTURE 2 | 3.30 | | | |
| ALTERNATE 1 | | 2724.60 | 2250.00 | 1855.44 |
| STRUCTURE 1 | 2.05 | | | |
| ALTERNATE 1 | | 874.61 | 523.20 | 348.89 |
| ALTERNATE 2 | .07 | | | |
| ALTERNATE 1 | | 115.03 | 88.72 | 41.31 |
| ALTERNATE 2 | .12 | | | |
| ALTERNATE 1 | | 304.37 | 253.11 | 155.42 |
| ALTERNATE 3 | .16 | | | |
| ALTERNATE 1 | | 444.29 | 374.34 | 238.96 |
| ALTERNATE 4 | .31 | | | |
| ALTERNATE 1 | | 384.02 | 284.74 | 112.71 |
| ALTERNATE 5 | .41 | | | |
| ALTERNATE 1 | | 718.23 | 573.95 | 310.78 |
| ALTERNATE 6 | .47 | | | |
| ALTERNATE 1 | | 894.77 | 725.87 | 413.14 |
| ALTERNATE 7 | .57 | | | |
| ALTERNATE 1 | | 1148.42 | 952.24 | 589.15 |
| ALTERNATE 8 | .59 | | | |
| ALTERNATE 1 | | 1163.88 | 985.43 | 577.88 |
| ALTERNATE 9 | .46 | | | |
| ALTERNATE 1 | | 938.85 | 764.99 | 432.59 |
| ALTERNATE 10 | .47 | | | |
| ALTERNATE 1 | | 978.95 | 799.69 | 455.98 |
| ALTERNATE 11 | 1.05 | | | |
| ALTERNATE 1 | | 2076.73 | 1712.96 | 1004.82 |
| ALTERNATE 1 | | | | 372.29 |

REV PC 09/83(1.1)

SUMMARY TABLE 3 - DISCHARGE (CFS) AT SECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

| SECTION/
STRUCTURE
ID | DISCHARGE
AREA
(SQ MI) | STORM NUMBER..... 2 | 3 | 4 |
|-----------------------------|------------------------------|---------------------|---------|---------|
| SECTION 12 | 1.11 | | | |
| ALTERNATE 1 | | 2249.61 | 1857.79 | 1098.53 |
| SECTION 13 | 1.11 | | | |
| ALTERNATE 1 | | 2249.61 | 1857.79 | 1098.53 |
| SECTION 14 | 2.05 | | | |
| ALTERNATE 1 | | 874.61 | 523.20 | 348.89 |
| SECTION 15 | 2.25 | | | |
| ALTERNATE 1 | | 1049.29 | 614.50 | 313.80 |
| SECTION 16 | .15 | | | |

REV PC 09/83(1.1)

SUMMARY TABLE 3 - DISCHARGE (CFS) AT SECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

| SECTION/
STRUCTURE
ID | DISCHARGE
AREA
(SQ MI) | STORM NUMBER..... 2 | 3 | 4 |
|-----------------------------|------------------------------|---------------------|---------|---------|
| SECTION 17 | .31 | | | |
| ALTERNATE 1 | | 354.89 | 313.78 | 210.81 |
| SECTION 18 | .20 | | | |
| ALTERNATE 1 | | 687.83 | 591.76 | 398.24 |
| SECTION 19 | .44 | | | |
| ALTERNATE 1 | | 488.98 | 422.13 | 287.37 |
| SECTION 20 | .75 | | | |
| ALTERNATE 1 | | 925.81 | 797.40 | 532.08 |
| SECTION 21 | .75 | | | |
| ALTERNATE 1 | | 1573.25 | 1354.30 | 906.41 |
| SECTION 22 | 3.00 | | | |
| ALTERNATE 1 | | 1573.25 | 1354.30 | 906.41 |
| SECTION 23 | 3.03 | | | |
| ALTERNATE 1 | | 2158.43 | 1805.87 | 1231.32 |
| SECTION 25 | 2.05 | | | |
| ALTERNATE 1 | | 2216.04 | 1859.35 | 1266.73 |
| SECTION 26 | 3.30 | | | |
| ALTERNATE 1 | | 3476.37 | 2840.08 | 1825.61 |
| ALTERNATE 1 | | 2708.87 | 2287.57 | 1548.85 |
| ALTERNATE 1 | | | | 765.63 |

REV PC 09/83(1.1)

SUMMARY TABLE 3 - DISCHARGE (CFS) AT SECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

| SECTION/
STRUCTURE
ID | DISCHARGE
AREA
(SQ MI) | STORM NUMBER..... 2 | 3 | 4 |
|-----------------------------|------------------------------|---------------------|---------|---------|
| SECTION 27 | 3.45 | | | |
| ALTERNATE 1 | | 2216.11 | 1910.52 | 1109.67 |
| SECTION 28 | 1.00 | | | |
| ALTERNATE 1 | | | | .00 |

REV PC 09/83(1.1)

WASTE WATER MASTER PLAN

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 Waikamilo Rd., Suite 411
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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:
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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 (DWWWM)

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 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.

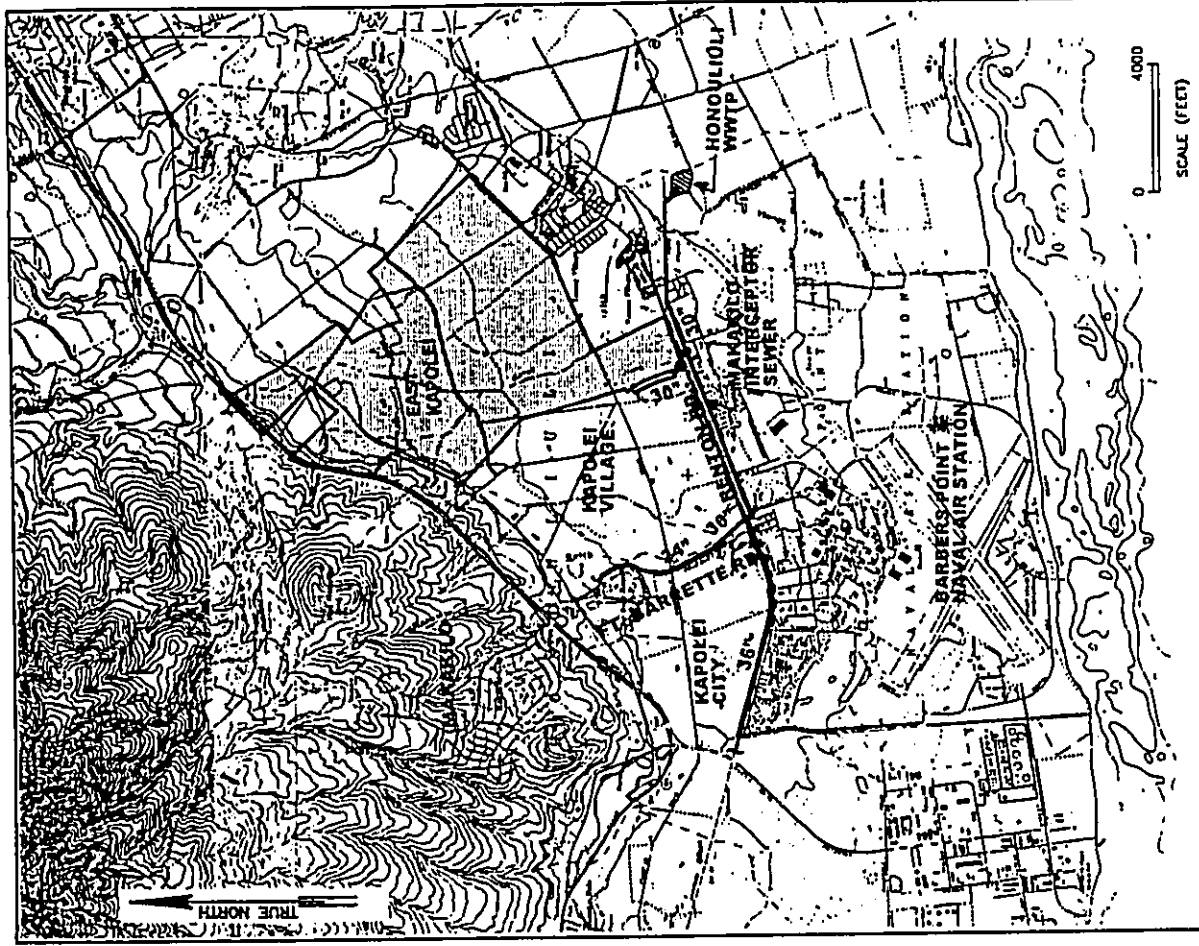


FIGURE 1-1
EAST KAPOLEI
SEWER
MASTER PLAN
R.M. TOWILL CORPORATION

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 (DWWWM). 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 Niakakilo 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.

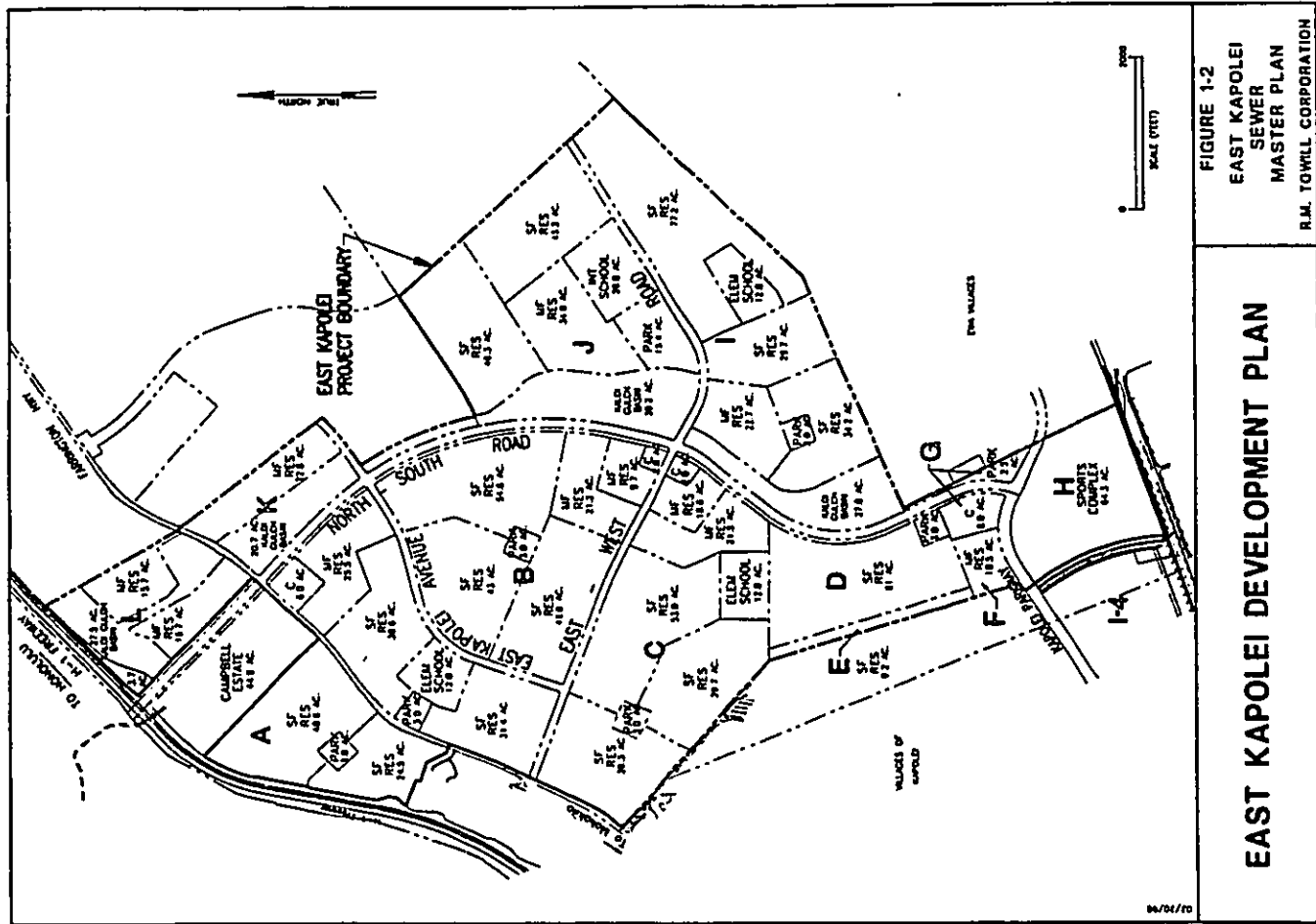


FIGURE 1-2
EAST KAPOLEI
SEWER
MASTER PLAN
R.M. TOWELL CORPORATION

**Table 3-1
EAST KAPOLEI
PROJECTED SEWER DEMANDS**

| Parcel | Unit Type | Acres | 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 | 0.008 | 75 | 0.001 | 0.008 | 3,750 | 0.010 |
| | Commy/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 | 11,898 | 0.199 | 0.828 | 91,375 | 0.917 |
| | SUBTOTAL | 121.0 | 585 | 0.691 | | 3.334 | 20,751 | 0.712 | 3.355 | 151,250 | 3.506 |
| B | Park | 8.0 | | 0.002 | 5.00 | 0.012 | 150 | 0.003 | 0.012 | 7,500 | 0.020 |
| | Commercial | 8.0 | | 0.026 | 5.00 | 0.128 | 1,800 | 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 | 211.8 | 1083 | 0.542 | 4.40 | 2.383 | 33,856 | 0.578 | 2.417 | 284,500 | 2.882 |
| | Multi Family | 56.4 | 677 | 0.152 | 5.00 | 0.758 | 9,475 | 0.181 | 0.787 | 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 | 0.008 | 75 | 0.001 | 0.008 | 3,750 | 0.010 |
| | Commercial | 2.0 | | 0.008 | 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 | 185,000 | 1.538 |
| | Multi Family | 32.1 | 385 | 0.086 | 4.80 | 0.423 | 5,393 | 0.082 | 0.428 | 40,125 | 0.468 |
| | SUBTOTAL | 181.1 | 1,441 | 0.462 | | 3.75 | 32,988 | 0.495 | 1.865 | 228,375 | 2.222 |
| D | Park | 3.0 | | 0.001 | 5.00 | 0.008 | 75 | 0.001 | 0.008 | 3,750 | 0.010 |
| | Single Family | 61.0 | 488 | 0.156 | 4.40 | 0.687 | 9,780 | 0.168 | 0.687 | 78,250 | 0.773 |
| | SUBTOTAL | 64.0 | 488 | 0.157 | | 0.693 | 9,855 | 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 | 128 | 0.028 | 5.00 | 0.141 | 1,784 | 0.030 | 0.143 | 13,125 | 0.158 |
| G | Park | 2.5 | | 0.001 | 5.00 | 0.005 | 83 | 0.001 | 0.005 | 3,125 | 0.008 |
| | Commercial | 8.0 | | 0.026 | 5.00 | 0.128 | 1,800 | 0.027 | 0.130 | 10,000 | 0.140 |
| | SUBTOTAL | 10.5 | 0 | 0.027 | | 0.133 | 1,883 | 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 | 0.008 | 75 | 0.001 | 0.008 | 3,750 | 0.010 |
| | Elementary School | 12.0 | | 0.030 | 5.00 | 0.150 | 6,000 | 0.036 | 0.156 | 15,000 | 0.171 |
| | Single Family | 141.1 | 1128 | 0.381 | 4.50 | 1.825 | 22,578 | 0.384 | 1.848 | 178,375 | 1.824 |
| | Multi Family | 22.7 | 272 | 0.081 | 4.85 | 0.296 | 3,814 | 0.085 | 0.300 | 26,375 | 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 | Acres | 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 | | 0.008 | 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 | 1.018 | 15,120 | 0.257 | 1.031 | 118,125 | 1.149 |
| | Multi Family | 34.0 | 408 | 0.091 | 4.80 | 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 | 0.081 | 5.00 | 0.306 | 3,830 | 0.065 | 0.310 | 28,500 | 0.336 |
| L | Multi Family | 32.4 | 389 | 0.087 | 5.00 | 0.435 | 5,443 | 0.083 | 0.441 | 40,500 | 0.481 |
| TOTALS (W/O UHWC) | | 1,152.5 | 8,311 | 3.148 | | 14.436 | 192,041 | 3.338 | 14.628 | 1,438,875 | 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 | 4.748 | | 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:

$$\text{Velocity} = \frac{1.486 C^{0.58} S^{0.54}}{n}$$

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 1, 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:

| | | |
|-----------------------|---------------------------|--------------------|
| | Onsite 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 WWTTP. 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

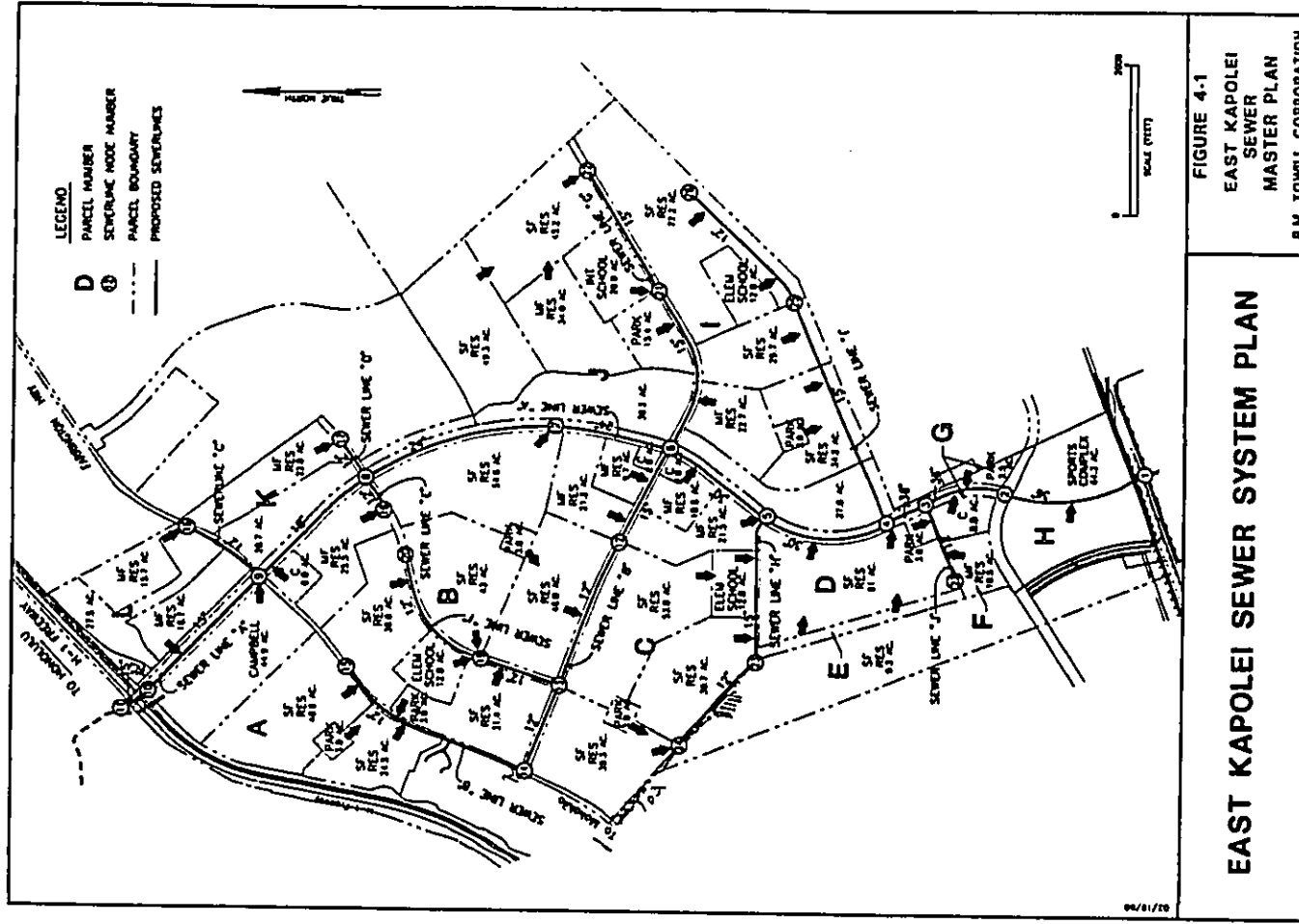


FIGURE 4-1
EAST KAPOLEI
SEWER
MASTER PLAN
R.M. TOWELL CORPORATION

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

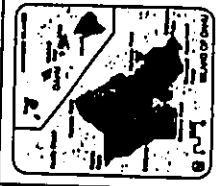
The analyses for the proposed sewer system are shown in the Appendix. On-site contributions are analyzed separately from the ultimate conditions (with UHWOC) in order to determine minimum pipe slopes and velocities. Analysis of the ultimate condition is done to determine minimum pipe sizes.

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.

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**Kapolei
Area
Long Range
Master Plan**
Ewa, Oahu, Hawaii
THE STATE OF HAWAII
October 1987



Land Use Classification

| | |
|-------|--------------------------------|
| U-1 | Residential |
| U-2 | Low Density Residential |
| U-3 | Medium Density Residential |
| U-4 | High Density Residential |
| U-5 | Community Center |
| U-6 | Business Park |
| U-7 | Light Industrial |
| U-8 | Heavy Industrial/Manufacturing |
| U-9 | Public |
| U-10 | Public |
| U-11 | Public |
| U-12 | Public |
| U-13 | Public |
| U-14 | Public |
| U-15 | Public |
| U-16 | Public |
| U-17 | Public |
| U-18 | Public |
| U-19 | Public |
| U-20 | Public |
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| U-90 | Public |
| U-91 | Public |
| U-92 | Public |
| U-93 | Public |
| U-94 | Public |
| U-95 | Public |
| U-96 | Public |
| U-97 | Public |
| U-98 | Public |
| U-99 | Public |
| U-100 | Public |

Circulation

Proposed
Existing



APPENDIX

WATER MASTER PLAN

DRAFT REPORT for the

EAST KAPOLEI WATER MASTER PLAN
Ewa, Oahu, Hawaii

FEBRUARY 1998

PREPARED FOR:

Housing Finance and Development Corporation
State of Hawaii

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EAST KAPOLEI
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Ewa, Oahu, Hawaii

February 23, 1998

Prepared for:

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**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

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plans. These master plans have been updated on several occasions to reflect the actual water system layout as construction in the areas have progressed.

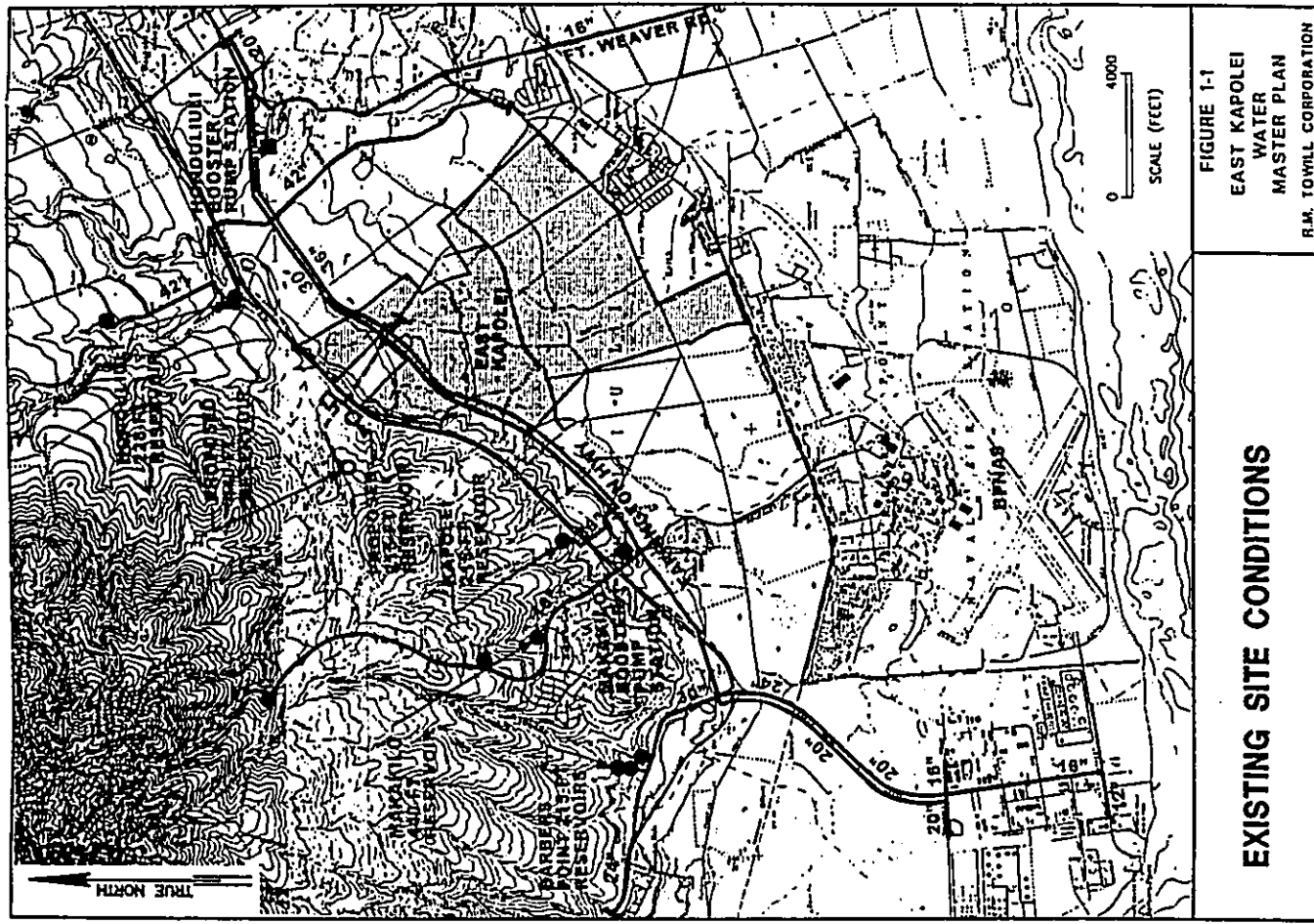
1.4 Existing Conditions

The East Kapolei area extends from elevations of 45-foot MSL on its makai boundaries up to 230-foot MSL above Farrington Highway. These elevations span two Board of Water Supply (BWS) service pressure zones, 215-foot and 440-foot. 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.



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 HIFDC.

Pipeline 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®.

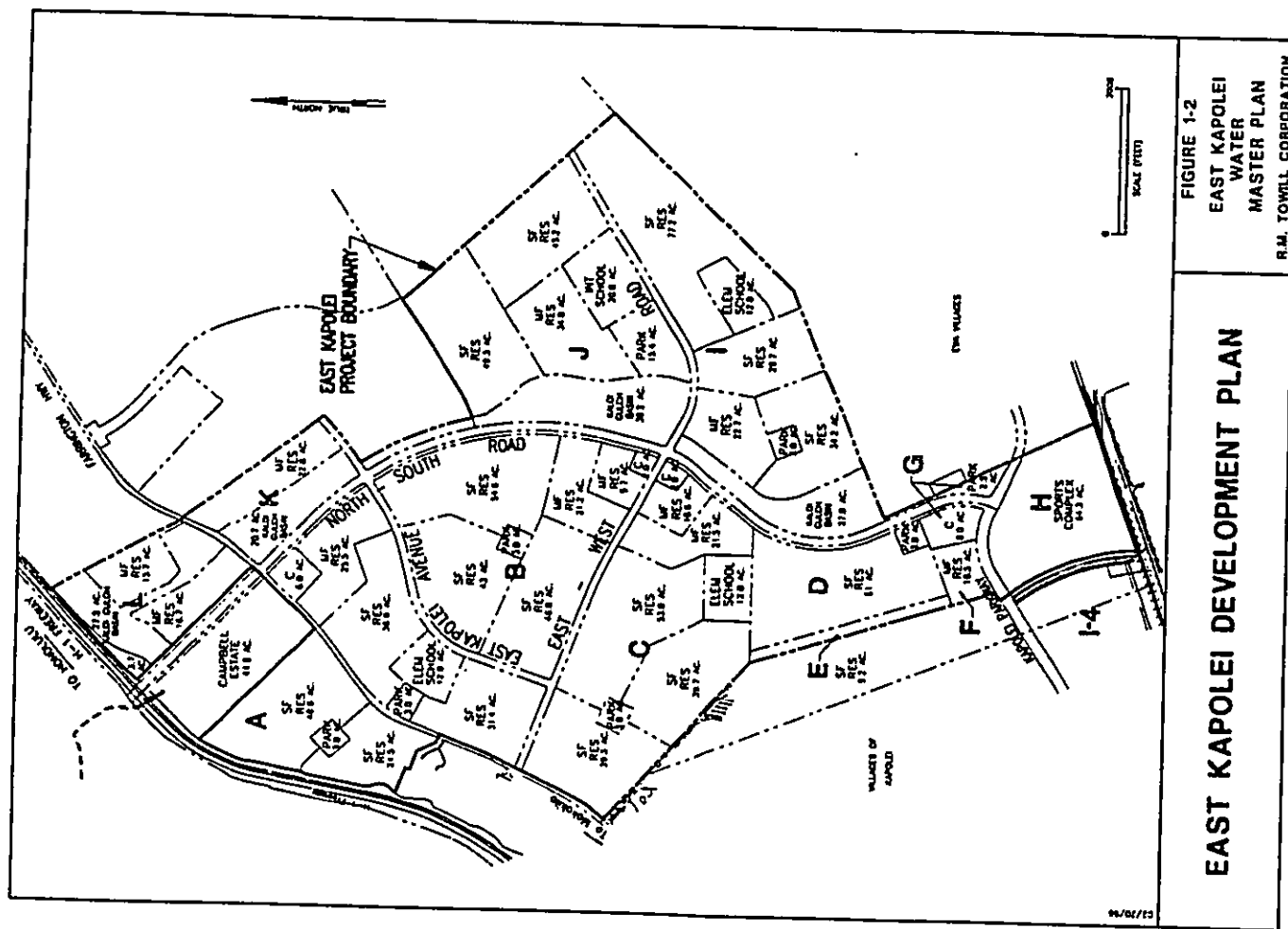


TABLE 2-1
WATER SYSTEM DESIGN CRITERIA

| Land Use | Unit Demand | AU Potable System | Dual System | | | | | | |
|-------------------------|---------------------------|-------------------|----------------|-------------|-------------------|-------------|--|--|--|
| | | | Avg. Water Use | | Avg. Daily Demand | | | | |
| | | | Potable | Non-Potable | Potable | Non-Potable | | | |
| Residential | | | | | | | | | |
| -Single Family | GPD/Unit | 500 | 345 | 155 | 414 | 186 | | | |
| -Multi-Family Low Rise | GPD/Unit | 400 | 276 | 124 | 331 | 149 | | | |
| -Multi-Family High Rise | GPD/Unit | 300 | 207 | 93 | 248 | 112 | | | |
| Commercial, Offices | GPD/Acre | 3,000 | 1,800 | 1,200 | 2,160 | 1,440 | | | |
| Resort | GPD/Unit | 330 | 203 | 147 | 244 | 176 | | | |
| | GPD/Acre | 4,000 | 2,320 | 1,680 | 2,784 | 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 Ft ² | 100 | 60 | 40 | 72 | 48 | | | |
| Commercial/Residential | GPD/1,000 Ft ² | 120 | 83 | 37 | 100 | 44 | | | |

PIPELINE, STORAGE, AND WELL PUMP SIZING CRITERIA

- Demand Factors
 - 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.
 - MAXIMUM DAY DEMAND = (1.5) x AVERAGE DAY DEMAND.
 - PEAK HOUR RATE = (3.0) x AVERAGE DAY DEMAND.
- Fire protection can be met in either the potable or non-potable system subject to meeting all present fire protection standards.
- Reservoir Size
 - The potable reservoir volume shall be equivalent to MAXIMUM DAY DEMAND.
 - The non-potable reservoir volume shall be equivalent to AVERAGE DAY DEMAND. 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.
- 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 | 6.82 |
| 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.

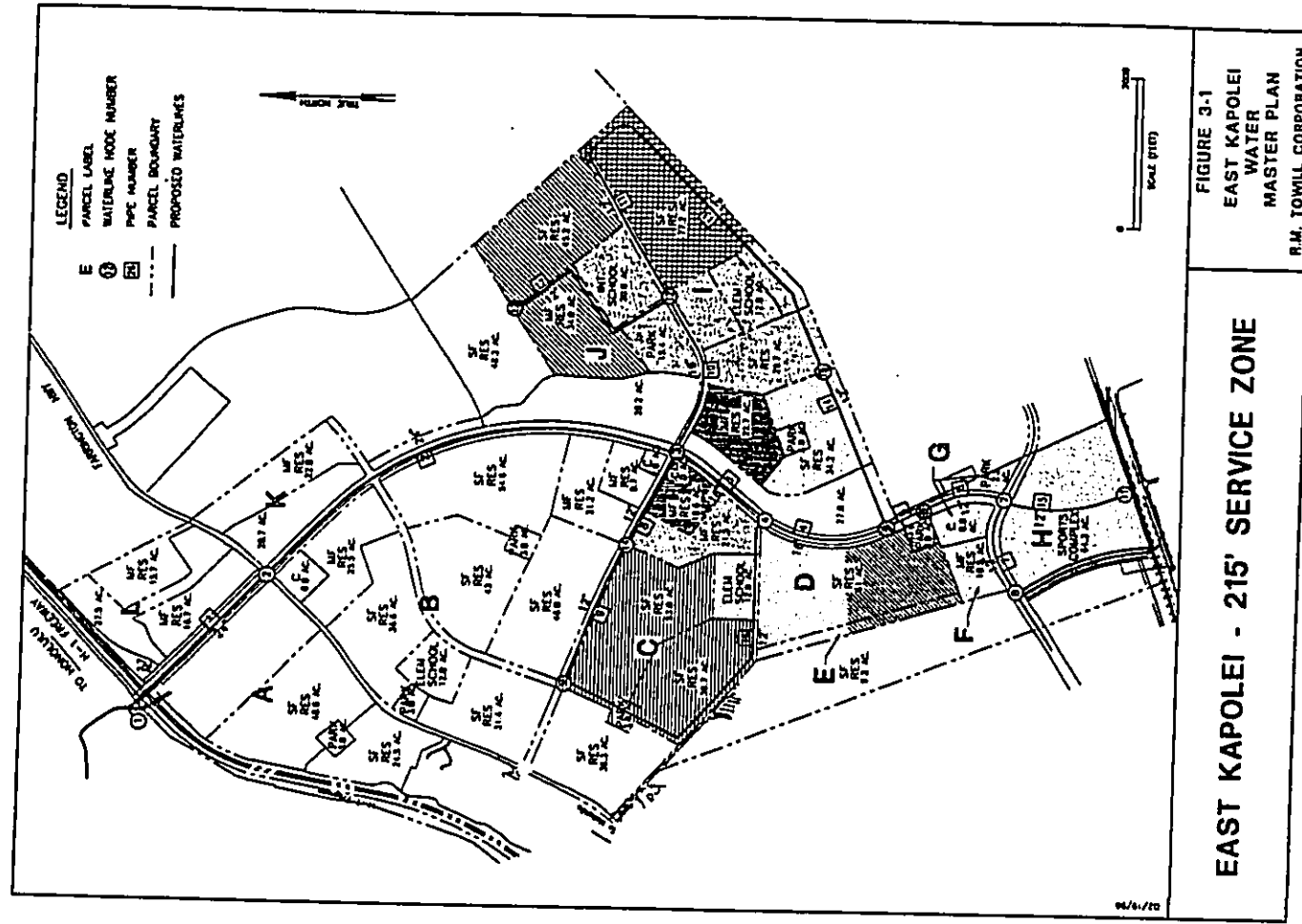
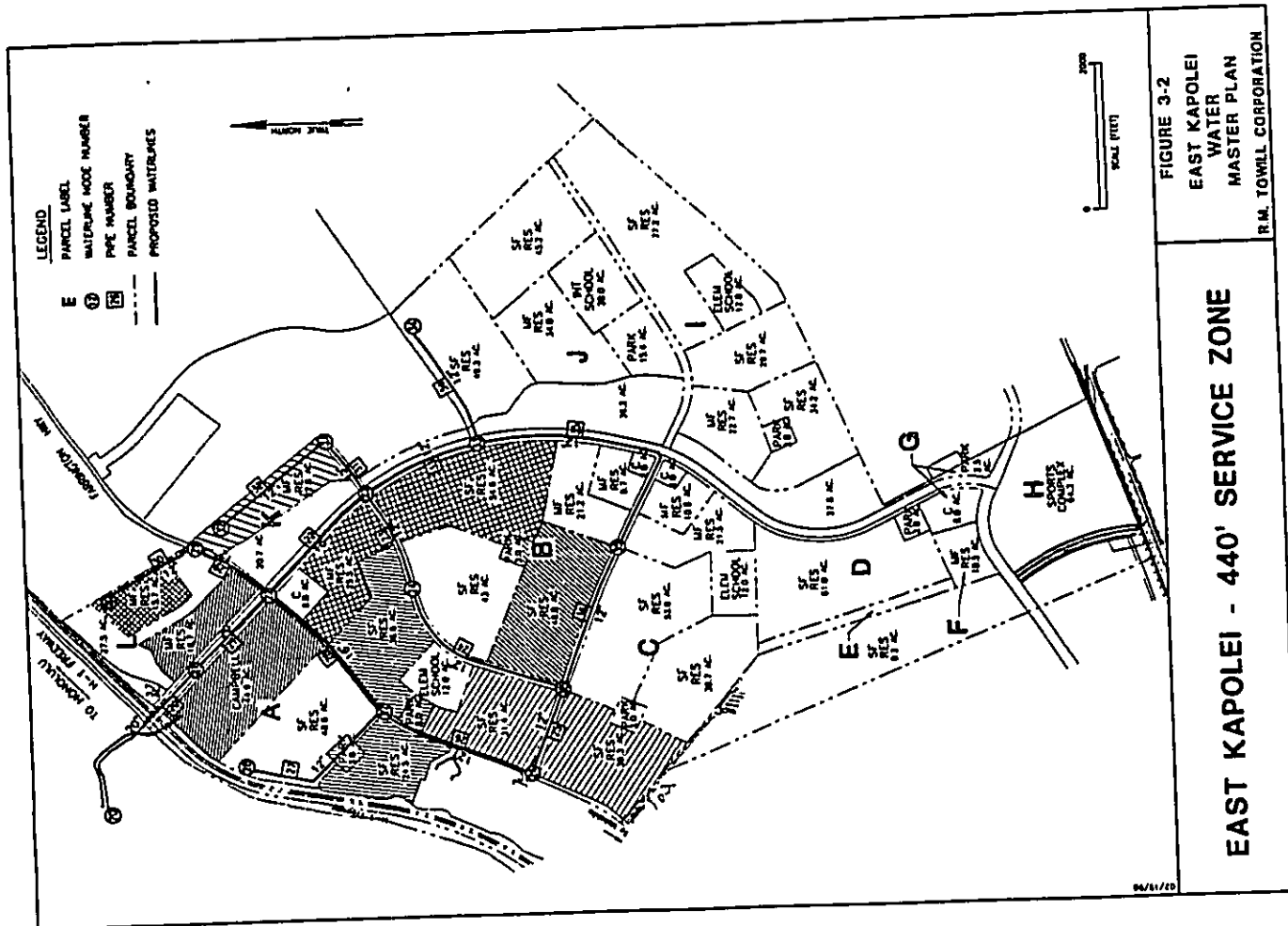


FIGURE 3-1
EAST KAPOLEI
WATER
MASTER PLAN
R.M. TOWILL CORPORATION

**Table 3-1
EAST KAPOLEI
PROJECTED POTABLE WATER DEMAND**

| Parcel | Unit Type | Acreage | Number of Units | Criteria | | Average Daily Demand | | Max Daily Demand | | Fire Flow (gpm) | Peak Daily Demand | |
|-----------------|--------------------|--------------|-----------------------|------------|---------------|----------------------|---------------|------------------|--------------|-----------------|-------------------|--------------|
| | | | | (gal/unit) | (gal/acre) | (mgd) | (gpm) | (mgd) | (gpm) | | (mgd) | (gpm) |
| A | Park | 3.0 | | | 4,000 | 0.0120 | 8.3 | 0.0180 | 12.5 | 2,000 | 0.0360 | 25.0 |
| | Comm/Campbell East | 44.9 | | | 3,000 | 0.1347 | 93.5 | 0.2021 | 140.3 | 4,000 | 0.4041 | 260.6 |
| | Single Family | 73.1 | 585 | 500 | | 0.2924 | 203.0 | 0.4388 | 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 | 1,268.6 | | 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 | 0.0080 | 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 | 1,099.8 |
| | Multi Family | 32.1 | 385 | 400 | | 0.1541 | 107.0 | 0.2311 | 160.5 | 1,500 | 0.4822 | 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 | 0.3860 | 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 | 8.2 | 74 | 500 | | 0.0368 | 25.8 | 0.0552 | 38.3 | 1,000 | 0.1104 | 78.7 |
| | Multi Family | 10.5 | 128 | 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 | 0.0483 | 32.1 | 0.0694 | 48.2 | 2,000 | 0.1389 | 98.4 |



**FIGURE 3-2
EAST KAPOLEI
WATER PLAN
MASTER PLAN
R.M. TOWILL CORPORATION**

EAST KAPOLEI - 440' SERVICE ZONE

**TABLE 3-3
PROJECTED POTABLE WATER DEMAND
440' ZONE**

| Node No | Parcel | Unit Type | Acreage | Number of Units | Criteria | | Average Daily Demand | | Max Daily Demand | | Fire Flow (gpm) | Peak Hourly Demand | |
|--------------------|--------|--------------------|--------------|-----------------------|------------|------------|----------------------|--------------|------------------|--------------|-----------------|--------------------|----------------|
| | | | | | (gal/unit) | (gal/acre) | (mgd) | (gpm) | (mgd) | (gpm) | | (mgd) | (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 | 8.0 | | | 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 | 356 | 2,500 | 1.0224 | 710 |
| 24 | B | Single Family | 43.0 | 344 | 500 | | 0.1720 | 119 | 0.2580 | 179 | 1,000 | 0.5180 | 358 |
| | B | Elementary School | 12.0 | 1200 @ 60 GPD/Student | | | 0.0720 | 50 | 0.1080 | 75 | 2,000 | 0.2180 | 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 | 0.2258 | 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 | 296 | 2,000 | 0.8484 | 589 |
| 27 | B | Single Family | 36.6 | 293 | 500 | | 0.1464 | 102 | 0.2196 | 152 | 1,000 | 0.4392 | 306 |
| | B | Park | 3.0 | | | 4,000 | 0.0120 | 8 | 0.0180 | 12 | 2,000 | 0.0360 | 25 |
| | A | Single Family | 24.3 | 198 | 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 | 0.8062 | 559 |
| 28 | A | Single Family | 48.8 | 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 | 206 | 1,000 | 0.5918 | 411 |
| 35 | B | Multi Family | 30.9 | 371 | 400 | | 0.1488 | 103 | 0.2225 | 154 | 1,500 | 0.4450 | 306 |
| | 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 | | | 2.2556 | 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 | | Average Daily Demand | | Max Daily Demand | | Fire Flow (gpm) | Peak Daily Demand | |
|----------------------------|---------------------|----------|-----------------|------------|------------|----------------------|--------------|------------------|--------------|-----------------|-------------------|----------------|
| | | | | (gal/unit) | (gal/acre) | (mgd) | (gpm) | (mgd) | (gpm) | | (mgd) | (gpm) |
| | Road Planting Areas | 40.7 | | | 4,000 | 0.1628 | 113.0 | 0.2442 | 169.8 | | 0.4884 | 339.1 |
| H | Sports Complex | 64.3 | | | 4,080 | 0.2823 | 182.2 | 0.3935 | 273.3 | | 0.7870 | 546.5 |
| I | Detention Basin | 27.8 | | | 4,000 | 0.1112 | 77.2 | 0.1668 | 115.8 | | 0.3338 | 231.7 |
| J | Park | 15.4 | | | 4,080 | 0.0828 | 43.8 | 0.0942 | 65.4 | | 0.1885 | 130.9 |
| | Detention Basin | 39.2 | | | 4,000 | 0.1588 | 108.8 | 0.2352 | 163.3 | | 0.4704 | 328.6 |
| | | SUBTOTAL | 54.6 | | | | 0.2196 | 152.5 | 0.3294 | 228.8 | | 0.6589 |
| K | Detention Basin | 20.7 | | | 4,000 | 0.0828 | 57.5 | 0.1242 | 86.2 | | 0.2484 | 172.5 |
| L | Detention Basin | 27.5 | | | 4,000 | 0.1100 | 78.4 | 0.1650 | 114.8 | | 0.3300 | 229.2 |
| TOTALS (W/O UH/WOC) | | | 235.8 | | | 0.9488 | 658.8 | 1.4232 | 986.2 | | 2.8483 | 1,978.5 |

| | | | | | | | | | | | | |
|--------------------|----------------------|----------|--|--|-------|---------------|----------------|---------------|----------------|---------|---------------|----------------|
| 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 | 418.8 | | 1.2000 | 833.3 |
| | | SUBTOTAL | 400.0 | | | | 1.6000 | 1,111.0 | 2.4000 | 1,668.6 | | 4.8000 |
| GRAND TOTAL | | | 635.8 | | | 2.5488 | 1,769.9 | 3.8232 | 2,854.8 | | 7.6483 | 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**

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.

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

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. I*, 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 FBR 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.

The number of data points for the pump curve is 3

0 Node No. P Elev of Pump Flows and Related Heads
 No. Par1 Pump 0. 4000. 9000.

1 1 215. 0. 0. 0.00012
 Net unbalanced flow in subnet 1 is

0 The number of pseudo loops is 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

| Pipe | Up | Down | Pipe | Flow | Head | Velocity | Upstream |
|--------|------|------|------|----------|------|----------|----------|
| INCHES | Node | Node | No. | US GPM | Loss | FT/SEC | HGL |
| 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 |

| Node | Elevation | Demand | HGL | Pressure |
|------|-----------|----------|--------|----------|
| FEET | US GPM | FEET | 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 |

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 | Diameter | Roughness | coeff | K |
|---------|-------|---------|----------|-----------|-------|---|
| | | FEET | INCHES | | | |
| 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 | |

| Node | 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 | 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

| | | | | |
|----|--------|--------|--------|-------|
| 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

EAST KAPOLEI POTABLE WATER SYSTEM (PEAK DEMAND CONDITIONS-215'ZONE)

Data file name : ekvmp215.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 | Units: | Length FEET | Diameter INCHES | Flow US GPM | Headloss FEET | Height FEET | Pressure PSI | Velocity FT/ |
|---|--------|-------------|-----------------|-------------|---------------|-------------|--------------|--------------|
|---|--------|-------------|-----------------|-------------|---------------|-------------|--------------|--------------|

There are 16 pipes and 15 nodes

1 List of pipe information including resistance factor K

| Pipe no | Nodes | Length FEET | Diameter INCHES | Flow US GPM | Headloss FEET | Height FEET | Pressure PSI | Velocity FT/ |
|---------|-------|-------------|-----------------|-------------|---------------|-------------|--------------|--------------|
| 1 | 1 2 | 3000.00 | 24.00 | 130.00 | 130.00 | | | .72738E |
| 2 | 2 3 | 6100.00 | 24.00 | 130.00 | 130.00 | | | .14790E |
| 3 | 3 4 | 1500.00 | 16.00 | 120.00 | 120.00 | | | .30388E |
| 4 | 4 5 | 2000.00 | 16.00 | 120.00 | 120.00 | | | .40518E |
| 5 | 5 6 | 500.00 | 12.00 | 110.00 | 110.00 | | | .48111E |
| 6 | 6 7 | 1200.00 | 12.00 | 110.00 | 110.00 | | | .11595E |
| 7 | 7 8 | 1000.00 | 12.00 | 110.00 | 110.00 | | | .96621E |
| 8 | 8 9 | 1450.00 | 12.00 | 110.00 | 110.00 | | | .14010E |
| 9 | 9 10 | 1950.00 | 12.00 | 110.00 | 110.00 | | | .18841E |
| 10 | 10 11 | 2250.00 | 16.00 | 120.00 | 120.00 | | | .45582E |
| 11 | 11 12 | 2850.00 | 12.00 | 110.00 | 110.00 | | | .21740E |
| 12 | 12 13 | 2850.00 | 12.00 | 110.00 | 110.00 | | | .27537E |
| 13 | 13 14 | 4800.00 | 12.00 | 110.00 | 110.00 | | | .46378E |
| 14 | 14 15 | 2400.00 | 12.00 | 110.00 | 110.00 | | | .23189E |
| 15 | 15 16 | 2000.00 | 12.00 | 110.00 | 110.00 | | | .19324E |
| 16 | 16 1 | 5300.00 | 12.00 | 110.00 | 110.00 | | | .51209E |

| INode | 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 |

For checking purposes, note that the last node # is 15
 the total demand (to be met by water sources) is 4680.60

Opump data for 1 pumps at source nodes
 The number of data points for the pump curve is 3
 0 Node No. P Elev of Pump Flows and
 No. Parl Pump No. 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

6 60.00 24.90 196.52 59.10
 7 50.00 272.10 196.14 63.26
 8 50.00 795.00 196.14 63.26
 9 109.00 462.00 196.41 39.57
 10 75.00 462.00 194.79 51.86
 11 45.00 803.10 196.14 65.43
 12 75.00 717.90 195.93 52.35
 13 98.00 215.10 190.58 40.08
 14 95.00 309.90 198.38 44.76
 15 66.00 309.90 195.05 55.87

1 Maximum unbalanced head in any loop .0000 In loop # 1

| Pipe Dia | Up Node | Down Node | Pipe No. | Flow US GPM | Head Loss FEET | Velocity FT/SEC | Upstream HGL FEET | Downstream HGL FEET | Pressure PSI |
|----------|---------|-----------|----------|-------------|----------------|-----------------|-------------------|---------------------|--------------|
| 24.00 | 1 | 2 | 1 | 4680.600 | 4.55 | 3.32 | 215.00 | 215.00 | .00 |
| 24.00 | 2 | 3 | 2 | 4680.600 | 9.26 | 3.32 | 210.45 | 210.45 | 22.92 |
| 16.00 | 3 | 4 | 3 | 1730.229 | 3.01 | 2.76 | 201.19 | 201.19 | 50.30 |
| 16.00 | 4 | 5 | 4 | 1006.304 | 1.47 | 1.61 | 198.17 | 198.17 | 53.10 |
| 12.00 | 5 | 6 | 5 | 297.000 | .18 | .84 | 196.70 | 196.70 | 57.01 |
| 12.00 | 6 | 7 | 6 | 272.100 | .37 | .77 | 196.52 | 196.52 | |
| 12.00 | 7 | 8 | 7 | 728.675 | .00 | .00 | 196.14 | 196.14 | |
| 12.00 | 8 | 9 | 8 | 513.576 | 1.97 | 1.46 | 201.19 | 201.19 | |
| 16.00 | 9 | 10 | 9 | 1876.096 | 5.25 | 2.99 | 198.38 | 198.38 | |
| 12.00 | 10 | 11 | 10 | 355.096 | 1.15 | 1.01 | 201.19 | 201.19 | |
| 12.00 | 11 | 12 | 11 | 717.900 | 5.36 | 2.04 | 195.93 | 195.93 | |
| 12.00 | 12 | 13 | 12 | -106.904 | -.27 | -.30 | 194.79 | 194.79 | |
| 12.00 | 13 | 14 | 13 | 416.804 | 1.65 | 1.18 | 196.70 | 196.70 | |
| 12.00 | 14 | 15 | 14 | .000 | .00 | .00 | 196.14 | 196.14 | |
| 12.00 | 15 | 16 | 15 | 281.424 | 1.76 | .80 | 198.17 | 198.17 | |

| 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 |

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
 Units: Length FEET Diameter INCHES Flow US GPM Headloss FEET Height FEET Pressure PSI Velocity FT/SEC

There are 16 pipes and 15 nodes
 List of pipe information including resistance factor K

| Pipe no | Nodes | Length FEET | Diameter INCHES | Roughness | coeff K | Height FEET | Pressure PSI | Velocity FT/SEC |
|---------|-------|-------------|-----------------|-----------|---------|-------------|--------------|-----------------|
| 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 | .40318E | | | |
| 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 | 8 9 | 1450.00 | 12.00 | 110.00 | .14010E | | | |
| 9 | 9 10 | 1950.00 | 12.00 | 110.00 | .18841E | | | |
| 10 | 10 11 | 2250.00 | 12.00 | 110.00 | .45582E | | | |
| 11 | 11 12 | 2250.00 | 12.00 | 110.00 | .21740E | | | |
| 12 | 12 13 | 2850.00 | 12.00 | 110.00 | .27537E | | | |
| 13 | 13 14 | 4800.00 | 12.00 | 110.00 | .46378E | | | |
| 14 | 14 15 | 2400.00 | 12.00 | 110.00 | .23189E | | | |
| 15 | 15 16 | 2000.00 | 12.00 | 110.00 | .19324E | | | |
| 16 | 16 1 | 5300.00 | 12.00 | 110.00 | .51209E | | | |

| Node | 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 | 1601.03000 | 75.00000 |
| 13 | 239.30000 | 98.00000 |
| 14 | 71.70000 | 95.00000 |
| 15 | 103.30000 | 65.00000 |

For checking purposes, note that the last node # is 15
 The total demand (to be met by water sources) is 4340.29

Opump data for 1 pumps at source nodes
 The number of data points for the pump curve is 3
 Node No. P Elev of Pump Flows and Related Heads
 No. Parl Pump 0. 4000. 9000.
 1 1 215. 0. 0. 0.00000
 Net unbalanced flow in subnet 1 is 0
 The number of pseudo loops is 0
 Pipes in loop 8
 Loop # 1 -3 -16 9 8 3 -10 -11
 2 -13 14 4 3 -10 -11
 Bandwidth of matrix = 2

Number of loops = 2
 Initial flows and corresponding HGLs at source nodes
 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
 Number of iterations = 5
 Final flows and corresponding HGLs at source nodes
 Node Flow Pump HGL Total HGL
 1 -4340.295 .00 215.00

| Pipe | Up Dia INCHES | Down Dia INCHES | Pipe Node No. | Flow US GPM | Head Loss FEET | Velocity FT/SEC | Upstream HGL FEET | Downstream HGL FEET |
|------|---------------|-----------------|---------------|-------------|----------------|-----------------|-------------------|---------------------|
| 1 | 24.00 | 12.00 | 1 2 | 4340.295 | 3.96 | 3.08 | 215.00 | 215.00 |
| 2 | 24.00 | 24.00 | 2 3 | 4340.295 | 8.05 | 3.08 | 211.04 | 211.04 |
| 3 | 16.00 | 16.00 | 3 4 | 1186.586 | 1.50 | 1.89 | 202.99 | 202.99 |
| 4 | 16.00 | 16.00 | 4 5 | 872.469 | 1.13 | 1.39 | 201.49 | 201.49 |
| 5 | 12.00 | 12.00 | 5 6 | 148.500 | .05 | .42 | 200.36 | 200.36 |
| 6 | 12.00 | 12.00 | 6 7 | 136.050 | .10 | .39 | 200.31 | 200.31 |
| 7 | 12.00 | 12.00 | 7 8 | .000 | .00 | .00 | 200.20 | 200.20 |
| 8 | 12.00 | 12.00 | 8 9 | 412.183 | .98 | 1.17 | 202.99 | 202.99 |
| 9 | 12.00 | 12.00 | 9 10 | 304.633 | .75 | .86 | 202.01 | 202.01 |
| 10 | 16.00 | 16.00 | 10 11 | 2568.726 | 9.40 | 4.10 | 202.99 | 202.99 |
| 11 | 12.00 | 12.00 | 11 12 | -191.769 | -3.37 | -5.4 | 193.59 | 193.59 |
| 12 | 12.00 | 12.00 | 12 13 | 358.950 | 1.48 | 1.02 | 193.59 | 193.59 |
| 13 | 12.00 | 12.00 | 13 14 | -422.769 | -3.38 | -1.20 | 193.96 | 193.96 |
| 14 | 12.00 | 12.00 | 14 15 | 577.719 | 3.02 | 1.64 | 200.36 | 200.36 |
| 15 | 12.00 | 12.00 | 15 16 | .000 | .00 | .00 | 200.20 | 200.20 |
| 16 | 12.00 | 12.00 | 16 1 | 92.867 | .23 | .26 | 201.49 | 201.49 |

Node Elevation FEET Demand US GPM HGL FEET Pressure PSI
 1 215.00 -4340.29 215.00 23.18
 2 157.50 .00 211.04 51.08
 3 85.00 172.80 202.99

62.30
66.58
66.58
43.08
54.15
68.75
54.12
30.67
47.71
58.86

203.91
203.80
203.80
204.53
200.08
203.80
200.01
168.84
205.20
201.96

12.45
136.05
.00
397.50
231.00
.00
251.55
1858.50
107.55
154.95

60.00
50.00
50.00
105.00
75.00
45.00
98.00
95.00
66.00

6
7
8
9
10
11
12
13
14
15

0
1
Maximum unbalanced head in any loop .0056 in loop # 2

OPump data for 1 pumps at source nodes
The number of data points for the pump curve is 3
ONode No. P Elev of Pump Flows and Related Heads
No. Parl Pump 0. 4000. 9000.
1 1 215. 0. 0. 1 is .00000
Net unbalanced flow in subnet 1 is 0
The number of pseudo loops is 0
0 Loop # Pipes in loop 8 3 -10 -11
-3 -13 14 4
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

| Pipe Dia INCHES | Up Node | Down Node | Pipe NO. | Flow US GPM | Head Loss FEET | Velocity FT/SEC | Upstream HGL FEET | Downstream HGL FEET |
|-----------------|---------|-----------|----------|-------------|----------------|-----------------|-------------------|---------------------|
| 24.00 | 1 | 2 | 1 | 3689.850 | 2.93 | 2.62 | 215.00 | 212.07 |
| 24.00 | 2 | 3 | 2 | 3689.850 | 5.96 | 2.62 | 206.11 | 204.83 |
| 16.00 | 3 | 4 | 3 | 1088.002 | 1.28 | 1.74 | 203.91 | 203.80 |
| 16.00 | 4 | 5 | 4 | 757.522 | .87 | 1.21 | 203.80 | 203.91 |
| 16.00 | 5 | 6 | 5 | 148.500 | .05 | .42 | 203.80 | 203.80 |
| 12.00 | 6 | 7 | 6 | 136.050 | .10 | .39 | 205.20 | 205.20 |
| 12.00 | 7 | 8 | 7 | .000 | .00 | .00 | 206.11 | 206.11 |
| 12.00 | 8 | 9 | 8 | 395.820 | .90 | 1.12 | 200.01 | 200.01 |
| 12.00 | 9 | 10 | 9 | 288.270 | .68 | .82 | 200.01 | 200.01 |
| 16.00 | 10 | 11 | 10 | 2033.228 | 6.09 | 3.24 | 200.08 | 200.08 |
| 12.00 | 11 | 12 | 11 | -76.822 | -.07 | -.22 | 203.96 | 203.96 |
| 12.00 | 12 | 13 | 12 | 1858.500 | 31.17 | 5.27 | 203.80 | 203.80 |
| 12.00 | 13 | 14 | 13 | -307.822 | -1.88 | -.87 | 204.83 | 204.83 |
| 12.00 | 14 | 15 | 14 | 462.772 | 2.00 | 1.31 | 204.83 | 204.83 |
| 12.00 | 15 | 16 | 15 | .000 | .00 | .00 | 215.00 | 215.00 |
| 12.00 | 16 | 1 | 16 | 109.230 | .30 | .31 | 215.00 | 215.00 |

| Node | Elevation FEET | Demand US GPM | HGL FEET | Pressure PSI |
|------|----------------|---------------|----------|--------------|
| 1 | 215.00 | -3689.85 | 215.00 | 23.62 |
| 2 | 157.50 | .00 | 212.07 | 52.43 |
| 3 | 85.00 | 172.80 | 206.11 | 55.99 |
| 4 | 75.50 | 221.25 | 204.83 | 60.16 |
| 5 | 65.00 | 146.25 | 203.96 | |

| | | | | |
|----|--------|---------|--------|-------|
| 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 |

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 FEET Diameter INCHES Flow US GPM Headloss FEET Height FEET Pressure PSI Velocity FT/

1 Maximum unbalanced head in any loop .0000 In loop # 2

There are 16 pipes and 15 nodes

1 List of pipe information including resistance factor K

| Pipe no | Nodes | Length FEET | Diameter INCHES | Flow US GPM | Headloss FEET | Height FEET | Pressure PSI | Velocity FT/ | Resistance factor K |
|---------|-------|-------------|-----------------|-------------|---------------|-------------|--------------|--------------|---------------------|
| 1 | 1 2 | 3000.00 | 24.00 | 3000.00 | 130.00 | 130.00 | .72738E | | |
| 2 | 2 3 | 6100.00 | 24.00 | 6100.00 | 130.00 | 130.00 | .14790E | | |
| 3 | 3 4 | 1500.00 | 16.00 | 1500.00 | 120.00 | 120.00 | .30388E | | |
| 4 | 4 5 | 2000.00 | 16.00 | 2000.00 | 120.00 | 120.00 | .40518E | | |
| 5 | 5 6 | 500.00 | 12.00 | 500.00 | 110.00 | 110.00 | .48311E | | |
| 6 | 6 7 | 1200.00 | 12.00 | 1200.00 | 110.00 | 110.00 | .11595E | | |
| 7 | 7 8 | 1000.00 | 12.00 | 1000.00 | 110.00 | 110.00 | .96621E | | |
| 8 | 8 9 | 1450.00 | 12.00 | 1450.00 | 110.00 | 110.00 | .14010E | | |
| 9 | 9 10 | 1950.00 | 12.00 | 1950.00 | 110.00 | 110.00 | .18841E | | |
| 10 | 10 11 | 2250.00 | 12.00 | 2250.00 | 110.00 | 110.00 | .45582E | | |
| 11 | 11 12 | 2250.00 | 12.00 | 2250.00 | 110.00 | 110.00 | .21740E | | |
| 12 | 12 13 | 2850.00 | 12.00 | 2850.00 | 110.00 | 110.00 | .27537E | | |
| 13 | 13 14 | 4800.00 | 12.00 | 4800.00 | 110.00 | 110.00 | .46378E | | |
| 14 | 14 15 | 2400.00 | 12.00 | 2400.00 | 110.00 | 110.00 | .23189E | | |
| 15 | 15 16 | 2000.00 | 12.00 | 2000.00 | 110.00 | 110.00 | .19324E | | |
| 16 | 16 15 | 5300.00 | 12.00 | 5300.00 | 110.00 | 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

OPump data for 1 pumps at source nodes
 The number of data points for the pump curve is 3
 ONode No. P Elev of Pump Flows and Related Heads
 No. Parl Pump 0. 4000. 9000.

1 1 215. 0. 0. 0.00000
 Net unbalanced flow in subnet 1 is
 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

| 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 | 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 |

| 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 |

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 Units: Length FEET Diameter INCHES Flow US GPM Headloss FEET Height FEET Pressure PSI Velocity FT/Sec
 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 | 8 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 |

| Node | 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 |

1 For checking purposes, note that the last node # is 15
 0 The total demand (to be met by water sources) is 3840.30

6 60.00 12.45 203.37 62.07
 7 50.00 136.05 203.27 66.35
 8 50.00 203.27 203.27 66.35
 9 105.00 397.50 196.43 39.58
 10 75.00 231.00 203.20 55.50
 11 45.00 401.55 203.27 68.51
 12 75.00 203.77 203.77 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
 1 Maximum unbalanced head in any loop .0033 In loop # 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 Units: Length FEET Diameter INCHES Flow US GPM Headloss FEET Height FEET Pressure PSI Velocity FT/

There are 16 pipes and 15 nodes
 1 List of pipe information including resistance factor K

| Pipe no | Nodes | Length FEET | Diameter INCHES | Flow US GPM | Headloss FEET | Height FEET | Pressure PSI | Velocity FT/ |
|---------|-------|-------------|-----------------|-------------|---------------|-------------|--------------|--------------|
| 1 | 1 2 | 3000.00 | 24.00 | 130.00 | 24.00 | 130.00 | .72738E | |
| 2 | 2 3 | 6100.00 | 24.00 | 130.00 | 24.00 | 130.00 | .14790E | |
| 3 | 3 4 | 1500.00 | 16.00 | 120.00 | 16.00 | 120.00 | .30388E | |
| 4 | 4 5 | 2000.00 | 16.00 | 120.00 | 16.00 | 120.00 | .40518E | |
| 5 | 5 6 | 500.00 | 12.00 | 110.00 | 12.00 | 110.00 | .48111E | |
| 6 | 6 7 | 1200.00 | 12.00 | 110.00 | 12.00 | 110.00 | .11595E | |
| 7 | 7 8 | 1000.00 | 12.00 | 110.00 | 12.00 | 110.00 | .96221E | |
| 8 | 8 9 | 1450.00 | 12.00 | 110.00 | 12.00 | 110.00 | .14010E | |
| 9 | 9 10 | 1950.00 | 12.00 | 110.00 | 12.00 | 110.00 | .18841E | |
| 10 | 10 11 | 2250.00 | 12.00 | 110.00 | 12.00 | 110.00 | .45582E | |
| 11 | 11 12 | 2250.00 | 12.00 | 110.00 | 12.00 | 110.00 | .21740E | |
| 12 | 12 13 | 2850.00 | 12.00 | 110.00 | 12.00 | 110.00 | .27537E | |
| 13 | 13 14 | 4800.00 | 12.00 | 110.00 | 12.00 | 110.00 | .46378E | |
| 14 | 14 15 | 2400.00 | 12.00 | 110.00 | 12.00 | 110.00 | .23189E | |
| 15 | 15 16 | 2000.00 | 12.00 | 110.00 | 12.00 | 110.00 | .19324E | |
| 16 | 16 15 | 5300.00 | 12.00 | 110.00 | 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 |

For checking purposes, note that the last node # is 15
 The total demand (to be met by water sources) is 4339.85

OPump data for 1 pumps at source nodes
 The number of data points for the pump curve is 3
 ONode No. P Elev of Pump Flows and Related Heads
 No. Parl Pump 0. 4000. 9000.
 1 1 215. 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

| Pipe Dia INCHES | Up Node | Down Node | Pipe No. | Flow US GPM | Head Loss FEET | Velocity FT/SEC | Upstream HGL FEET | Downstream HGL FEET |
|-----------------|---------|-----------|----------|-------------|----------------|-----------------|-------------------|---------------------|
| 24.00 | 1 | 2 | 1 | 4339.845 | 3.96 | 3.08 | 215.00 | 211.04 |
| 24.00 | 2 | 3 | 2 | 4339.845 | 8.05 | 3.08 | 211.04 | 202.99 |
| 16.00 | 3 | 4 | 3 | 2149.553 | 4.50 | 3.43 | 202.99 | 198.49 |
| 16.00 | 4 | 5 | 4 | 2050.085 | 5.50 | 3.27 | 198.49 | 192.99 |
| 12.00 | 5 | 6 | 5 | 2148.495 | 7.15 | 6.10 | 192.99 | 185.83 |
| 12.00 | 6 | 7 | 6 | 2136.045 | 16.98 | 6.06 | 185.83 | 168.85 |
| 12.00 | 7 | 8 | 7 | .000 | .00 | .00 | 168.85 | 202.99 |
| 12.00 | 8 | 9 | 8 | 626.832 | 2.12 | 1.78 | 202.99 | 200.87 |
| 12.00 | 9 | 10 | 9 | 519.282 | 2.01 | 1.47 | 200.87 | 202.99 |
| 16.00 | 10 | 11 | 10 | 1390.660 | 3.02 | 2.22 | 202.99 | 199.97 |
| 12.00 | 11 | 12 | 11 | 630.610 | 3.33 | 1.79 | 199.97 | 196.65 |
| 12.00 | 12 | 13 | 12 | 358.500 | 1.48 | 1.02 | 196.65 | 192.99 |
| 12.00 | 13 | 14 | 13 | 399.610 | 3.05 | 1.13 | 192.99 | 168.85 |
| 12.00 | 14 | 15 | 14 | -244.660 | -.62 | -.69 | 168.85 | 198.49 |
| 12.00 | 15 | 16 | 15 | .000 | .00 | .00 | 198.49 | 215.00 |
| 12.00 | 16 | 1 | 16 | -121.782 | -.37 | -.35 | 215.00 | 211.04 |

| Node | Elevation FEET | Demand US GPM | HGL FEET | Pressure PSI |
|------|----------------|---------------|----------|--------------|
| 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 | |

0
 1
 Maximum unbalanced head in any loop .0098 In loop # 2

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

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 Length Diameter Flow Headloss Height Pressure Velo
 Units: FEET INCHES US GPM FEET FEET PSI FT/

There are 16 pipes and 15 nodes
 List of pipe information including resistance factor K

| Pipe no | Nodes | Length FEET | Diameter INCHES | Flow US GPM | Headloss FEET | Height FEET | Pressure PSI | Velo FT/ |
|---------|-------|-------------|-----------------|-------------|---------------|-------------|--------------|----------|
| 1 | 2 | 3000.00 | 24.00 | 130.00 | .72738E | | | |
| 2 | 3 | 6100.00 | 24.00 | 130.00 | .14790E | | | |
| 3 | 3 | 1500.00 | 16.00 | 120.00 | .30388E | | | |
| 4 | 4 | 2000.00 | 16.00 | 120.00 | .40318E | | | |
| 5 | 5 | 500.00 | 12.00 | 110.00 | .48311E | | | |
| 6 | 6 | 1200.00 | 12.00 | 110.00 | .11595E | | | |
| 7 | 7 | 1000.00 | 12.00 | 110.00 | .96621E | | | |
| 8 | 3 | 1450.00 | 12.00 | 110.00 | .14010E | | | |
| 9 | 14 | 1950.00 | 12.00 | 110.00 | .18841E | | | |
| 10 | 3 | 2250.00 | 16.00 | 120.00 | .45582E | | | |
| 11 | 12 | 2250.00 | 12.00 | 110.00 | .21740E | | | |
| 12 | 12 | 2850.00 | 12.00 | 110.00 | .27537E | | | |
| 13 | 10 | 4800.00 | 12.00 | 110.00 | .46378E | | | |
| 14 | 5 | 2400.00 | 12.00 | 110.00 | .23189E | | | |
| 15 | 7 | 2000.00 | 12.00 | 110.00 | .19324E | | | |
| 16 | 4 | 5300.00 | 12.00 | 110.00 | .51209E | | | |

| Node | 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 |

For checking purposes, note that the last node # is 15
 The total demand (to be met by water sources) is 4310.29

OPump data for 1 pumps at source nodes
 The number of data points for the pump curve is 3
 Node No. P Elev of Pump Flows and Related Heads
 No. Parl Pump 0. 4000. 9000.

1 1 215. 0. 0. 0.
 Net unbalanced flow in subnet 1 is .00000
 The number of pseudo pipes in loop 0
 Loop # Pipes in loop
 1 -3 -16 9 8
 2 -13 14 4 3 -10 -11
 Bandwidth of matrix = 2

0 Number of loops = 2
 0 Initial flows and corresponding HGLs at source nodes
 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
 Number of iterations = 4
 0 Final flows and corresponding HGLs at source nodes
 Node Flow Pump HGL Total HGL
 1 -4340.295 .00 215.00

| Pipe | Up | Down | Pipe | Flow | Head | Velocity | Upstream | Do |
|--------|------|------|------|----------|-------|----------|----------|--------|
| INCHES | Node | Node | No. | US GPM | Loss | FT/SEC | HGL | HGL |
| | | | | | FEET | | FEET | FEET |
| 24.00 | 1 | 2 | 1 | 4340.295 | 3.96 | 3.08 | 215.00 | 215.00 |
| 24.00 | 2 | 3 | 2 | 4340.295 | 8.05 | 3.08 | 211.04 | 211.04 |
| 16.00 | 3 | 4 | 3 | 1621.986 | 2.67 | 2.59 | 202.99 | 202.99 |
| 16.00 | 4 | 5 | 4 | 365.814 | .23 | .58 | 200.31 | 200.31 |
| 12.00 | 5 | 6 | 5 | 148.500 | .05 | .42 | 200.09 | 200.09 |
| 12.00 | 6 | 7 | 6 | 136.050 | .10 | .39 | 200.04 | 200.04 |
| 12.00 | 7 | 8 | 7 | .000 | .00 | .00 | 199.93 | 199.93 |
| 12.00 | 3 | 14 | 8 | 1470.124 | 10.27 | 4.17 | 202.99 | 202.99 |
| 12.00 | 14 | 9 | 9 | 1362.573 | 12.00 | 3.87 | 192.71 | 192.71 |
| 16.00 | 3 | 12 | 10 | 1075.386 | 1.87 | 1.72 | 202.99 | 202.99 |
| 12.00 | 12 | 10 | 11 | 314.886 | .92 | .89 | 201.11 | 201.11 |
| 12.00 | 12 | 13 | 12 | 358.950 | 1.48 | 1.02 | 201.11 | 201.11 |
| 12.00 | 10 | 15 | 13 | 83.886 | .17 | .24 | 200.19 | 200.19 |
| 12.00 | 5 | 15 | 14 | 71.064 | .06 | .20 | 200.09 | 200.09 |
| 12.00 | 7 | 11 | 15 | .000 | .00 | .00 | 199.93 | 199.93 |
| 12.00 | 4 | 9 | 16 | 1034.921 | 19.60 | 2.94 | 200.31 | 200.31 |

| 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 |

EAST KAPOLEI POTABLE WATER SYSTEM (AVERAGE FLOW CONDITIONS-40'ZONE)

Data file name : ekave40.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

Units: Length FEET Diameter INCHES Flow US GPM Headloss FEET Height FEET Pressure PSI Velo FT/

| | | | | |
|----|--------|---------|--------|-------|
| 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 |

Maximum unbalanced head in any loop .0002 In loop # 1

There are 17 pipes and 16 nodes

List of pipe information including resistance factor K

| Pipe no | Nodes | Length FEET | Diameter INCHES | Flow US GPM | Headloss FEET | Height FEET | Pressure PSI | Velo FT/ |
|---------|-------|-------------|-----------------|-------------|---------------|-------------|--------------|----------|
| 20 | 20 | 3650.00 | 20.00 | 120.00 | 24942E | 120.00 | .24942E | .24942E |
| 21 | 21 | 1450.00 | 20.00 | 120.00 | .99085E | 120.00 | .99085E | .99085E |
| 22 | 22 | 2000.00 | 16.00 | 120.00 | .40518E | 120.00 | .40518E | .40518E |
| 23 | 23 | 1700.00 | 12.00 | 110.00 | .16426E | 110.00 | .16426E | .16426E |
| 24 | 24 | 2300.00 | 12.00 | 110.00 | .22223E | 110.00 | .22223E | .22223E |
| 25 | 25 | 1200.00 | 12.00 | 110.00 | .11595E | 110.00 | .11595E | .11595E |
| 26 | 26 | 2200.00 | 12.00 | 110.00 | .21257E | 110.00 | .21257E | .21257E |
| 27 | 27 | 2500.00 | 12.00 | 110.00 | .24155E | 110.00 | .24155E | .24155E |
| 28 | 28 | 2300.00 | 16.00 | 120.00 | .46595E | 120.00 | .46595E | .46595E |
| 29 | 29 | 1200.00 | 12.00 | 110.00 | .11595E | 110.00 | .11595E | .11595E |
| 30 | 30 | 1450.00 | 12.00 | 110.00 | .14010E | 110.00 | .14010E | .14010E |
| 31 | 31 | 500.00 | 12.00 | 110.00 | .48311E | 110.00 | .48311E | .48311E |
| 32 | 32 | 1850.00 | 12.00 | 110.00 | .17875E | 110.00 | .17875E | .17875E |
| 33 | 33 | 1800.00 | 12.00 | 110.00 | .17392E | 110.00 | .17392E | .17392E |
| 34 | 34 | 1800.00 | 12.00 | 110.00 | .17392E | 110.00 | .17392E | .17392E |
| 35 | 35 | 3950.00 | 12.00 | 110.00 | .38165E | 110.00 | .38165E | .38165E |
| 36 | 36 | 1950.00 | 12.00 | 110.00 | .18841E | 110.00 | .18841E | .18841E |

Node 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 |

For checking purposes, note that the last node # is 35

The total demand (to be met by water sources) is 1603.00

Pump data for 1 pumps at source nodes

The number of data points for the pump curve is 3

0 Node No. P Elev of Pump Flows and Related Heads
 No. Parl Pump 0. 4000. 9000.

20 1 440. 0. 0. 0.
 0 PRV # in Pipe # Ref source # Working HGL Hd-loss ChKV action?
 1 20 340.00 .0000 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
 OPRVs 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

| 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
 1 Maximum unbalanced head in any loop .0000 In loop # 1

| Pipe Dia
INCHES | Up Node | Down Node | Pipe No. | Flow
US GPM | Head Loss
FEET | Velocity
FT/SEC | Upstream HGL
FEET | Downstream HGL
FEET |
|--------------------|---------|-----------|----------|----------------|-------------------|--------------------|----------------------|------------------------|
| 20.00 | 20 | 21 | 20 | 1603.000 | 100.00 | 1.64 | 440.00 | 440.00 |
| 20.00 | 21 | 22 | 21 | 1454.000 | .71 | 1.49 | 340.00 | 340.00 |
| 16.00 | 22 | 23 | 22 | 786.906 | .93 | 1.26 | 339.29 | 339.29 |
| 12.00 | 23 | 24 | 23 | 244.171 | .43 | .69 | 338.35 | 338.35 |
| 12.00 | 24 | 25 | 24 | 75.171 | .07 | .21 | 337.92 | 337.92 |
| 12.00 | 25 | 26 | 25 | -86.094 | -.04 | -.24 | 337.85 | 337.85 |
| 12.00 | 26 | 27 | 26 | -282.094 | -.73 | -.80 | 337.90 | 337.90 |
| 12.00 | 27 | 28 | 27 | 135.000 | .21 | .38 | 338.63 | 338.63 |
| 16.00 | 22 | 27 | 28 | 603.094 | .66 | .96 | 339.29 | 339.29 |
| 12.00 | 22 | 29 | 29 | 52.000 | .02 | .15 | 339.27 | 339.27 |
| 12.00 | 29 | 30 | 30 | 87.000 | .02 | .25 | 338.35 | 338.35 |
| 12.00 | 31 | 31 | 31 | 87.000 | .02 | .25 | 338.34 | 338.34 |
| 12.00 | 31 | 32 | 32 | 218.735 | .37 | .62 | 338.35 | 338.35 |
| 12.00 | 33 | 33 | 33 | 137.000 | .16 | .39 | 337.98 | 337.98 |
| 12.00 | 33 | 34 | 34 | 81.735 | .13 | .23 | 337.98 | 337.98 |
| 12.00 | 35 | 25 | 35 | -25.265 | -.01 | -.07 | 337.85 | 337.85 |

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

Units: Length FEET Diameter INCHES Flow Headloss FEET Height FEET Pressure PSI Velocity FT/Sec

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 | 21 | 3650.00 | 20.00 | 120.00 | .24942E |
| 21 | 21 | 1450.00 | 20.00 | 120.00 | .99085E |
| 22 | 23 | 2000.00 | 16.00 | 120.00 | .40518E |
| 23 | 24 | 1700.00 | 12.00 | 110.00 | .16426E |
| 24 | 25 | 2300.00 | 12.00 | 110.00 | .22223E |
| 25 | 26 | 1200.00 | 12.00 | 110.00 | .11595E |
| 26 | 27 | 2200.00 | 12.00 | 110.00 | .21257E |
| 27 | 28 | 2500.00 | 12.00 | 110.00 | .24155E |
| 28 | 22 | 2300.00 | 16.00 | 120.00 | .46595E |
| 29 | 22 | 2300.00 | 12.00 | 110.00 | .11595E |
| 30 | 29 | 1450.00 | 12.00 | 110.00 | .14010E |
| 31 | 31 | 500.00 | 12.00 | 110.00 | .48311E |
| 32 | 31 | 1850.00 | 12.00 | 110.00 | .17875E |
| 33 | 33 | 1800.00 | 12.00 | 110.00 | .17392E |
| 34 | 34 | 1800.00 | 12.00 | 110.00 | .17392E |
| 35 | 33 | 3950.00 | 12.00 | 110.00 | .38165E |
| 36 | 25 | 1950.00 | 12.00 | 110.00 | .18841E |

| Node | 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 |

For checking purposes, note that the last node # is 35

The total demand (to be met by water sources) is 5004.00

OPump data for 1 pumps at source nodes

The number of data points for the pump curve is 3

0 Node No. P Elev of Pump Flows and Related Heads

No. Parl Pump 0. 4000. 9000.

20 1 440. 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

OPRVs 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 Up Down Pipe Flow Head Loss Velocity Upstream Do

INCHES US GPM FEET FT/SEC FEET

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 .42 334.25

12.00 29 30 30 147.000 .14 .74 327.08

12.00 31 31 31 261.000 .53 .74 326.93

12.00 31 32 32 664.289 2.93 1.88 327.08

12.00 23 33 33 414.000 1.22 1.17 324.15

12.00 33 34 34 250.289 1.05 .71 324.15

12.00 35 25 25 -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

1 Maximum unbalanced head in any loop .0000 In loop # 2

EAST KAPOLEI POTABLE WATER SYSTEM (PEAK DEMAND CONDITIONS-440'ZONE)

Data file name : ekmp440.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

Units: Length FEET Diameter INCHES Flow US GPM Headloss FEET Height FEET Pressure PSI Velocity FT/

There are 17 pipes and 16 nodes

1 List of pipe information including resistance factor K

| Pipe no | Nodes | Length
FEET | Diameter
INCHES | Flow
US GPM | Headloss
FEET | Height
FEET | Pressure
PSI | Velocity
FT/ |
|---------|-------|----------------|--------------------|----------------|------------------|----------------|-----------------|-----------------|
| 20 | 20 21 | 3650.00 | 20.00 | 120.00 | 120.00 | 120.00 | .24942E | |
| 21 | 21 22 | 1450.00 | 20.00 | 120.00 | 120.00 | 120.00 | .99085E | |
| 22 | 22 23 | 2000.00 | 16.00 | 120.00 | 120.00 | 120.00 | .40518E | |
| 23 | 23 24 | 1700.00 | 12.00 | 110.00 | 110.00 | 110.00 | .16426E | |
| 24 | 24 25 | 2300.00 | 12.00 | 110.00 | 110.00 | 110.00 | .2223E | |
| 25 | 25 26 | 1200.00 | 12.00 | 110.00 | 110.00 | 110.00 | .11595E | |
| 26 | 26 27 | 2200.00 | 12.00 | 110.00 | 110.00 | 110.00 | .21257E | |
| 27 | 27 28 | 2500.00 | 12.00 | 110.00 | 120.00 | 120.00 | .24155E | |
| 28 | 22 27 | 2300.00 | 16.00 | 120.00 | 120.00 | 120.00 | .46595E | |
| 29 | 22 29 | 1200.00 | 12.00 | 110.00 | 110.00 | 110.00 | .11595E | |
| 30 | 29 30 | 1450.00 | 12.00 | 110.00 | 110.00 | 110.00 | .14010E | |
| 31 | 31 32 | 500.00 | 12.00 | 110.00 | 110.00 | 110.00 | .48311E | |
| 32 | 31 32 | 1850.00 | 12.00 | 110.00 | 110.00 | 110.00 | .17875E | |
| 33 | 33 34 | 1800.00 | 12.00 | 110.00 | 110.00 | 110.00 | .17392E | |
| 34 | 33 34 | 1800.00 | 12.00 | 110.00 | 110.00 | 110.00 | .17392E | |
| 35 | 33 35 | 3950.00 | 12.00 | 110.00 | 110.00 | 110.00 | .38165E | |
| 36 | 35 25 | 1950.00 | 12.00 | 110.00 | 110.00 | 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

The total demand (to be met by water sources) is 4776.00

opump data for 1 pumps at source nodes
 The number of data points for the pump curve is 3
 0 Node No. P Elev of Pump Flows and Related Heads
 No. Parl Pump 0. 4000. 9000.

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
 0 PRVs 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

| Node | 12.00 | 33 | 35 | 35 | 36 | 36 | 247.590 | 1.03 | .70 | 324.76 |
|------|-------|-----------|----------|--------|----------|----|---------|------|------|--------|
| | 12.00 | 35 | 25 | 25 | 36 | 36 | -73.410 | -.05 | -.21 | 323.72 |
| | Node | Elevation | Demand | HGL | Pressure | | | | | |
| | | FEET | US GPM | FEET | PSI | | | | | |
| 20 | 20 | 440.00 | -4776.00 | 440.00 | .00 | | | | | |
| 21 | 21 | 190.00 | 447.00 | 340.00 | 64.94 | | | | | |
| 22 | 22 | 157.50 | 36.00 | 334.63 | 76.68 | | | | | |
| 23 | 23 | 131.00 | 711.00 | 327.64 | 85.13 | | | | | |
| 24 | 24 | 131.00 | 507.00 | 324.30 | 83.68 | | | | | |
| 25 | 25 | 105.00 | 408.00 | 323.78 | 94.71 | | | | | |
| 26 | 26 | 125.00 | 588.00 | 324.10 | 86.19 | | | | | |
| 27 | 27 | 141.00 | 558.00 | 329.64 | 81.66 | | | | | |
| 28 | 28 | 229.00 | 405.00 | 328.01 | 42.86 | | | | | |
| 29 | 29 | 164.00 | .00 | 334.50 | 73.81 | | | | | |
| 30 | 30 | 190.00 | 156.00 | 334.34 | 62.48 | | | | | |
| 31 | 31 | 135.00 | .00 | 327.53 | 83.35 | | | | | |
| 32 | 32 | 164.00 | 228.00 | 327.11 | 70.61 | | | | | |
| 33 | 33 | 112.00 | .00 | 324.76 | 92.10 | | | | | |
| 34 | 34 | 112.00 | 411.00 | 323.55 | 91.58 | | | | | |
| 35 | 35 | 95.00 | 321.00 | 323.72 | 99.01 | | | | | |

Maximum unbalanced head in any loop .0000 In loop # 1

| Pipe Dia | Up Node | Down Node | Pipe No. | Flow US GPM | Head Loss FEET | Velocity FT/SEC | Upstream HGL FEET | Downstream HGL FEET |
|----------|---------|-----------|----------|-------------|----------------|-----------------|-------------------|---------------------|
| 20.00 | 20 | 21 | 20 | 4776.000 | 100.00 | 4.88 | 440.00 | 440.00 |
| 20.00 | 21 | 22 | 21 | 4329.000 | 5.37 | 4.42 | 340.00 | 340.00 |
| 16.00 | 22 | 23 | 22 | 2333.359 | 6.99 | 3.72 | 334.63 | 334.63 |
| 12.00 | 23 | 24 | 23 | 735.769 | 3.34 | 2.09 | 327.64 | 327.64 |
| 12.00 | 24 | 25 | 24 | 228.768 | .52 | .65 | 324.30 | 324.30 |
| 12.00 | 25 | 26 | 25 | -252.642 | -.33 | -.72 | 323.78 | 323.78 |
| 12.00 | 26 | 27 | 26 | -840.642 | -5.54 | -2.39 | 324.10 | 329.64 |
| 12.00 | 27 | 28 | 27 | 405.000 | 1.63 | 1.15 | 329.64 | 334.63 |
| 16.00 | 28 | 29 | 28 | 1803.642 | 4.99 | 2.88 | 334.63 | 334.63 |
| 12.00 | 22 | 29 | 29 | 156.000 | .13 | .44 | 334.63 | 334.50 |
| 12.00 | 29 | 30 | 30 | 156.000 | .16 | .44 | 334.50 | 327.64 |
| 12.00 | 31 | 31 | 31 | 228.000 | .11 | .65 | 327.64 | 327.53 |
| 12.00 | 31 | 32 | 32 | 228.000 | .42 | .65 | 327.53 | 327.64 |
| 12.00 | 23 | 33 | 33 | 658.590 | 2.88 | 1.87 | 327.64 | 324.76 |
| 12.00 | 33 | 34 | 34 | 411.000 | 1.20 | 1.17 | 324.76 | 324.76 |

The total demand (to be met by water sources) is 6387.99

OPump data for 1 pumps at source nodes

The number of data points for the pump curve is 3

ONode No. P Elev of Pump Flows and Related Heads

No. Parl Pump 0. 4000. 9000.

20 1 440. 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

OPRVs 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

1 20 -6387.990 .00 440.00

Pipe Up Down Pipe Flow Head Head Loss Velocity Upstream Do

Dia Node Node No. US GPM FEET FEET FT/SEC HGL

INCHES

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 28 29 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

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 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 Diameter Roughness coeff K

FEET INCHES

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 28 29 2300.00 16.00 120.00 .46595E

29 29 30 1200.00 12.00 110.00 .11595E

30 30 31 1450.00 12.00 110.00 .14010E

31 31 32 500.00 12.00 110.00 .48311E

32 32 33 1850.00 12.00 110.00 .17875E

33 33 34 1800.00 12.00 110.00 .17392E

34 34 35 1800.00 12.00 110.00 .17392E

35 35 36 3950.00 12.00 110.00 .38165E

36 36 25 1950.00 12.00 110.00 .18841E

1Node Demand Elevation

US GPM 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

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/

1 There are 17 pipes and 16 nodes

1 List of pipe information including resistance factor K

| Pipe no | Nodes | Length FEET | Diameter INCHES | Flow US GPM | Headloss FEET | Height FEET | Pressure PSI | Velo FT/ |
|---------|---------------|----------------|-----------------|-------------|---------------|-------------|--------------|----------|
| 20 | 20 21 | 3650.00 | 20.00 | 120.00 | 120.00 | 120.00 | 120.00 | .24942E |
| 21 | 21 22 | 1450.00 | 20.00 | 120.00 | 120.00 | 120.00 | 120.00 | .99085E |
| 22 | 22 23 | 2000.00 | 16.00 | 120.00 | 120.00 | 120.00 | 120.00 | .40518E |
| 23 | 23 24 | 1700.00 | 12.00 | 110.00 | 110.00 | 110.00 | 110.00 | .16426E |
| 24 | 24 25 | 2300.00 | 12.00 | 110.00 | 110.00 | 110.00 | 110.00 | .22223E |
| 25 | 25 26 | 1200.00 | 12.00 | 110.00 | 110.00 | 110.00 | 110.00 | .11595E |
| 26 | 26 27 | 2200.00 | 12.00 | 110.00 | 110.00 | 110.00 | 110.00 | .21257E |
| 27 | 27 28 | 2500.00 | 12.00 | 110.00 | 110.00 | 110.00 | 110.00 | .46595E |
| 28 | 28 29 | 2300.00 | 16.00 | 120.00 | 120.00 | 120.00 | 120.00 | .11595E |
| 29 | 29 30 | 1450.00 | 12.00 | 110.00 | 110.00 | 110.00 | 110.00 | .14010E |
| 30 | 30 31 | 500.00 | 12.00 | 110.00 | 110.00 | 110.00 | 110.00 | .48311E |
| 31 | 31 32 | 1850.00 | 12.00 | 110.00 | 110.00 | 110.00 | 110.00 | .17875E |
| 32 | 32 33 | 1800.00 | 12.00 | 110.00 | 110.00 | 110.00 | 110.00 | .17392E |
| 33 | 33 34 | 1800.00 | 12.00 | 110.00 | 110.00 | 110.00 | 110.00 | .17392E |
| 34 | 34 35 | 3950.00 | 12.00 | 110.00 | 110.00 | 110.00 | 110.00 | .38165E |
| 35 | 35 25 | 1950.00 | 12.00 | 110.00 | 110.00 | 110.00 | 110.00 | .18841E |
| 36 | Demand US GPM | Elevation FEET | | | | | | |

0 Maximum unbalanced head in any loop .0000 In loop # 1

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 |

| Node | Demand US GPM | Elevation FEET |
|------|---------------|----------------|
| 20 | .00000 | 440.00000 |
| 21 | 149.00000 | 190.00000 |
| 22 | 1145.33000 | 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 | 52.00000 | 164.00000 |
| 30 | .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

Other total demand (to be met by water sources) is 4388.00

0 Pump data for 1 pumps at source nodes
 The number of data points for the pump curve is 3
 0 Node No. P Elev of Pump Flows and Related Heads
 No. Par1 Pump 0. 4000. 9000.
 20 1 440. 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 230.819 in loop # 1
 Iteration # 2 Max change in flow is 17.294 in loop # 1
 0 PRVs 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

| Pipe Dia INCHES | Up Node | Down Node | Pipe No. | Flow US GPM | Head Loss FEET | Velocity FT/SEC | Upstream HGL FEET | Downstream HGL FEET |
|-----------------|---------|-----------|----------|-------------|----------------|-----------------|-------------------|---------------------|
| 20.00 | 20 | 21 | 20 | 4387.995 | 100.00 | 4.48 | 440.00 | 440.00 |
| 20.00 | 21 | 22 | 21 | 4164.495 | 5.00 | 4.25 | 340.00 | 340.00 |
| 16.00 | 22 | 23 | 22 | 1166.679 | 1.94 | 1.86 | 335.00 | 335.00 |
| 12.00 | 23 | 24 | 23 | 367.884 | .93 | 1.04 | 333.07 | 333.07 |
| 12.00 | 24 | 25 | 24 | 114.384 | .14 | .32 | 332.14 | 332.14 |
| 12.00 | 25 | 26 | 25 | -126.321 | -.09 | -.36 | 332.09 | 332.09 |
| 12.00 | 26 | 27 | 26 | -420.321 | -1.53 | -1.19 | 333.62 | 333.62 |
| 16.00 | 27 | 28 | 27 | 202.500 | .45 | .57 | 335.00 | 335.00 |
| 16.00 | 28 | 29 | 28 | 901.821 | 1.38 | 1.44 | 335.00 | 335.00 |
| 12.00 | 29 | 30 | 29 | 78.000 | .04 | .22 | 334.97 | 334.97 |
| 12.00 | 30 | 31 | 30 | 78.000 | .04 | .32 | 333.07 | 333.07 |
| 12.00 | 31 | 32 | 31 | 114.000 | .12 | .32 | 333.04 | 333.04 |
| 12.00 | 32 | 33 | 32 | 329.295 | .80 | .93 | 333.07 | 333.07 |
| 12.00 | 33 | 34 | 33 | 205.500 | .33 | .58 | 332.27 | 332.27 |
| 12.00 | 34 | 35 | 34 | 123.795 | .29 | .35 | 332.27 | 332.27 |
| 12.00 | 35 | 36 | 35 | -36.705 | -.01 | -.10 | 331.98 | 331.98 |

| 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 | 81.39 |
| 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 |

Maximum unbalanced head in any loop .0000 In loop # 1

0 The total demand (to be met by water sources) is 4388.00

0 Pump data for 1 pumps at source nodes
 The number of data points for the pump curve is 3

0 Node No. P Elev of Pump Flows and
 No. Parl Pump 0. 4000. 9000.

20 1 440. 0. 0.
 0 PRV # in Pipe # Ref source # Working HGL Hd-loss Chkv action?
 1 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

OPRVs 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 | Downstream HGL FEET |
|-------|-----------------|---------|-----------|----------|-------------|----------------|-----------------|-------------------|---------------------|
| 20.00 | 20 | 21 | 20 | 20 | 4387.995 | 100.00 | 4.48 | 440.00 | 440.00 |
| 20.00 | 21 | 22 | 21 | 21 | 4164.495 | 5.00 | 4.25 | 340.00 | 340.00 |
| 16.00 | 22 | 23 | 22 | 22 | 2544.035 | 8.20 | 4.06 | 335.00 | 335.00 |
| 12.00 | 23 | 24 | 23 | 23 | 1440.004 | 11.59 | 4.09 | 326.80 | 326.80 |
| 12.00 | 24 | 25 | 24 | 24 | -813.491 | -5.45 | -2.31 | 315.21 | 315.21 |
| 12.00 | 25 | 26 | 25 | 25 | -748.960 | -2.44 | -2.12 | 320.65 | 320.65 |
| 12.00 | 26 | 27 | 26 | 26 | -1042.960 | -8.26 | -2.96 | 323.09 | 323.09 |
| 12.00 | 27 | 28 | 27 | 27 | 202.500 | .45 | .57 | 331.35 | 331.35 |
| 12.00 | 28 | 29 | 28 | 28 | 1524.460 | 3.65 | 2.43 | 335.00 | 335.00 |
| 16.00 | 29 | 30 | 29 | 29 | 78.000 | .04 | .22 | 335.00 | 335.00 |
| 12.00 | 30 | 31 | 30 | 30 | 114.000 | .03 | .12 | 334.97 | 334.97 |
| 12.00 | 31 | 32 | 31 | 31 | 114.000 | .03 | .12 | 326.80 | 326.80 |
| 12.00 | 32 | 33 | 32 | 32 | 114.000 | .12 | .32 | 326.77 | 326.77 |

ENST 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 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 | .22233E |
| 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 | 28 29 | 2300.00 | 16.00 | 120.00 | .46595E |
| 29 | 29 30 | 1200.00 | 12.00 | 110.00 | .11595E |
| 30 | 30 31 | 1450.00 | 12.00 | 110.00 | .14010E |
| 31 | 31 32 | 500.00 | 12.00 | 110.00 | .48311E |
| 32 | 32 33 | 1850.00 | 12.00 | 110.00 | .17875E |
| 33 | 33 34 | 1800.00 | 12.00 | 110.00 | .17392E |
| 34 | 34 35 | 1800.00 | 12.00 | 110.00 | .17392E |
| 35 | 35 36 | 3950.00 | 12.00 | 110.00 | .38165E |
| 36 | 36 25 | 1950.00 | 12.00 | 110.00 | .18841E |

| Node | 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 |

For checking purposes, note that the last node # is 35

EAST KAPOLEI POTABLES 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 | Flow US GPM | Headloss FEET | Height FEET | Pressure PSI | Velo FT/ | Resistance factor 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 | 31 32 | 500.00 | 12.00 | | | 110.00 | | | .48311E |
| 32 | 32 33 | 1850.00 | 12.00 | | | 110.00 | | | .17875E |
| 33 | 33 34 | 1800.00 | 12.00 | | | 110.00 | | | .17392E |
| 34 | 34 35 | 1800.00 | 12.00 | | | 110.00 | | | .17392E |
| 35 | 35 36 | 1950.00 | 12.00 | | | 110.00 | | | .38165E |
| 36 | 35 25 | 1950.00 | 12.00 | | | 110.00 | | | .18841E |

| Node | 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

| 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 |

1 Maximum unbalanced head in any loop .0000 In loop # 2

The number of data points for the pump curve is 3
 0 Node No. P Elev of Pump Flows and Related Heads
 No. Parl Pump 0. 4000. 9000.

0 PRV # in Pipe # Ref source # Working HGL Hd-loss Chkv action?
 1 20 20 340.00 .0000 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

OPRVs 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

| Pipe Dia INCHES | Up Node | Down Node | Pipe No. | Flow US GPM | Head Loss FEET | Velocity FT/SEC | Upstream HGL FEET | Downstream HGL FEET |
|-----------------|---------|-----------|----------|-------------|----------------|-----------------|-------------------|---------------------|
| 20.00 | 20 | 21 | 20 | 3387.990 | 100.00 | 3.46 | 440.00 | 440.00 |
| 20.00 | 21 | 22 | 21 | 3164.490 | 3.01 | 3.23 | 340.00 | 340.00 |
| 16.00 | 22 | 23 | 22 | 1381.730 | 2.65 | 2.21 | 336.99 | 336.99 |
| 12.00 | 23 | 24 | 23 | 489.103 | 1.57 | 1.39 | 334.35 | 334.35 |
| 12.00 | 24 | 25 | 24 | 235.603 | .55 | .67 | 332.78 | 332.78 |
| 12.00 | 25 | 26 | 25 | 88.730 | .05 | .25 | 332.23 | 332.23 |
| 12.00 | 26 | 27 | 26 | -205.270 | -.41 | -.58 | 332.18 | 332.18 |
| 12.00 | 27 | 28 | 27 | 1202.490 | 12.21 | 3.41 | 332.59 | 332.59 |
| 16.00 | 22 | 27 | 28 | 1686.760 | 4.41 | 2.69 | 336.99 | 336.99 |
| 12.00 | 22 | 29 | 29 | 78.000 | .04 | .22 | 336.96 | 336.96 |
| 12.00 | 29 | 30 | 30 | 114.000 | .03 | .32 | 334.35 | 334.35 |
| 12.00 | 31 | 31 | 31 | 114.000 | .12 | .32 | 334.31 | 334.31 |
| 12.00 | 31 | 32 | 32 | 423.127 | 1.27 | 1.20 | 334.35 | 334.35 |
| 12.00 | 33 | 33 | 33 | 205.500 | .33 | .58 | 333.08 | 333.08 |
| 12.00 | 33 | 34 | 34 | 217.627 | .81 | .62 | 333.08 | 333.08 |
| 12.00 | 35 | 35 | 35 | 57.127 | .03 | .16 | 332.26 | 332.26 |

| 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 | 330.38 | 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
 1 Maximum unbalanced head in any loop .0000 In loop # 2

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

Units: Length DIAMETER Flow HEADLOSS Height Pressure Velo
FEET INCHES US GPM FEET FEET PSI FT/

There are 17 pipes and 16 nodes

List of pipe information including resistance factor K

| Pipe no | Nodes | Length FEET | Diameter INCHES | Flow US GPM | Headloss FEET | Height FEET | Pressure PSI | Velocity FT/ | Roughness coeff | K |
|---------|-------|-------------|-----------------|-------------|---------------|-------------|--------------|--------------|-----------------|---|
| 20 | 20 | 3650.00 | 20.00 | | | 120.00 | | | .24942E | |
| 21 | 21 | 1450.00 | 20.00 | | | 120.00 | | | .99085E | |
| 22 | 22 | 2000.00 | 16.00 | | | 120.00 | | | .40518E | |
| 23 | 23 | 1700.00 | 12.00 | | | 110.00 | | | .16426E | |
| 24 | 24 | 2300.00 | 12.00 | | | 110.00 | | | .22223E | |
| 25 | 25 | 1200.00 | 12.00 | | | 110.00 | | | .11595E | |
| 26 | 26 | 2200.00 | 12.00 | | | 110.00 | | | .21257E | |
| 27 | 27 | 2500.00 | 12.00 | | | 110.00 | | | .24155E | |
| 28 | 28 | 2300.00 | 16.00 | | | 120.00 | | | .46595E | |
| 29 | 29 | 1200.00 | 12.00 | | | 110.00 | | | .11595E | |
| 30 | 30 | 1450.00 | 12.00 | | | 110.00 | | | .14010E | |
| 31 | 31 | 500.00 | 12.00 | | | 110.00 | | | .48311E | |
| 32 | 32 | 1850.00 | 12.00 | | | 110.00 | | | .17875E | |
| 33 | 33 | 1800.00 | 12.00 | | | 110.00 | | | .17392E | |
| 34 | 34 | 1800.00 | 12.00 | | | 110.00 | | | .17392E | |
| 35 | 35 | 3950.00 | 12.00 | | | 110.00 | | | .38165E | |
| 36 | 35 | 1950.00 | 12.00 | | | 110.00 | | | .18841E | |

| Node | 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 | 105.00000 |
| 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 |

For checking purposes, note that the last node # is 35
The total demand (to be met by water sources) is 3888.00

Opump data for 1 pumps at source nodes

The number of data points for the pump curve is 3
Node No. P Elev of Pump Flows and Related Heads
No. Parl Pump
20 1 440. 0. 4000. 9000.
0 PRV # in Pipe # Ref source # Working HGL Hd-loss Chkv action?
1 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
OPRVs 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

| Pipe Dia INCHES | Up Node | Down Node | Pipe No. | Flow US GPM | Head Loss FEET | Velocity FT/SEC | Upstream HGL FEET | Downstream HGL FEET |
|-----------------|---------|-----------|----------|-------------|----------------|-----------------|-------------------|---------------------|
| 20.00 | 20 | 21 | 20 | 3888.000 | 100.00 | 3.97 | 440.00 | 440.00 |
| 20.00 | 21 | 22 | 21 | 3664.500 | 3.94 | 3.74 | 340.00 | 340.00 |
| 16.00 | 22 | 23 | 22 | 1166.679 | 1.94 | 1.86 | 336.06 | 336.06 |
| 12.00 | 23 | 24 | 23 | 367.884 | .93 | 1.04 | 334.12 | 334.12 |
| 12.00 | 24 | 25 | 24 | 114.384 | .14 | .32 | 333.19 | 333.19 |
| 12.00 | 25 | 26 | 25 | -126.321 | -.09 | -.36 | 333.05 | 333.05 |
| 12.00 | 26 | 27 | 26 | -420.321 | -1.53 | -1.19 | 333.14 | 333.14 |
| 12.00 | 27 | 28 | 27 | 202.500 | .45 | .57 | 334.67 | 334.67 |
| 16.00 | 22 | 27 | 28 | 901.821 | 1.38 | 1.44 | 336.06 | 336.06 |
| 12.00 | 22 | 29 | 29 | 1578.000 | 9.69 | 4.48 | 326.36 | 326.36 |
| 12.00 | 29 | 30 | 30 | 1578.000 | 11.71 | 4.48 | 334.12 | 334.12 |
| 12.00 | 23 | 31 | 31 | 114.000 | .03 | .32 | 334.09 | 334.09 |
| 12.00 | 31 | 32 | 32 | 114.000 | .12 | .32 | 334.12 | 334.12 |
| 12.00 | 23 | 33 | 33 | 329.295 | .80 | .93 | 333.32 | 333.32 |
| 12.00 | 33 | 34 | 34 | 205.500 | .33 | .58 | 333.32 | 333.32 |
| 12.00 | 33 | 35 | 35 | 121.795 | .29 | .35 | 333.32 | 333.32 |
| 12.00 | 35 | 25 | 36 | -36.705 | -.01 | -.10 | 333.04 | 333.04 |

1 Node Elevation FEET Demand US GPM HGL FEET Pressure PSI

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 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

| Node | 440.00 | -3888.00 | 440.00 | .00 |
|------|--------|----------|--------|--------|
| 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

1 Maximum unbalanced head in any loop .0000 In loop # 1

| Pipe no | Nodes | Length FEET | Diameter INCHES | Roughness | coef | K |
|---------|-------|-------------|-----------------|-----------|------|---------|
| 20 | 20 | 3650.00 | 20.00 | 120.00 | | .24942E |
| 21 | 21 | 1450.00 | 20.00 | 120.00 | | .99085E |
| 22 | 22 | 2000.00 | 16.00 | 120.00 | | .40518E |
| 23 | 23 | 1700.00 | 12.00 | 110.00 | | .16426E |
| 24 | 24 | 2300.00 | 12.00 | 110.00 | | .22223E |
| 25 | 25 | 1200.00 | 12.00 | 110.00 | | .11595E |
| 26 | 26 | 2200.00 | 12.00 | 110.00 | | .21257E |
| 27 | 27 | 2500.00 | 12.00 | 110.00 | | .24155E |
| 28 | 22 | 2300.00 | 16.00 | 120.00 | | .46595E |
| 29 | 22 | 1200.00 | 12.00 | 110.00 | | .11595E |
| 30 | 29 | 1450.00 | 12.00 | 110.00 | | .14010E |
| 31 | 31 | 500.00 | 12.00 | 110.00 | | .48311E |
| 32 | 31 | 1850.00 | 12.00 | 110.00 | | .17875E |
| 33 | 33 | 1800.00 | 12.00 | 110.00 | | .17392E |
| 34 | 33 | 1800.00 | 12.00 | 110.00 | | .17392E |
| 35 | 33 | 3950.00 | 12.00 | 110.00 | | .38165E |
| 36 | 35 | 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
 0 Node No. P Elev of Pump Flows and Related Heads
 NO. Parl Pump 0. 4000. 9000.
 20 1 440. 0. 0.
 0 PRV # in Pipe # Ref source # Working HGL Hd-loss Chkv action?
 1 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
 OPRVs 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

| 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 |

Maximum unbalanced head in any loop .0000 In loop # 2

| Pipe Dia INCHES | Up Node | Down Node | Pipe No. | Flow US GPM | Head Loss FEET | Velocity FT/SEC | Upstream HGL FEET | Downstream HGL FEET |
|-----------------|---------|-----------|----------|-------------|----------------|-----------------|-------------------|---------------------|
| 20.00 | 20 | 21 | 20 | 4387.995 | 100.00 | 4.48 | 440.00 | 440.00 |
| 20.00 | 21 | 22 | 21 | 4164.495 | 5.00 | 4.25 | 340.00 | 340.00 |
| 16.00 | 22 | 23 | 22 | 2473.375 | 7.79 | 3.95 | 335.00 | 335.00 |
| 12.00 | 23 | 24 | 23 | 898.801 | 4.84 | 2.55 | 327.22 | 327.22 |
| 12.00 | 24 | 25 | 24 | 645.301 | 3.55 | 1.83 | 322.37 | 322.37 |
| 12.00 | 25 | 26 | 25 | -819.620 | -2.88 | -2.33 | 318.83 | 318.83 |
| 12.00 | 26 | 27 | 26 | -1113.620 | -9.32 | -3.16 | 321.71 | 321.71 |
| 12.00 | 27 | 28 | 27 | 202.500 | .45 | .57 | 331.03 | 331.03 |
| 16.00 | 28 | 29 | 28 | 1595.120 | 3.97 | 2.55 | 335.00 | 335.00 |
| 12.00 | 29 | 30 | 29 | 78.000 | .04 | .22 | 335.00 | 335.00 |
| 12.00 | 30 | 31 | 30 | 78.000 | .04 | .22 | 334.97 | 334.97 |
| 12.00 | 31 | 32 | 31 | 114.000 | .03 | .32 | 327.22 | 327.22 |
| 12.00 | 32 | 33 | 32 | 114.000 | .12 | .32 | 327.19 | 327.19 |
| 12.00 | 33 | 34 | 33 | 1105.074 | 7.52 | 3.14 | 327.22 | 327.22 |
| 12.00 | 34 | 35 | 34 | 205.500 | .33 | .58 | 319.70 | 319.70 |
| 12.00 | 35 | 33 | 35 | 899.574 | 11.27 | 2.55 | 319.70 | 319.70 |

ELECTRICAL DEMANDS AND REFUSE CALCULATIONS

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

C. AGRICULTURAL IMPACT ASSESSMENT

**EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT:
IMPACT ON AGRICULTURE**

**EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT:
IMPACT ON AGRICULTURE**

Decision Analysts Hawaii, Inc.

**PREPARED FOR:
Housing Finance & Development Corporation
State of Hawaii**

**PREPARED BY:
Decision Analysts Hawaii, Inc.**

December 1996

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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 followed 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.

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 followed 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 followed). Of this amount,

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).*¹¹

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.

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 Types¹¹

The land within the Project area consists of 13 soil types:

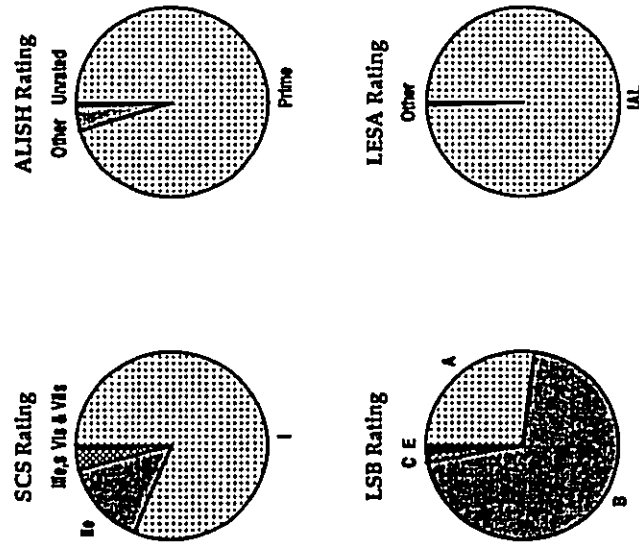
- EaB Ewa silty clay loam, 3 to 6% slopes;
- EwC Ewa stony silty clay, 6 to 12% slopes;
- HxA Honouliuli clay, 0 to 2% slopes;
- HxB Honouliuli clay, 2 to 6% slopes;
- KlaB Kawaihapai stony clay loam, 2 to 6% slopes;
- KlBC Kawaihapai very stony clay loam, 0 to 15% slopes;
- KyA Kunia silty clay, 0 to 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.

Table 1.— EAST KAPOLEI MASTER PLAN DEVELOPMENT PROJECT:
SOIL TYPES, ACRES, AGRICULTURAL USES, AND SOIL RATINGS

| Soil Type | Acres | Agricultural Uses | SCS Rating ¹ | LESA Rating |
|-----------|-------|--|-------------------------|-------------|
| EaB | 62 | Sugarcane, truck crops, pasture | Ile | 85 |
| EwC | 9 | Pasture | IIIe | 77 |
| HxA | 906 | Sugarcane, truck crops, pasture | I | 87 |
| HxB | 104 | Sugarcane, truck crops, pasture | Ile | 85 |
| KIaB | 15 | Sugarcane, truck crops, pasture | Ile | 83 |
| KIbC | 4 | Pasture | VIIs | 46 |
| KyA | 29 | Sugarcane, pineapple ² | I | 95 |
| MnC | 22 | Sugarcane, truck crops, pasture | IIIs | 66 |
| MuB | 4 | Sugarcane, pineapple, ² pasture | Ile | 88 |
| MuC | 18 | Sugarcane, pineapple, ² pasture | IIIe | 81 |
| rST | 2 | None | VIIIs | 30 |
| WkA | 113 | Sugarcane, truck crops, pasture | I | 93 |
| WzA | 12 | Sugarcane | I | 92 |
| TOTAL | 1,300 | | | |

1. Assuming irrigation, except for KIbC 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.¹¹

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).¹²
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.*¹³

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.¹⁴ 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.¹⁵

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

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.⁶⁶ Rainfall averages near 20 inches per year.⁶⁷

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.⁶⁷

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.

Combined Agricultural Impacts
A total of 380 acres of agricultural land *outside* the Project area will be followed; 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 followed by Sugarland Farms + 140 acres followed 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 followed by Sugarland Farms + 140 acres followed 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 Wai'ale'ale 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 followed 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

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 followed 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.

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."¹⁰¹ 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):¹⁰¹

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)^(a)
(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)⁽¹⁾⁽¹⁾

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

- 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.¹¹⁾ 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.

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.

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.¹²⁻⁴¹

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.¹³ 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.¹⁴ Most of these fields have good soils, the areas is sunny, and irrigation costs are low.¹⁵ 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.¹⁵

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 Waiialua Sugar Co., Inc.

Most of the 12,000 acres being released by the closure of Waiialua Sugar Co., Inc. are also of high quality.¹⁶ 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 Analysis 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 Analysis Hawaii, Inc.
- (6) Decision Analysis 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

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Staff Submittal

May 14, 1997

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 TMA 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.

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.

Item 4

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 basal 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 basal 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.

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).

ANALYSIS/ISSUES:

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.

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 "Injo 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 Puuloa 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)

EDUARDO J. CAHILL
GOVERNOR OF HAWAII



STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT
P. O. BOX 831
HONOLULU, HAWAII 96809

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KENNETH W. HONOLUIA, JR.
DAVID

May 14, 1997

STAFF SUBMITTAL

for the meeting of the
COMMISSION ON WATER RESOURCE MANAGEMENT

May 14, 1997
Honolulu, Oahu

APPLICATIONS FOR WATER USE PERMITS
REQUESTS 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

| | |
|---|------|
| Staff Submittal | 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 Mikoahu St., #D
Ewa Beach, HI 96706 | Same |
| (Well No. 2002-12)
Palm Court Association
91-1019 Puanuu St., #25R
Ewa Beach, HI 96706 | Same |
| (Well No. 1902-01)
Haseko (Ewa), Inc.
820 Milliani St., Suite 810
Honolulu, HI 96813 | Same |

LANDOWNERS:

(Well Nos. 1905-08, 10)
The Estate of James Campbell
1001 Kamokila Blvd.
Kapolei, HI 96707

(Well Nos. 2003-04, 07)
State of Hawaii,
Housing Finance & Development Corp.
7 Waterfront Plaza, Suite 300
500 Ala Moana Blvd.
Honolulu, HI 96813

(Well Nos. 2003-01, 02, 05)
Kapolei People's Inc.
91-701 Farrington Hwy.
Kapolei, HI 96707

(Well Nos. 1900-02, 17 to 20 & 1901-03)
Hawaii Prince Golf Club
91-1200 Fort Weaver Rd.
Ewa Beach, HI 96706

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:

FCUG NONPOTABLE WATER MASTER PLAN

The staff's comments regarding the latest Puuloa Caprock Users Group (FCUG) 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.

Staff Submittal

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, PUULOLOA 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.

Staff Submittal

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 (i.e. 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, PUULOLOA 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

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● Reclaimed Water

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.

● Conditions for a Water Use Permit

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

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Staff Submittal

● Requests for Variance from Non-Renewal of Unused Interim Permits

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.

● Request for Variance from Domestic Consumption Guideline

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 not recommending approval for an additional 0.150 mgd requested by Hawaii Prince to offset evaporative losses from the 32-acres of open lake surfaces.

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 to 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 EBIGC 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).

Staff Submittal

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 (i.e. 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, PUULO 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.

Staff Submittal

- 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, PUULO 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.

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 Ir (1905-08,10) | 0.302 | Landscape Irrigation |
| State HFDC | Kapolei Ir C-1,D (2003-04,07) | 0.494 | Dust Control, Irrigation |
| Kapolei People's Inc. | Kapolei Ir 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" as

"...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.

Staff Submittal

- 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.

Staff Submittal

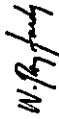
- a. Delegate the authority to the Commission staff to approve or modify the proposed pump test procedure.
- 3. Require The Estate of James Campbell to propose a pump test and conduct such test prior to reactivation of Well No. 2000-01 to confirm that the source can sustain withdrawals at the current 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.

Staff Submittal

May 14, 1997

c. Require adherence to the Conservation Conditions shown in Exhibit 12.

Respectfully submitted,



W. 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

INTRODUCTION

The project site occupies approximately 1300 acres in Honolulu, 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.

EAST KAPOLEI MASTER PLAN BIOLOGICAL SURVEY

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 *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 virgate*). 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*), cockspur (*Xanthium strumarium*) and pill (*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 composition of the project site. Transects were established throughout the site and all plants observed were recorded and their relative abundance determined. In conjunction

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For: FBR Hawaii
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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 with 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 (*Homardica 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 (*Tripsax 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 mauka 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 Palchun 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 rattiepod, 'uhaloa, castor bean (Ricinus communis), graceful spurge (Chamaesyce hypericifolia) and re-sprouting nut grass. Vegetational cover is about 25-50%. In two fields watermelons (Citrullus 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 kiu, koa-hoole, 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.

Kalo'i 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-hoole 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 (Coccoloba grandis) is abundant, often completely enshrouding the Guinea grass and koa-hoole. Paragrass (Bracharia mutica), wood rose (Merremia tuberosa),

moon flower (Ipomoea alba) 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 rattiepod, buffelgrass, graceful spurge, virgate mimosa, peria, lion's ear (Leonotis nepetifolia), Australian saltbush (Atriplex semibaccata), goosegrass (Elysiene indica), Natal reedtop (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 site 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'oloo'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'oloo'ula, all of the native species in the site are common lowland species in Hawaii. Ko'oloo'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'oloo'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 Luolualei 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 Luolualei 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 (Herpestis auro-punctatus) 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 Munehune Gulch near Plantation Road. As there was no water in either Munehune 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 Eva 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 Eva 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.

Barrèd 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 koo-haole shrubs along Plantation Road.

Kentucky cardinal (Richmondia cardinalis)

One individual was seen in the Fallowed Fields Mixed Herb Association.

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 cultivation the vegetation is entirely secondary and thenative ('ilima, pa'uohi'iake) or possibly native (hoary abutilon, 'uhaloa) species which are so common in the site are merely recolonizing an already completely altered habitat. According to 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'iake, '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 these 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.

PHASIANIDAE

Francolin (Francolinus sp.)

About a dozen were seen in the Abandoned Cane Fields near Kalo'i 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-checked waxbill (Estrilda melipoda)

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.

The plant survey was conducted at 80% coverage and although a more intensive search was conducted in the vicinity of each ko'oloa'ua 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.

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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:

- H - 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



LEGEND FOR FIGURE 2

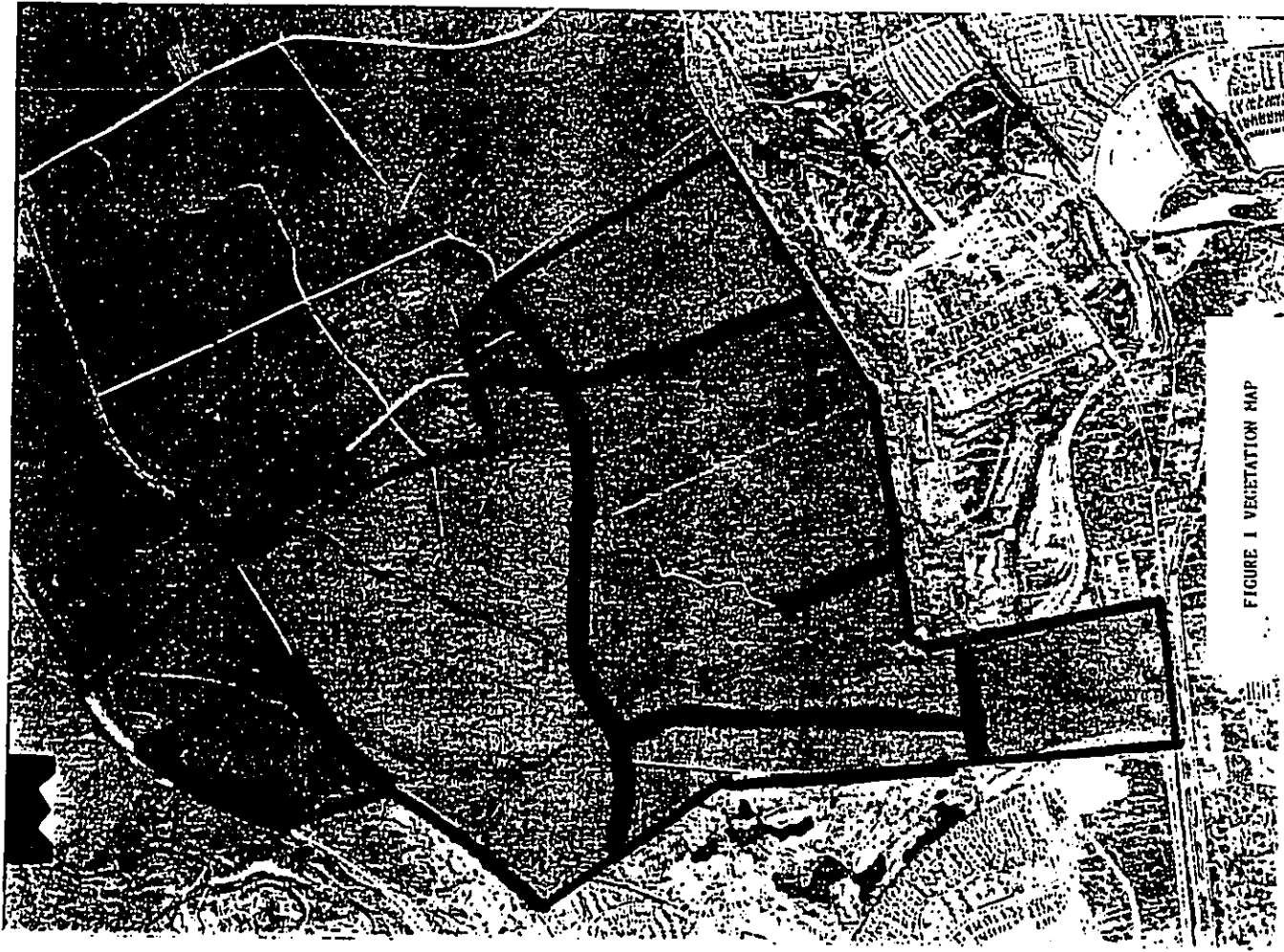
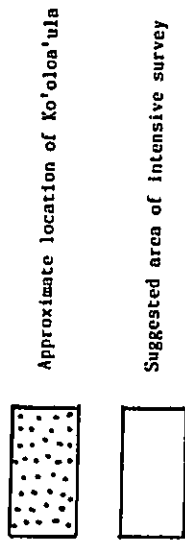


FIGURE 1 VEGETATION MAP

CHECK LIST OF PLANTS

| SCIENTIFIC NAME | CHECKLIST OF ANIMALS | COMMON NAME | STATUS | RELATIVE ABUNDANCE | | | | | | | | |
|---------------------------|----------------------|--------------------------|--------|--------------------|----|----|---|---|----|----|---|--|
| | | | | ACS | FM | FE | A | C | CA | CU | R | |
| ALCEDINIDAE | | | | | | | | | | | | |
| <i>Alcedo coronata</i> | | Cattle egret | 1 | | | | | | | | | |
| <i>Alcedo albica</i> | | White-necked night heron | 1 | | | | | | | | | |
| ALCEDINIDAE | | | | | | | | | | | | |
| <i>Alcedo albica</i> | | Pacific golden-plover | H | | | | | | | | | |
| COLUMBIDAE | | | | | | | | | | | | |
| <i>Columba livia</i> | | Rock dove | 1 | | | | | | | | | |
| <i>Columba livia</i> | | Barn dove | 1 | | | | | | | | | |
| <i>Columba livia</i> | | Lace-neck dove | 1 | | | | | | | | | |
| FRINGILLIDAE | | | | | | | | | | | | |
| <i>Fringilla coronata</i> | | Red-crowned cardinal | 1 | | | | | | | | | |
| <i>Fringilla coronata</i> | | Red-crowned cardinal | 1 | | | | | | | | | |
| FRINGILLIDAE | | | | | | | | | | | | |
| <i>Fringilla coronata</i> | | Red-crowned cardinal | 1 | | | | | | | | | |
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| <i>Fringilla coronata</i> | | Red-crowned cardinal | 1 | | | | | | | | | |
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| <i>Fringilla coronata</i> | | Red-crowned cardinal | 1 | | | | | | | | | |
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| <i>Fringilla coronata</i> | | Red-crowned cardinal | 1 | | | | | | | | | |
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| <i>Fringilla coronata</i> | | Red-crowned cardinal | 1 | | | | | | | | | |
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| <i>Fringilla coronata</i> | | Red-crowned cardinal | 1 | | | | | | | | | |
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| <i>Fringilla coronata</i> | | Red-crowned cardinal | 1 | | | | | | | | | |
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| <i>Fringilla coronata</i> | | Red-crowned cardinal | 1 | | | | | | | | | |
| FRINGILLIDAE | | | | | | | | | | | | |
| <i>Fringilla coronata</i> | | Red-crowned cardinal | 1 | | | | | | | | | |
| FRINGILLIDAE | | | | | | | | | | | | |
| <i>Fringilla coronata</i> | | Red-crowned cardinal | 1 | | | | | | | | | |
| FRINGILLIDAE | | | | | | | | | | | | |
| <i>Fringilla coronata</i> | | Red-crowned cardinal | 1 | | | | | | | | | |
| FRINGILLIDAE | | | | | | | | | | | | |
| <i>Fringilla coronata</i> | | Red-crowned cardinal | 1 | | | | | | | | | |
| FRINGILLIDAE | | | | | | | | | | | | |
| <i>Fringilla coronata</i> | | Red-crowned cardinal | 1 | | | | | | | | | |
| FRINGILLIDAE | | | | | | | | | | | | |
| <i>Fringilla coronata</i> | | Red-crowned cardinal | 1 | | | | | | | | | |
| FRINGILLIDAE | | | | | | | | | | | | |
| <i>Fringilla coronata</i> | | Red-crowned cardinal | 1 | | | | | | | | | |
| FRINGILLIDAE | | | | | | | | | | | | |
| <i>Fringilla coronata</i> | | Red-crowned cardinal | 1 | | | | | | | | | |
| FRINGILLIDAE | | | | | | | | | | | | |
| <i>Fringilla coronata</i> | | Red-crowned cardinal | 1 | | | | | | | | | |

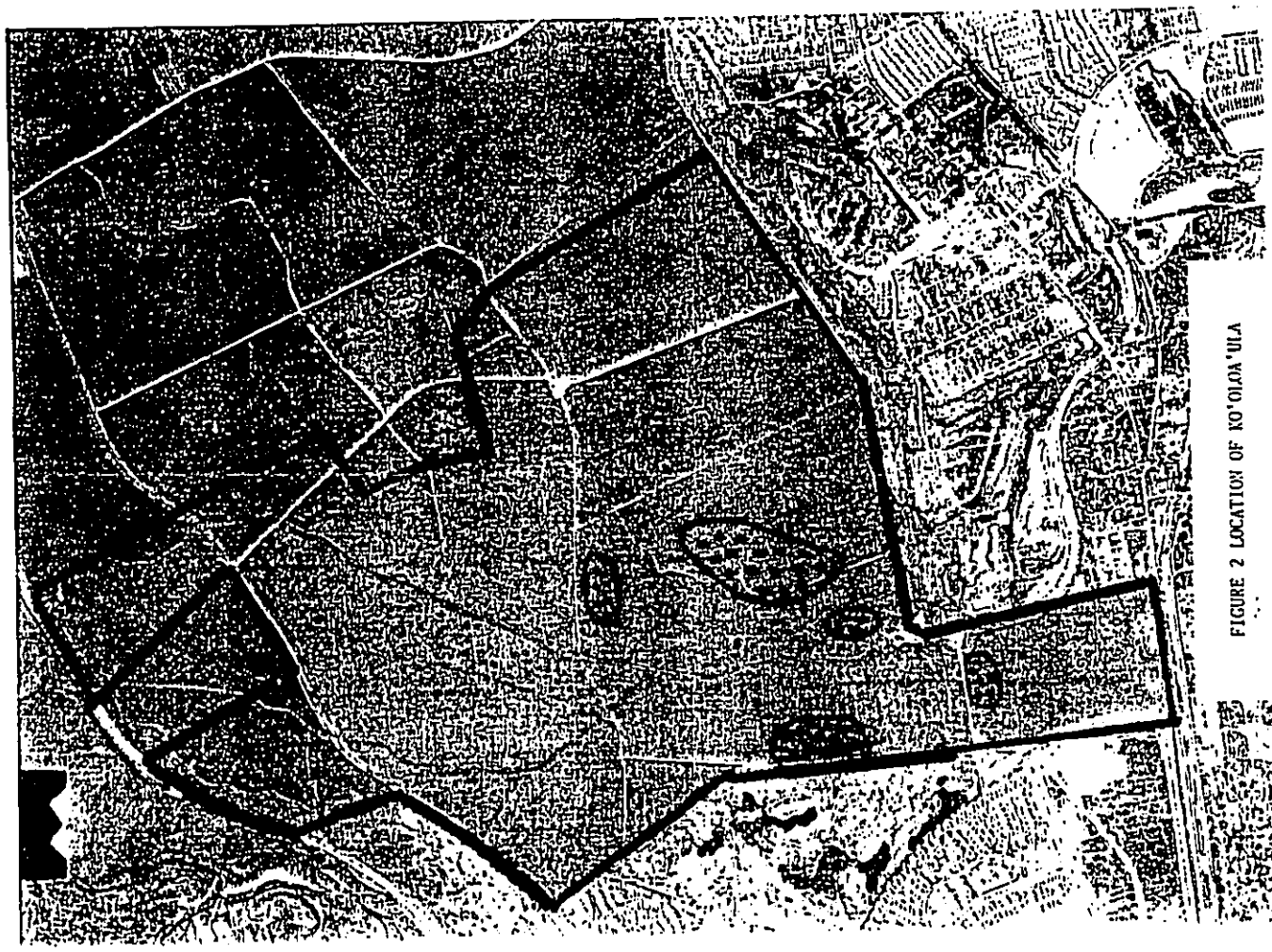


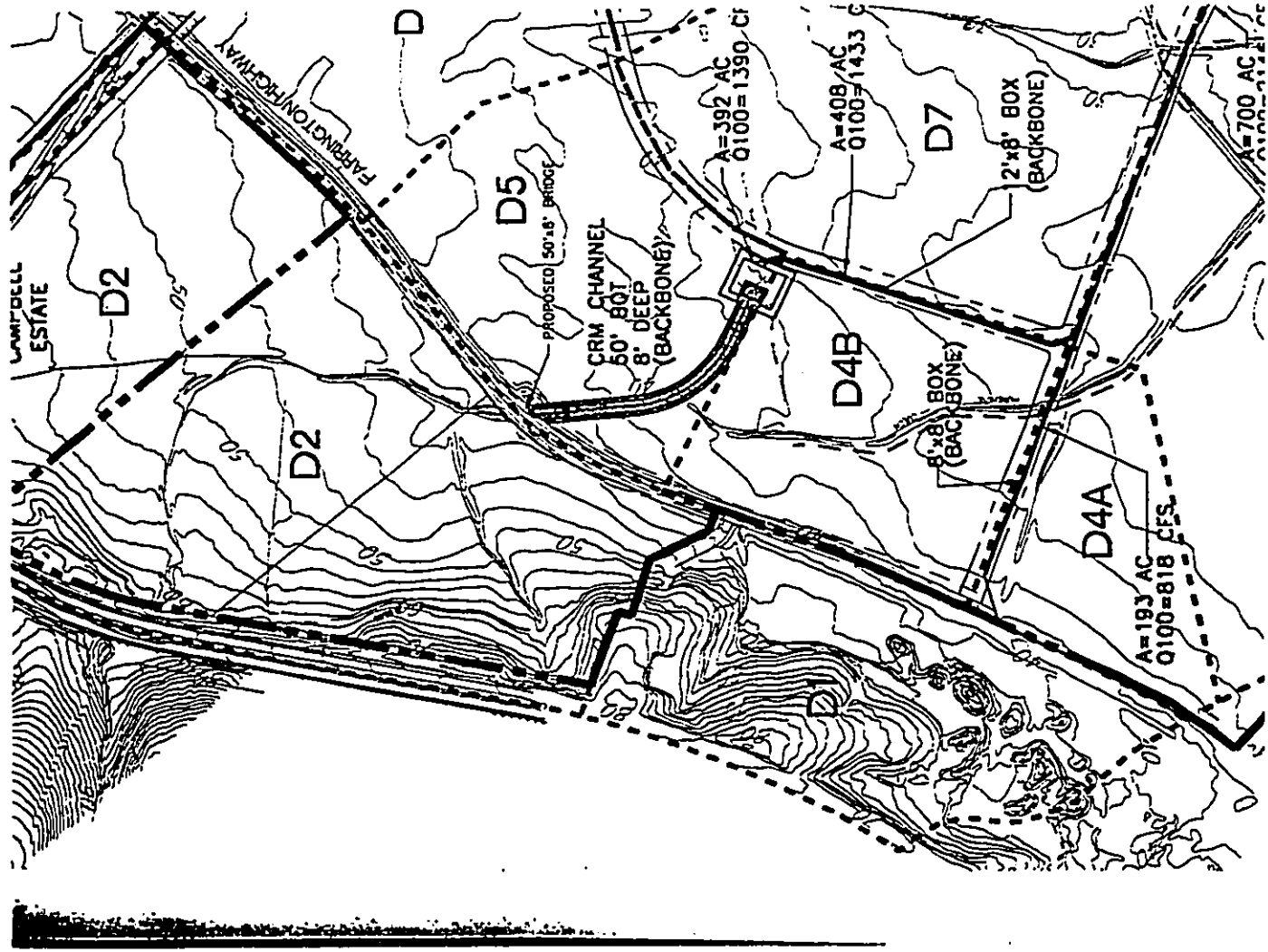
FIGURE 2 LOCATION OF KO'OLOA 'U'LA

CHECK LIST OF PLANTS

Table with columns: SCIENTIFIC NAME, COMMON NAME, STATUS, RELATIVE ABUNDANCE. Rows include families like FABACEAE (e.g., Brachidium tortuosum) and LEGUMINOSAE (e.g., Lumnitzera nepetifolia).

CHECK LIST OF PLANTS

Table with columns: SCIENTIFIC NAME, COMMON NAME, STATUS, RELATIVE ABUNDANCE. Rows include families like TILIACEAE (e.g., Triumfetta emuticloba) and ZYGDOPHYTEAE (e.g., Tribulus terrestris).



APPENDIX D
BACKBONE DRAINAGE SYSTEM HYDRAULIC SIZING

- ▶ HEC-2 Computations for CRM Channel
- ▶ Hunchune Stream Channel Improvements
- ▶ Box Drain Sizing and Hydraulic Data

CHECK LIST OF PLANTS

| SCIENTIFIC NAME | COMMON NAME | STATUS | RELATIVE ABUNDANCE | | | | | | |
|---|----------------------|--------|--------------------|----|----|---|---|----|---|
| | | | AC | FA | PA | A | C | GU | R |
| CYPERACEAE | | | | | | | | | |
| <i>Cyperus rotundus</i> L. | nut grass | I | U | U | U | U | U | U | |
| POLYPODIALES | | | | | | | | | |
| <i>Polypodium scolopendria</i> (L.) A. DC. | Pitted beardgrass | I | U | U | U | U | U | U | |
| <i>Brachiaria mutica</i> (Forst.) Stapf | Parrotia | I | U | U | U | U | U | U | |
| <i>Chloris ciliata</i> L. | Bottlegrass | I | U | U | U | U | U | U | |
| <i>Chloris barbata</i> (L.) Sw. | Swollen fingergrass | I | U | U | U | U | U | U | |
| <i>C. radiata</i> (L.) Sw. | Red-tate fingergrass | I | U | U | U | U | U | U | |
| <i>Cyperus dactyloides</i> (L.) Pers. | Bermuda grass | I | U | U | U | U | U | U | |
| <i>Digitaria involuta</i> (L.) Mez ex Emen | Sourgrass | I | U | U | U | U | U | U | |
| <i>Echinochloa crus-galli</i> (L.) P. Beauv. | Barneyard grass | I | U | U | U | U | U | U | |
| <i>Echinochloa polystachya</i> (L.) Gaertn. | Coolidge grass | I | U | U | U | U | U | U | |
| <i>Eragrostis ciliata</i> (L.) Link. | Spikegrass | I | U | U | U | U | U | U | |
| <i>Eragrostis ciliata</i> (L.) Link. | Japanese lovegrass | I | U | U | U | U | U | U | |
| <i>Leptochloa uniseriata</i> (L. Presl) Hitchc. | Guinea grass | I | U | U | U | U | U | U | |
| <i>Panicum molle</i> Jacq. | Natal redtop | I | U | U | U | U | U | U | |
| <i>Rhynchospora repens</i> (Willd.) Hubb. | Sugar cane | I | U | U | U | U | U | U | |
| <i>Saccharum officinarum</i> L. | Warty grass | I | U | U | U | U | U | U | |
| <i>Syntherisma sanguinalis</i> (L.) P. Beauv. | Johnson grass | I | U | U | U | U | U | U | |
| <i>Sorghum halepense</i> (L.) Pers. | | | | | | | | | |
| DICOTYLEDONALES | | | | | | | | | |
| ASTRUCHEAE | | | | | | | | | |
| <i>Achyrocline satureioides</i> (L.) DC. | Red shell flower | I | U | U | U | U | U | U | |
| <i>Achyrocline satureioides</i> (L.) DC. | Spike amaranth | I | U | U | U | U | U | U | |
| <i>A. villosa</i> L. | | | | | | | | | |
| APURCANTHACEAE | | | | | | | | | |
| <i>Mangifera indica</i> L. | Mango | I | U | U | U | U | U | U | |
| <i>Salicida torbangalensis</i> Waddi | Christmas berry | I | U | U | U | U | U | U | |
| SCITIFOLIACEAE | | | | | | | | | |
| <i>Calotropis algenia</i> (L.) W. & Aiton | Crown flower | I | U | U | U | U | U | U | |
| ASTERACEAE | | | | | | | | | |
| <i>Aster pilosus</i> L. | Spanish needle | I | U | U | U | U | U | U | |
| <i>Aster pilosus</i> var. minor (Bl.) Sherif | | | | | | | | | |
| <i>Cordia alliodora</i> (L.) Lam. | Hairy horseweed | I | U | U | U | U | U | U | |
| <i>Malva lewisii</i> Nicolson | Flora's painbrush | I | U | U | U | U | U | U | |
| <i>Flourensia trinervis</i> (Spring.) C. Muhr | Frickly bitouche | I | U | U | U | U | U | U | |
| <i>Lactuca serriola</i> L. | Indian flatweed | I | U | U | U | U | U | U | |
| <i>Pluchea indica</i> (L.) Less. | Indian flatweed | I | U | U | U | U | U | U | |
| <i>P. indica</i> var. major (Bl.) Sherif | | | | | | | | | |
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January 1997

SUMMARY OF FINDINGS KO'OLOA'ULA ON EAST KAPOLEI PROJECT SITE 'EWA DISTRICT, ISLAND OF O'AHU

INTRODUCTION

The ko'olua'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'ala 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 Luaiualei 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'olua'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 population of the ko'olua'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'olua'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

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 remyi, 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

EAST KAPOLEI MASTER PLAN
HABITAT CONSERVATION PLAN
FOR ABUTILON MENZIESII



State of Hawai'i
Housing Finance
Development Corporation

State of Hawai'i
Housing Finance
Development Corporation

Prepared by



Land Planning, Landscape Architecture
Environmental Studies

June 1998

June 1998

EAST KAPOLEI MASTER PLAN
Habitat Conservation Plan

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| <p>HABITAT CONSERVATION PLAN</p> <p>(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. 5</p> <p>(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. 11</p> <p>(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. 14</p> <p>(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. 30</p> <p>(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</p> | |

ROY S. OSHIRO
EXECUTIVE DIRECTOR

848-7461/1610

98:DEV/2316



STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
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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)



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in the ecosystems, natural communities, or habitat types in the plan area.31

(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.32

(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.33

(8) Provide for an adaptive management strategy that specifies the actions to be taken periodically if the plan is not achieving its goals.36

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A North-South Road Mitigation Plan for *Abutilon Menziesii*

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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 Hawai'i 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

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.

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.

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 drainage way, 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 ('iima and pa'uohi'aka), two are probably indigenous ('uhalea 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.

EAST KAPOLEI MASTER PLAN
Habitat Conservation 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).

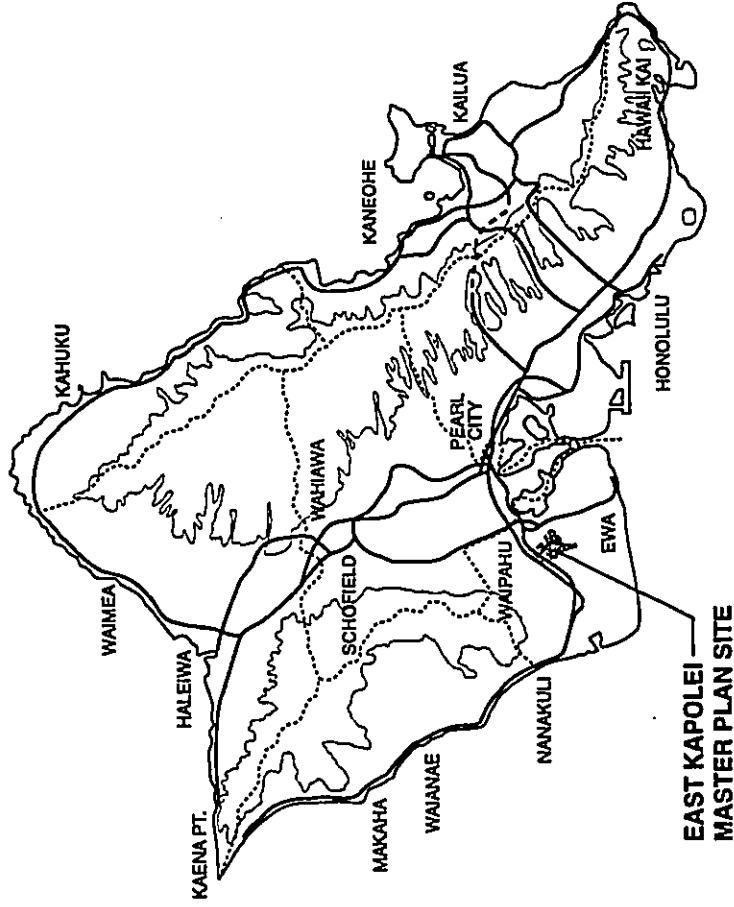


FIGURE 1
REGIONAL LOCATION MAP
HFDC EAST KAPOLEI MASTER PLAN
HAWAIIAN FORECASTING DESIGN CENTER
PDR

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.

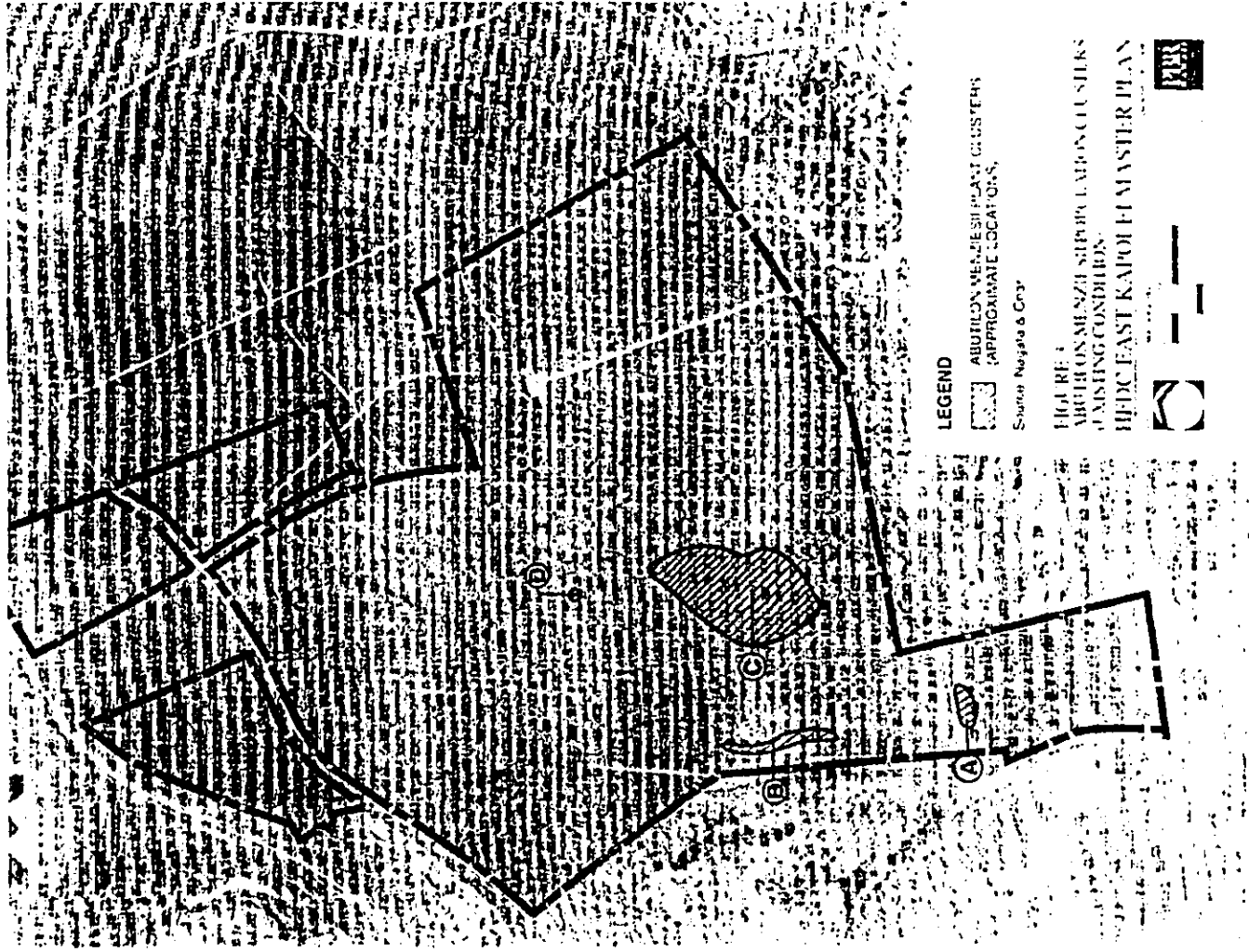


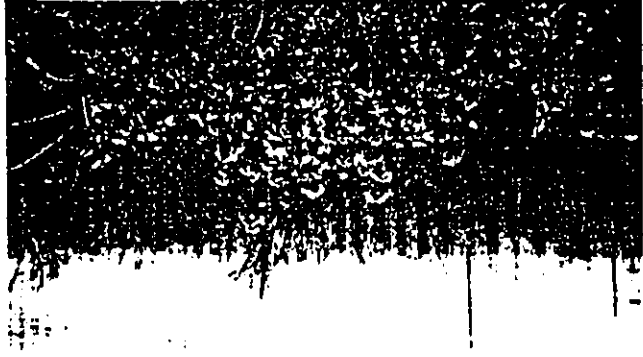
FIGURE 2
PHOTOGRAPHS AND THICKNESS
HDIC EAST KAPIHI MASTER PLAN



D) Young *Phacelia nodosa* (Thicket A)



B) *Phacelia nodosa*



A) Mature *Phacelia nodosa* thicket, south of the HDIC boundary



C) Thick *Phacelia nodosa* thicket, south of the HDIC boundary

EAST KAPOLEI MASTER PLAN
Habitat Conservation 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).

EAST KAPOLEI MASTER PLAN
Habitat Conservation Plan

(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.

EAST KAPOLEI MASTER PLAN
Habitat Conservation 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.

Drainage/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.

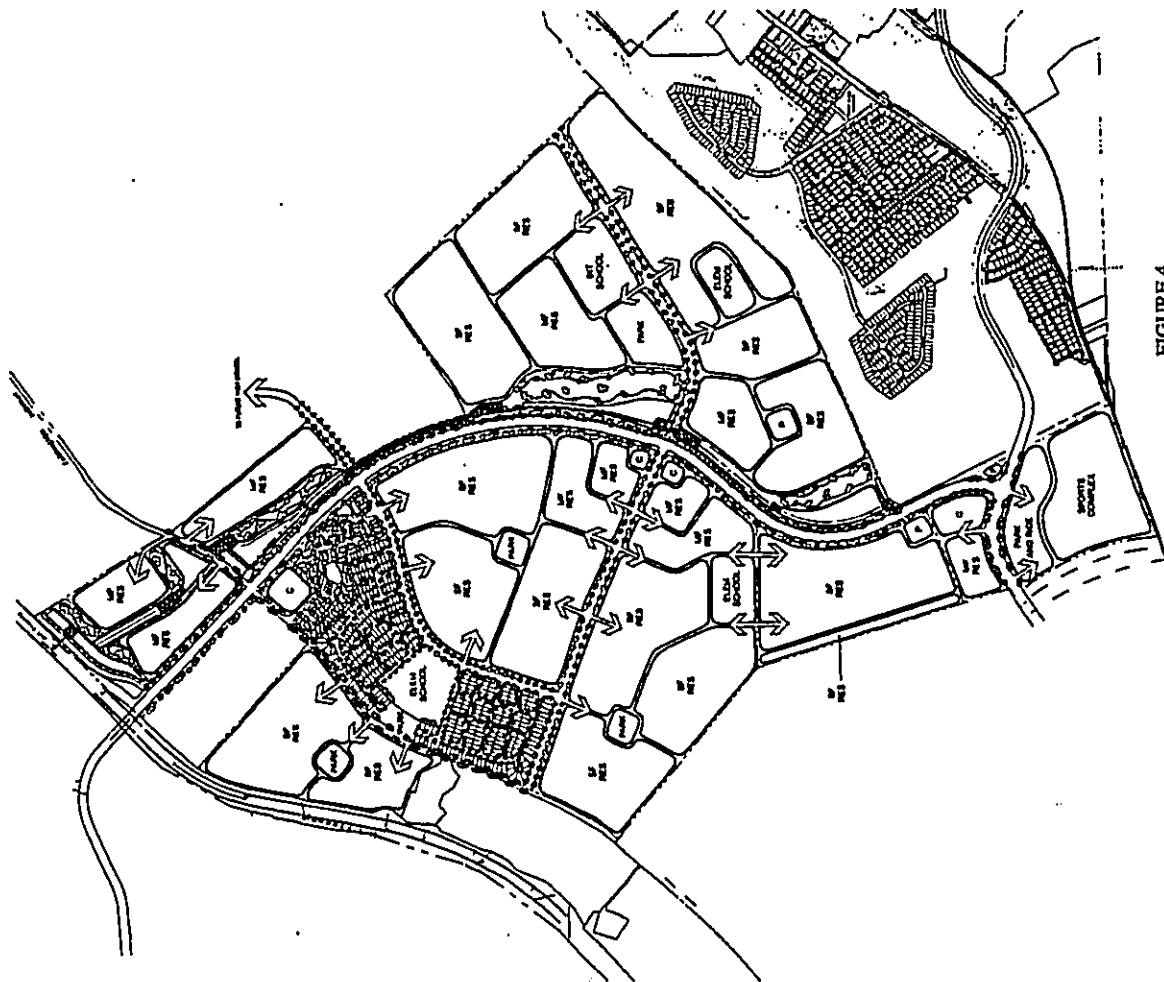


FIGURE 4
CONCEPTUAL DEVELOPMENT PLAN
HFDC EAST KAPOLEI MASTER PLAN
SCALE: 1" = 100' (AS SHOWN)
DATE: 10/15/03

EAST KAPOLEI MASTER PLAN
Habitat Conservation Plan

- (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 (Hobby in FWS 1994). A more recent reporting has been made of a single individual on Navy property at Luualalei (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 Kalamimoku 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, Kapaa, 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.

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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 <i>Abutilon menziesii</i> prior to construction |
| 4 | Locate off-site facilities for re-location of <i>Abutilon menziesii</i> |
| 5 | Establish on-site nursery for re-location and propagation of <i>Abutilon menziesii</i> |
| 6 | Transplant <i>Abutilon menziesii</i> to constructed on-site drainage/open space corridor |
| 7 | Long-term protection and management of permanent <i>Abutilon menziesii</i> populations |
| 8 | Incorporate <i>Abutilon menziesii</i> into project landscaping |
| 9 | Conduct essential research |

Strategy 1. Determine Master Plan development schedule and mitigation phasing sequence

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,

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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.

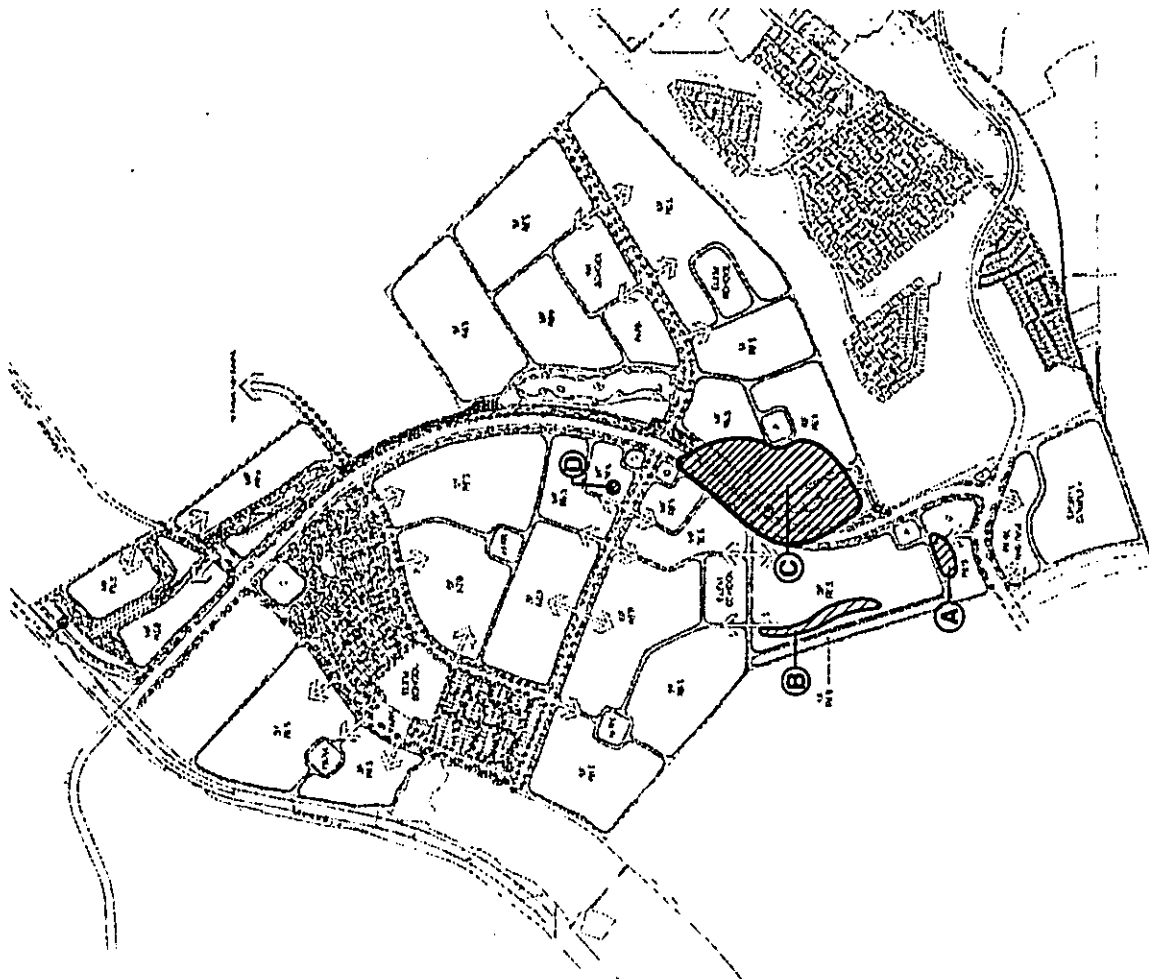


FIGURE 5
ABUTILON MENZIESII PLANT CLUSTER MAP
HFDC EAST KAPOLEI MASTER PLAN
LAND AND WATER DIVISION
STATE OF HAWAII

LEGEND
ABUTILON MENZIESII PLANT CLUSTERS

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2.1 On-Site Consultant Project Manager

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 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 Consultant Field Support Staff

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 Researcher

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 Kapolei 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. Interim management of existing population prior to construction

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 drainage/open space areas. The drainage/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).

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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 Secure habitat for current populations.

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 Manage current populations.

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-foot 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.

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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. Locate off-site facilities for propagation of *Abutilon menziesii*

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. Establish on-site nursery facility for propagation of *Abutilon menziesii*

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 drainage/open space corridor when the construction disturbance is ended.

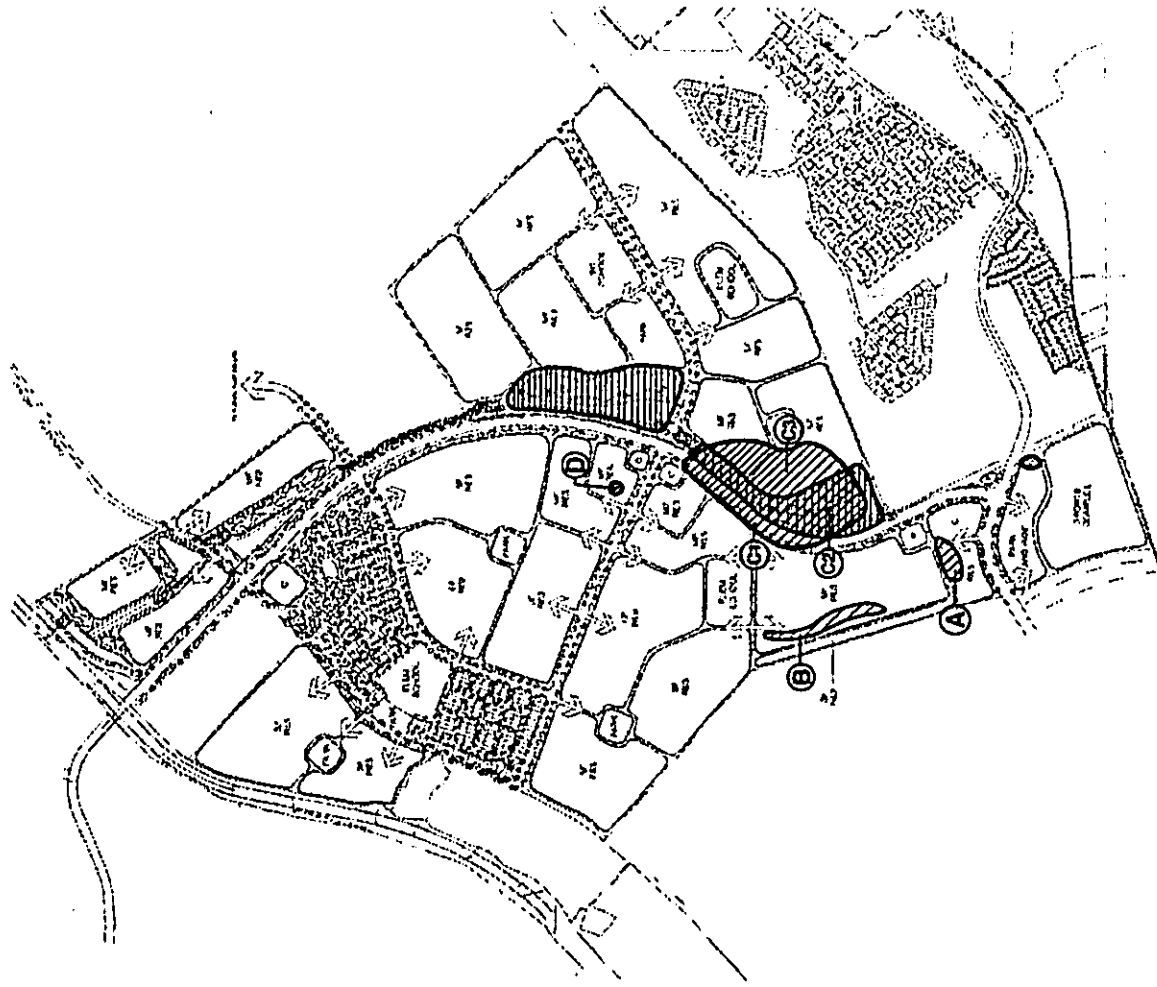


FIGURE 6
HABITAT CONSERVATION PLAN AREA
HFDC EAST KAPOLEI MASTER PLAN

LEGEND

- ABUTILON MENZIESII PLANT CLUSTERS
- POTENTIAL MITIGATION AREA
- PROPAGATION FACILITY (POTENTIAL LOCATION)

SCALE OF MAP: 1" = 100'

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. Transplant *Abutilon menziesii* to on-site drainage/open space corridor

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

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 seedling 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

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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 drainage way 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 drainage way (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 drainage way 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 drainage way 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 drainage way 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

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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

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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 catastrophic 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 drainage-way 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 taxon 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.

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- **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 on 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 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 drainage-way 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.

EAST KAPOLEI MASTER PLAN
Habitat Conservation Plan

EAST KAPOLEI MASTER PLAN
Habitat Conservation Plan

(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.*

(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.*

(4a) *Measures or actions to be undertaken to protect, maintain, restore, or enhance the ecosystems, natural communities, or habitat types*

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.

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

EAST KAPOLEI MASTER PLAN
Habitat Conservation Plan

- (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.

EAST KAPOLEI MASTER PLAN
Habitat Conservation Plan

- (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% of plant | Air-layers
(#/Plant) | Cuttings
(#/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/fruitlet)

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.

EAST KAPOLEI MASTER PLAN
Habitat Conservation Plan

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 total population) 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 | No. | 50% survival | No. | |
| C-2 | 10 | 5 | 2 | 0 | 21 | 1 | 6 | 0 | |
| C-1 (offsite) | 20 | 10 | 5 | 56 | N/A | N/A | N/A | N/A | |
| A | 15 | 7 | 3 | 40 | 20 | 10 | 40 | 2 | 10 |
| B | 20 | 10 | 5 | 56 | 28 | 14 | 56 | 2 | 14 |
| D | 0 | N/A | N/A | 0 | N/A | 0 | N/A | 1 | 0 |
| C-3 | 60 | 30 | 15 | 164 | 82 | 41 | 164 | 8 | 41 |
| 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 I 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.

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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.

(b) 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.

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MITIGATION 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. 5
- (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. 7
- (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. 8
- (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. 14

NORTH - SOUTH ROAD
MITIGATION PLAN
FOR ABUTILON MENZIESII



Prepared for:
Parsons Brinckerhoff Quade & Douglas, Inc.
and
State of Hawaii
Department of Transportation

June 1998

NORTH-SOUTH ROAD
Mitigation Plan for *Abutilon Menziesii*

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Char & Associates, 1997

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(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. 15

(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. 15

(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. 15

(8) Provide for an adaptive management strategy that specifies the actions to be taken periodically if the plan is not achieving its goals. 16

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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 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

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 to 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 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.

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Mitigation Plan for *Abutilon menziesii*

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.

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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),

Attached to the HFDC HCP umbrella plan are appendices which are applicable to the subject Mitigation Plan. They include 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'olaa'ua 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.

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Mitigation Plan for *Abutilon menziesii*

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

NORTH-SOUTH ROAD
Mitigation Plan for *Abutilon menziesii*

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'ua, 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

NORTH-SOUTH ROAD
Mitigation Plan for *Abutilon menziesii*

(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 <i>Abutilon menziesii</i> |
| 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 |

NORTH-SOUTH ROAD
Mitigation Plan for *Abutilon menziesii*

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 cunefield 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 descended 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 (Hobby in FWS 1994). A more recent reporting has been made of a single individual on Navy property at Luualalei (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 Kalamimoku 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, Kapanae, Kauai, in FWS 1994) and air layers are been reported to be 95 percent successful (Woolliams 1998, Waimea Arboretum, personal communication).

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 Nagam (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 Gardens 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 Lihoukalani Garden), Kaneohe (Hoomaluhia), Wahiawa, and Koko Crater. The Koko Crater and Lihoukalani 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, Woolliams, 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 (*Aderatus 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.

NORTH-SOUTH ROAD
Mitigation Plan for *Abutilon menziesii*

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.

NORTH-SOUTH ROAD
Mitigation Plan for *Abutilon menziesii*

(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*

NORTH-SOUTH ROAD
Mitigation Plan for *Abutilon Mendelii*

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

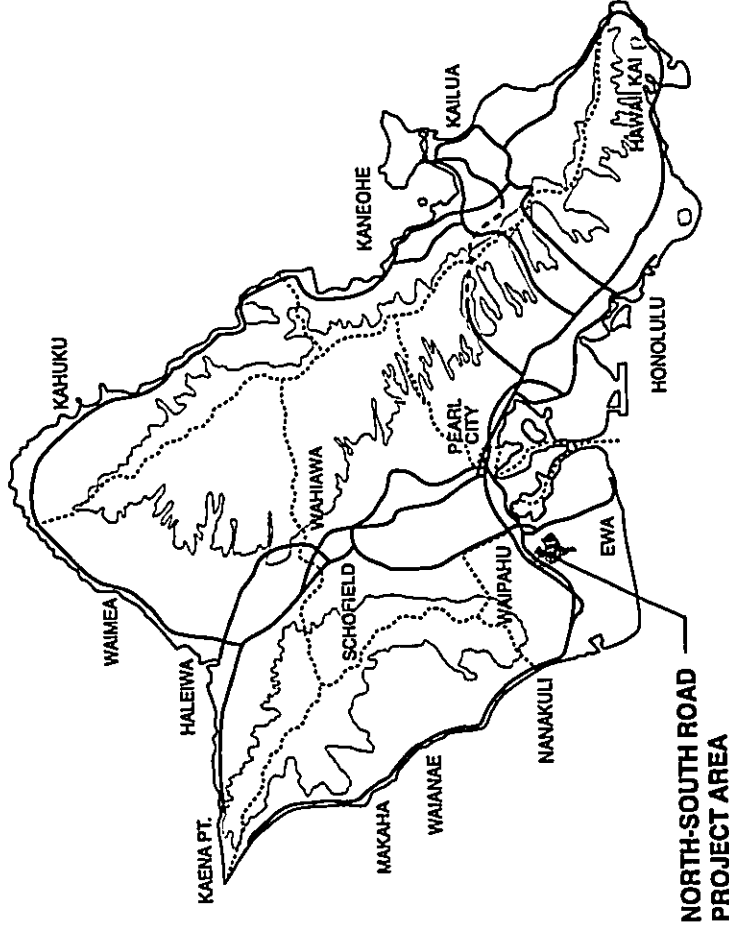
The off-site mitigation program for the North-South Road is planned as a three-year program. The goals are expected to be achieved during this period.

(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.



**NORTH-SOUTH ROAD
PROJECT AREA**

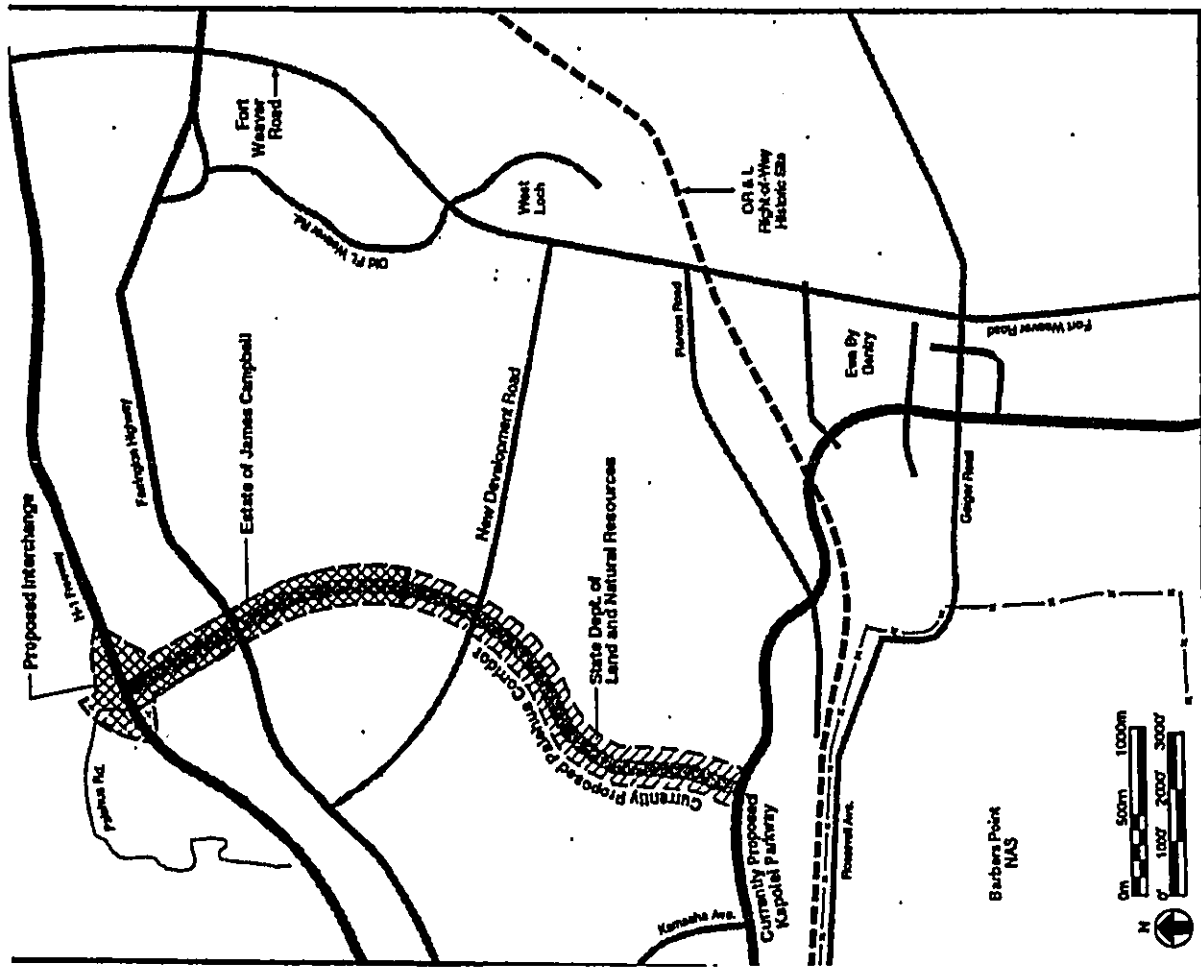


EXHIBIT 2
 LAND OWNERSHIP
 NORTH/SOUTH ROAD
SCALE OF MAP
 JPRK
June 1988

Source: Parsons Brinckerhoff Quade & Douglas, Inc.

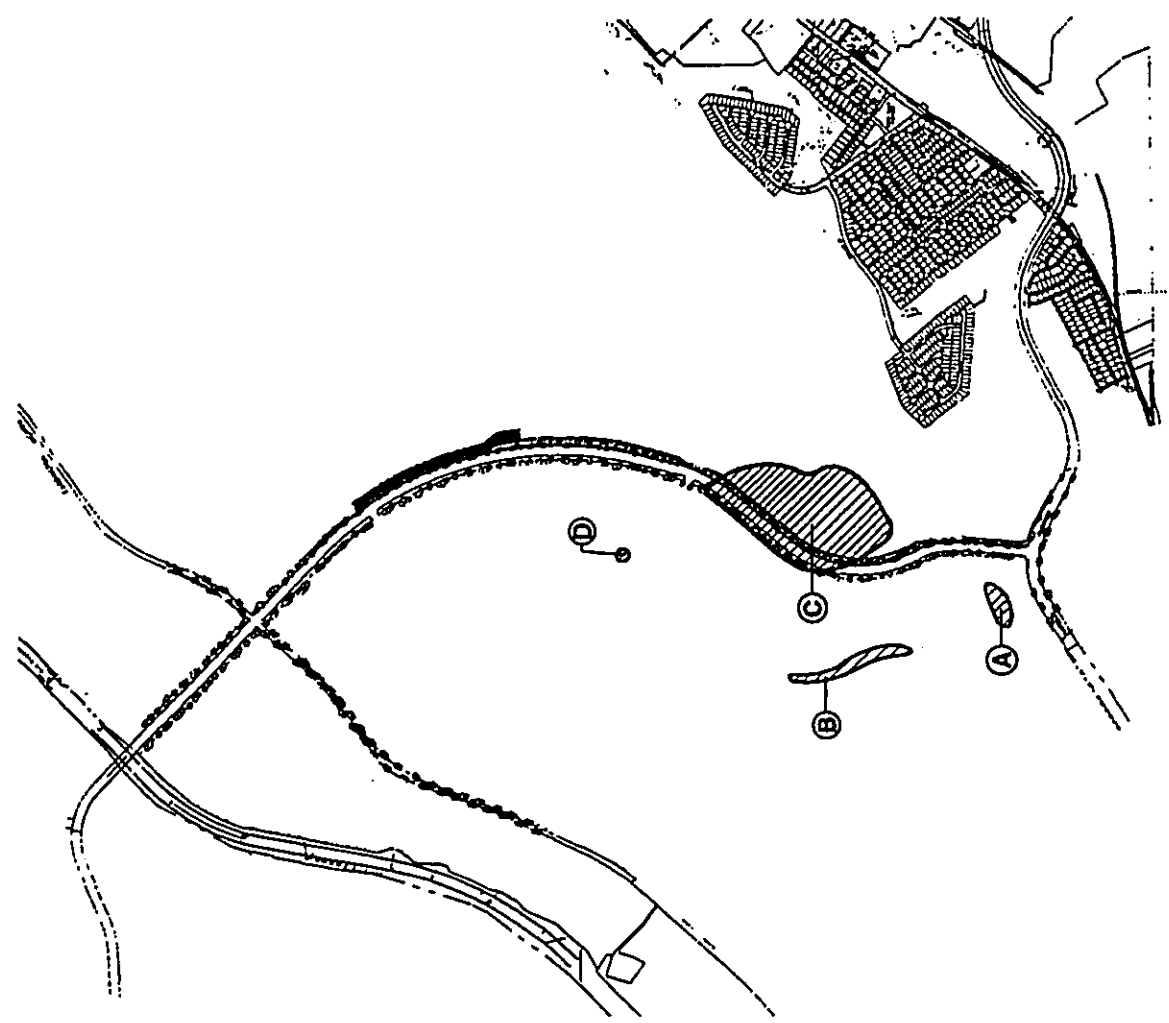


EXHIBIT 3
 MITIGATION PLAN AREA
 NORTH/SOUTH ROAD
SCALE OF MAP
 JPRK
June 1988

LEGEND
 ABUTILON MENZIESII PLANT CLUSTERS

APPENDIX A

**NORTH-SOUTH ROAD
CORRIDOR STUDY**

Ewa, Oahu, Hawaii
Project No. HWY-0-01-92

BOTANICAL SURVEY REPORT

October 1997

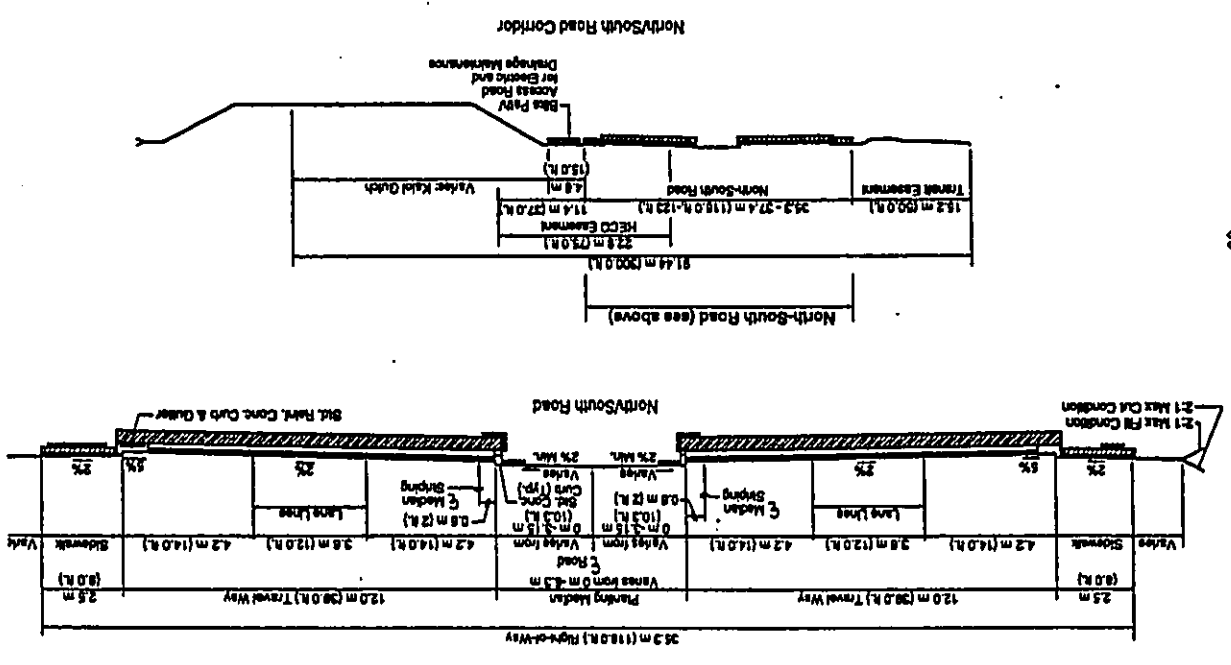


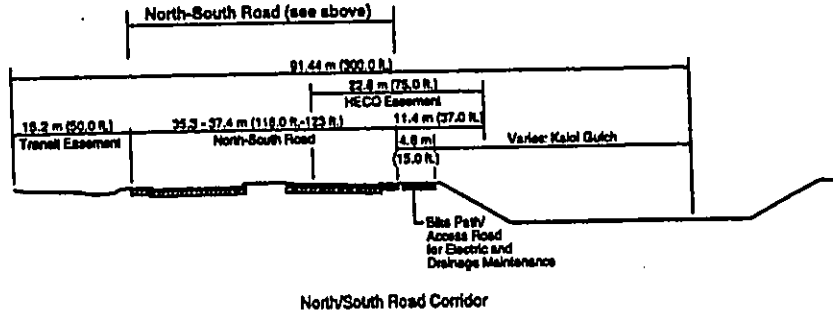
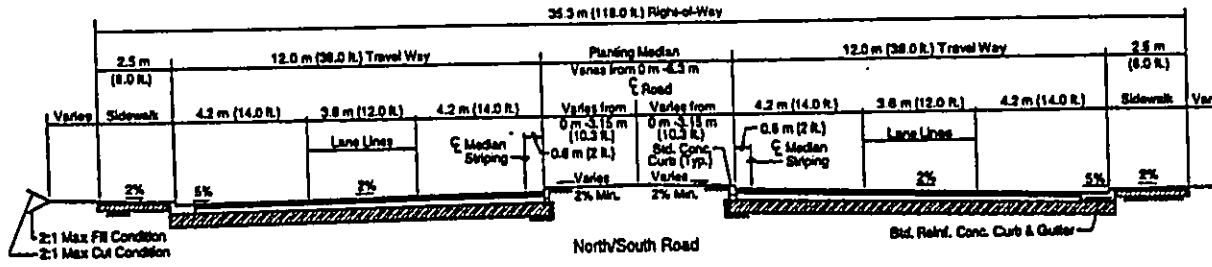
PARSONS
BRINCKERHOFF
KAKU
ASSOCIATES
R.M. TOWILL
CORPORATION



EXHIBIT 4
ROADWAY SECTION
NORTH/SOUTH ROAD

Source: Parsons Brinckerhoff Guide & Douglas, Inc.





20

EXHIBIT 4
ROADWAY SECTION
NORTH/SOUTH ROAD



Source: Parsons Brinckerhoff Quade & Douglas, Inc.

June 1996



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October 1997

BOTANICAL SURVEY REPORT

APPENDIX A
NORTH-SOUTH ROAD
CORRIDOR STUDY
Ewa, Oahu, Hawaii
Project No. HWY-0-01-92

NORTH-SOUTH ROAD CORRIDOR STUDY
Ewa, Oahu, Hawaii
Project No. HWY-0-01-92

BOTANICAL RESOURCES STUDY
NORTH-SOUTH ROAD CORRIDOR
(H-1 FREEWAY TO KAPOLEI PARKWAY)
'EWA DISTRICT, ISLAND OF O'AHU

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
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Prepared for:
PARSONS BRINCKERHOFF

October 1997

October 1997

PBOD Reference: 16218A - Product 8.6A

BOTANICAL RESOURCES STUDY
NORTH-SOUTH ROAD CORRIDOR
(H-1 FREEWAY TO KAPOLEI PARKWAY)
'EWA DISTRICT, ISLAND OF O'AHU

(*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.

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

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.

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), 'illima (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 (Coccoloba 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

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

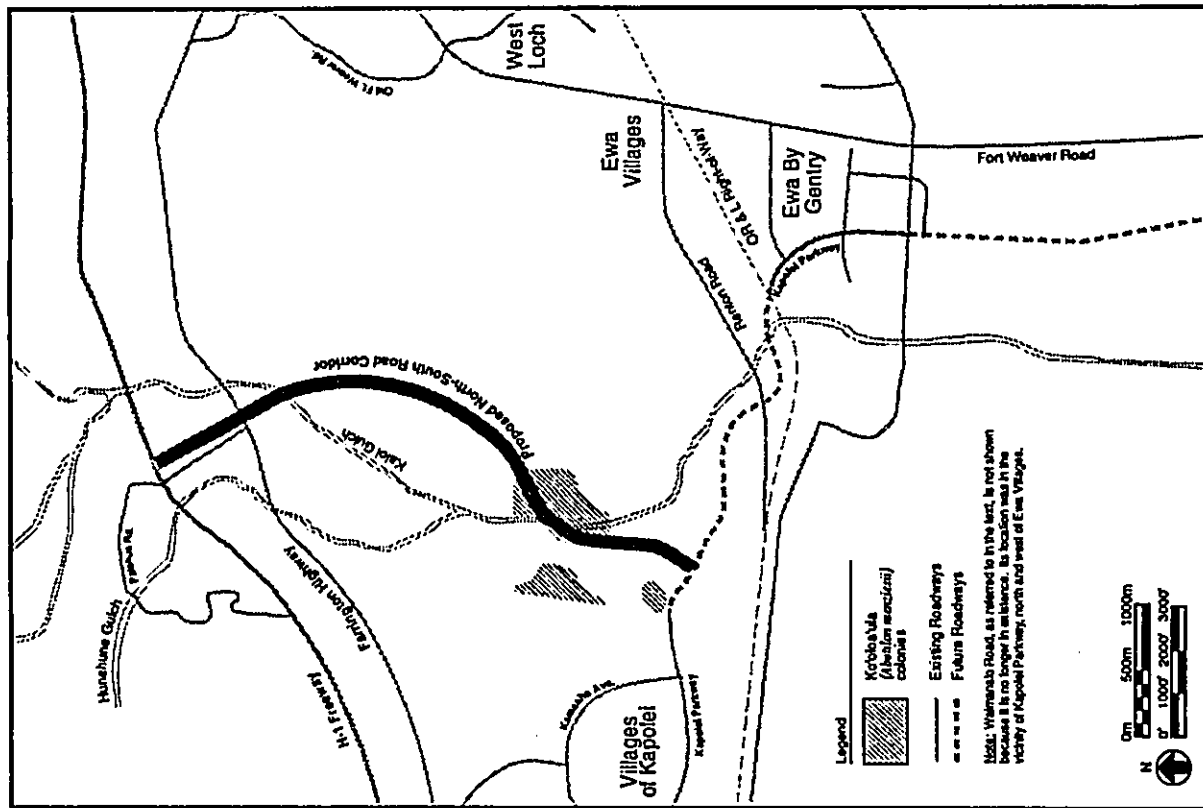
At the interchange with H-1, dense koa haole shrubs (Leucaena leucocephala) border the highway and cover the southwest portion of the interchange. Clumps of Guinea grass (Panicum maximum), 3 to 5 ft. tall, form a thick cover between the shrubs. Scattered through this koa haole/Guinea grass scrub are 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

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 Kalae-loa 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 seabaeoides) and 'ihi'ihii (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 rain-fall 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.

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SPECIES LIST -- North-South Road Corridor
(H-1 Freeway to Kapele 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 (Ficoid family) | | |
| Trianthema portulacastrum L. | | X |
| AMARANTHACEAE (Amaranthus family) | | |
| Achyranthes aspera L. | spiny amaranth, pakai | X |
| Amaranthus spinosus L. | 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 southistle, pualele | 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) | | |
| Spatheodea 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 | Scientific name | Common name | Status |
|---|---|--------|---|------------------------------------|--------|
| CONVOLVULACEAE (Morning-glory family) | | | Abutilon menziesii Seem. | ko'oloa'ula | E |
| Ipomoea obscura (L.) Ker-Gawl. | field bindweed | X | Malvastrum coromandelianum (L.) Garcke | false mallow | X |
| Ipomoea triloba L. | pink bindweed, little bell | X | Sida fallax Walp. | 'ilima | I |
| Merremia aegyptia (L.) Urb. | hairy merremia, koali kua hulu, kuahulu | X? | Sida rhombifolia L. | | X |
| CUCURBITACEAE (Gourd family) | | | MYRTACEAE (Myrtle family) | | |
| Coccinia grandis (L.) Voigt | ivy gourd, scarlet-fruited gourd | X | Syzygium cumini (L.) Skeels | Java plum | X |
| Momordica charantia L. | wild bittermelon | X | NYCTAGINACEAE (Four-o'clock family) | | |
| EUPHORBIACEAE (Spurge family) | | | Boerhavia coccinea Mill. | red-flowered boerhavia | X |
| Aleurites moluccana (L.) Willd. | kukui, cutui | F | PASSIFLORACEAE (Passion flower family) | | |
| Chamaesyce hirta (L.) Millsp. | hairy spurge | X | Passiflora foetida L. | running pop, pohapoha | X |
| Chamaesyce hypericifolia (L.) Millsp. | graceful spurge | X | PORTULACACEAE (Purslane family) | | |
| Chamaesyce prostrata (Ait.) Small | prostrate spurge | X | Portulaca oleracea L. | pigweed, 'akulikuli kula | X |
| Euphorbia heterophylla L. | kaliko | X | SOLANACEAE (Nightshade family) | | |
| Phyllanthus debilis Klein ex Willd. | niruri | X | Lycopersicon pimpinellifolium (Jusl.) Mill. | currant tomato | X |
| Ricinus communis L. | castor bean, pa'aiala, koli | X | Nicandra physalodes (L.) Gaertn. | apple of Peru | X |
| FABACEAE (Pea family) | | | Nicotiana glauca R.C. Graham | tree tobacco, paka | X |
| Crotalaria incana L. | fuzzy rattlepod, kukae-hoki | X | Solanum americanum Mill. | glossy nightshade, popolo, 'olohua | I? |
| Crotalaria pallida Aiton | smooth rattlepod, pika-kani | X | STERCULIACEAE (Cacao family) | | |
| Desmanthus virgatus (L.) Willd. | slender mimosa | X | Waltheria indica L. | 'uhaloa, hi'aloa, kanakalao | I? |
| Indigofera suffruticosa Mill. | indigo, 'iniko | X | ZYGOPHYLLACEAE (Creosote bush family) | | |
| Indigofera spicata Forssk. | creeping indigo | X | Tribulus terrestris L. | puncture vine, goat head | X |
| Leucaena leucocephala (Lam.) de Wit | koa haole | X | MONOCOTS | | |
| Macroptilium lathyroides (L.) Urb. | wild bean, cow pea | X | COMMELINACEAE (Dayflower family) | | |
| Phaseolus sp. | 'opiuma | X | Commelina benghalensis L. | hairy honohono | X |
| Pithecellobium dulce (Roxb.) Benth. | kiawe | X | CYPERACEAE (Sedge family) | | |
| Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth | senna | X | Cyperus rotundus L. | nut sedge, nutgrass | X |
| Senna pendula (Humb. & Bonpl. ex Willd.) H. Irwin & Barneby | lion's ear | X | POACEAE (Grass family) | | |
| LAMIACEAE (Mint family) | | | Bothriochloa pertusa (L.) A. Camus | pitted beardgrass | X |
| Leonotis nepetifolia (L.) R. Br. | hairy abutilon, ma'o | X | Brachiaria mutica (Forssk.) Stapf | California grass | X |
| MALVACEAE (Mallow family) | ma'o, hoary abutilon | I? | | | |
| Abutilon grandifolium (Willd.) Sweet | | | | | |
| Abutilon incanum (Link) Sweet | | | | | |

| <u>Scientific name</u> | <u>Common name</u> | <u>Status</u> |
|---|---|---------------|
| <i>Brachiaria subquadrifaria</i> (Trin.) | | X |
| Hitchc. ciliaris L. | buffel grass | X |
| <i>Cenchrus echinatus</i> L. | common sandbur, 'ume'alu,
mau'u kuku | X |
| <i>Chloris barbata</i> (L.) Sw. | swollen fingergrass,
mau'u lei | X |
| <i>Chloris radiata</i> (L.) Sw. | plush grass | X |
| <i>Cynodon dactylon</i> (L.) Pers. | Bermuda grass, manienie | X |
| <i>Dactyloctenium aegyptium</i> (L.)
Willd. | beach wiregrass | X |
| <i>Digitaria insularis</i> (L.) Mez.
ex Ekman | sourgrass | X |
| <i>Eleusine indica</i> Gaertn. | goose grass, wire grass | X |
| <i>Leptochloa uninervis</i> (Presl.)
Hitchc. & Chase | leptochloa | X |
| <i>Melinis repens</i> (Willd.) Zizka | Natal reedtop, Natal grass | X |
| <i>Panicum maximum</i> Jacq. | Guinea grass | X |
| <i>Panicum maximum</i> var. <i>trichoglume</i>
Eyles ex Robyns | green panicgrass | X |
| <i>Saccharum officinarum</i> L. | sugar cane, ko | X |
| <i>Setaria verticillata</i> (L.) Beauv. | bristly foxtail | X |
| <i>Sorghum halepense</i> (L.) Pers. | Johnson grass | X |

APPENDIX B
NAGATA SURVEY



EAST KAPOLEI MASTER PLAN
BIOLOGICAL SURVEY

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 (Prosonis pallida). Because of the arid conditions of the region the vegetation cover is generally sparse. Dominant shrubs include kiu (Acacia farnesiana), kon-haole (Leucaena leucocephala) and 'ilitaa (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 (Halvastrum 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 mauka of the project site, including the village of Eva (Funk 1990). Among the vegetation types recognized were Sugar Cane Fields, Ruderai 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 kon-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 mauka of the project site (Nagata 1996) and in Kaloi Gulch (Nagata 1994).

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For: PBR Hawaii
17 September 1996

METHODS AND MATERIAL

A walk-through survey was conducted in all plant communities between mid-September and early October, 1996 to determine the floristic composition 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 with 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 (*Homordica 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 enceloides*) 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 mauka 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 (Citrullus lanatus) have been planted and along the Eva 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, Boerhavia coccinea, garden spurge (Chamaesyce hirta) and virgate mimosa (Desmanthus virgatus) are found in small numbers.

Gulch Association (GU)

Kalo 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 (Coccoloba grandis) is abundant, often completely enshrouding the Guinea grass and koa-haole. Paragrass (Brachiaria mutica), wood rose (Merrremia tuberosa),

moon flower (Ipomoea alba) 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 (Elymus indicus), Natal redtop (Rhynchelytrum repens) and stinkgrass (Eragrostis ciliaris) 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 site 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'olua'ula, Abutilon wenziesii). 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'olua'ula, all of the native species in the site are common lowland species in Hawaii. Ko'olua'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'olua'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 (*Herpestis surpunctatus*) 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 Kalo'i 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 Eva 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 Eva 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.

Borred 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-haoie shrubs along Plantation Road.

Kentucky cardinal (*Richmondia cardinalis*)

One individual was seen in the Fallowed Fields Mixed Herb Association.

PHASIANIDAE

Francois (Francois 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.

POCCEIDAE

House finch (Carpodacus mexicanus)

About 20 were seen in the property, mostly along the roadways.

Orange-cheeked waxbill (Estrilda melopoda)

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 cultivation the vegetation is entirely secondary and the native ('ilima, pa'uohi'ika) or possibly native (hoary abutilon, 'uhaloa) species which are so common in the site are merely recolonizing an already completely altered habitat. According to 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'ika, 'uhaloa and hoary abutilon. These are all common lowland species and their loss 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 therefore recommended that a 100% survey be undertaken in selected areas as indicated in Figure 2.

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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:

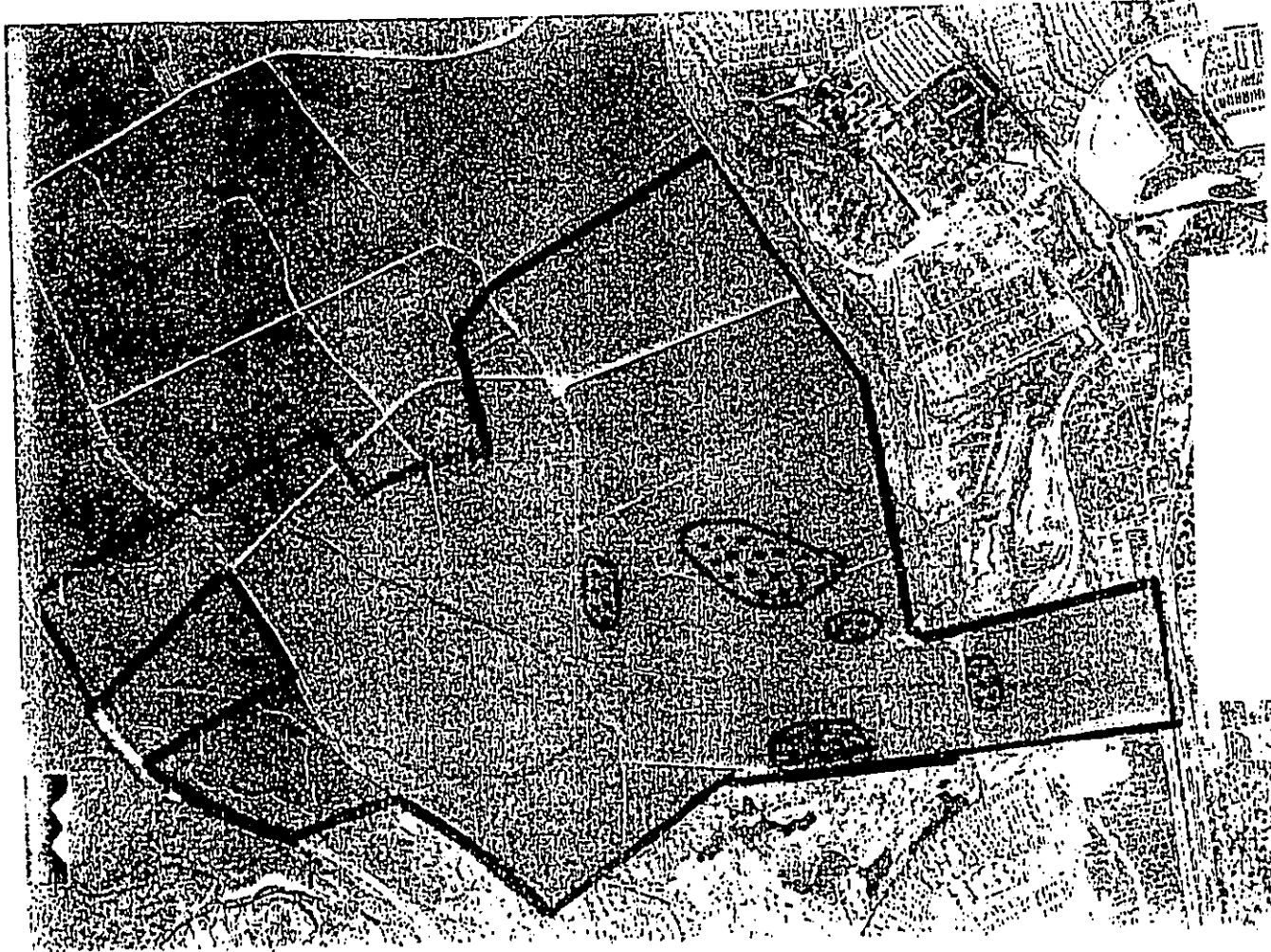
- E - Endemic to the Hawaiian Islands, i.e. occurring naturally nowhere else in the world.
- I - Indigenous, i.e. native to the Hawaiian Islands but also occurring naturally elsewhere.
- X - Exotic (alien), i.e. plants introduced after the Western discovery of the islands.
- P - Polynesian introductions, i.e. 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
- CU - Gulch Association
- R - Roadside Vegetation



CHECK LIST OF PLANTS

| SCIENTIFIC NAME | COMMON NAME | STATUS | RELATIVE ABUNDANCE | | | | | | | | | | | | | | | |
|---------------------------------|--------------------|--------|--------------------|----|----|---|----|----|----|----|---|---|--|--|--|--|--|--|
| | | | AC | FM | JA | A | C | CH | CI | CA | U | R | | | | | | |
| <i>Asteraceae</i> | | | | | | | | | | | | | | | | | | |
| <i>Senecio</i> | | | | | | | | | | | | | | | | | | |
| <i>Helianthus</i> | Sunflower | 1 | | | | | | | | | | | | | | | | |
| <i>Rhizoma</i> | Wild yam | 1 | | | | | | | | | | | | | | | | |
| <i>Viburnum acerifolium</i> | Black haw | 1 | | | | | | | | | | | | | | | | |
| <i>Hamamelis virginiana</i> | Witch-hamamel | 1 | | | | | | | | | | | | | | | | |
| <i>Asplenium platyneuron</i> | Rock-fern | 1 | | | | | | | | | | | | | | | | |
| <i>Sparganium angustifolium</i> | Sparganium | 1 | | | | | | | | | | | | | | | | |
| <i>Belmontia peruviana</i> | Belmontia | 1 | | | | | | | | | | | | | | | | |
| <i>Cypripedium</i> | | | | | | | | | | | | | | | | | | |
| <i>Clematis flammula</i> | Flammula | 1 | | | | | | | | | | | | | | | | |
| <i>Conoclinium</i> | | | | | | | | | | | | | | | | | | |
| <i>Aster</i> | | | | | | | | | | | | | | | | | | |
| <i>Thalictrum flavum</i> | Black-thistle | 1 | | | | | | | | | | | | | | | | |
| <i>Yucca alopecuroides</i> | Spiky-leaved yucca | 1 | | | | | | | | | | | | | | | | |
| <i>Yucca filamentosa</i> | Spiky-leaved yucca | 1 | | | | | | | | | | | | | | | | |
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| <i>Yucca filamentosa</i> | Spiky-leaved yucca | 1 | | | | | </ | | | | | | | | | | | |

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Botanical/Environmental Consultants

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Honolulu, Hawaii 96816
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January 1997

SUMMARY OF FINDINGS KO'OLOA'ULA ON EAST KAPOLEI PROJECT SITE 'EWA DISTRICT, ISLAND OF O'AHU

APPENDIX C CHAR SURVEY



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 Luualalei 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 population 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

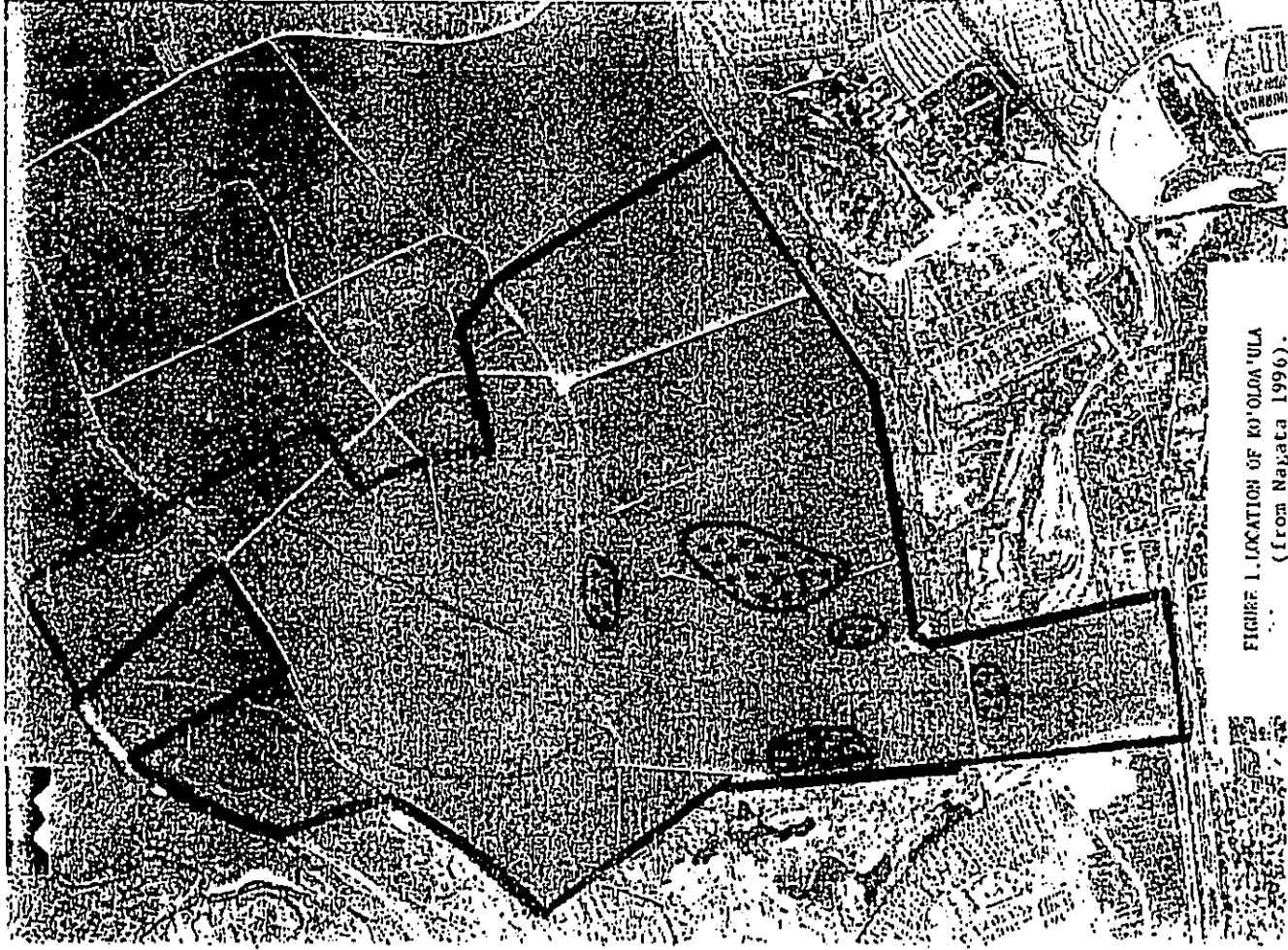


FIGURE 1. LOCATION OF KO'OLOA'ULA
(from Nagata 1996).

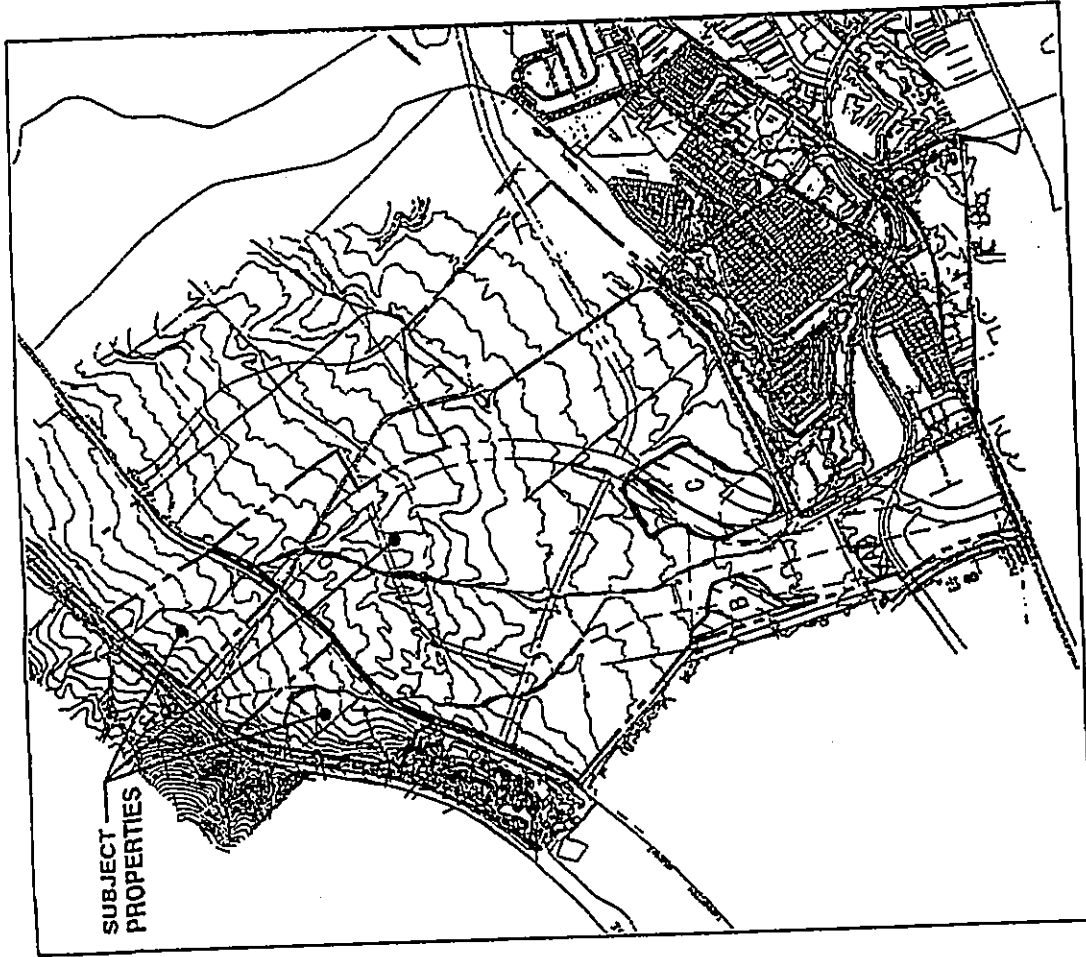


FIGURE 2
LOCATION OF KO'OLOA 'ULA DURING
THIS SURVEY.



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*1
(HFDC) | Cluster B
Res / DHHL
(HFDC) | Cluster D
Res / HFDC
(HFDC) | Cluster C-3
Res / DHHL
(HFDC) |
|--|--|--|---|--|--|--|
| 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 approval | 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 available | 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 | FIHWA/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)

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G.

ARCHAEOLOGY

SCIENTIFIC CONSULTANT SERVICES, Inc.



711 Kapolei Blvd., Suite 777 Honolulu, Hawaii 96813

11-6-96

Mr. David Hulise
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. Hulise;

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 Hunchune 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)

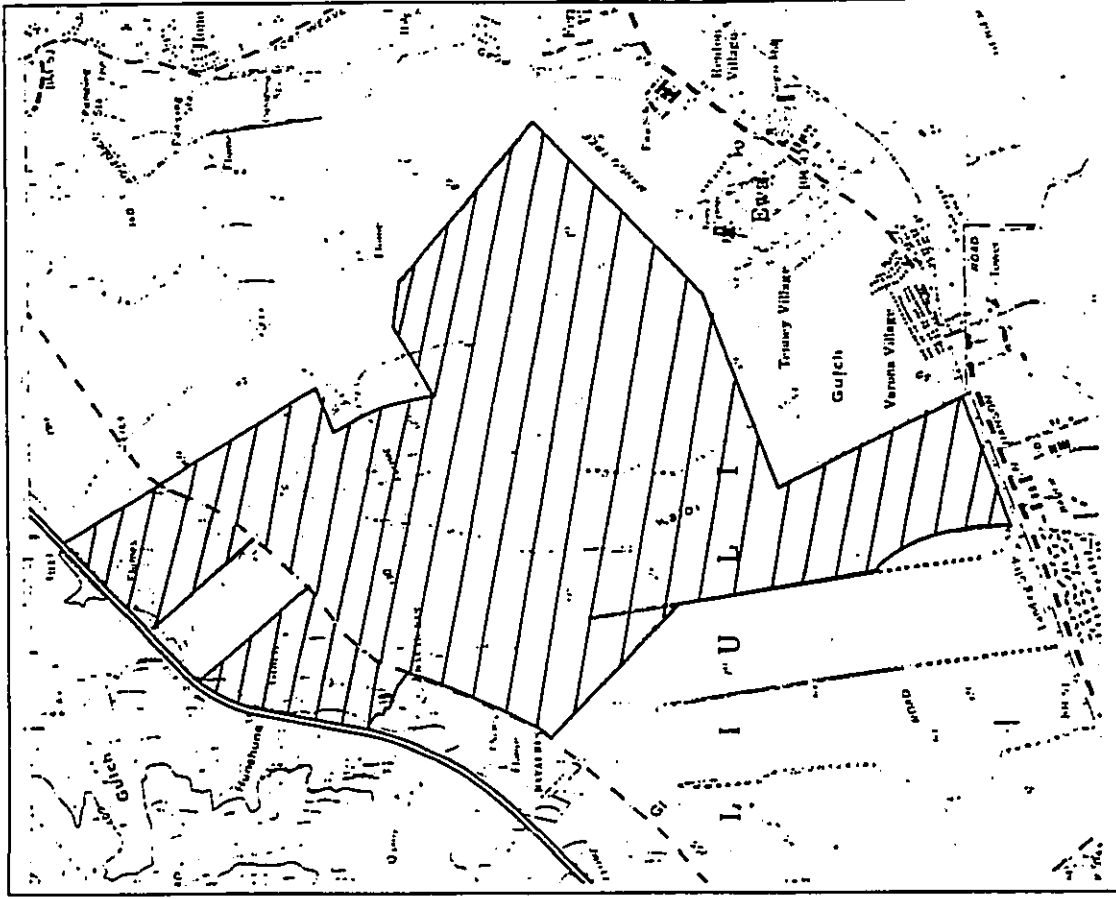


FIGURE 1: USGS EWA QUADRANGLE SHOWING PROJECT AREA.

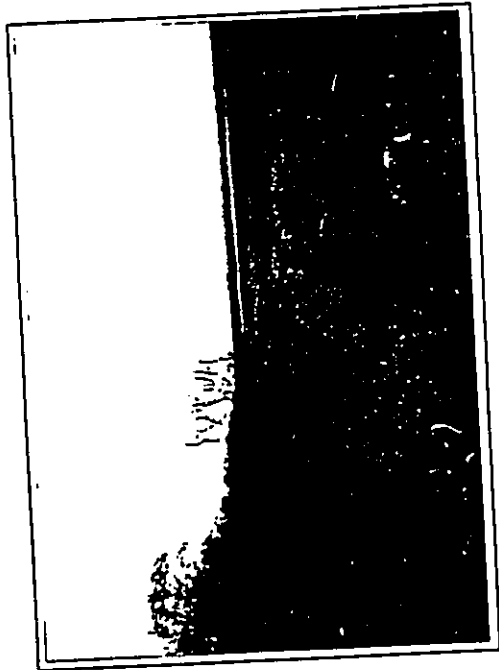


FIGURE 3: GENERAL PROJECT AREA VIEW WITH HUNEIHUNE GULCH IN THE DISTANCE. VIEW TO SOUTH.



FIGURE 4: GENERAL PROJECT AREA VIEW ALONG KALOI GULCH. VIEW TO SOUTHWEST.

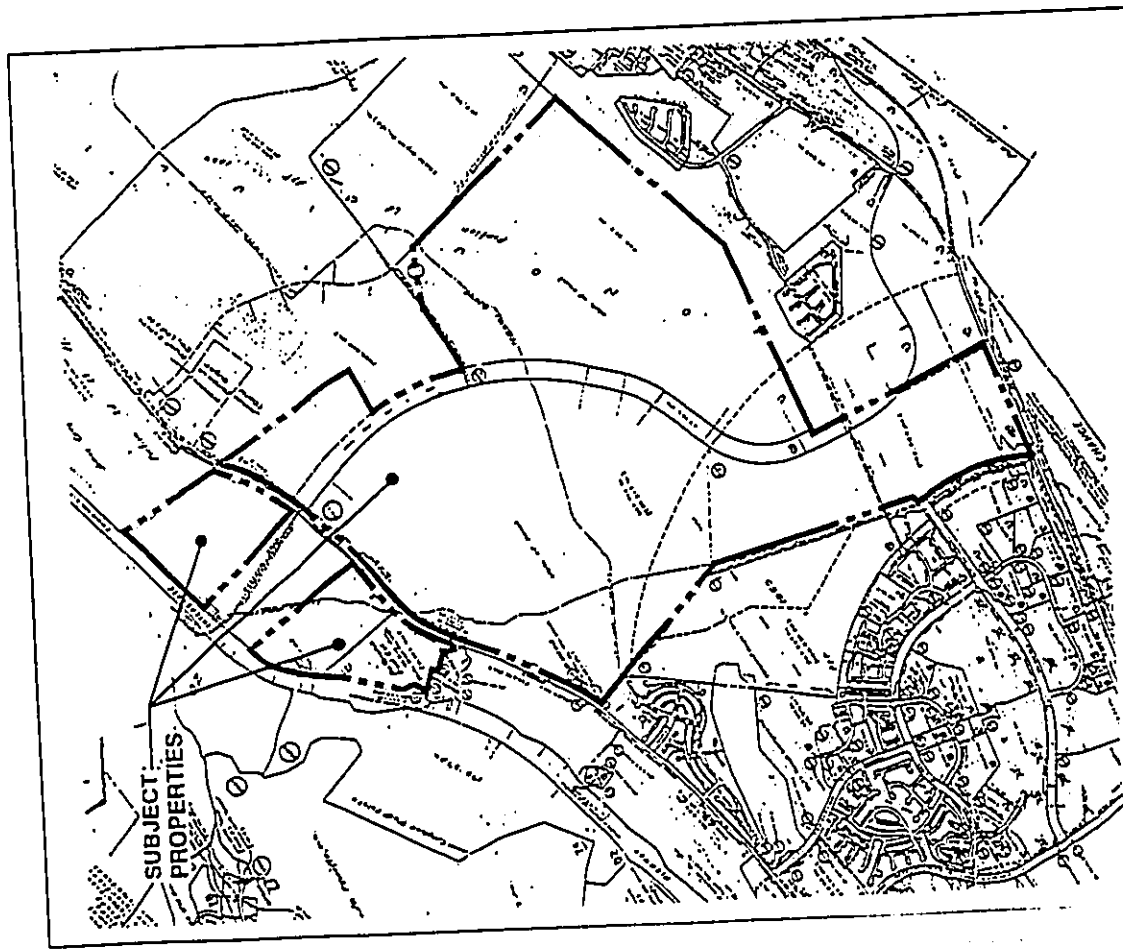


FIGURE 2: TAX MAP KEY 9-1-16. (VARIOUS) SHOWING PROJECT AREA (FROM PBR 1990).

ATTACHMENT A

MADE IN HAWAII
STATE OF HAWAII

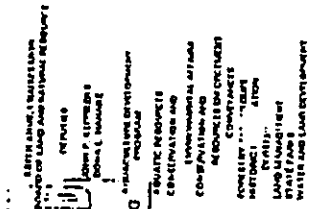


STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 8TH FLOOR
HONOLULU, HAWAII 96813

41712



August 4, 1994

MEMORANDUM

LANG NO: 13362
DOC NO: 94HR1001

TO: Dean Uchida
Hawaii Agricultural and Rural Development Program (HARRP)

FROM: Don Hibbard, Administrator
Historic Preservation Division

SUBJECT: State Lands at Kapa'ia, Reclassification from Agriculture in Ii'iahu
Honouliuli, Ewa, O'ahu
TMK: 2-1-16: HDR, 25, 9-1-17: par. 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.

DD 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

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| Exhibit 1 - Project Site Plan, Portion of Kapolei, Oahu | |
| Exhibit 2 - Traffic Assignments, Year 2020 | |
| Exhibit 3 - Intersection Laneage and Levels of Service | |
| Appendix - Levels of Service | following exhibit |

**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 study¹ 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 estimated³ 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

| | 24-hour | | AM Peak Hour | | PM Peak Hour | |
|---|---------|-------|--------------|-------|--------------|-------|
| | WB | EB | WB | EB | WB | EB |
| H-1 Freeway, west of Kunia Interchange * | | | | | | |
| February 8-9 | 74,790 | 2,456 | 2,841 | 2,831 | 2,863 | 2,863 |
| March 20-21 | 73,870 | 2,840 | 2,937 | 2,931 | 2,913 | 2,913 |
| March 21-22 | 74,680 | 2,677 | 2,923 | 3,030 | 3,029 | 3,029 |
| May 7 | 70,800 | 2,749 | 3,107 | 3,050 | 2,783 | 2,783 |
| May 8 | 73,380 | 2,716 | 3,077 | 2,993 | 2,803 | 2,803 |
| May 20-21 | 70,920 | 2,641 | 3,138 | 2,757 | 2,658 | 2,658 |
| September 3-4 | 71,410 | 2,528 | 3,077 | 2,992 | 2,416 | 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 *** | | | | | | |
| unusual (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
/Acre | PM Peak Hour
Rate
/Acre |
|---|-------------------------------|-------------------------------|
| 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% |
| Middle School (per acre) | 23.0 | 57% |
| Park and Ride Lot (per acre) | 50.0 | 80% |
| Recreational Center (per acre) | 13.2 | 66% |

Equations from *Trip Generation - 6th Edition* [T = trip ends]:

- (1) $T = 0.700 \cdot (X) + 9.477$ [X = dwelling units]
- (2) $T = 0.901 \cdot L_n (X) + 0.527$ [X = dwelling units]
- (3) $T = 0.497 \cdot (X) + 3.238$ [X = dwelling units]
- (4) $T = 0.541 \cdot (X) + 18.743$ [X = dwelling units]
- (5) $T = 0.589 \cdot L_n (X) + 2.378$ [X = 1,000 gross square feet]
- (6) $T = 0.637 \cdot L_n (X) + 3.553$ [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 | | PM Peak Hour | |
|---------------------------|-------------------------------|-------------------------|--------------|-------|
| | enter | exit | enter | exit |
| Area A: | 439 | 3.0 acres, park | 79 | 238 |
| Area B: | 1,270 | single family dwellings | 14 | 6 |
| | 564 | multifamily dwellings | 225 | 673 |
| | 8.0 acres, commercial | 65 | 219 | 201 |
| | 12.0 acres, elementary school | 341 | 210 | 376 |
| | 6.0 acres, park | 103 | 71 | 48 |
| Area C: | 792 | single family dwellings | 28 | 12 |
| | 321 | multifamily dwellings | 141 | 423 |
| | 2.0 acres, commercial | 37 | 126 | 119 |
| | 12.0 acres, elementary school | 151 | 92 | 155 |
| | 3.0 acres, park | 103 | 71 | 48 |
| Area D: | 366 | single family dwellings | 14 | 6 |
| | 3.0 acres, park | 66 | 200 | 207 |
| Area E: | 55 | single family dwellings | 14 | 6 |
| Area F: | 105 | multifamily dwellings | 12 | 36 |
| Area G: | 8.0 acres, commercial | 13 | 42 | 47 |
| | 2.5 acres, park | 341 | 210 | 376 |
| Area H: | 64.3 acres, park | 12 | 5 | 7 |
| Area I: | 846 | single family dwellings | 297 | 127 |
| | 227 | multifamily dwellings | 153 | 458 |
| | 12.0 acres, elementary school | 27 | 89 | 88 |
| | 3.0 acres, park | 103 | 71 | 48 |
| Area J: | 567 | single family dwellings | 14 | 6 |
| | 340 | multifamily dwellings | 102 | 304 |
| | 20.0 acres, middle school | 40 | 132 | 126 |
| | 15.4 acres, park | 236 | 178 | 40 |
| Area K: | 228 | multifamily dwellings | 71 | 31 |
| Area L: | 324 | multifamily dwellings | 27 | 90 |
| 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: | 105 | 314 | 316 | 211 |
| Area B: | 14 | 6 | 9 | 17 |
| Area C: | 299 | 896 | 824 | 550 |
| Area D: | 78 | 262 | 239 | 146 |
| Area E: | 341 | 210 | 376 | 361 |
| Area F: | 103 | 71 | 48 | 72 |
| Area G: | 28 | 12 | 18 | 35 |
| Area H: | 187 | 562 | 539 | 359 |
| Area I: | 45 | 150 | 141 | 86 |
| Area J: | 151 | 92 | 155 | 150 |
| Area K: | 103 | 71 | 48 | 72 |
| Area L: | 14 | 6 | 9 | 17 |
| 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 analysis, 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. 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 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.

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 1 1/2 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 Length (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 to hold EB = eastbound, NB = northbound, SB = southbound, WB = westbound
* deceleration distance for no load condition

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 Parcel "K" and "L" at Farrington Highway | 4.6 A | 3.7 A |
| southbound right turn | 25.5 D | 25.1 D |
| southbound left/through | 3.8 A | 4.6 A |
| westbound left turn | 5.3 B | 4.4 A |
| eastbound left turn | 48.2 F | 35.0 E |
| northbound left turn | 15.3 C | 12.7 C |
| northbound through/right | | |

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 (22 1/2 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 Average delay (sec) LOS | PM Peak Hour Average delay (sec) LOS |
|--|--------------------------------------|--------------------------------------|
| Farrington Highway and Road serving Parcel "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 Parcel "I" and "J" | 22.7 C | 21.8 C |
| East Road serving Parcel "I" and "J" | 17.9 C | 18.0 C |
| Kapolei Parkway and: Road serving Parcel "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.

Table 8
Recommendations for Storage Lengths
Left Turn Lanes (East-West Road)

| East-West Road to: | Turning Volumes | Left Turn Lane Storage | Turnst | Total |
|---|-----------------|------------------------|--------|-------|
| East Kapolei Avenue (EB to NB) | 115 | 150 | 180 | 330 |
| AM Peak Hour | 205 | 275 | 180 | 455 |
| PM Peak Hour | | | | |
| East Kapolei Avenue (WB to SB) | 105 | 150 | 180 | 330 |
| AM Peak Hour | 35 | 50 | 180 | 230 |
| PM Peak Hour | | | | |
| East Kapolei Avenue (EB to NB) | 115 | 150 | 180 | 330 |
| AM Peak Hour | 205 | 275 | 180 | 455 |
| PM Peak Hour | | | | |
| East Kapolei Avenue (WB to SB) | 200 | 275 | 180 | 455 |
| AM Peak Hour | 180 | 250 | 180 | 430 |
| PM Peak Hour | | | | |
| Road serving Parcel "C" (WB to SB) | 210 | 300 | 180 | 480 |
| AM Peak Hour | 70 | 100 | 180 | 280 |
| PM Peak Hour | | | | |
| West Road serving Parcel "J" (EB to NB) | 190 | 275 | 180 | 455 |
| AM Peak Hour | 275 | 375 | 180 | 555 |
| PM Peak Hour | | | | |
| West Road serving Parcel "I" (WB to SB) | 50 | 75 | 180 | 255 |
| AM Peak Hour | 95 | 125 | 180 | 315* |
| PM Peak Hour | | | | |
| East Road serving Parcel "J" (EB to NB) | 125 | 175 | 180 | 355 |
| AM Peak Hour | 185 | 250 | 180 | 490 |
| PM Peak Hour | | | | |
| East Road serving Parcel "I" (WB to SB) | 35 | 50 | 180 | 230 |
| AM Peak Hour | 65 | 100 | 180 | 335* |
| PM Peak Hour | | | | |

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)

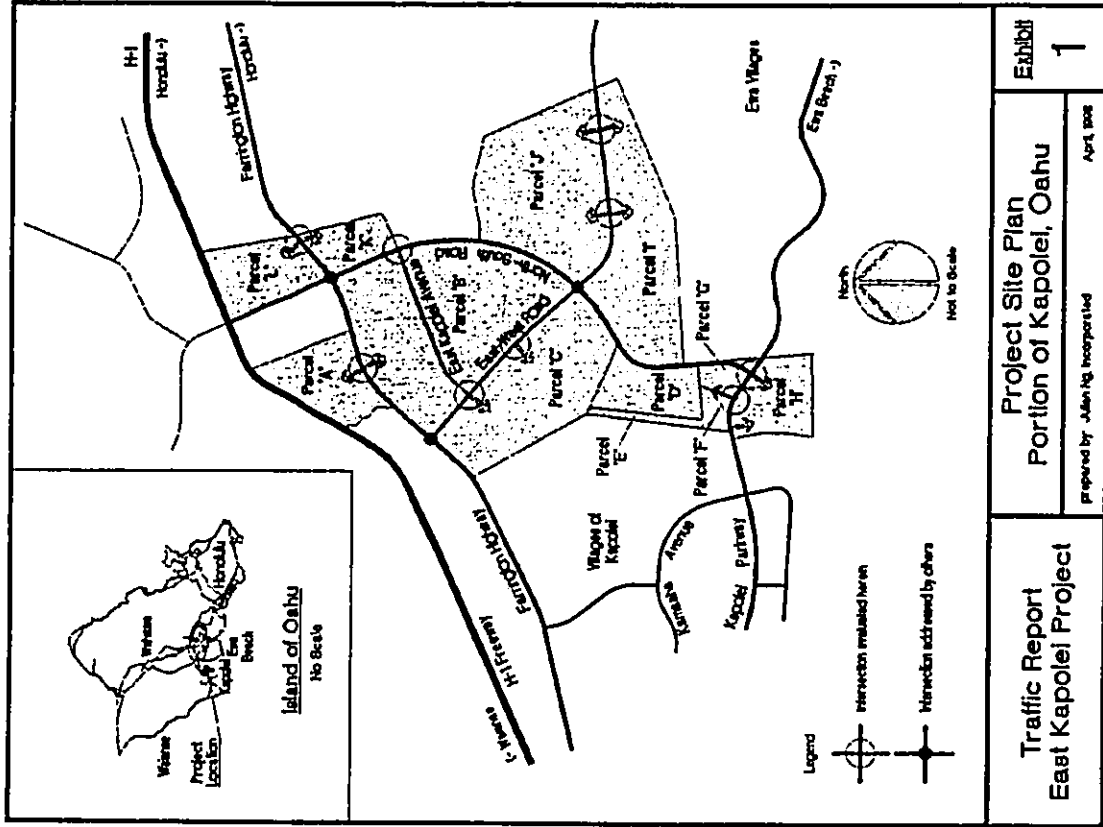
| North-South Road to: | Turning Volumes | Left Turn Lane Storage | Turnst | Total |
|---|-----------------|------------------------|--------|-------|
| East Kapolei Avenue (NB to WB) | 170 | 225 | 180 | 405 |
| AM Peak Hour | 430 | 600 | 180 | 780 |
| PM Peak Hour | | | | |
| Kapolei Parkway (SB to EB) | 375 | 300 | 180 | 480 |
| AM Peak Hour | 760 | 575 | 180 | 755 |
| PM Peak Hour | | | | |
| Kapolei Parkway (NB to WB) | 65 | 100 | 180 | 280 |
| AM Peak Hour | 120 | 175 | 180 | 355 |
| PM Peak Hour | | | | |
| East Kapolei Avenue to: | | | | |
| North-South Road (EB to NB) | 465 | 650 | 180 | 830 |
| AM Peak Hour | 205 | 275 | 180 | 355 |
| PM Peak Hour | | | | |
| Kapolei Parkway to: | | | | |
| Road serving Parcels "F" & "G" (EB to NB) | 115 | 150 | 180 | 330 |
| AM Peak Hour | 195 | 275 | 180 | 455 |
| PM Peak Hour | | | | |
| North-South Road (EB to NB) | 370 | 275 | 180 | 455 |
| AM Peak Hour | 705 | 550 | 180 | 750 |
| PM Peak Hour | | | | |
| North-South Road (WB to SB) | 175 | 250 | 180 | 435 |
| AM Peak Hour | 60 | 75 | 180 | 255 |
| PM Peak Hour | | | | |

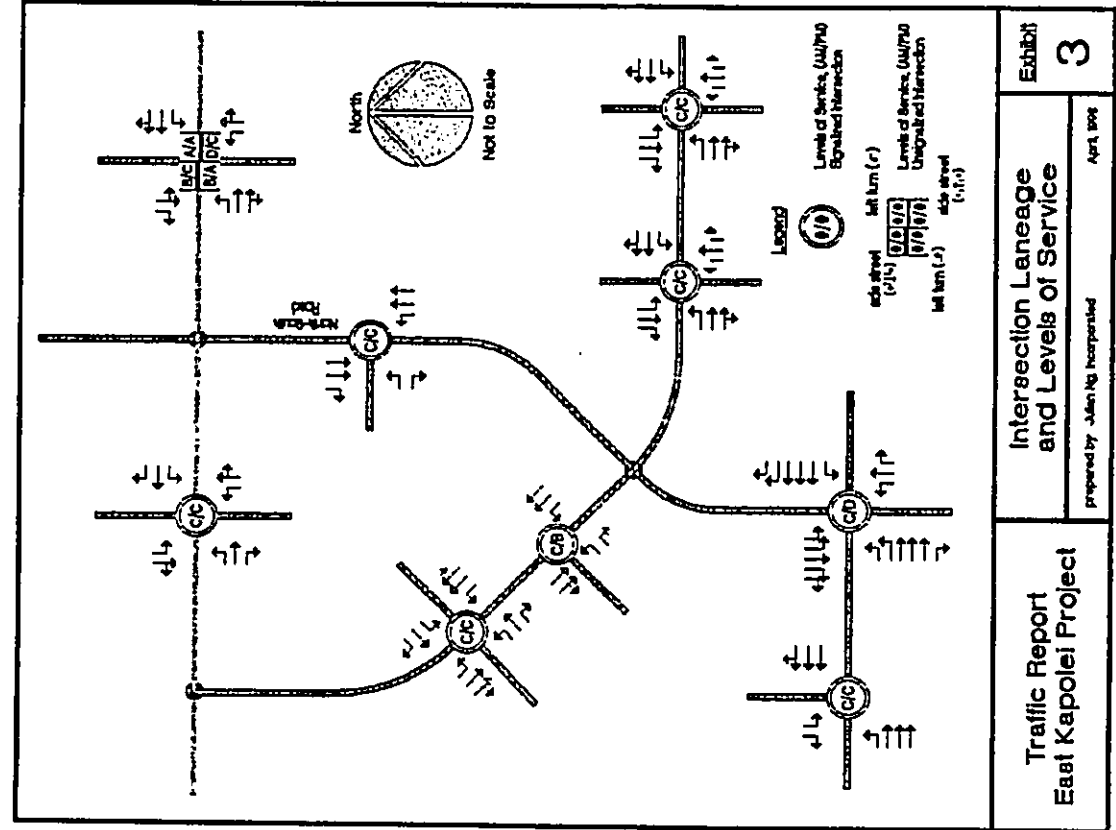
recommended minimum length of left turn lane in bold
 EB = eastbound, NB = northbound, SB = southbound, WB = westbound
 * deceleration distance for no load condition
 ** minimum storage length

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.



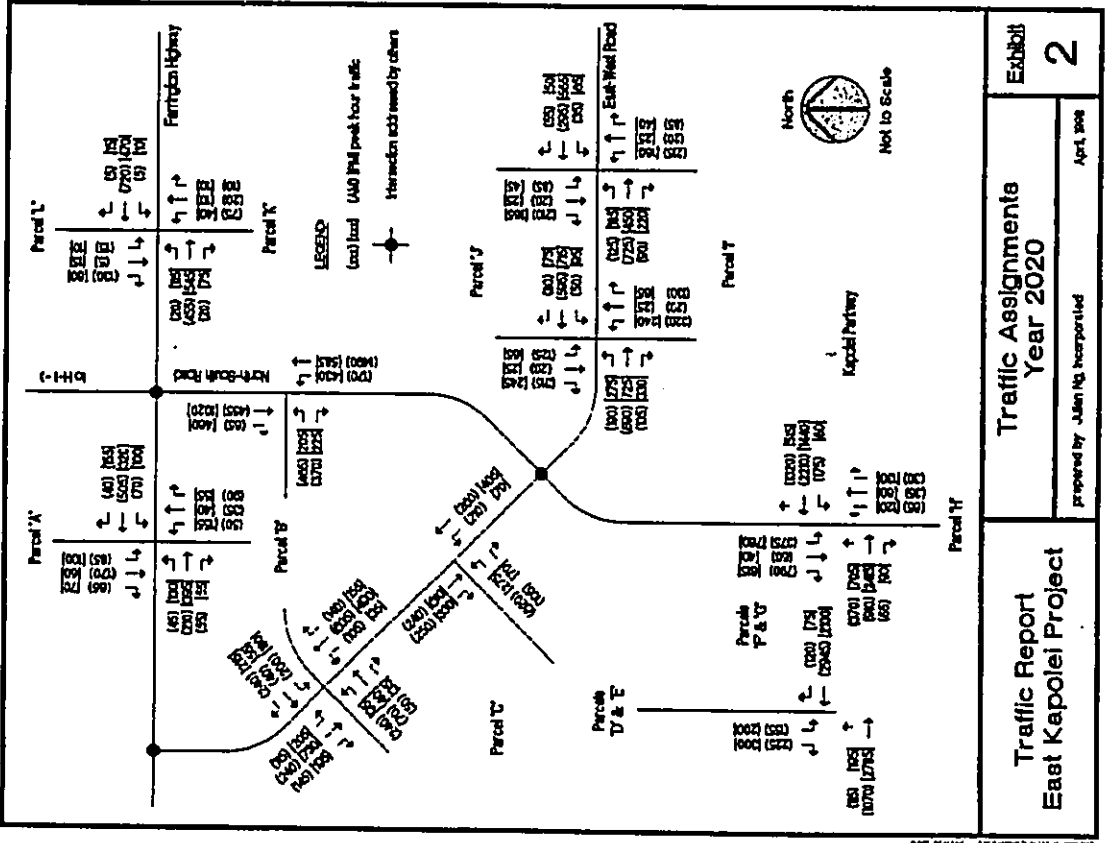


**Traffic Report
East Kapolei Project**

**Intersection Laneage
and Levels of Service**

Prepared by: John Ng Incorporated
April 2008

Exhibit 3



**Traffic Report
East Kapolei Project**

**Traffic Assignments
Year 2020**

Prepared by: John Ng Incorporated
April 2008

Exhibit 2

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

Page 1 of 1

| GENERAL INFORMATION | | TRAFFIC DATA | | CALCULATIONS | | RESULTS | |
|---|--|---|--|---|--|--|--|
| <p>INTERSECTION TYPE: T-intersection</p> | | <p>APPROACH: N-S</p> <p>Volume: 1000 (N), 1000 (S)</p> <p>Capacity: 1000 (N), 1000 (S)</p> | | <p>APPROACH: E-W</p> <p>Volume: 500 (E), 500 (W)</p> <p>Capacity: 500 (E), 500 (W)</p> | | <p>LOS: A</p> <p>Delay: 5.0 (N), 5.0 (S)</p> | |
| <p>APPROACH: N-S</p> <p>Volume: 1000 (N), 1000 (S)</p> <p>Capacity: 1000 (N), 1000 (S)</p> | | <p>APPROACH: E-W</p> <p>Volume: 500 (E), 500 (W)</p> <p>Capacity: 500 (E), 500 (W)</p> | | <p>LOS: A</p> <p>Delay: 5.0 (N), 5.0 (S)</p> | | <p>LOS: A</p> <p>Delay: 5.0 (E), 5.0 (W)</p> | |

Planning Analysis (94 HCM) file: HCM3-AB1.FMT.A3*2 print: 04/17/98 04/19/98 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: 788 (under capacity), Xcm = 8.56

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) | 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) | | | | | | | | | | | | |
| 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
 Phase 8 13 13 18
 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 | Phase | Adj. Flow | Adj. Sat. | Flow rate | Green | Lane Gr. | Lane Gr. | Overall | First Term Delay | Second Term Delay | Lane Group | LOS | Approach | | | |
| Movements | Type | rate | Flow Rate | v/h | ratio/C | Capacity | v/c ratio | Lane Gr. | sec/veh | DT | sec | sec/veh | sec/veh | LOS | sec/veh | LOS |
| EB LT | T | 148 | 1,650 | 0.090 | 0.150 | 248 | 0.60 | | 30.2 | 0.85 | 18 | 2.8 | 28.5 | D | | |
| EB TH | T | 395 | 1,650 | 0.239 | 0.420 | 693 | 0.57 | | 18.8 | 0.85 | 18 | 0.6 | 15.1 | C | | 18.0 |
| EB RT | T | 63 | 1,650 | 0.038 | 0.420 | 693 | 0.09 | | 13.3 | 0.85 | 18 | 0.0 | 11.3 | B | | |
| WB LT | T | 114 | 1,650 | 0.069 | 0.110 | 182 | 0.63 | | 32.3 | 0.85 | 18 | 4.6 | 32.1 | D | | |
| WB TH | T | 320 | 1,650 | 0.194 | 0.380 | 627 | 0.51 | | 18.1 | 0.85 | 18 | 0.6 | 16.0 | C | | 16.4 |
| WB RT | T | 178 | 1,650 | 0.107 | 0.380 | 627 | 0.28 | | 16.4 | 0.85 | 18 | 0.1 | 14.0 | B | | |
| SB LT | T | 114 | 1,650 | 0.069 | 0.160 | 264 | 0.43 | | 28.8 | 0.85 | 18 | 0.7 | 25.2 | D | | |
| SB TH | T | 140 | 1,650 | 0.085 | 0.130 | 215 | 0.65 | | 31.4 | 0.85 | 18 | 4.7 | 31.4 | D | | 28.6 |
| NB LT | T | 178 | 1,650 | 0.107 | 0.160 | 264 | 0.67 | | 30.0 | 0.85 | 18 | 4.4 | 29.9 | D | | |
| NB TH | T | 103 | 1,650 | 0.062 | 0.130 | 215 | 0.48 | | 30.7 | 0.85 | 18 | 1.3 | 27.4 | D | | 29.0 |

Cycle length, C = 100 seconds, Lost time per cycle = 18.0 seconds Y = Sum (v/s) = 0.506 Xr = Y * C / (C-L) = 0.610 Overall Intersection: 21.4 C

Planning Analysis (94 HCM) file: HCM3-AB1.FMT.A3*1 print: 04/17/98 04/19/98 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 = 9.80

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) | 45 | 210 | 55 | 70 | 505 | 40 | 85 | 170 | 65 | 50 | 35 | 60 |
| 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) | | | | | | | | | | | | |
| 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
 Phase 8 23 23 8
 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 | Phase | Adj. Flow | Adj. Sat. | Flow rate | Green | Lane Gr. | Lane Gr. | Overall | First Term Delay | Second Term Delay | Lane Group | LOS | Approach | | | |
| Movements | Type | rate | Flow Rate | v/h | ratio/C | Capacity | v/c ratio | Lane Gr. | sec/veh | DT | sec | sec/veh | sec/veh | LOS | sec/veh | LOS |
| EB LT | T | 51 | 1,650 | 0.031 | 0.050 | 83 | 0.82 | | 35.4 | 0.85 | 18 | 9.0 | 39.1 | D | | |
| EB TH | T | 210 | 1,650 | 0.127 | 0.430 | 710 | 0.30 | | 14.1 | 0.85 | 18 | 0.1 | 12.1 | B | | 18.1 |
| EB RT | T | 63 | 1,650 | 0.038 | 0.430 | 710 | 0.09 | | 12.8 | 0.85 | 18 | 0.0 | 10.9 | B | | |
| WB LT | T | 80 | 1,650 | 0.048 | 0.100 | 165 | 0.48 | | 32.3 | 0.85 | 18 | 1.8 | 29.3 | D | | |
| WB TH | T | 505 | 1,650 | 0.305 | 0.480 | 792 | 0.64 | | 14.8 | 0.85 | 18 | 1.2 | 13.8 | B | | 15.4 |
| WB RT | T | 46 | 1,650 | 0.028 | 0.480 | 792 | 0.06 | | 10.6 | 0.85 | 18 | 0.0 | 9.0 | B | | |
| SB LT | T | 97 | 1,650 | 0.059 | 0.120 | 198 | 0.49 | | 31.3 | 0.85 | 18 | 1.5 | 28.1 | D | | |
| SB TH | T | 244 | 1,650 | 0.148 | 0.230 | 380 | 0.64 | | 26.4 | 0.85 | 18 | 2.8 | 25.0 | D | | 25.9 |
| NB LT | T | 57 | 1,650 | 0.034 | 0.060 | 99 | 0.57 | | 34.8 | 0.85 | 18 | 5.8 | 35.2 | D | | |
| NB TH | T | 137 | 1,650 | 0.083 | 0.170 | 281 | 0.49 | | 28.6 | 0.85 | 18 | 1.1 | 25.4 | D | | 28.3 |

Cycle length, C = 100 seconds, Lost time per cycle = 18.0 seconds Y = Sum (v/s) = 0.519 Xr = Y * C / (C-L) = 0.634 Overall Intersection: 19.6 C

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) | 205 | 0 | 225 | 0 | 0 | 0 | 0 | 1,020 | 480 | 430 | 585 | 0 |
| Arrival type (1-6) (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 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 0 |
| 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 | Phase 2 | Phase 3 | Phase 4 | Phase 5 | Phase 6 | Phase 7 | Phase 8 |
|----------------------|---------|---------|---------|---------|---------|---------|---------|---------|
| Phase 1 | 18 | | | | | | | |
| Phase 2 | | | | | | | | |
| Phase 3 | | | | | | | | |
| Phase 4 | | | | | | | | |
| Phase 5 | | | | | | | | 73 |
| Phase 6 | | | | | | | | |
| Phase 7 | | | | | | | | |
| Phase 8 | | | | | | | | 37 |

Major= 2,495 Minor= 205 warranted by: MUTCD Figure 4-5, 2&1 curve

Capacity Analysis and Level of Service Module

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | |
|---------------------|------------|----------------|---------------------|---------------|-----------------|-------------------|--------------------|-------------------|--------------------------|---------------------|----------------|--------------|
| Lane Group Movement | Phase Type | Adj. Flow Rate | Adj. Sat. Flow Rate | Flow rate v/h | Green ratio g/C | Lane Gr. Capacity | Lane Gr. v/c ratio | Critical Lane Gr. | First Term Delay sec/veh | Second Term Delay m | Lane Group LOS | Approach LOS |
| EB LT | T | 233 | 1,650 | 0.141 | 0.180 | 297 | 0.79 | ----- | 29.8 | 0.85 | 18 | 8.8 |
| EB TH | T | 0 | 1,650 | 0.000 | 0.180 | 297 | 0.00 | ----- | ----- | ----- | 34.1 | D |
| EB RT | T | 258 | 1,650 | 0.155 | 0.500 | 625 | 0.31 | ----- | 11.2 | 0.85 | 18 | 0.1 |
| SB TH | T | 1,020 | 3,300 | 0.309 | 0.385 | 1,205 | 0.85 | ----- | 22.2 | 0.85 | 16 | 4.1 |
| SB RT | T | 524 | 1,650 | 0.317 | 0.365 | 602 | 0.87 | ----- | 22.4 | 0.85 | 16 | 9.1 |
| NB LT | T | 490 | 1,650 | 0.297 | 0.320 | 528 | 0.93 | ----- | 25.0 | 0.85 | 18 | 16.3 |
| NB TH | T | 585 | 3,300 | 0.177 | 0.730 | 2,409 | 0.24 | ----- | 3.4 | 0.85 | 16 | 0.0 |

Cycle length, C = 100 seconds, Lost time per cycle = 18.0 seconds Y = Sum (v/s)d = 0.769 Xc = Y * C / (C-L) = 0.838 Overall Intersection: 22.1 C

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) | 465 | 0 | 370 | 0 | 0 | 0 | 0 | 455 | 85 | 170 | 1,490 | 0 |
| Arrival type (1-6) (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 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 0 |
| 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 | Phase 2 | Phase 3 | Phase 4 | Phase 5 | Phase 6 | Phase 7 | Phase 8 |
|----------------------|---------|---------|---------|---------|---------|---------|---------|---------|
| Phase 1 | 37 | | | | | | | |
| Phase 2 | | | | | | | | |
| Phase 3 | | | | | | | | |
| Phase 4 | | | | | | | | |
| Phase 5 | | | | | | | | |
| Phase 6 | | | | | | | | 54 |
| Phase 7 | | | | | | | | |
| Phase 8 | | | | | | | | 19 |

Major= 2,180 Minor= 465 warranted by: MUTCD Figure 4-5, 2&1 curve

Capacity Analysis and Level of Service Module

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | |
|---------------------|------------|----------------|---------------------|---------------|-----------------|-------------------|--------------------|-------------------|--------------------------|---------------------|----------------|--------------|
| Lane Group Movement | Phase Type | Adj. Flow Rate | Adj. Sat. Flow Rate | Flow rate v/h | Green ratio g/C | Lane Gr. Capacity | Lane Gr. v/c ratio | Critical Lane Gr. | First Term Delay sec/veh | Second Term Delay m | Lane Group LOS | Approach LOS |
| EB LT | T | 525 | 1,650 | 0.321 | 0.370 | 611 | 0.87 | ----- | 22.2 | 0.85 | 18 | 8.9 |
| EB TH | T | 0 | 1,650 | 0.000 | 0.370 | 611 | 0.00 | ----- | ----- | ----- | 27.8 | D |
| EB RT | T | 421 | 1,650 | 0.255 | 0.560 | 924 | 0.48 | ----- | 9.9 | 0.85 | 18 | 0.3 |
| SB TH | T | 455 | 3,300 | 0.138 | 0.305 | 1,007 | 0.45 | ----- | 21.3 | 0.85 | 16 | 0.2 |
| SB RT | T | 74 | 1,650 | 0.045 | 0.305 | 503 | 0.15 | ----- | 19.2 | 0.85 | 18 | 0.0 |
| NB LT | T | 194 | 1,650 | 0.117 | 0.190 | 314 | 0.62 | ----- | 28.2 | 0.85 | 16 | 2.6 |
| NB TH | T | 1,490 | 3,300 | 0.452 | 0.540 | 1,782 | 0.84 | ----- | 14.7 | 0.85 | 18 | 2.6 |

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

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) | 205 | 730 | 195 | 35 | 490 | 155 | 180 | 55 | 215 | 50 | 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 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---------|----|----|----|---|---|----|----|----|
| Phase 1 | 23 | | | | | | | |
| Phase 2 | | | | | | 37 | 37 | |
| Phase 3 | | | | | | | 17 | 17 |
| Phase 4 | | | | | | | | |
| Phase 5 | | | | | 5 | | | |
| Phase 6 | | 55 | 55 | | | | | |
| Phase 7 | | | | | | | | 12 |
| Phase 8 | | | | | | | 10 | 10 |

Majors= 1,810 Minors= 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 rate | Adj. Sat. Flow Rate | Flow rate v/s | Green time g/C | Lane Gr. Capacity | Lane Gr. v/s ratio | Critical Lane Gr. | First Term Delay sec/veh | DT | Second Term Delay m | sec/veh | Lane Group LOS | Approach | sec/veh | LOS |
| EB LT | T | 233 | 1,850 | 0.141 | 0.240 | 380 | 0.81 | EB TH | 26.2 | 0.85 | 18 | 2.1 | 24.4 | C | | |
| EB TH | T | 952 | 3,300 | 0.288 | 0.550 | 1,815 | 0.52 | WB LT | 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 | WB TH | 35.1 | 0.85 | 16 | 3.4 | 33.2 | D | | |
| WB TH | T | 688 | 3,300 | 0.202 | 0.370 | 1,221 | 0.55 | SB LT | 18.9 | 0.85 | 18 | 0.4 | 18.5 | C | 17.4 | C |
| SB LT | T | 205 | 1,650 | 0.124 | 0.170 | 281 | 0.73 | SB TH | 29.9 | 0.85 | 18 | 6.3 | 31.7 | D | | |
| SB TH | T | 55 | 1,650 | 0.033 | 0.100 | 165 | 0.33 | SB RT | 31.8 | 0.85 | 18 | 0.5 | 27.5 | D | 24.3 | C |
| SB RT | T | 245 | 1,650 | 0.148 | 0.330 | 545 | 0.45 | NB LT | 29.0 | 0.85 | 18 | 0.4 | 17.4 | C | | |
| NB LT | T | 108 | 1,650 | 0.066 | 0.120 | 198 | 0.55 | NB TH | 31.5 | 0.85 | 18 | 2.4 | 29.2 | D | | |
| NB TH | T | 40 | 1,650 | 0.024 | 0.050 | 83 | 0.48 | NB RT | 35.1 | 0.85 | 18 | 3.4 | 33.2 | D | 29.8 | D |
| NB RT | T | 40 | 1,650 | 0.024 | 0.100 | 165 | 0.24 | | 31.5 | 0.85 | 18 | 0.2 | 27.0 | D | | |

Cycle length, C = 100 seconds, Lost time per cycle = 18.0 seconds Y = Sum (v/s) = 6.537 Xc = Y * C / (C-L) = 0.680 Overall Intersection: 17.3 C

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 | 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 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---------|----|----|----|---|----|----|----|----|
| Phase 1 | 16 | | | | | | | |
| Phase 2 | | | | | | 35 | 35 | |
| Phase 3 | | | | | | | 23 | 23 |
| Phase 4 | | | | | | | | |
| Phase 5 | | | | | 14 | | | |
| Phase 6 | | 37 | 37 | | | | | |
| Phase 7 | | | | | | | | 23 |
| Phase 8 | | | | | | | 8 | 8 |

Majors= 1,380 Minors= 310 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 rate | Adj. Sat. Flow Rate | Flow rate v/s | Green time g/C | Lane Gr. Capacity | Lane Gr. v/s ratio | Critical Lane Gr. | First Term Delay sec/veh | DT | Second Term Delay m | sec/veh | Lane Group LOS | Approach | sec/veh | LOS |
| EB LT | T | 131 | 1,650 | 0.079 | 0.180 | 254 | 0.50 | EB TH | 28.1 | 0.85 | 16 | 1.2 | 25.9 | D | | |
| EB TH | T | 405 | 3,300 | 0.123 | 0.370 | 1,221 | 0.33 | WB LT | 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 | WB TH | 30.3 | 0.85 | 16 | 1.7 | 27.5 | D | | |
| WB TH | T | 794 | 3,300 | 0.241 | 0.350 | 1,155 | 0.69 | SB LT | 21.1 | 0.85 | 16 | 1.2 | 18.1 | C | 20.2 | C |
| SB LT | T | 228 | 1,650 | 0.138 | 0.230 | 380 | 0.60 | SB TH | 26.1 | 0.85 | 18 | 1.9 | 24.1 | C | | |
| SB TH | T | 40 | 1,650 | 0.024 | 0.080 | 132 | 0.30 | SB RT | 33.0 | 0.85 | 18 | 0.4 | 28.5 | D | 25.3 | D |
| SB RT | T | 273 | 1,650 | 0.165 | 0.240 | 396 | 0.60 | NB LT | 26.3 | 0.85 | 16 | 3.5 | 25.9 | D | | |
| NB LT | T | 273 | 1,650 | 0.165 | 0.230 | 380 | 0.72 | NB TH | 27.0 | 0.85 | 16 | 4.5 | 27.5 | D | | |
| NB TH | T | 70 | 1,650 | 0.042 | 0.080 | 132 | 0.53 | NB RT | 33.8 | 0.85 | 16 | 3.1 | 31.7 | D | 27.2 | D |
| NB RT | T | 57 | 1,650 | 0.034 | 0.220 | 363 | 0.18 | | 23.9 | 0.85 | 16 | 0.0 | 20.3 | C | | |

Cycle length, C = 100 seconds, Lost time per cycle = 18.0 seconds Y = Sum (v/s) = 6.851 Xc = Y * C / (C-L) = 0.794 Overall Intersection: 21.9 C

Planning Analysis (94 HCM) file: HCM3-BC2.FMT.A3=2 print: 06/11/94 04/19/98 by: Julian Ng, Incorporated page 1 of 1
 Intersection of: East-West Road and Road Servicing Parcel C Case: PM Peak Hour (LOS A)
 Condition: PM Peak Hour (2020) Critical Movement Analysis: 815 (under capacity), Xcm = 8.58

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) | 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) | | | | | | | | | | | | |
| 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

| Phase | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|----------------------|------|------|------|-----|------|------|-----|----------------|
| Green Time (seconds) | 0.0 | 0.0 | 0.0 | | | | | |
| Phase 1 | | | | | 65.5 | 65.5 | | |
| Phase 2 | | | | | | | 0.0 | |
| Phase 3 | | | | | | | | 25.5 25.5 25.5 |
| Phase 4 | | | | | | | | |
| Phase 5 | | | | 8.0 | | | | |
| Phase 6 | 53.0 | 53.0 | 53.0 | | | | | |
| Phase 7 | | | | | | | 0.0 | 0.0 |
| Phase 8 | | | | | | | | |

Major= 1,415 Minor= 275 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) |
|------------|-------|----------------|---------------------|----------------|-----------------|-------------------|--------------------|-------------------|--------------------------|------|---------------------|---------|---------|------|----------|------|
| Line Group | Phase | Adj. Flow rate | Adj. Sat. Flow Rate | Flow ratio v/s | Green ratio g/C | Line Gr. Capacity | Line Gr. v/s ratio | Critical Lane Gr. | First Term Delay sec/veh | DF | Second Term Delay m | sec/veh | sec/veh | LOS | Approach | LOS |
| EB TH | T | 996 | 3,300 | 0.299 | 0.530 | 1,749 | 0.56 | ***** | 12.0 | 0.85 | 18 | 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 | 18 | 5.3 | 34.0 | D | | |
| WB TH | T | 405 | 3,300 | 0.123 | 0.655 | 2,182 | 0.19 | ***** | 5.2 | 0.85 | 18 | 0.0 | 4.4 | A | 9.3 | B |
| NB LT | T | 313 | 1,650 | 0.190 | 0.255 | 421 | 0.74 | ***** | 28.0 | 0.85 | 18 | 4.8 | 26.9 | D | | |
| NB TH | T | 0 | 1,650 | 0.000 | 0.255 | 421 | 0.00 | ***** | | | | | | | | |
| NB RT | T | 80 | 1,650 | 0.048 | 0.255 | 421 | 0.19 | ***** | 22.2 | 0.85 | 18 | 0.0 | 18.9 | C | 25.3 | D |

Cycle length, C = 100 seconds, Lost time per cycle = 9.0 seconds Y = Sum (v/s)d = 8.537 X = Y * C / (C-L) = 0.590 Overall Intersection: 13.3 B

Planning Analysis (94 HCM) file: HCM3-BC2.FMT.A3=1 print: 06/11/94 04/19/98 by: Julian Ng, Incorporated page 1 of 1
 Intersection of: East-West Road and Road Servicing Parcel C Case: AM Peak Hour (LOS C)
 Condition: AM Peak Hour (2020) Critical Movement Analysis: 1,975 (under capacity), Xcm = 8.77

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) | 0 | 240 | 250 | 210 | 250 | 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) | | | | | | | | | | | | |
| 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

| Phase | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|----------------------|------|------|------|---|------|------|-----|----------------|
| Green Time (seconds) | 0.0 | 0.0 | 0.0 | | | | | |
| Phase 1 | | | | | 42.5 | 42.5 | | |
| Phase 2 | | | | | | | 0.0 | |
| Phase 3 | | | | | | | | 48.5 48.5 48.5 |
| Phase 4 | | | | | | 18.0 | | |
| Phase 5 | | | | | | | | |
| Phase 6 | 20.0 | 20.0 | 20.0 | | | | | |
| Phase 7 | | | | | | | | 0.0 |
| Phase 8 | | | | | | | 0.0 | 0.0 |

Major= 900 Minor= 620 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) |
|------------|-------|----------------|---------------------|----------------|-----------------|-------------------|--------------------|-------------------|--------------------------|------|---------------------|---------|---------|------|----------|------|
| Line Group | Phase | Adj. Flow rate | Adj. Sat. Flow Rate | Flow ratio v/s | Green ratio g/C | Line Gr. Capacity | Line Gr. v/s ratio | Critical Lane Gr. | First Term Delay sec/veh | DF | Second Term Delay m | sec/veh | sec/veh | LOS | Approach | LOS |
| EB TH | T | 525 | 3,300 | 0.159 | 0.200 | 660 | 0.79 | ***** | 28.9 | 0.85 | 18 | 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 | 18 | 10.1 | 35.5 | D | | |
| WB TH | T | 280 | 3,300 | 0.079 | 0.425 | 1,403 | 0.19 | ***** | 13.6 | 0.85 | 18 | 0.0 | 11.6 | B | 23.0 | C |
| NB LT | T | 708 | 1,650 | 0.428 | 0.485 | 800 | 0.88 | ***** | 17.6 | 0.85 | 18 | 8.0 | 23.0 | C | | |
| NB TH | T | 0 | 1,650 | 0.000 | 0.485 | 800 | 0.00 | ***** | | | | | | | | |
| NB RT | T | 120 | 1,650 | 0.072 | 0.485 | 800 | 0.15 | ***** | 10.9 | 0.85 | 18 | 0.0 | 9.3 | B | 21.0 | C |

Cycle length, C = 100 seconds, Lost time per cycle = 9.0 seconds Y = Sum (v/s)d = 8.732 X = Y * C / (C-L) = 0.894 Overall Intersection: 23.9 C

Planning Analysis (M HCM)

file: HCM3-11.FMT.A3=2

print: 04:43 PM 04/19/96 by: Julian Ng, Incorporated page 1 of 1

Intersection of: East-West Road and First Road: Parcels I and J
 Condition: PM Peak Hour (2020)

Case: PM Peak Hour (LOS B)
 Critical Movement Analysis: 845 (under capacity), Xcm = 8.68

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) | 275 | 725 | 330 | 95 | 715 | 95 | 65 | 25 | 245 | 240 | 25 | 65 |
| Arrival type (1-6) (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) | | | | | | | | | | | | |
| 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 | 25 |
| Phase 2 | |
| Phase 3 | 31 31 |
| Phase 4 | 14 |
| Phase 5 | |
| Phase 6 | 12 12 |
| Phase 7 | 10 |
| Phase 8 | 46 46 |
| Phase 9 | 23 |
| Phase 10 | 3 3 |
| Phase 11 | 23 |
| Phase 12 | |

Major= 2,235 Minor= 265 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 Movement | Phase Type | Aq. Flow rate | Aq. Sat. Flow Rate | Flow rate v/h | Green ratio g/C | Lane Cr. Capacity | Lane Cr. v/h ratio | Critical Lane Cr. | First Term Delay sec/veh | DP | Second Term Delay m | sec/veh | Lane Group sec/veh | LOS | Approach sec/veh | LOS |
| EB LT | T | 313 | 1,650 | 0.190 | 0.250 | 413 | 0.78 | ***** | 28.4 | 0.85 | 18 | 5.5 | 27.9 | D | | |
| EB TH | T | 1,101 | 3,300 | 0.334 | 0.460 | 1,518 | 0.73 | ***** | 16.6 | 0.85 | 18 | 1.2 | 15.3 | C | 18.1 | C |
| WB LT | T | 108 | 1,650 | 0.068 | 0.100 | 185 | 0.88 | ***** | 32.9 | 0.85 | 18 | 6.1 | 34.1 | D | | |
| WB TH | T | 823 | 3,300 | 0.249 | 0.310 | 1,023 | 0.80 | ***** | 24.1 | 0.85 | 18 | 3.4 | 23.9 | C | 25.1 | D |
| SBLT | T | 74 | 1,650 | 0.045 | 0.140 | 231 | 0.32 | ***** | 29.4 | 0.85 | 18 | 0.3 | 25.3 | D | | |
| SB TH | T | 25 | 1,650 | 0.015 | 0.030 | 50 | 0.51 | ***** | 38.3 | 0.85 | 18 | 6.4 | 37.3 | D | 23.4 | C |
| SB RT | T | 279 | 1,650 | 0.169 | 0.280 | 462 | 0.80 | ***** | 23.7 | 0.85 | 18 | 1.8 | 21.7 | C | | |
| NBLT | T | 273 | 1,650 | 0.166 | 0.230 | 380 | 0.72 | ***** | 27.0 | 0.85 | 18 | 4.5 | 27.5 | D | | |
| NB TH | T | 25 | 1,650 | 0.015 | 0.120 | 198 | 0.13 | ***** | 29.9 | 0.85 | 18 | 0.0 | 25.4 | D | 26.0 | D |
| NB RT | T | 74 | 1,650 | 0.045 | 0.220 | 363 | 0.20 | ***** | 24.2 | 0.85 | 18 | 0.0 | 20.6 | C | | |

Cycle length, C = 100 seconds, Lost time per cycle = 18.0 seconds Y = Sum (v/h) = 6.774 Xc = Y * C / (C-L) = 0.844 Overall Intersection: 21.8 C

Planning Analysis (M HCM)

file: HCM3-11.FMT.A3=1

print: 04:43 PM 04/19/96 by: Julian Ng, Incorporated page 1 of 1

Intersection of: East-West Road and First Road: Parcels I and J
 Condition: AM Peak Hour (2020)

Case: AM Peak Hour (LOS B)
 Critical Movement Analysis: 853 (under capacity), Xcm = 8.81

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) | 190 | 690 | 135 | 50 | 595 | 50 | 125 | 20 | 315 | 320 | 20 | 130 |
| Arrival type (1-6) (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) | | | | | | | | | | | | |
| 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 | 31 |
| Phase 2 | |
| Phase 3 | 27 27 |
| Phase 4 | 19 19 |
| Phase 5 | |
| Phase 6 | 15 15 |
| Phase 7 | 8 |
| Phase 8 | 42 42 |
| Phase 9 | 28 |
| Phase 10 | 6 6 |
| Phase 11 | 28 |
| Phase 12 | |

Major= 1,710 Minor= 340 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 Movement | Phase Type | Aq. Flow rate | Aq. Sat. Flow Rate | Flow rate v/h | Green ratio g/C | Lane Cr. Capacity | Lane Cr. v/h ratio | Critical Lane Cr. | First Term Delay sec/veh | DP | Second Term Delay m | sec/veh | Lane Group sec/veh | LOS | Approach sec/veh | LOS |
| EB LT | T | 218 | 1,650 | 0.131 | 0.210 | 347 | 0.82 | ***** | 27.3 | 0.85 | 18 | 2.5 | 25.7 | D | | |
| EB TH | T | 844 | 3,300 | 0.256 | 0.420 | 1,386 | 0.81 | ***** | 17.2 | 0.85 | 18 | 0.6 | 15.2 | C | 17.3 | C |
| WB LT | T | 57 | 1,650 | 0.034 | 0.060 | 96 | 0.57 | ***** | 34.8 | 0.85 | 18 | 5.8 | 35.2 | D | | |
| WB TH | T | 652 | 3,300 | 0.198 | 0.270 | 891 | 0.73 | ***** | 25.2 | 0.85 | 18 | 2.2 | 23.6 | C | 24.5 | C |
| SBLT | T | 142 | 1,650 | 0.088 | 0.190 | 314 | 0.45 | ***** | 27.3 | 0.85 | 18 | 0.7 | 23.9 | C | | |
| SB TH | T | 20 | 1,650 | 0.012 | 0.060 | 99 | 0.20 | ***** | 34.0 | 0.85 | 18 | 0.1 | 29.0 | D | 27.7 | D |
| SB RT | T | 358 | 1,650 | 0.217 | 0.270 | 448 | 0.80 | ***** | 25.9 | 0.85 | 18 | 7.1 | 29.1 | D | | |
| NBLT | T | 364 | 1,650 | 0.221 | 0.280 | 462 | 0.79 | ***** | 25.3 | 0.85 | 18 | 6.1 | 27.6 | D | | |
| NB TH | T | 20 | 1,650 | 0.012 | 0.150 | 248 | 0.08 | ***** | 27.8 | 0.85 | 18 | 0.0 | 23.6 | C | 26.1 | D |
| NB RT | T | 148 | 1,650 | 0.090 | 0.210 | 347 | 0.43 | ***** | 26.1 | 0.85 | 18 | 0.5 | 22.7 | C | | |

Cycle length, C = 100 seconds, Lost time per cycle = 18.0 seconds Y = Sum (v/h) = 0.767 Xc = Y * C / (C-L) = 0.835 Overall Intersection: 22.7 C

Intersection of: East-West Road and Second Road: Parcels I and J Case: PM Peak Hour (LOS A)
 Condition: PM Peak Hour (2028) Critical Movement Analysis: 678 (under capacity), Xcm = 0.48

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) | 185 | 450 | 220 | 85 | 585 | 50 | 45 | 25 | 165 | 180 | 25 | 40 |
| Arrival type (1-6) (seconds) | 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) | | | | | | | | | | | | |
| 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
 Phase 2 34 34
 Phase 3 13 13
 Phase 4 13 13
 Phase 5 8 8
 Phase 6 48 48
 Phase 7 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 | 10 (4) | 11 (3) | 12 (7) | 13 (8) | 14 (9) | 15 (10) | 16 (11) | 17 (12) |
|------------|-------|-----------|-----------|------------|----------|----------|----------|----------|------------------|-------------------|------------|----------|------------|----------|------------|----------|
| Lane Group | Phase | Adj. Flow | Adj. Sat. | Flow ratio | Green | Lane Gr. | Lane Gr. | Overall | First Term Delay | Second Term Delay | Lane Group | Approach | Lane Group | Approach | Lane Group | Approach |
| Movement | Type | rate | Flow Rate | w/s | time/g/C | Capacity | w/rate | 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 | ----- | 28.5 | 0.85 | 18 | 1.7 | 24.2 | C | | |
| EB TH | T | 700 | 3,300 | 0.212 | 0.480 | 1,584 | 0.44 | ----- | 13.0 | 0.85 | 18 | 0.1 | 11.2 | B | 14.2 | B |
| WB LT | T | 74 | 1,650 | 0.045 | 0.080 | 132 | 0.58 | ----- | 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 | 18 | 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 | 0.36 | ----- | 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 | ----- | 28.0 | 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(w/s) = 0.540 Xc = Y * C / (C-L) = 0.859 Overall Intersection: 17.9 C

Intersection of: East-West Road and Second Road: Parcels I and J Case: AM Peak Hour (LOS A)
 Condition: AM Peak Hour (2028) Critical Movement Analysis: 678 (under capacity), Xcm = 0.48

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) | 125 | 725 | 80 | 35 | 285 | 55 | 85 | 20 | 210 | 215 | 20 | 85 |
| Arrival type (1-6) (seconds) | 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) | | | | | | | | | | | | |
| 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
 Phase 2 24 24
 Phase 3 17 17
 Phase 4 14 14
 Phase 5 5 5
 Phase 6 48 48
 Phase 7 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 | 10 (4) | 11 (3) | 12 (7) | 13 (8) | 14 (9) | 15 (10) | 16 (11) | 17 (12) |
|------------|-------|-----------|-----------|------------|----------|----------|----------|----------|------------------|-------------------|------------|----------|------------|----------|------------|----------|
| Lane Group | Phase | Adj. Flow | Adj. Sat. | Flow ratio | Green | Lane Gr. | Lane Gr. | Overall | First Term Delay | Second Term Delay | Lane Group | Approach | Lane Group | Approach | Lane Group | Approach |
| Movement | Type | rate | Flow Rate | w/s | time/g/C | Capacity | w/rate | 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 | 18 | 0.1 | 18.0 | C | | |
| EB TH | T | 827 | 3,300 | 0.251 | 0.460 | 1,518 | 0.55 | ----- | 14.8 | 0.85 | 18 | 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 | 18 | 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(w/s) = 0.548 Xc = Y * C / (C-L) = 0.893 Overall Intersection: 18.0 C

Intersection of: Kapelei Parkway and North-South Road Case: PM Peak Hour (LOS E)
 Condition: PM Peak Hour (2008) Critical Movement Analysis: 1,298 (NEAR capacity), Xcm = 0.83

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 | 80 | 60 | 1,440 | 515 | 780 | 40 | 815 | 120 | 70 | 180 |
| Arrival type (1-6) (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
 Green Time (seconds): 3.5 seconds yellow 1.0 second all-red

| Phase | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---------|----|---|----|----|----|----|----|----|
| Phase 1 | 29 | | | | | | | 29 |
| Phase 2 | | | | | 36 | 36 | | |
| Phase 3 | | | | | | | 32 | 32 |
| Phase 4 | | | | | | | | |
| Phase 5 | | | | | | 8 | | |
| Phase 6 | | | 59 | 59 | | | | |
| Phase 7 | | | | | | | | 14 |
| Phase 8 | | | | | | | 23 | 23 |

Major= 5,185 Minor= 800 warranted by: MUTCD Figure 4-5, 2&1 curve

Capacity Analysis and Level of Service Module

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | |
|------------|-------|----------------|---------------------|----------------|----------------|-------------------|--------------------|------------------|--------------------------|---------------------------|----------------|--------------|
| Lane Group | Phase | Adj. Flow rate | Adj. Sat. Flow Rate | Flow ratio w/s | Green time g/C | Lane Gr. Capacity | Lane Gr. v/s ratio | Overall Lane Gr. | First Turn Delay sec/veh | Second Turn Delay sec/veh | Lane Group LOS | Approach LOS |
| EB LT | T | 791 | 3,300 | 0.240 | 0.242 | 798 | 0.99 | 34.5 | 0.85 | 18 | 22.7 | E |
| EB TH | T | 2,365 | 4,950 | 0.478 | 0.492 | 2,434 | 0.97 | 22.8 | 0.85 | 18 | 9.2 | D |
| EB RT | T | 102 | 1,650 | 0.062 | 0.608 | 1,004 | 0.10 | 7.5 | 0.85 | 18 | 0.0 | B |
| WB LT | T | 68 | 1,650 | 0.041 | 0.050 | 83 | 0.83 | 42.9 | 0.85 | 16 | 31.3 | F |
| WB TH | T | 1,440 | 4,950 | 0.291 | 0.300 | 1,485 | 0.97 | 31.5 | 0.85 | 16 | 12.4 | D |
| WB RT | T | 586 | 3,300 | 0.178 | 0.567 | 1,670 | 0.31 | 10.4 | 0.85 | 16 | 0.0 | B |
| SB LT | T | 865 | 3,300 | 0.262 | 0.267 | 880 | 0.98 | 33.2 | 0.85 | 16 | 19.7 | E |
| SB TH | T | 40 | 1,650 | 0.024 | 0.192 | 316 | 0.13 | 30.5 | 0.85 | 16 | 0.0 | D |
| SB RT | T | 700 | 3,300 | 0.212 | 0.433 | 1,430 | 0.49 | 18.6 | 0.85 | 16 | 0.2 | C |
| NB LT | T | 137 | 1,650 | 0.083 | 0.117 | 193 | 0.71 | 38.8 | 0.85 | 16 | 7.7 | E |
| NB TH | T | 70 | 1,650 | 0.042 | 0.042 | 69 | 1.02 | 43.7 | 0.85 | 16 | 90.6 | F |
| NB RT | T | 205 | 1,650 | 0.124 | 0.092 | 151 | 1.35 | 41.4 | 0.85 | 16 | 277.5 | F |

Cycle length, C = 120 seconds, Lost time per cycle = 18.0 seconds Y = Sum (w/s) = 0.917 Xc = Y * C / (C-L) = 1.079 Overall Intersection: 41.7 E

Intersection of: Kapelei 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 = 0.83

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) (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) | | | | | | | | | | | | |
| Lanes provided* | 1 | 3 | 0 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

Signal Timing
 C = 100 seconds
 Green Time (seconds): 3.5 seconds yellow 1.0 second all-red

| Phase | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---------|------|---|------|------|------|------|------|------|
| Phase 1 | 11.0 | | | | | | | 11.0 |
| Phase 2 | | | | | 58.5 | 58.5 | | |
| Phase 3 | | | | | | | 17.0 | 17.0 |
| Phase 4 | | | | | | | | |
| Phase 5 | | | | | | 0.0 | | |
| Phase 6 | | | 74.0 | 74.0 | | | | |
| Phase 7 | | | | | | | | 0.0 |
| Phase 8 | | | | | | | | 0.0 |

Major= 4,250 Minor= 155 warranted by: MUTCD Figure 4-5, 2&1 curve

Capacity Analysis and Level of Service Module

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | |
|------------|-------|----------------|---------------------|----------------|----------------|-------------------|--------------------|------------------|--------------------------|---------------------------|----------------|--------------|
| Lane Group | Phase | Adj. Flow rate | Adj. Sat. Flow Rate | Flow ratio w/s | Green time g/C | Lane Gr. Capacity | Lane Gr. v/s ratio | Overall Lane Gr. | First Turn Delay sec/veh | Second Turn Delay sec/veh | Lane Group LOS | Approach LOS |
| EB LT | T | 131 | 1,650 | 0.079 | 0.110 | 182 | 0.72 | 32.7 | 0.85 | 16 | 8.7 | D |
| EB TH | T | 1,070 | 4,950 | 0.218 | 0.740 | 3,683 | 0.29 | 3.3 | 0.85 | 16 | 0.0 | A |
| WB TH | T | 2,945 | 4,950 | 0.595 | 0.585 | 2,898 | 1.02 | 15.8 | 0.85 | 16 | 16.8 | D |
| WB RT | T | 137 | 1,650 | 0.083 | 0.755 | 1,245 | 0.11 | 2.5 | 0.85 | 16 | 0.0 | A |
| SB LT | T | 178 | 1,650 | 0.107 | 0.170 | 281 | 0.83 | 29.3 | 0.85 | 16 | 3.1 | D |
| SB TH | T | 0 | 1,650 | 0.000 | 0.170 | 281 | 0.00 | | | | | |
| SB RT | T | 256 | 1,650 | 0.155 | 0.280 | 462 | 0.55 | 23.3 | 0.85 | 16 | 1.1 | C |

Cycle length, C = 100 seconds, Lost time per cycle = 18.0 seconds Y = Sum (w/s) = 0.839 Xc = Y * C / (C-L) = 1.012 Overall Intersection: 22.8 C

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) | 185 | 2,785 | 0 | 0 | 2,100 | 75 | 200 | 0 | 300 | 0 | 0 | 0 |
| Arrival type (1-6) (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) | | | | | | | | | | | | |
| 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 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---------|------|---|------|------|------|------|------|------|
| Phase 1 | 18.0 | | | | | | | 18.0 |
| Phase 2 | | | | | 43.5 | 43.5 | | |
| Phase 3 | | | | | | | 25.0 | 25.0 |
| Phase 4 | | | | | | | | |
| Phase 5 | | | | | 0.0 | | | |
| Phase 6 | | | 68.0 | 68.0 | | | | |
| Phase 7 | | | | | | | | 0.0 |
| Phase 8 | | | | | | | | 0.0 |

Major= 5,155 Minor= 200 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 | 10 | 11 | 12 | |
|------------|-------|----------------|---------------------|---------------|-----------------|-------------------|--------------------|------------------|-----------------------|---------------------|----------------|--------------|
| Lane Group | Phase | Adj. Flow rate | Adj. Sat. Flow Rate | Flow rate v/s | Green ratio g/C | Lane Gr. Capacity | Lane Gr. v/s ratio | Overall Lane Gr. | First Term Delay s/vh | Second Term Delay s | Lane Group LOS | Approach LOS |
| EB LT | T | 222 | 1,650 | 0.135 | 0.180 | 297 | 0.75 | | 29.5 | 0.85 | 16 | 6.8 |
| EB TH | T | 2,785 | 4,950 | 0.563 | 0.860 | 3,267 | 0.85 | | 10.0 | 0.85 | 16 | 17 |
| WB TH | T | 2,100 | 4,950 | 0.424 | 0.435 | 2,153 | 0.98 | | 21.1 | 0.85 | 16 | 10.5 |
| WB RT | T | 85 | 1,650 | 0.052 | 0.685 | 1,130 | 0.08 | | 4.0 | 0.85 | 16 | 0.0 |
| SB LT | T | 228 | 1,650 | 0.138 | 0.250 | 413 | 0.56 | | 24.8 | 0.85 | 16 | 1.2 |
| SB TH | T | 0 | 1,650 | 0.000 | 0.250 | 413 | 0.00 | | | | | |
| SB RT | T | 342 | 1,650 | 0.207 | 0.430 | 710 | 0.48 | | 15.8 | 0.85 | 16 | 0.4 |

Cycle length, C = 100 seconds, Lost time per cycle = 18.0 seconds Y = Sum (v/s) = 0.770 Xc = Y * C / (C-L) = 0.839 Overall Intersection: 18.3 C

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) | 370 | 910 | 85 | 175 | 2,210 | 1,320 | 375 | 60 | 790 | 85 | 35 | 30 |
| Arrival type (1-6) (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) | | | | | | | | | | | | |
| 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 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---------|----|---|----|----|----|----|----|----|
| Phase 1 | 15 | | | | | | | 15 |
| Phase 2 | | | | | 48 | 48 | | |
| Phase 3 | | | | | | | 15 | 15 |
| Phase 4 | | | | | | | | |
| Phase 5 | | | | | 15 | | | |
| Phase 6 | | | 48 | 48 | | | | |
| Phase 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) | 2 | 3 | 4 | 5 | 6 (3) | 7 (6) | 8 (2) | 9 | 10 | 11 | 12 | |
|------------|-------|----------------|---------------------|---------------|-----------------|-------------------|--------------------|------------------|-----------------------|---------------------|----------------|--------------|
| Lane Group | Phase | Adj. Flow rate | Adj. Sat. Flow Rate | Flow rate v/s | Green ratio g/C | Lane Gr. Capacity | Lane Gr. v/s ratio | Overall Lane Gr. | First Term Delay s/vh | Second Term Delay s | Lane Group LOS | Approach LOS |
| EB LT | T | 421 | 3,300 | 0.128 | 0.150 | 495 | 0.85 | | 31.5 | 0.85 | 16 | 9.3 |
| EB TH | T | 910 | 4,950 | 0.184 | 0.480 | 2,277 | 0.40 | | 13.6 | 0.85 | 16 | 0.1 |
| EB RT | T | 74 | 1,650 | 0.045 | 0.530 | 875 | 0.08 | | 8.8 | 0.85 | 16 | 0.0 |
| WB LT | T | 189 | 1,650 | 0.121 | 0.150 | 248 | 0.80 | | 31.2 | 0.85 | 16 | 11.8 |
| WB TH | T | 2,210 | 4,950 | 0.448 | 0.480 | 2,277 | 0.97 | | 20.0 | 0.85 | 16 | 9.5 |
| WB RT | T | 1,503 | 3,300 | 0.455 | 0.610 | 2,013 | 0.75 | | 10.6 | 0.85 | 16 | 1.1 |
| SB LT | T | 427 | 3,300 | 0.129 | 0.150 | 495 | 0.88 | | 31.5 | 0.85 | 16 | 10.1 |
| SB TH | T | 60 | 1,650 | 0.039 | 0.140 | 231 | 0.28 | | 29.2 | 0.85 | 16 | 0.1 |
| SB RT | T | 899 | 3,300 | 0.273 | 0.290 | 957 | 0.94 | | 26.3 | 0.85 | 16 | 12.0 |
| NB LT | T | 74 | 1,650 | 0.045 | 0.070 | 118 | 0.64 | | 34.4 | 0.85 | 16 | 7.8 |
| NB TH | T | 35 | 1,650 | 0.021 | 0.060 | 99 | 0.35 | | 34.3 | 0.85 | 16 | 0.9 |
| NB RT | T | 34 | 1,650 | 0.021 | 0.210 | 347 | 0.10 | | 24.2 | 0.85 | 16 | 0.0 |

Cycle length, C = 100 seconds, Lost time per cycle = 18.0 seconds Y = Sum (v/s) = 0.900 Xc = Y * C / (C-L) = 1.098 Overall Intersection: 23.4 C

I. NOISE IMPACT ASSESSMENT



D. L. ADAMS ASSOCIATES, LTD.

DARBY & ASSOCIATES
ACOUSTICAL CONSULTANTS

CONTENTS

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

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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 Barber's 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 (DOT) 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_{dn} 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 I-1 Freeway, Farrington Highway, North-South Road, East-West Road and Kapelei 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} , 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 I-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 houses 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} , due to air traffic associated with HIA will be less than 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_{50} 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.

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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.

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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.

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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. *Kaalaeoia 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 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

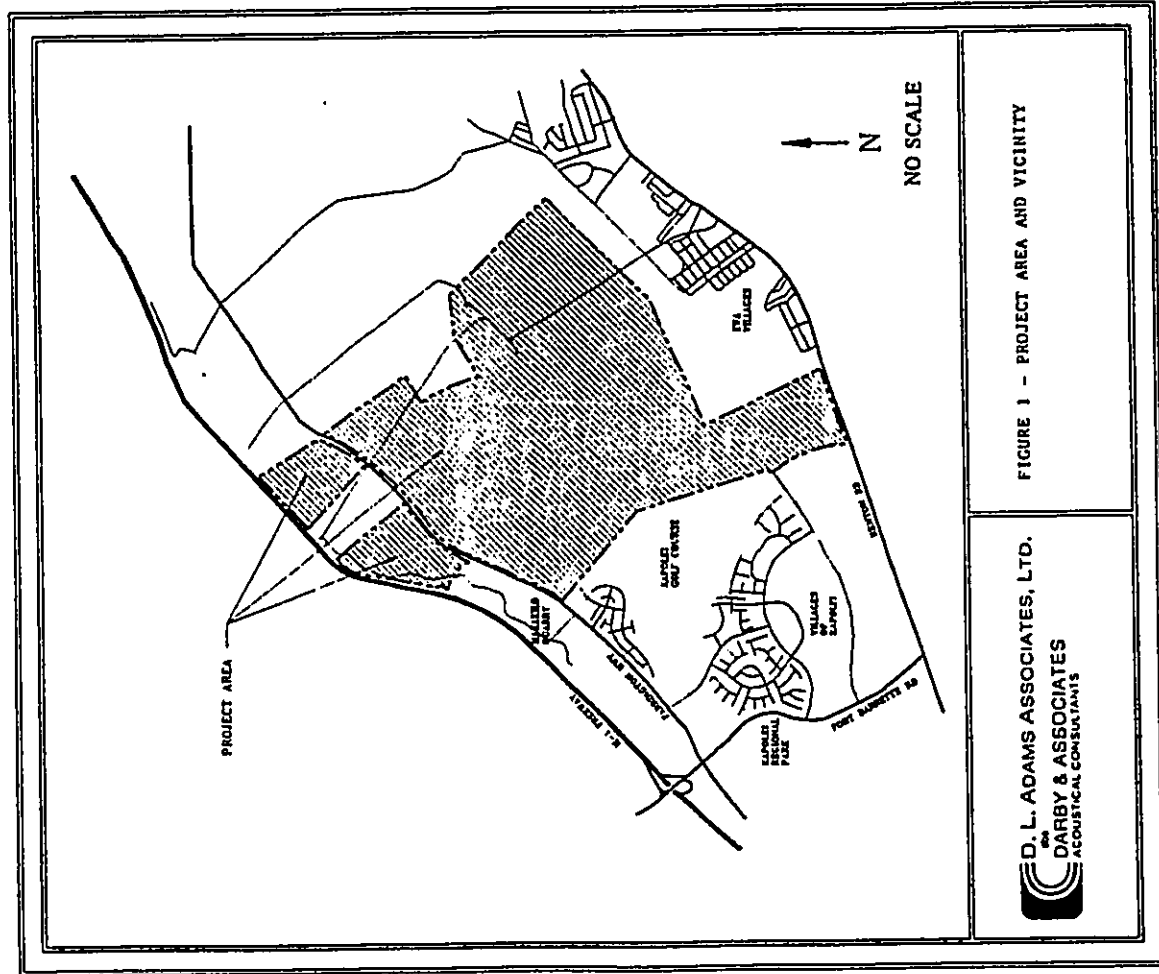
TABLE 3

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 |

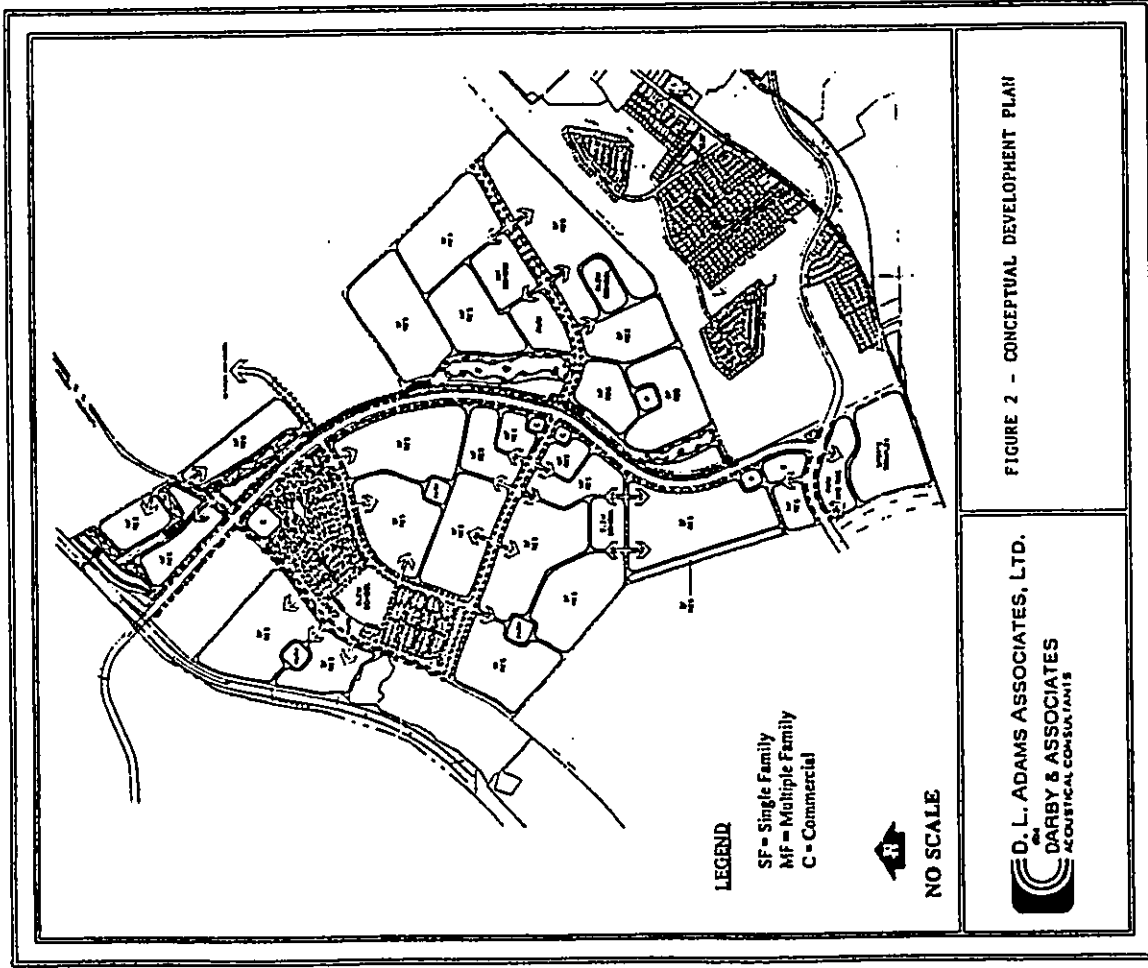
* Effects of terrain and roadway elevations and any noise shielding afforded by man made structures were not included in the calculations.

** See Figure 6.



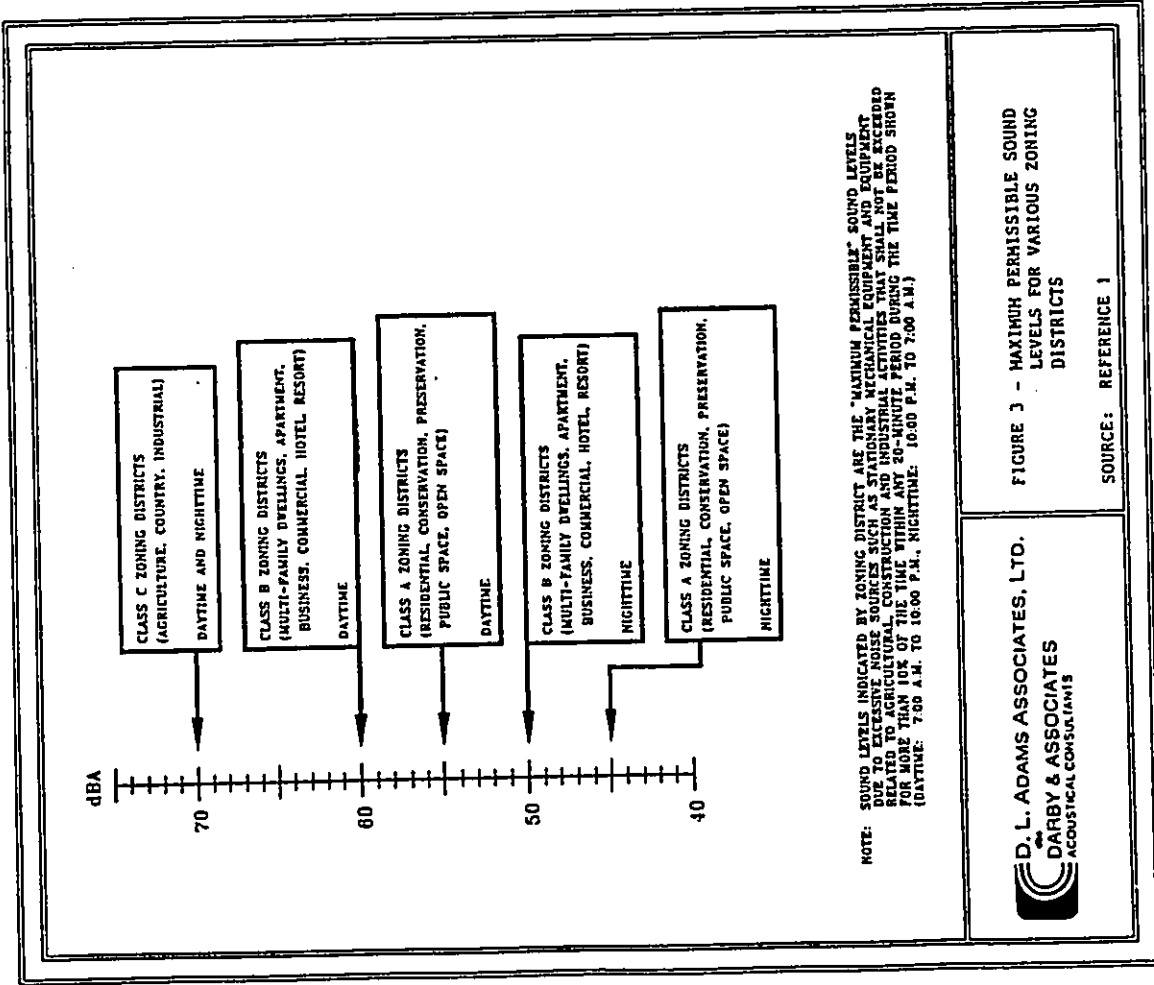
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FIGURE 1 - PROJECT AREA AND VICINITY



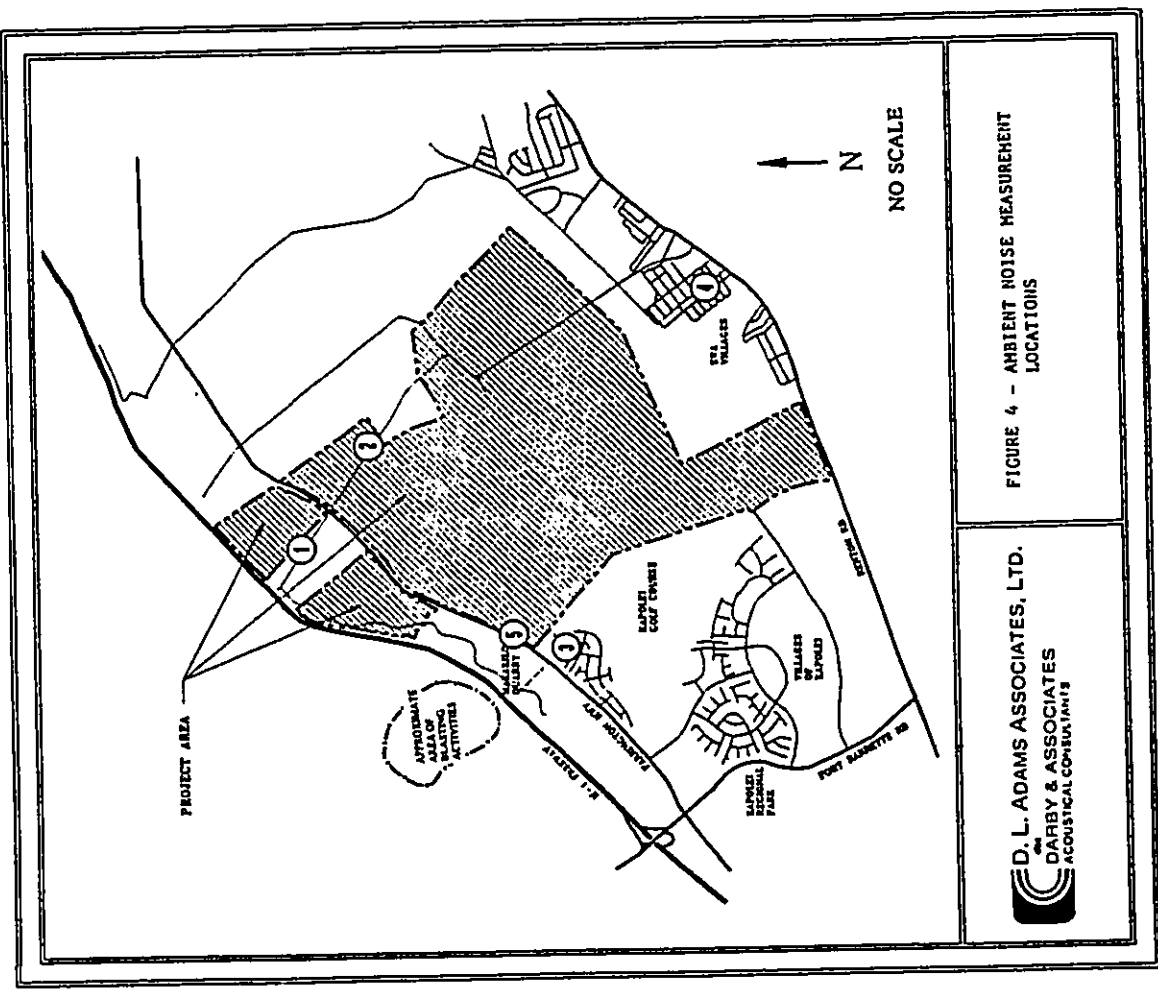
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FIGURE 2 - CONCEPTUAL DEVELOPMENT PLAN



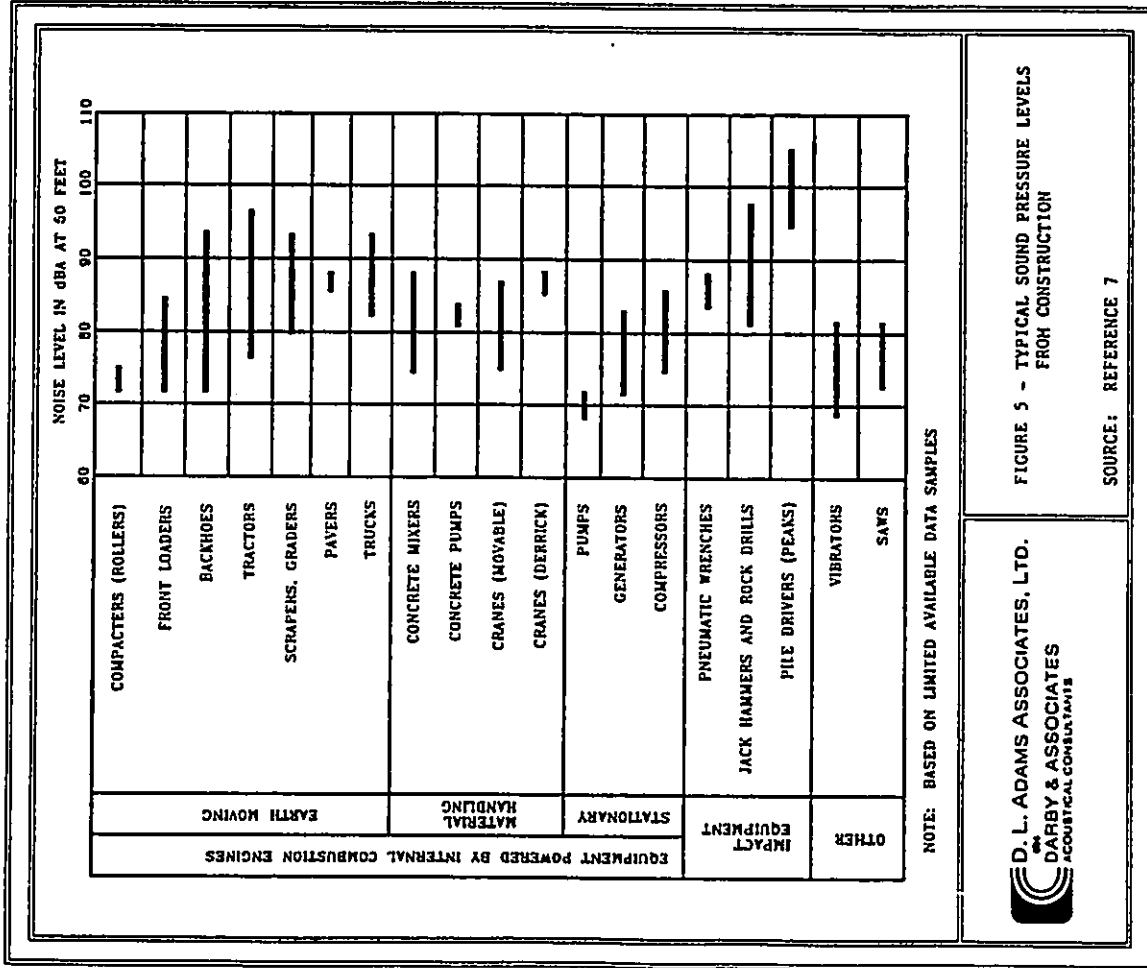
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FIGURE 3 - MAXIMUM PERMISSIBLE SOUND LEVELS FOR VARIOUS ZONING DISTRICTS
 SOURCE: REFERENCE 1



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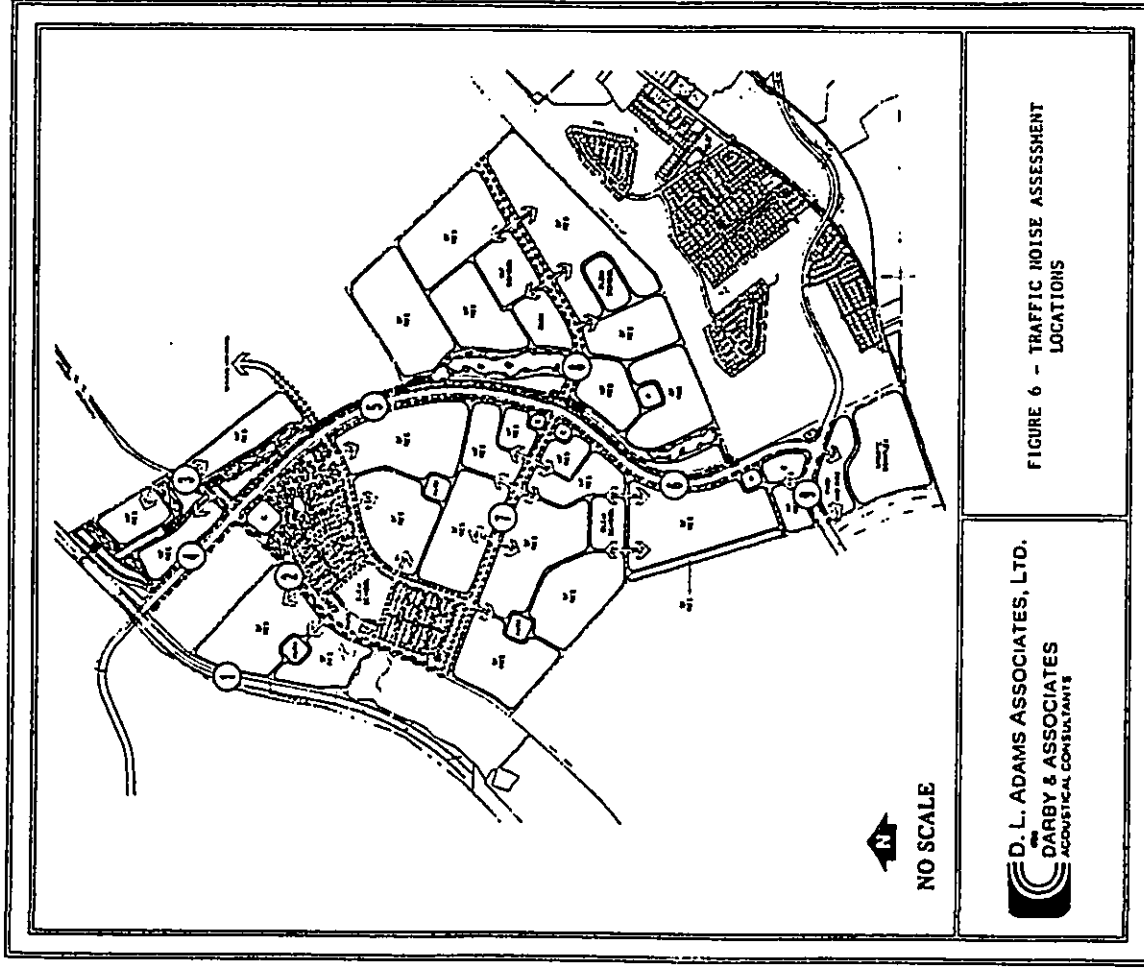
FIGURE 4 - AMBIENT NOISE MEASUREMENT LOCATIONS



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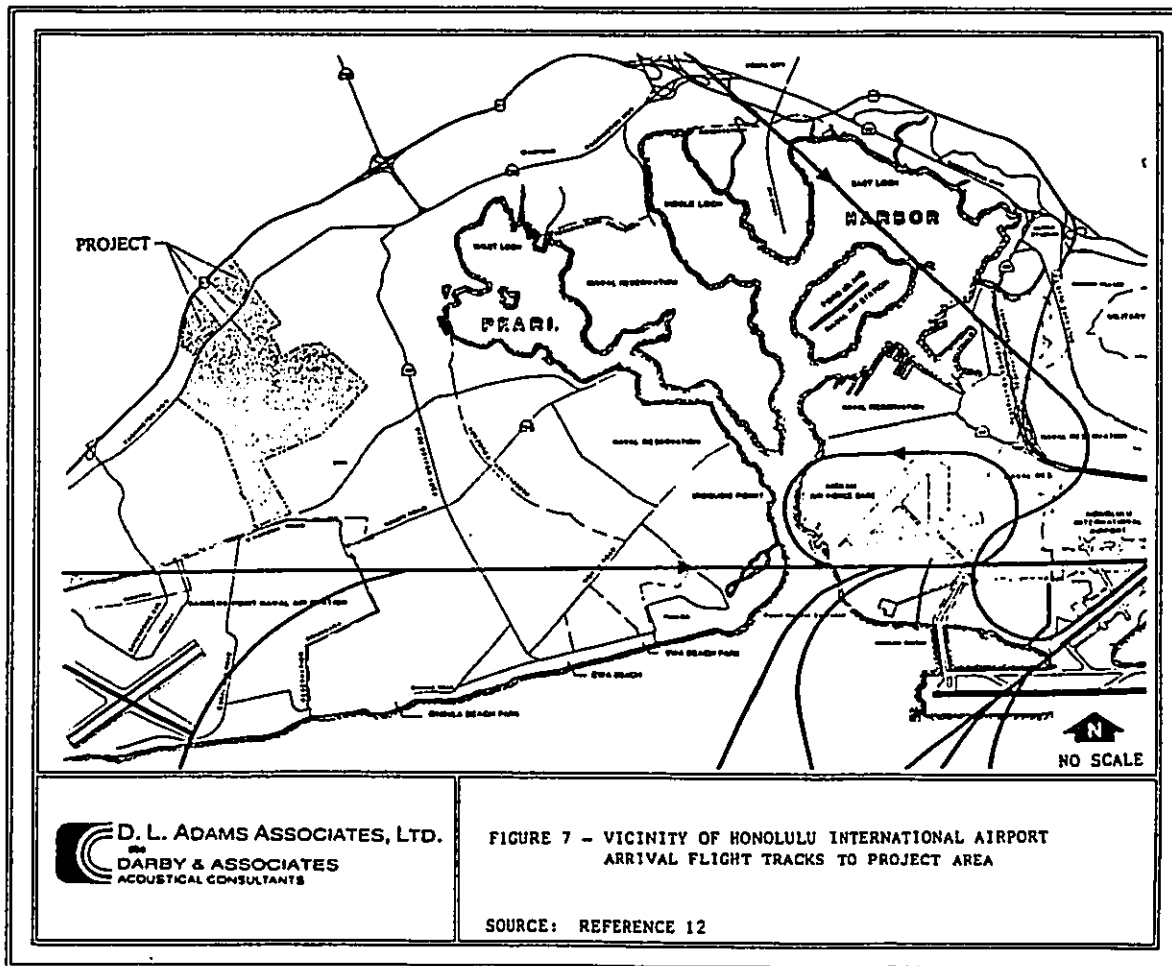
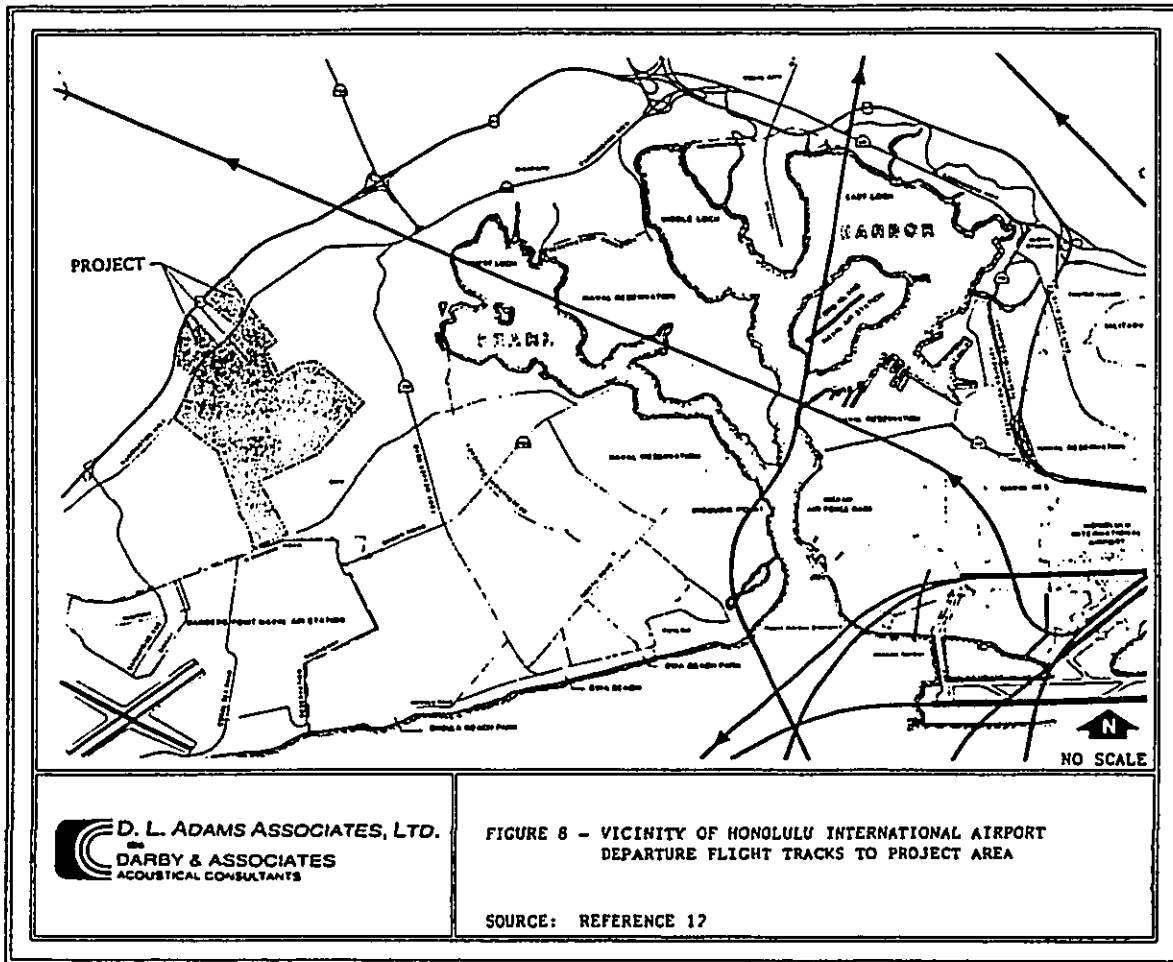
FIGURE 5 - TYPICAL SOUND PRESSURE LEVELS FROM CONSTRUCTION

SOURCE: REFERENCE 7



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FIGURE 6 - TRAFFIC NOISE ASSESSMENT LOCATIONS



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:

$$\text{SPL} = 20 \log (P/\text{Pref}) \text{ dB}$$

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.

Appendix A Acoustical Terminology (Continued)

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_{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.

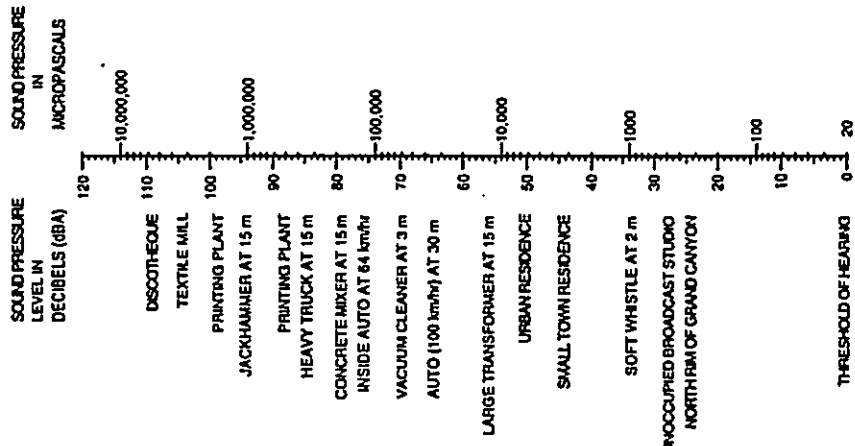


FIGURE A-1 THE RELATION BETWEEN SOUND PRESSURE, P, AND SOUND PRESSURE LEVEL, SPL. ALSO SHOWN ARE TYPICAL VALUES OF A-WEIGHTED SOUND LEVELS OF VARIOUS NOISE SOURCES.

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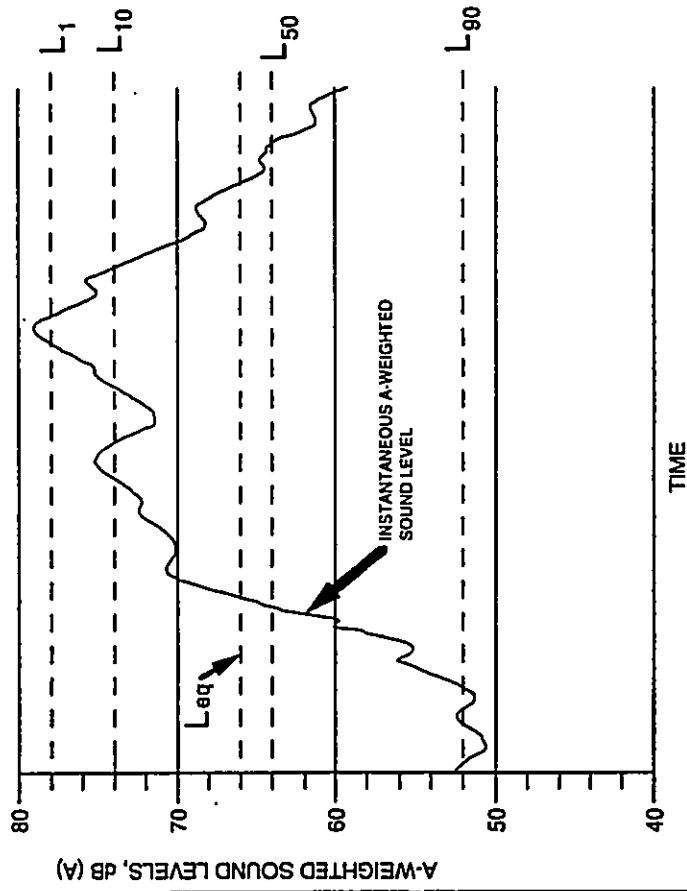


FIGURE A-2 COMPARISON OF AN INSTANTANEOUS SOUND LEVEL AND THE CORRESPONDING STATISTICAL SOUND LEVELS

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12 11 10 9 8 7 6 5 4 3 2 1

J. AIR QUALITY

**AIR QUALITY STUDY
FOR THE PROPOSED
EAST KAPOLEI PROJECT**

EWA, OAHU, HAWAII

Prepared for:
PBR Hawaii

April 1998



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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 project, 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 $\mu\text{g}/\text{m}^3$.

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 $\mu\text{g}/\text{m}^3$ from 1991 through 1993. Average daily concentrations were approximately 25 $\mu\text{g}/\text{m}^3$. 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 $\mu\text{g}/\text{m}^3$ 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 $\mu\text{g}/\text{m}^3$ 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 $\mu\text{g}/\text{m}^3$, 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 contaminants.

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 without 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/m³) 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/m³, 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/m³ during the morning peak-hour and 13.5 mg/m³ 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/m³ 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/m³ 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/m³. However, future worst-case concentrations with the project were predicted to exceed the more stringent state 1-hour standard of 10 mg/m³ 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/m³ and was predicted to occur near the intersection of Kapolei Parkway and the north-south road. A value of 7.3 mg/m³ 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/m³ at the intersection of Farrington Highway and the project access road to areas K and L to 5.4 mg/m³ 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

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.

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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

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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.

Table 1
SUMMARY OF STATE OF HAWAII AND NATIONAL
AMBIENT AIR QUALITY STANDARDS

| Pollutant | Units | Averaging Time | Maximum Allowable Concentration | | State of Hawaii |
|-----------------------------------|-------------------|-------------------------------|---------------------------------|--------------------|-------------------|
| | | | National Primary | National Secondary | |
| Particulate Matter (<10 microns) | µg/m ³ | Annual
24 Hours | 50 ^a | 50 ^a | 50 |
| | | | 150 ^b | 150 ^b | 150 ^c |
| Particulate Matter (<2.5 microns) | µg/m ³ | Annual
24 Hours | 15 ^a | 15 ^a | - |
| | | | 65 ^d | 65 ^d | - |
| Sulfur Dioxide | µg/m ³ | Annual
24 Hours
3 Hours | 80 | - | 80 |
| | | | 365 ^e | - | 365 ^e |
| Nitrogen Dioxide | µg/m ³ | Annual | - | 1300 ^f | 1300 ^f |
| | | | 100 | 100 | 70 |
| Carbon Monoxide | mg/m ³ | 8 Hours
1 Hour | 10 ^c | - | 5 ^c |
| | | | 40 ^c | - | 10 ^c |
| Ozone | µg/m ³ | 8 Hours
1 Hour | 157 ^g | 157 ^g | - |
| | | | 235 ^g | 235 ^g | 100 ^g |
| Lead | µg/m ³ | Calendar
Quarter | 1.5 | 1.5 | 1.5 |
| | | | - | - | - |
| Hydrogen Sulfide | µg/m ³ | 1 Hour | - | - | 35 ^h |

^a Three-year average of annual arithmetic mean.

^b 90th Percentile value averaged over three years.

^c Not to be exceeded more than once per year.

^d 95th Percentile value averaged over three years.

^e Five-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.

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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.
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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 2
ANNUAL WIND FREQUENCY FOR BARBERS POINT, OAHU (%)

| Wind Direction | Wind Speed (knots) | | | | | Total | |
|----------------|--------------------|------|------|-------|-------|-------|-------|
| | 0-3 | 4-6 | 7-10 | 11-16 | 17-21 | | >21 |
| 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 |
| W | 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 |
| W | 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 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 / Makaha Gulch | | | | | |
| No. of 24-Hr Samples | - | - | 329 | 327 | 284 |
| Range of 24-Hr Values (µg/m ³) | - | - | 0-28 | 0-27 | 0-47 |
| Average Daily Value (µg/m ³) | - | - | 3 | 4 | 6 |
| No. of State AAQS Exceedances | - | - | 0 | 0 | 0 |
| PM-10 / Kapolei | | | | | |
| No. of 24-Hr Samples | - | - | 38 | 48 | 26 |
| Range of 24-Hr Values (µg/m ³) | - | - | 11-71 | 8-166 | 11-60 |
| Average Daily Value (µg/m ³) | - | - | 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/m ³) | - | - | 0.1-8.0 | 0.0-1.7 | 0.0-17.8 |
| Avg. Daily Maximum 1-Hr Value (mg/m ³) | - | - | 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 | 310 | 312 | 298 | 280 |
| Range of Daily Max. 1-Hr Values (ppb/m ³) | 0-86 | 4-114 | 9-120 | 9-126 | 21-111 |
| Avg. Daily Maximum 1-Hr Value (ppb/m ³) | 15 | 36 | 50 | 54 | 48 |
| No. of State AAQS Exceedances | 0 | 2 | 3 | 6 | 7 |
| Lead / Downtown Honolulu | | | | | |
| No. of 24-Hr Samples | - | - | 50 | 46 | 51 |
| Range of 24-Hr Values (µg/m ³) | - | - | 0-0.1 | 0-0.1 | 0-0.1 |
| Average Quarterly Value (µg/m ³) | - | - | 0.0 | 0.0 | 0.0 |
| No. of State AAQS Exceedances | - | - | 0 | 0 | 0 |
| Nitrogen Dioxide / Kapolei | | | | | |
| No. of 24-Hr Samples | - | - | - | - | 121 |
| Range of 24-Hr Values (ppb/m ³) | - | - | - | - | 4-28 |
| Average Daily Value (ppb/m ³) | - | - | - | - | 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 EXCEEDANCES OF AIR QUALITY STANDARDS
 FOR MONITORING STATIONS MAASST
 EAST KAPOLEI PROJECT

| Parameter / Location | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|------|-------|---------|---------|----------|
| Sulfur Dioxide / Makaiwa Gulch | | | | | |
| No. of 24-Hr Samples | - | - | 229 | 327 | 286 |
| Range of 24-Hr Values (µg/m ³) | - | - | 0-28 | 0-27 | 0-47 |
| Average Daily Value (µg/m ³) | - | - | 3 | 4 | 3 |
| No. of State AAQS Exceedances | - | - | 0 | 0 | 0 |
| PM-10 / Kapolei | | | | | |
| No. of 24-Hr Samples | - | - | 29 | 48 | 36 |
| Range of 24-Hr Values (µg/m ³) | - | - | 11-71 | 9-164 | 11-60 |
| Average Daily Value (µg/m ³) | - | - | 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/m ³) | - | - | 0.1-8.0 | 0.0-1.7 | 0.0-17.6 |
| Avg. Daily Maximum 1-Hr Value (mg/m ³) | - | - | 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 | 310 | 312 | 298 | 290 |
| Range of Daily Max. 1-Hr Values (ppb/m ³) | 0-86 | 4-118 | 9-120 | 9-126 | 21-111 |
| Avg. Daily Maximum 1-Hr Value (ppb/m ³) | 15 | 36 | 50 | 54 | 60 |
| 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/m ³) | - | - | 0-0.1 | 0-0.1 | 0-0.1 |
| Average Quarterly Value (µg/m ³) | - | - | 0.0 | 0.0 | 0.0 |
| No. of State AAQS Exceedances | - | - | 0 | 0 | 0 |
| Nitrogen Dioxide / Kapolei | | | | | |
| No. of 24-Hr Samples | - | - | - | - | 121 |
| Range of 24-Hr Values (µg/m ³) | - | - | - | - | 4-29 |
| Average Daily Value (µg/m ³) | - | - | - | - | 12 |
| No. of State AAQS Exceedances | - | - | - | - | 0 |

Source: State of Hawaii Department of Health

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*

| Air Pollutant | Emission Rate (tons/year) |
|-------------------|---------------------------|
| Particulate | 53 |
| Sulfur Dioxide | 533 |
| Carbon Monoxide | 40 |
| Volatile Organics | <1 |
| Nitrogen Oxides | 200 |

*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*

| Air Pollutant | Emission Rate
(tons/year) |
|-----------------|------------------------------|
| Particulate | <1 |
| Sulfur Dioxide | 44 |
| Carbon Monoxide | 14 |
| Nitrogen Oxides | 110 |

*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.

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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 Oahu (UHWO) campus to be located mauka of the project. The State Department of Hawaiian 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.

March 1998

Prepared for:

PBR Hawaii
Housing Finance & Development Corporation
Department of Accounting and General Services

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 Allen Bauer Associates
 Customer Insight Company
 International Survey
 Research
 Simmons Market
 Research Bureau, Inc.
 Strategic Marketing, Inc.

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. (DHL 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 DHL 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 Hawaii'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.

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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.)

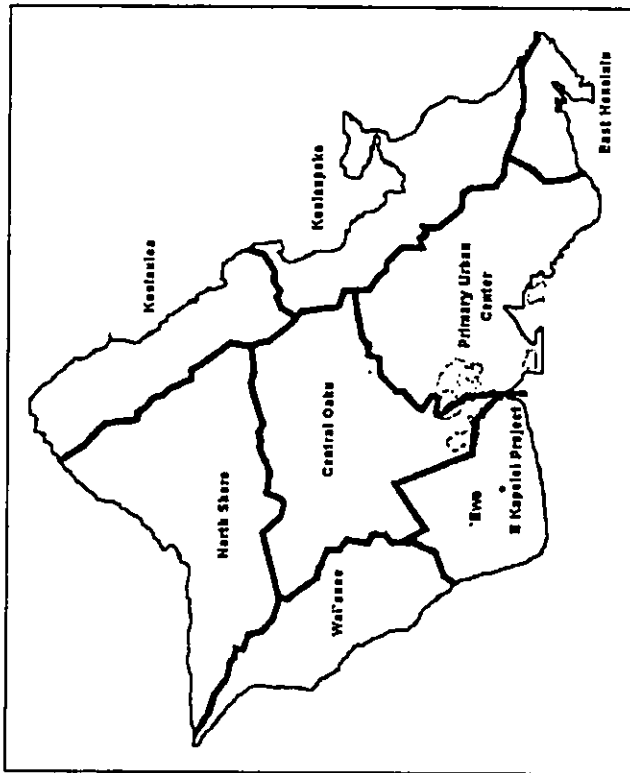
The HFDC plans to develop basic infrastructure for the site. It will then sell development rights for large housing areas. Once development costs are covered, proceeds of the land sales would go to finance construction of the University of Hawai'i West O'ahu campus. Other parts of the project will be developed by the Department of Hawaiian 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.

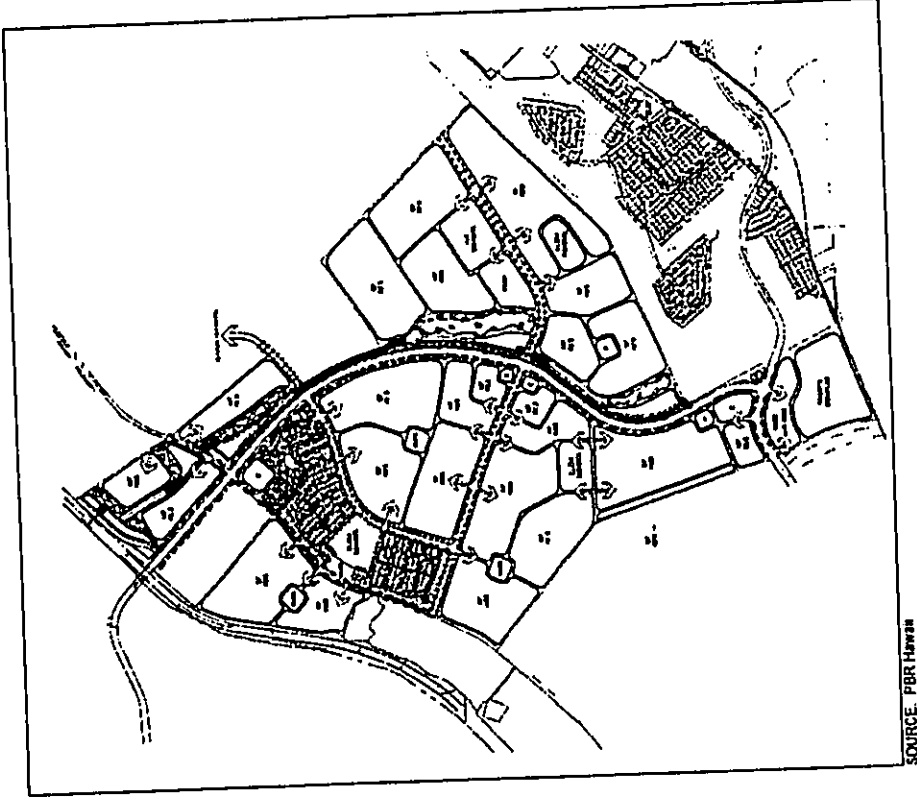
Apart from the Sports Complex, the proposed development would consist of housing with supporting infrastructure and public facilities. The residential portion of the project will probably include:

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 Hawaiians, 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.

Exhibit 1-B: PRELIMINARY CONCEPT PLAN



- 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.)

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 Hawaii.

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, Highway 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 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. Hawaiians 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 Waianae 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 Waianae 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, Waianae 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

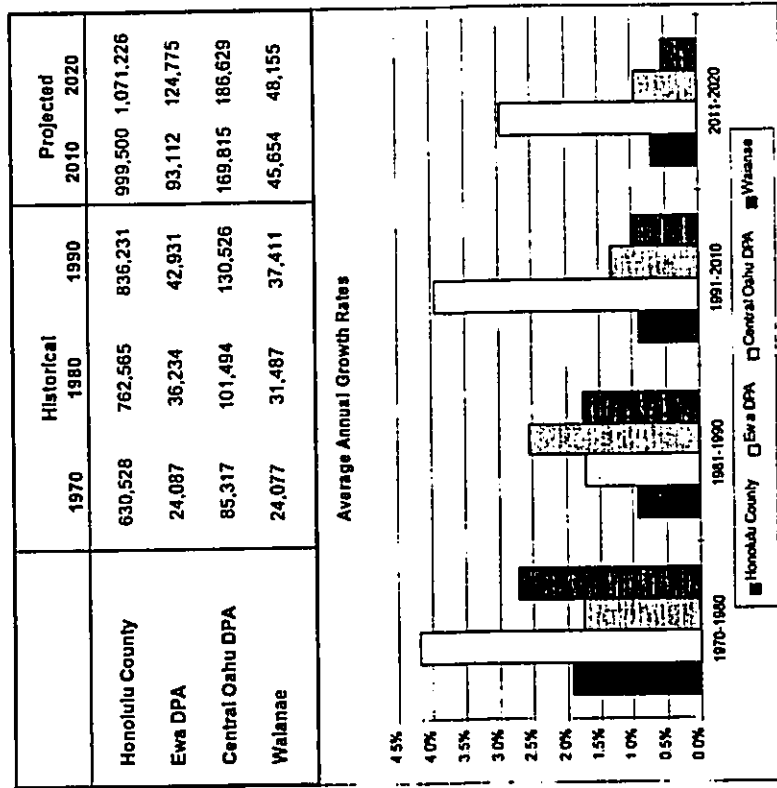
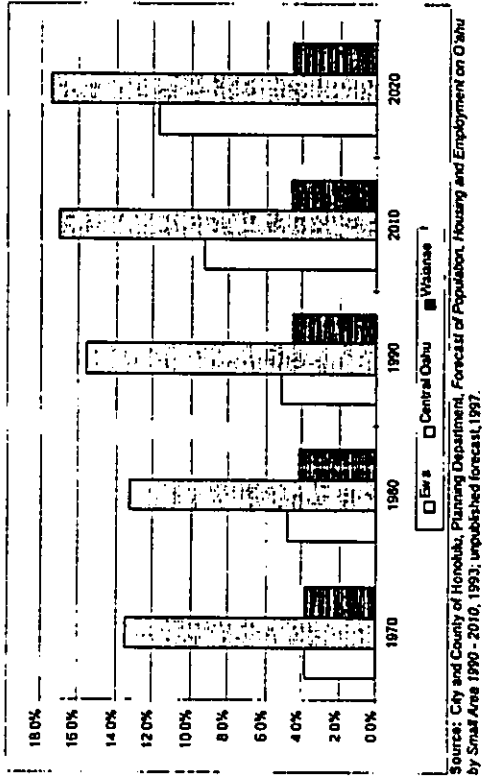


Exhibit 2-B: PERCENT OF ISLAND POPULATION FOR SELECTED DEVELOPMENT PLAN AREAS



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 1998) 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 Hawaii. 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 Hawaii West Oahu 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 Hawaii, 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 Oahu;

- 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 miti 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 built. 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 built. 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 Hawaiian, this area in the south-central portion of Honolulu 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 Hawaiian 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 Hawaii 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.

Non-Residential Developments

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 (Hawaii), Inc. is starting construction on 11 model residences of the first phase of Ke Alina 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 Genby | 2,600 |
| 'Ewa Marina | 2,250 |
| 'Ewa Fairways | 1,400 |
| Villages of Keppel | 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 Waikale 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.

Wa'anae. Wa'anae's growth is forecast by the City as modest in comparison to 'Ewa and Central Oahu. By 2010, Wa'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 Oahu. 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 built by mid-1997).
- **Village Pōka'i Bay.** A total of about 507 single-family homes are planned for this Wa'anae 'ahupua'a project. As of mid-1997, this project was 70% completed.

The City's forecasts for Wa'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 Oahu the majority of land held by DHHL is in Wa'anae. As of mid-1997, the City and County of Honolulu Planning Office's Development Plan Annual Report shows that in Wa'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 Wa'anae Coast, will be developed. The 9,000 jobs anticipated there are a significant resource for Wa'anae DPA residents as well as 'Ewa. If resort development does not proceed, no major new job center will be closer to Wa'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.

Major growth areas are located near Milliani and on the mauka side of Waipahu. Near Milliani, Milliani 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 or are expected to be completed by mid-1998. In Lanani Valley, over 500 units had been built, of a planned total of 1,028. The nearby Milliani Technology Park is still being developed.

Near Waipahu, Waikela 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 Oahu Sugar Mill site in Waipahu. These developments will likely bring more jobs to the area than operation at OSCO recently provided.

2.4.2 Wa'anae Development Plan Area

Wa'anae is relatively isolated, with one major roadway linking the region to the rest of Oahu. (A second road connection through the Wa'anae Range has been proposed.) Major land uses include military uses (at Luatulei and Mākua Valley), Hawaiian Homelands areas (in Nanakuli, Luatulei, and Wa'anae) and a golf course in Makaha.

The region is known for a distinctive "country" lifestyle based in the Native Hawaiian culture of many residents. Households are larger than in nearby regions. In 1990, the average household size in Wa'anae was 3.93 persons.

In 1990, Native Hawaiians made up 41% of the DPA population. About three-quarters of the population was born in Hawaii. 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 Wa'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).

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 Kapolei, 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 Makiki/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.

3. SPORTS COMPLEX

3.1 OVERVIEW

- **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 Honolulu Sewage Treatment Plant would be capable of handling the waste water treatment needs of the proposed development.

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 Hawaii 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.

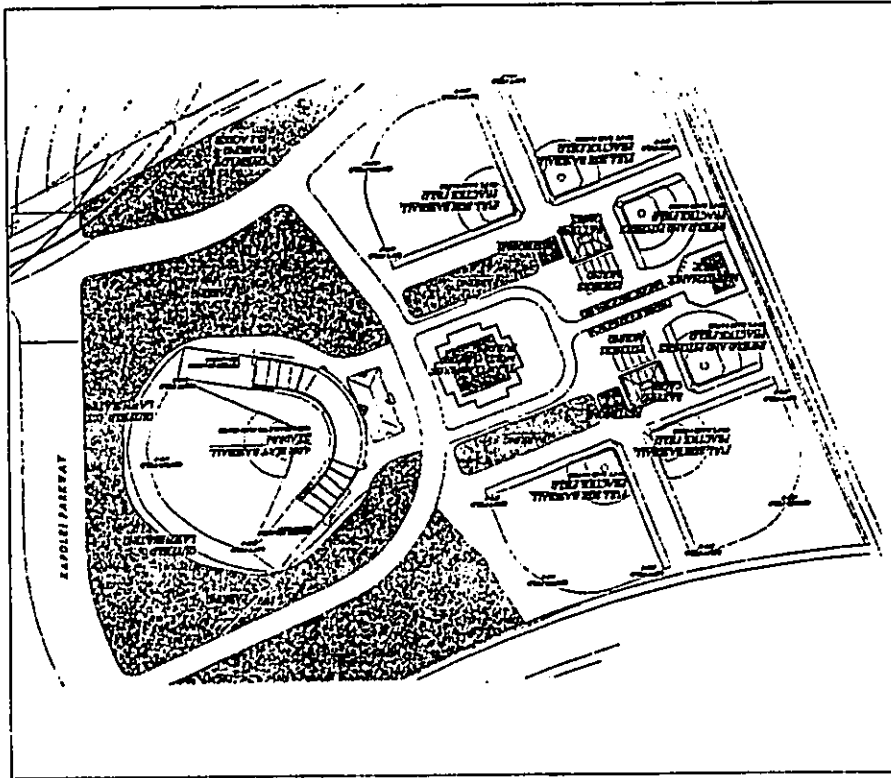
The proposal includes:

- 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 Hawaii; the Hawaii 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 Hawaii, 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 Direct Total | -\$500K
-\$20K | If viable --
\$100K to \$350K
\$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 Hawaii 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 Hawaii'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 Hawaii'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. Hawaii'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 Hawaii'i Winter League. Currently, the outfield is cramped, but it will increase in size as land donated by Amfac/JMB Hawaii'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. Hawaii'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 Waioala 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 Waioala 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 Hawaii'i. The Honolulu City Council has failed to date to vote funds for construction at Waioala. 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 1998, 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 been 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 Hawaiian 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 | | Phoenix |
| Dave Dunn | Promotion, State | | Mesa |
| Robert Brinton | Stadium Manager | HoHoKam Park | Mesa |
| Rob Harman | Mesa VCB, Director | | Phoenix |
| | Park's Dept | Phoenix Muni and Maryvale | |
| Ron Pies | City of Tempe, Pres. | Diablo Stadium | Tempe |
| Will Gorman | AZ Bball Commission | | Tempe |
| Dana Braccia | Stadium Coordinator | Diablo 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 |
| Abbe Scoggins | General Manager | NY Mel/Thomas J. White Stadium | Port St. Lucie |
| Don Miers | | Houston | Katimnee |
| | | Astros/Osceola County Stadium | |
| Rob Rabenecker | General Manager | Sports Complex | Jupiter |
| Grant Giffaser | GM, Vero Beach | LA Dodgers/Holman Stadium, Dodgerstown | Vero Beach |
| | Dodgers, Stadium Operations | | |
| Caroline Ginn | City Commissioner, | LA Dodgers/Holman Stadium, Dodgerstown | Vero Beach |
| Mat Thomas | Indian River County Dir of Economic Development, Indian River County | LA Dodgers/Holman Stadium, Dodgerstown | Vero Beach |
| Manney Brown | Asst Stadium Mgr. | Cincinnati Reds /Ed Smith Stadium | Sarasota |
| Patrick Calhoun | Sports Facilities Director | Cincinnati Reds /Ed Smith Stadium | Sarasota |
| Pete Schneider | Deputy City Administrator | Cincinnati Reds /Ed Smith Stadium | Sarasota |

Instructional League Baseball. The Hawaii 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.

Hawaii 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, Hawaii 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 Hawaii. 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 Hawaii, 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 Waikiki 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 shoofs.** 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 JumboIron scoreboard. Without Major League spring training in Hawaii, 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 Hawaii, 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 Barbours 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 Hawaii 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 Hawaii, 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 Hawaii 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 Hawaii, 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 Hironoto | Public Relations | Chiba Lotte Marines |
| Mr. Iijima | Asst. Director, Administration | Yomiuri Giants |

Most expressed polite interest in training in Hawaii, 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 Hawaii site will face serious competition from sites nearer Japan and Korea. Points that could favor development of spring training in Hawaii 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 Hawaii 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 Hawaii facility could stand out if equipped for serious training based on American research.

- **Ties to Japanese interests in Hawaii:** The teams training in Hawaii in the past include the Seibu Lions, who stayed at Seibu Railways' Maui Prince Hotel while training. Hawaii 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 Hawaii as their next spring training site. Retaining a team year after year may be more difficult.

- **Development of a Hawaii spring exhibition season:** Over the long term, Hawaii 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 |
| Hawai'i-based Hawai'i 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.

Exhibit 3-F: ESTIMATED ANNUAL OPERATING COSTS

| | Wages
per FTE | Range,
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 | \$ 488,640 |
| Contract services | | <i>Range per event</i> | | |
| 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 | | | | \$ 100,000 |
| water/sewer | | | | \$ 100,000 |
| electric | | | | \$ 20,000 |
| other | | | | \$ 5,000 |
| Promotion | | | | \$ - |
| Insurance | | | | \$ - |
| Off-Site Management | | | | \$ - |
| TOTAL | | | | \$ 994,640 |

NOTE: Estimated from costs of comparable US Marland facilities.

(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 Hawaii 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 Hawaii. 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-G: ESTIMATED ANNUAL OPERATING REVENUES

| | Potential Operator Revenues
Per Event | Annuality, HI |
|---|--|-------------------|
| PROFESSIONAL SPORTS (1) | | |
| Major League Baseball Spring Training (1) | \$ 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) | \$ 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 | \$ 1,600 | \$ 18,000 |
| OTHER STADIUM USES | | |
| Corporate Rentals | \$ 1,500 | \$ 12,000 |
| Concerts | \$ 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 | \$ 81,957 | \$ 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 1,125 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

| Assumptions affecting | Share | Low Range | High Range |
|-------------------------|---------|-----------|------------|
| Numbers of units | | 6 | 8 |
| Units/acre SF | | 10 | 12 |
| Units/acre MF | | | 561.3 |
| SF Acreage | | 561.3 | 166.3 |
| General | | | |
| DHHL | | 188.2 | 188.2 |
| MF Acreage | | 22.7 | 22.7 |
| General | | | |
| DHHL | | 3,368 | 4,490 |
| SF | | 1,010 | 1,346 |
| General | | | |
| DHHL | | 1,882 | 2,258 |
| MF | | 227 | 272 |
| Sales Price Basis | | | |
| Affordable (General) | 30% (1) | 1,575 | 2,025 |
| MF | | | |
| Market (General) | 70% | 3,368 | 4,490 |
| SF | | 307 | 234 |
| MF | | | |
| Self-help (DHHL) | 20% (2) | 247 | 324 |
| SF | | | |
| Contractor-built (DHHL) | 80% (2) | 762 | 1,023 |
| SF | | 227 | 272 |
| MF | | | |

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 | | | | | |
| Low Range | 671 | 475 | 375 | 85 | - |
| High Range | 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 | 126 | 1,195 | 2,264 | 3,199 | 3,199 |
| SF: General | 285 | 760 | 959 | 959 | 959 |
| SF: DHHL | 84 | 788 | 1,509 | 1,788 | 1,788 |
| MF: General | 143 | 259 | 259 | 259 | 259 |
| MF: DHHL | 638 | 3,010 | 4,991 | 6,205 | 6,205 |
| TOTAL | | | | | |
| High Range | 126 | 1,195 | 2,264 | 3,333 | 4,266 |
| SF: General | 285 | 760 | 1,235 | 1,279 | 1,279 |
| SF: DHHL | 84 | 796 | 1,509 | 2,145 | 2,145 |
| MF: General | 143 | 259 | 259 | 259 | 259 |
| MF: DHHL | 638 | 3,010 | 5,287 | 7,016 | 7,949 |
| TOTAL | | | | | |

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) Occupancy estimated as 95% of units built.

(4) The Prudential Locations, Inc., 1997, estimates of DHHL buildout by SMS Research, after discussions with DHHL staff.

SOURCES:

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 Hawaii 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 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 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 local impacts from absolute ones. An absolute impact is a change that will occur with a project, but would not occur otherwise; a local 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 Hawaii; 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 Hawaii. Arguably, sports teams and their supporters would come in response to invitations from other Hawaii 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 Hawaii can be estimated using multipliers from the model of input-output relations in Hawaii'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
(in 1,000,000s, 1997 \$) | | | | | |
| 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 | 1,332 | 2,175 | 2,346 | 1,481 | - |
| Direct jobs | 2,065 | 3,372 | 3,636 | 2,295 | - |
| Indirect and induced jobs | 3,398 | 5,547 | 5,982 | 3,776 | - |
| TOTAL JOBS | | | | | |
| Low Range | 1,356 | 2,217 | 2,590 | 1,906 | 1,167 |
| Direct jobs | 2,102 | 3,437 | 4,016 | 2,954 | 1,809 |
| Indirect and induced jobs | 3,459 | 5,654 | 6,606 | 4,859 | 2,977 |
| Construction-related income
(in 1,000,000s, 1997 \$) | | | | | |
| Low Range | \$ 58.7 | \$ 95.8 | \$ 103.4 | \$ 65.2 | \$ - |
| Direct jobs | \$ 56.5 | \$ 92.3 | \$ 99.5 | \$ 62.8 | \$ - |
| Indirect and induced jobs | \$ 115.2 | \$ 188.1 | \$ 202.8 | \$ 128.0 | \$ - |
| TOTAL INCOME | | | | | |
| Low Range | \$ 59.8 | \$ 97.7 | \$ 114.1 | \$ 84.0 | \$ 51.4 |
| Direct jobs | \$ 57.5 | \$ 94.0 | \$ 109.9 | \$ 80.8 | \$ 49.5 |
| Indirect and induced jobs | \$ 117.3 | \$ 191.7 | \$ 224.0 | \$ 164.8 | \$ 100.9 |
| TOTAL INCOME | | | | | |

NOTES: Construction cost from assumptions in Exhibit 4-C. Jobs estimated from 1998 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 Hawaii 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 Hawaii'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 | 281 | 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 | 148 | 168 |
| 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 year
- Property mgmt. 3 per 100 MF units sold
- Commercial 2 per 100 SF units sold
- Schools 3 per 1,000 sf of commercial space built (GLA)
- Parks 45 per acre (@ 15,000 GLA/ac)
- Sports Complex 8.3 per 100 students
- Parks 6.2 per 100 students
- Sports Complex 8.5 per 100 students
- Parks 1.6 per 1,000 residents

SOURCES: Hawai'i 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 | 289 | 358 | 358 |
| Subtotal: Indirect and Induced Jobs | 148 | 642 | 968 | 1,128 | 1,101 |
| TOTAL: Direct, Indirect and Induced Jobs | 309 | 1,340 | 2,028 | 2,392 | 2,356 |
| 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 | 16 |
| Auto Repair | 9 | 44 | 75 | 80 | 80 |
| Eating and Drinking | 23 | 117 | 189 | 210 | 210 |
| Education | 22 | 96 | 165 | 215 | 241 |
| Real Estate | 31 | 140 | 201 | 253 | 250 |
| Retail Trade | 40 | 199 | 339 | 358 | 358 |
| Subtotal: Indirect and Induced Jobs | 148 | 646 | 1,064 | 1,214 | 1,248 |
| TOTAL: Direct, Indirect and Induced Jobs | 309 | 1,347 | 2,235 | 2,549 | 2,633 |
| Ewa Share of Operations Jobs | | | | | |
| Low Range | 161 | 698 | 1,060 | 1,264 | 1,255 |
| Direct | 8 | 43 | 76 | 102 | 107 |
| Indirect and Induced | 169 | 741 | 1,136 | 1,365 | 1,362 |
| TOTAL | 161 | 701 | 1,171 | 1,335 | 1,385 |
| High Range | 161 | 701 | 1,171 | 1,335 | 1,385 |
| Direct | 8 | 43 | 83 | 110 | 121 |
| Indirect and Induced | 169 | 745 | 1,254 | 1,445 | 1,507 |
| TOTAL | 161 | 701 | 1,171 | 1,335 | 1,385 |

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 DREDT version, but on Input-Output 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 direct jobs statewide (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-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 | 664 | 1,128 | 1,126 | 255 | - |
| General | 618 | 428 | - | - | - |
| DHHL | 1,281 | 1,554 | 1,128 | 255 | - |
| TOTAL | 664 | 1,126 | 1,126 | 887 | 247 |
| High Range | 618 | 428 | 428 | - | - |
| General | 618 | 428 | 428 | - | - |
| DHHL | 1,281 | 1,554 | 1,554 | 887 | 247 |
| TOTAL | 2,516 | 10,576 | 17,103 | 20,943 | 20,943 |
| Cumulative Population | | | | | |
| Low Range | 2,516 | 10,749 | 18,516 | 24,106 | 27,054 |
| High Range | 2,516 | 10,749 | 18,516 | 24,106 | 27,054 |

NOTES:
 (1) Unit count as shown in Exhibit 3-1.
 (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. Unpublished forecasts, Honolulu Planning Department, SMS Research, 1995.

SOURCES:

Project residents will largely already be residents of Hawaii. No new residents are likely to be attracted to Oahu by the housing areas or by the Sports Complex.

Exhibit 4-G: INCOME FROM OPERATIONS-RELATED JOBS

| | 2002 | 2007 | 2012 | 2017 | 2022 |
|---|-----------|-----------|-----------|-----------|-----------|
| Amounts are in \$1,000s of 1997 dollars | | | | | |
| Low Range | | | | | |
| Direct Jobs | \$ 216 | \$ 1,096 | \$ 1,889 | \$ 2,380 | \$ 2,380 |
| Agriculture (Landscaping) | \$ 402 | \$ 402 | \$ 402 | \$ 402 | \$ 402 |
| Amusement Services | \$ 196 | \$ 980 | \$ 1,470 | \$ 1,764 | \$ 1,764 |
| Auto Repair | \$ 354 | \$ 1,768 | \$ 2,652 | \$ 3,183 | \$ 3,183 |
| Eating and Drinking | \$ 871 | \$ 3,662 | \$ 5,923 | \$ 7,252 | \$ 7,252 |
| Education | \$ 325 | \$ 1,440 | \$ 2,075 | \$ 2,104 | \$ 1,842 |
| Real Estate | \$ 926 | \$ 4,632 | \$ 6,948 | \$ 8,337 | \$ 8,337 |
| Retail Trade | \$ 3,290 | \$ 13,981 | \$ 21,359 | \$ 25,423 | \$ 25,161 |
| Subtotal | \$ 4,047 | \$ 17,568 | \$ 26,421 | \$ 30,803 | \$ 30,113 |
| Indirect and Induced Jobs | \$ 7,337 | \$ 31,549 | \$ 47,780 | \$ 56,226 | \$ 55,274 |
| TOTAL | \$ 11,384 | \$ 49,117 | \$ 74,201 | \$ 87,029 | \$ 85,387 |
| High Range | | | | | |
| Direct Jobs | \$ 216 | \$ 1,119 | \$ 1,961 | \$ 2,689 | \$ 3,039 |
| Agriculture (Landscaping) | \$ 402 | \$ 402 | \$ 402 | \$ 402 | \$ 402 |
| Amusement Services | \$ 196 | \$ 980 | \$ 1,666 | \$ 1,764 | \$ 1,764 |
| Auto Repair | \$ 354 | \$ 1,768 | \$ 3,006 | \$ 3,183 | \$ 3,183 |
| Eating and Drinking | \$ 871 | \$ 3,722 | \$ 6,412 | \$ 8,346 | \$ 9,369 |
| Education | \$ 325 | \$ 1,459 | \$ 2,094 | \$ 2,827 | \$ 2,597 |
| Real Estate | \$ 926 | \$ 4,632 | \$ 7,874 | \$ 8,337 | \$ 8,337 |
| Retail Trade | \$ 3,280 | \$ 14,083 | \$ 23,415 | \$ 27,350 | \$ 28,691 |
| Subtotal | \$ 4,047 | \$ 17,680 | \$ 28,848 | \$ 33,208 | \$ 34,140 |
| Indirect and Induced Jobs | \$ 7,337 | \$ 31,763 | \$ 52,263 | \$ 60,559 | \$ 62,832 |
| TOTAL | \$ 11,384 | \$ 49,443 | \$ 81,111 | \$ 93,767 | \$ 96,972 |

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 Oahu housing among Native Hawaiian 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.

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 Hawaiian 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 | 1,365 |
| 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 | 4,689 |
| 'Ewa | 401 | 1,712 | 2,560 | 3,001 | 2,946 |
| High Range | | | | | |
| Statewide | 615 | 2,634 | 4,268 | 4,790 | 4,889 |
| 'Ewa | 401 | 1,722 | 2,627 | 3,175 | 3,259 |
| Workforce Households | | | | | |
| Low Range | | | | | |
| Statewide | 212 | 923 | 1,524 | 1,746 | 1,604 |
| 'Ewa | 118 | 507 | 778 | 935 | 933 |
| High Range | | | | | |
| Statewide | 212 | 923 | 1,524 | 1,746 | 1,604 |
| '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, 1997b

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 | 7,365 | 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-I

4.4.3 Visitor Population

Of the various components of the East Kapolei project, only the Sports Complex will attract visitors to Hawaii. 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 Hawaii (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 Hawaii 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 Hawaii. 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

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 (ANNUAL) | | | | | |
| 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 | - | 68.6 | 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) | \$0 | \$0 | \$0 | \$0 | \$0 |
| Unimproved Res | \$121,985 | \$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 | \$166,760 |
| 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 | \$96,000 | \$179,750 | \$235,250 | \$235,250 |
| Commercial | \$2,218 | \$17,744 | \$31,052 | \$39,974 | \$39,974 |
| TOTAL VALUE (LAND + IMPROVED) | \$208,526 | \$580,671 | \$981,054 | \$1,336,433 | \$1,347,194 |

(Continued)

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, Cont.

| | 2002 | 2007 | 2012 | 2017 | 2022 |
|---|------|-----------|-----------|-----------|-----------|
| C. ADJUSTMENT FOR OWNER-OCCUPANT EXEMPTION (4) | | | | | |
| VALUE OF EXEMPTIONS (3) | | | | | |
| Improved Residential | \$0 | \$41,320 | \$66,320 | \$131,320 | \$133,008 |
| Apartment | \$0 | \$27,520 | \$57,520 | \$75,260 | \$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 | \$181 | \$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. Units 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) | 296.6 | 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 | 189.2 |
| 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 | \$959 |
| Commercial | \$3,470 | \$6,248 | \$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 | \$44,808 | \$93,603 | \$142,400 | \$191,187 |
| Apartment | \$0 | \$19,895 | \$41,562 | \$63,270 | \$65,305 |
| Commercial | \$0 | \$0 | \$0 | \$0 | \$0 |
| ANNUAL NEW IMPROVED VALUE | | | | | |
| Improved Residential | \$0 | \$6,250 | \$6,250 | \$6,250 | \$6,250 |
| Apartment | \$0 | \$18,750 | \$18,750 | \$18,750 | \$0 |
| Commercial | \$2,218 | \$2,218 | \$2,218 | \$0 | \$0 |
| CUMULATIVE IMPROVED VALUE | | | | | |
| Improved Residential | \$0 | \$28,750 | \$53,500 | \$820,750 | \$1,102,000 |
| Apartment | \$0 | \$48,000 | \$179,750 | \$273,500 | \$282,300 |
| Commercial | \$2,218 | \$17,744 | \$33,270 | \$39,924 | \$39,924 |
| TOTAL VALUE (LAND + IMPROVED) | \$227,407 | \$608,562 | \$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 | \$46,320 | \$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 | \$450 | \$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 | | | | | |
| Annual | \$21 | \$2,050 | \$4,247 | \$6,369 | \$7,540 |
| Cumulative | \$21 | \$5,636 | \$22,895 | \$50,391 | \$45,933 |

NOTES: All figures in thousands of dollars, except Acreage (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.
- (2) Unit transferred to developers, State land is not taxed, so actual value is not at issue.
- (3) Land owned by State not taxed. Land sold for development taxed under urban classifications.
- (4) DHHIL land and improvements are excluded from these calculations as not taxed.
- (5) Standard homeowner's exemption (\$40,000) assumed for all units. Homeowner's exemption applied to improved value.

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 | Visitor |
| General government | \$6,963.0 | \$7.56 | \$7.56 |
| Control | \$83,181.0 | \$95.70 | \$0.00 |
| Staff | | | |
| Public safety | \$156,210.1 | \$169.70 | \$169.70 |
| Police and fire | \$20,574.1 | \$22.35 | \$22.35 |
| Other | \$28,413.1 | \$30.87 | \$30.87 |
| Highways | \$101,092.5 | \$109.82 | \$109.82 |
| Health and sanitation | \$55,149.2 | \$59.91 | \$59.91 |
| Recreation | \$72,323.7 | \$83.20 | \$0.00 |
| Interest | \$87,225.0 | \$100.35 | \$0.00 |
| Bond redemption | \$70,860.3 | \$81.52 | \$0.00 |
| Retirement and pension | \$27,926.4 | \$32.13 | \$0.00 |
| Economic and urban development | \$82,943.5 | \$95.42 | \$95.42 |
| Mass Transit | \$17,705.4 | \$20.37 | \$0.00 |
| Cash capital improvements | \$63,265.8 | \$72.78 | \$0.00 |
| Miscellaneous | | | |
| 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 \$) | 2002 | 2007 | 2012 | 2017 | 2022 |
|--------------------------------------|---------|------------|-------------|-------------|-------------|
| Revenues | | | | | |
| Real Property Taxes from Project | \$ 29.2 | \$ 2,165.0 | \$ 4,466.3 | \$ 6,258.2 | \$ 6,299.5 |
| Low Range | \$ 20.7 | \$ 2,049.6 | \$ 4,247.1 | \$ 6,369.1 | \$ 7,539.6 |
| High Range | | | | | |
| Costs | | | | | |
| Costs due to Increased Visitor Count | 35 | 58 | 58 | 58 | 58 |
| Average Visitor Count | \$ 0.02 | \$ 0.04 | \$ 0.04 | \$ 0.04 | \$ 0.04 |
| Costs | | | | | |
| Annual Balance | \$ 29.2 | \$ 2,165.0 | \$ 4,466.3 | \$ 6,258.2 | \$ 6,299.5 |
| Low Range | \$ 20.7 | \$ 2,049.6 | \$ 4,247.1 | \$ 6,369.1 | \$ 7,539.6 |
| High Range | | | | | |
| 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

| | 1998-2002 | 2003-2007 | 2008-2012 | 2013-2017 | 2018-2022 |
|--------------------------|-----------|-----------|-----------|-----------|-----------|
| <i>(in \$7,000,000s)</i> | | | | | |
| 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 | \$ - | \$ - | \$ - | \$ - | \$ - |
| Income Taxes | \$ 1.1 | \$ - | \$ - | \$ - | \$ - |
| Corporate (3) | \$ 0.5 | \$ 0.9 | \$ 0.8 | \$ 0.5 | \$ - |
| Personal (4) | \$ 4.6 | \$ 8.9 | \$ 8.0 | \$ 5.0 | \$ - |
| TOTAL | \$ 9.7 | \$ 18.6 | \$ 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 | \$ - | \$ - | \$ - | \$ - | \$ - |
| Income Taxes | \$ 1.1 | \$ 6.9 | \$ 7.8 | \$ 4.9 | \$ 3.0 |
| 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 by 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 Hawaii, 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 HAWAII: LOW RANGE

| | 1998-2002 | 2003-2007 | 2008-2012 | 2013-2017 | 2018-2022 |
|---|-----------|-----------|-----------|-----------|-----------|
| <i>In millions of 1997 \$</i> | | | | | |
| REVENUES | | | | | |
| Land Sales | \$ 216.2 | \$ 24.6 | \$ - | \$ - | \$ - |
| State Revenues Associated with Construction | \$ 10.0 | \$ 14.1 | \$ 15.2 | \$ 9.2 | \$ - |
| Revenues associated with Operations | \$ 0.9 | \$ 7.6 | \$ 14.7 | \$ 19.4 | \$ 19.5 |
| State Taxes on Operations Workforce Income | \$ 0.6 | \$ 2.5 | \$ 2.6 | \$ 2.6 | \$ 2.6 |
| Sports Center Operating Revenues | \$ 0.6 | \$ 2.3 | \$ 2.4 | \$ 2.4 | \$ 2.4 |
| Revenues from Visitor Spending Cash Flows | \$ 73.7 | \$ 60 | \$ 67 | \$ 62 | \$ 4.9 |
| Annual Total (end of period) | \$ 228.2 | \$ 279.2 | \$ 314.0 | \$ 347.6 | \$ 372.1 |
| Cumulative Total (end of period) | | | | | |
| COSTS | | | | | |
| Construction | \$ 94.8 | \$ - | \$ - | \$ - | \$ - |
| HFDC | \$ 27.8 | \$ - | \$ - | \$ - | \$ - |
| DAGS | \$ 7.7 | \$ - | \$ - | \$ - | \$ - |
| Other Development Costs | \$ - | \$ - | \$ - | \$ - | \$ - |
| Lending | \$ 27.4 | \$ - | \$ - | \$ - | \$ - |
| HFDC | \$ (17.9) | \$ 12.1 | \$ 12.1 | \$ 12.1 | \$ 2.4 |
| DAGS | \$ 0.1 | \$ 0.2 | \$ 0.2 | \$ 0.2 | \$ 0.2 |
| Costs due to Increased Visitor Count | \$ 7.4 | \$ 2.5 | \$ 2.5 | \$ 2.5 | \$ 0.0 |
| Annual Total (end of period) | \$ 139.8 | \$ 152.1 | \$ 164.4 | \$ 176.7 | \$ 179.3 |
| Cumulative Total (end of period) | | | | | |
| BALANCE | | | | | |
| HFDC | \$ 65.6 | \$ - | \$ - | \$ - | \$ - |
| Annual Total (end of period) | \$ 94.0 | \$ 118.5 | \$ 118.5 | \$ 118.5 | \$ 118.5 |
| Cumulative Total (end of period) | | | | | |
| All State Revenues and Costs | \$ 68.3 | \$ 3.6 | \$ 4.2 | \$ 3.7 | \$ 4.9 |
| Annual Total (end of period) | \$ 88.3 | \$ 127.1 | \$ 149.6 | \$ 170.9 | \$ 197.8 |
| Cumulative Total (end of period) | | | | | |

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 lending and amount of repayment by DHEIL or DAGS to HFDC is not shown. Again, DHEIL 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 8.25%. 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 HAWAII: HIGH RANGE

| | 1998-2002 | 2003-2007 | 2008-2012 | 2013-2017 | 2018-2022 |
|---|-----------|-----------|-----------|-----------|-----------|
| <i>In millions of 1997 \$</i> | | | | | |
| 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 | \$ 0.9 | \$ 7.6 | \$ 14.7 | \$ 19.4 | \$ 19.5 |
| State Taxes on Operations Workforce Income | \$ 0.6 | \$ 2.5 | \$ 2.6 | \$ 2.6 | \$ 2.6 |
| Sports Center Operating Revenues | \$ 0.6 | \$ 2.3 | \$ 2.4 | \$ 2.4 | \$ 2.4 |
| Revenues from Visitor Spending Cash Flows | \$ 84.8 | \$ 61 | \$ 72 | \$ 7.9 | \$ 5.1 |
| Annual Total (end of period) | \$ 263.6 | \$ 319.9 | \$ 356.3 | \$ 392.9 | \$ 424.6 |
| Cumulative Total (end of period) | | | | | |
| COSTS | | | | | |
| Construction | \$ 94.8 | \$ - | \$ - | \$ - | \$ - |
| HFDC | \$ 27.8 | \$ - | \$ - | \$ - | \$ - |
| DAGS | \$ 7.7 | \$ - | \$ - | \$ - | \$ - |
| Other Development Costs | \$ - | \$ - | \$ - | \$ - | \$ - |
| Lending | \$ 27.4 | \$ - | \$ - | \$ - | \$ - |
| HFDC | \$ (17.9) | \$ 12.1 | \$ 12.1 | \$ 12.1 | \$ 2.4 |
| DAGS | \$ 0.1 | \$ 0.2 | \$ 0.2 | \$ 0.2 | \$ 0.2 |
| Costs due to Increased Visitor Count | \$ 7.4 | \$ 2.5 | \$ 2.5 | \$ 2.5 | \$ 0.0 |
| Annual Total (end of period) | \$ 139.8 | \$ 152.1 | \$ 164.4 | \$ 176.7 | \$ 179.3 |
| Cumulative Total (end of period) | | | | | |
| BALANCE | | | | | |
| HFDC | \$ 76.7 | \$ - | \$ - | \$ - | \$ - |
| Annual Total (end of period) | \$ 129.3 | \$ 158.8 | \$ 158.8 | \$ 158.8 | \$ 158.8 |
| Cumulative Total (end of period) | | | | | |
| All State Revenues and Costs | \$ 77.3 | \$ 3.6 | \$ 4.7 | \$ 5.4 | \$ 5.1 |
| Annual Total (end of period) | \$ 123.8 | \$ 167.8 | \$ 191.9 | \$ 216.3 | \$ 245.3 |
| Cumulative Total (end of period) | | | | | |

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 lending and amount of repayment by DHEIL or DAGS to HFDC is not shown. Again, DHEIL 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 8.25%. 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

| <i>In millions of 1997 \$s</i> | | 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).

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.

Exhibit 4-T: ESTIMATED IMPACT OF UHWO TRANSFER ON HFDC

| | Gross Acres | Net Acres | Valuation (Million 1997 \$) | |
|---|-------------|----------------|-----------------------------|-----------------|
| | | | 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 |
| | | | <u>\$ 298.0</u> | <u>\$ 347.3</u> |
| Developable portion per gross acre | 1,235.7 | 951.4 | | |
| | | 77.0% | | |
| Excluding: DHHL area | 200.0 | 191.0 | \$ 57.3 | \$ 66.3 |
| Total realizable from Land Sales | | | <u>\$ 240.7</u> | <u>\$ 281.0</u> |
| 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 | | <u>1,015.7</u> | | |
| 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.)) minus share of infrastructure | | | \$120.6 | \$140.5 |
| | | | <u>\$35.9</u> | <u>\$35.9</u> |
| | | | <u>\$84.7</u> | <u>\$104.6</u> |
| D. Amount needed to cover costs | | | | |
| Infrastructure cost | | | \$ 94.8 | \$ 94.8 |
| Interest | | | \$ 27.4 | \$ 27.4 |
| UHWO | | | \$ 64.7 | \$ 104.6 |
| Total | | | <u>\$ 206.9</u> | <u>\$ 226.8</u> |
| 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 | | | <u>\$ 206.9</u> | <u>\$ 226.8</u> |
| Difference (cushion for HFDC) | | | <u>\$ 33.9</u> | <u>\$ 54.2</u> |

NOTES: Calculated by SMS based on land and usage assumptions of project, as shown above and in preceding exhibits.

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 Hawaii 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 park 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 Hawaii'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 Hawaii'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 Farington 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 Farington 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 Hawaii West Oahu 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 Hawaii 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 | 1,183 |

NOTES: (1) From Exhibit 4-1.

(2) Public school enrollments estimated on the basis of historical share of population in school age cohorts and in public schools. Factors used here --

9.5% 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.

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

- **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 overburdened.

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.

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'i families and will extend the Hawai'i 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 regional infrastructure and facilities (discussed in Section 6) can be addressed through:

Exhibit 7-A: POSSIBLE MITIGATION MEASURES

| POTENTIAL ADVERSE IMPACTS | MITIGATION MEASURES |
|---|---|
| <p>Quality of Life</p> <p>Regional physical and social infrastructure for growing community</p> <p>On-site: lack of childcare, limited community space</p> <p>On-site and in Kapolei Villages near Sports Complex: Irritation due to traffic congestion</p> <p>Possible disruptions of residential life due to events at Sports Complex</p> <p>Health and Safety</p> <p>Construction dust and noise</p> <p>Community Character</p> <p>Preservation of the character of nearby 'Ewa Villages</p> | <ul style="list-style-type: none"> • Develop infrastructure for project in coordination with other public agencies • Work with community groups to plan for regional facilities • 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 • Work for development of the North-South Road interchange with H-1 • Noise restrictions • Follow City and State regulations governing construction • Plan construction timing to limit duration of impact on adjoining areas • Anticipate, respond to resident complaints • 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 Barber's 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 Hawaii, 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 | 935,231 | 42,960 | 130,474 | 37,411 |
| ETHNICITY | | | | |
| Caucasian | 32% | 40% | 30% | 23% |
| Japanese | 23% | 9% | 20% | 6% |
| Filipino | 14% | 23% | 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% | 8% | 7% |
| Median age (years) | 32.2 | N/A | N/A | 28.3 |
| EDUCATION OF PERSONS | | | | |
| AGED 25 & OVER (2) | | | | |
| High School Diploma (3) | 81% | 80% | 82% | 69% |
| College Degree (4) | 33% | 23% | 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 18 to 64 | 4% | 5% | 4% | 8% |
| % of persons aged 65 or more | 18% | 20% | 20% | 26% |

NOTES: (1) See Appendix A-9 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 Associates, 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% | 48% | 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% | 28% | 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
4. INCOME CHARACTERISTICS, SELECTED DP AREAS, 1990 (1)

| | Honolulu County | SELECTED DP AREAS | | |
|---|-----------------|-------------------|----------|----------|
| | | Ewa | Central | Waiānae |
| 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 | \$39,506 | \$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 | \$730 | \$652 | \$551 |
| POPULATION (2) | | | | |
| PERSONS BELOW POVERTY LEVEL | | | | |
| % of persons aged 18 to 64 | 7% | 5% | 7% | 19% |
| % of persons aged 65 or more | 6% | 4% | 5% | 15% |
| % of related children aged less than 18 | 8% | 4% | 9% | 14% |
| % of unrelated individuals | 10% | 5% | 10% | 20% |
| | 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 \$15,000 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 rich and poor.
 (7) Owner costs include (but are not limited to) mortgage, real property tax, property insurance, utilities, and fuel.
 (8) Renter costs include (but are not limited to) rent, utilities, and fuel.
 (9) Monthly cash rent only. Does not include other costs.

SOURCES: U.S. Bureau of the Census, 1992, 1991.

Appendix A
3. HOUSING CHARACTERISTICS, SELECTED DP AREAS, 1990

| | Honolulu County | SELECTED DP AREAS | | |
|----------------------------------|-----------------|-------------------|-----------|-----------|
| | | Ewa | Central | Waiānae |
| HOUSING UNITS | | | | |
| TOTAL VACANT UNITS | 281,683 | 11,734 | 36,260 | 10,660 |
| Seasonal/recreational | 6% | 3% | 2% | 12% |
| | 2% | 0% | 0% | 4% |
| AGE OF STRUCTURE (1) | | | | |
| 1 year | 2% | 7% | 3% | 1% |
| 2 to 10 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 | | | | |
| TOTAL | 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 | | | | |
| Lightly crowded (2) | 8% | 11% | 10% | 16% |
| Very crowded (3) | 8% | 9% | 8% | 18% |
| MEAN VALUE (4) | \$312,624 | \$233,270 | \$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
5. LABOR FORCE CHARACTERISTICS, SELECTED DP AREAS, 1990 (1)

| | Honolulu County | SELECTED DP AREAS | | |
|--|-----------------|-------------------|---------------|---------------|
| | | Ewa | Central | Waiānae |
| POPULATION AGED 16 & OVER
In Armed Forces | 651,920
8% | 30,768
17% | 94,346
16% | 24,973
2% |
| POTENTIAL CIVILIAN LABOR FORCE
In Civilian Labor Force | 598,371
69% | 25,556
71% | 78,949
72% | 24,377
62% |
| CIVILIAN LABOR FORCE | 410,023 | 18,081 | 57,071 | 15,107 |
| MALE | | | | |
| Labor force participation (2) | 75% | 79% | 75% | 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% | 6% | 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% | 18% | 19% |
| Public administration | 9% | 11% | 12% | 9% |
| BY OCCUPATION | | | | |
| Managerial, professional | 28% | 18% | 23% | 17% |
| Technical, sales, support | 35% | 35% | 35% | 27% |
| Service | 17% | 16% | 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 | 42,903 |
| APPROXIMATE CENSUS AREAS | |
| Tracl 83.01 | 42,960 |
| Tracl 83.02 | 5,786 |
| Tracl 87.98 (BG 9 only) | 6,699 |
| Tracl 84 | 826 |
| Tracl 85 | 9,677 |
| Tracl 86.03 (all except BG 1) | 4,529 |
| Tracl 86.04 | 5,907 |
| Tracl 86.98 | 4,015 |
| DIFFERENCE | 5,521 |
| | 23 |
| CENTRAL DP AREA | 130,474 |
| APPROXIMATE CENSUS AREAS | |
| Tracl 82 | 130,474 |
| Tracl 86.03 (BG 1 only) | 0 |
| Tracl 87.01 | 802 |
| Tracl 87.02 | 7,596 |
| Tracl 87.98 (all except BG 9) | 4,181 |
| Tracl 88 | 3,645 |
| Tracl 89.01 | 6,172 |
| Tracl 89.04 | 8,084 |
| Tracl 89.05 | 5,183 |
| Tracl 89.06 | 7,581 |
| Tracl 89.07 | 4,025 |
| Tracl 89.08 | 4,560 |
| Tracl 89.09 | 6,668 |
| Tracl 89.10 | 3,779 |
| Tracl 89.11 | 10,444 |
| Tracl 89.12 | 11,893 |
| Waianua Division (1) | 2,193 |
| DIFFERENCE | 43,866 |
| | 0 |

NOTE: (1) Composed of Tracls 90, 91, 92, 93, 94, 95.01, 95.02, 95.03, 95.04, and 95.05

SOURCES: U.S. Bureau of the Census, 1992.
Shaw 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 | 838,231 | 2,218 | 14,315 | 3,780 | 9,828 | 1,992 |
| ETHNICITY | | | | | | |
| Caucasian | 32% | 78% | 23% | 8% | 47% | 31% |
| Japanese | 23% | 1% | 1% | 14% | 10% | 18% |
| Filipino | 11% | 8% | 3% | 8% | 18% | 28% |
| Hawaiian | 11% | 1% | 1% | 5% | 13% | 7% |
| Other | 20% | 15% | 12% | 5% | 14% | 15% |
| AGE | | | | | | |
| Less than 5 years | 7% | 18% | 7% | 7% | 8% | 10% |
| 5 to 17 years | 17% | 10% | 23% | 21% | 19% | 15% |
| 18 to 24 years | 31% | 61% | 30% | 27% | 34% | 45% |
| 25 to 34 years | 34% | 31% | 33% | 30% | 36% | 27% |
| 35 to 64 years | 11% | 0% | 7% | 15% | 3% | 3% |
| 65 or more years | 32% | 24% | 26% | 32% | 28% | 28% |
| EDUCATION OF PERSONS AGED 25 & OVER (1) | 81% | 90% | 71% | 55% | 90% | 88% |
| High School Diploma (2) | 33% | 15% | 17% | 12% | 37% | 37% |
| College Degree (3) | | | | | | |
| PERSONS AGED 5 & OVER WHO SPEAK A LANGUAGE OTHER THAN ENGLISH AT HOME (1) | 26% | 15% | 20% | 48% | 16% | 24% |
| PERSONS WITH MOBILITY OR SELF-CARE LIMITATIONS (1) | 4% | 2% | 6% | 4% | 5% | 3% |
| % of persons aged 18 to 64 | 18% | 0% | 18% | 22% | 15% | 0% |
| % of persons aged 65 or more | | | | | | |

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% | 83% | 62% | 45% | 52% |
| Other U.S.-born (3) | 30% | 78% | 18% | 5% | 43% | 31% |
| Foreign born | 16% | 9% | 20% | 33% | 12% | 17% |
| RESIDENCE YEARS PREVIOUS FOR PERSONS AGED 5 & OVER | | | | | | |
| Same house | 50% | 2% | 81% | 43% | 47% | 2% |
| Same county, different house | 26% | 5% | 20% | 50% | 29% | 28% |
| Same state, different county | 1% | 0% | 1% | 1% | 1% | 2% |
| Different state | 17% | 17% | 6% | 3% | 25% | 18% |
| Lived abroad | 6% | 14% | 3% | 4% | 6% | 3% |
| HOUSEHOLDERS (2) | | | | | | |
| WHEN HOUSEHOLDER MOVED INTO UNIT | | | | | | |
| In the last 5 years | 53% | 99% | 39% | 54% | 64% | 100% |
| 6 to 20 years ago | 29% | 1% | 49% | 23% | 28% | 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 | 838 | 3,050 | 732 |
| TOTAL VACANT UNITS | 8% | 1% | 2% | 4% | 2% | 6% |
| Seasonal/retiree | 2% | 0% | 0% | 0% | 0% | 0% |
| AGE OF STRUCTURE (1) | | | | | | |
| 1 year | 2% | 1% | 1% | 5% | 1% | 7% |
| 2 to 10 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 BY STRUCTURE | | | | | | |
| 1 unit | 55% | 49% | 89% | 95% | 79% | 50% |
| 2 to 4 units | 7% | 18% | 4% | 2% | 7% | 5% |
| 5 or more units | 38% | 30% | 8% | 1% | 13% | 44% |
| Trailer, other | 1% | 2% | 1% | 3% | 1% | 1% |
| NOT COMPLETE PLUMBING (1) | 1% | 0% | 1% | 0% | 0% | 0% |
| HOUSEHOLDS | 281,304 | 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% | 89% | 66% | 74% | 80% |
| Renter-occupied | 48% | 100% | 11% | 34% | 26% | 20% |
| PERSONS PER HOUSEHOLD | 3.02 | 3.32 | 4.26 | 4.19 | 3.30 | 2.81 |
| CROWDED HOUSEHOLDS | | | | | | |
| Slightly crowded (2) | 8% | 4% | 17% | 21% | 7% | 16% |
| Very crowded (2) | 8% | 1% | 15% | 21% | 5% | 7% |
| MEDIAN VALUE (4) | \$293,800 | \$275,000 | \$210,900 | \$116,500 | \$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 (7) | 13% | 14% | 11% | 13% | 3% | 5% |
| Highest (4) | 17% | 1% | 18% | 8% | 20% | 8% |
| Median Income (5) | \$40,581 | \$23,808 | \$45,184 | \$48,924 | \$50,264 | \$45,874 |
| Inequitable Range (8) | \$43,154 | \$13,400 | \$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 | 8% | 1% | 14% | 5% | 3% | 3% |
| OWNER HOUSING COSTS (7) | | | | | | |
| 35% or more of Household Income | 15% | N/A | 16% | 12% | 24% | 28% |
| 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% | 48% | 28% |
| Median Gross Rent | \$483 | \$664 | \$755 | \$127 | \$971 | \$873 |
| Median Contract Rent (8) | \$415 | \$444 | \$701 | \$99 | \$860 | \$907 |
| POPULATION (2) | | | | | | |
| PERSONS BELOW POVERTY LEVEL | | | | | | |
| % of persons aged 18 to 64 | 7% | 1% | 7% | 1% | 3% | 6% |
| % of persons aged 65 or more | 6% | 0% | 6% | 1% | 3% | 4% |
| % 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 \$15,000 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 fuel.
(8) Renter costs include (but are not limited to) rent, utilities, and fuel.
(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 | Barber's Point | Ewa Beach | Ewa Villages | Makakilo | Ewa Gentry |
|--|-----------------|----------------|---------------|--------------|--------------|--------------|
| POPULATION AGED 16 & OVER
In Armed Forces | 651,920
0% | 1,641
52% | 10,489
3% | 2,155
1% | 7,296
13% | 1,634
12% |
| POTENTIAL CIVILIAN LABOR FORCE
In Civilian Labor Force | 549,371
84% | 892
73% | 10,221
70% | 2,831
87% | 6,306
70% | 1,442
87% |
| CIVILIAN LABOR FORCE | 410,073 | 549 | 7,129 | 1,899 | 4,768 | 1,235 |
| MALE | | | | | | |
| Labor force participation (7) | 75% | 82% | 76% | 77% | 84% | 94% |
| Unemployed | 4% | 21% | 6% | 5% | 5% | 1% |
| FEMALE | | | | | | |
| Labor force participation (7) | 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% | 1% | 1% | 0% |
| Construction | 7% | 8% | 8% | 8% | 8% | 7% |
| Manufacturing | 8% | 2% | 8% | 13% | 9% | 10% |
| Transportation | 7% | 4% | 7% | 7% | 7% | 7% |
| Retail trade | 18% | 29% | 24% | 20% | 18% | 18% |
| 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% | 16% | 20% | 18% |
| Public administration | 8% | 16% | 7% | 9% | 15% | 15% |
| BY OCCUPATION | | | | | | |
| Managerial, professional | 28% | 15% | 12% | 9% | 20% | 28% |
| Technical, sales, support | 35% | 39% | 34% | 27% | 30% | 30% |
| Service | 17% | 26% | 22% | 20% | 13% | 14% |
| Farming, forestry, fishing | 2% | 0% | 1% | 0% | 1% | 0% |
| Precision, craft, repair | 10% | 13% | 14% | 13% | 13% | 11% |
| Operators, cleaners, laborers | 8% | 5% | 17% | 23% | 10% | 12% |
| COMMITTEE TO WORK | | | | | | |
| More than 45 minutes | 18% | 5% | 31% | 22% | 18% | 30% |
| More than 1 hour | 2% | 1% | 4% | 2% | 2% | 3% |

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 County 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 team 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, Kaula | Member, Makakilo/Kapolei/Honokai Hale
Neighborhood Board
President, West Oahu Development Corporation
Chairman, Wai'anae Coast Comprehensive Health
Center |
| Delahanty, Kathleen | Chairman, Kapolei Elementary SCBM
Task Force Member, Kapolei Middle School
Board Member, School to Work Opportunities
Consortium, Leeward District
Resident, Makakilo |
| Donlin, Obed | Director, Community Relations, Kaiti Mohala
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 |
|-----------------|---|
| Hui, Chuck | Manager, Commercial and Office Properties,
The Estate of James Campbell |
| Iwamasa, Merle | Principal, Ikena Intermediate School |
| Kaopua, Nani | Officer, Juvenile Services Division, Honolulu
Police Department
Site Coordinator, AKAMAI Youth Project, 'Ewa |
| Kushima, Lazley | President, Villages of Kapolei Community
Association |
| Leoward, 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 | Manager, 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, Quany Operations, Grace Pacific Corporation |
| Timson, Maeda | Chair, Makakilo/Kapolei/Honokai Hale Neighborhood Board
Commissioner, Barbers Point NAS Redevelopment Commission
Resident, Makakilo |
| Tokuwara, 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 |
| Wickramaina, 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

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APPENDIX F

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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 1997

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,

A handwritten signature in cursive script, appearing to read "Esther Ueda".

ESTHER UEDA
Executive Officer

EU:rg

encl: Boundary Interpretation Map dated November 25, 1997

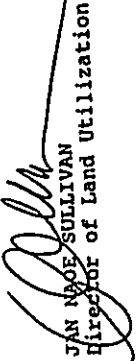
cc: Jan Sullivan, C&C of Honolulu DLU Director (w/encl.)
Attn: Carolyn Miyata
Glenn Y. Sato, Tax Maps & Records Supervisor (w/encl.)
C&C of Honolulu, Department of Finance

Mr. Joseph X. Conant, Executive Director
Page 3
June 23, 1998

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 Kaloii 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: /PBR Hawaii (David Hulse)

01pp01kapolei.djt



8 SULLIVAN, J. CAUTLING
CONTINUED

ROY'S OSHIRO
EXECUTIVE DIRECTOR

REPLY HERE TO:

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION

177 OAKEN STREET, SUITE 200
HONOLULU, HAWAII 96813
(808) 551-2000

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.
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.
- 2.



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 on the 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.

The Honorable Jan Nae Sullivan, Director
June 30, 1998
Page 4

Once again, thank you for participating in the environmental
review process.

Sincerely,



ROY S. OSHIRO
Executive Director

BENJAMIN J. CAYETANO
GOVERNOR

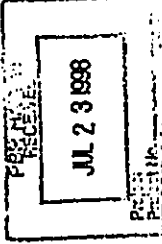


STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5087

July 20, 1998

KAZU HAYASHIDA
DIRECTOR
DEPUTY DIRECTOR
BENJAMIN J. CAYETANO
GOVERNOR
OLEWAI ILI, OAHU

IN REPLY REFER TO:
STP # 8684



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
FBR Hawaii



STATE OF HAWAII
DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM
HOUSING AND COMMUNITY DEVELOPMENT CORPORATION OF HAWAII
877 OWEA STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX: (808) 547-9600

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 (HCDC) East Kapolei Master Plan Development Project - Draft Environmental Impact Statement (DEIS)

Donald K. W. Lau

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. HCDC 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.

RONALD K. LAU
EXECUTIVE DIRECTOR

STATE OF HAWAII
DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

98:DEV/316

PHONE (808) 594-1888

FAX (808) 594-1865

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STATE OF HAWAII
OFFICE OF HAWAIIAN AFFAIRS
711 KAPOLEI BOULEVARD, SUITE 500
HONOLULU, HAWAII 96813

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.

Letter to Mr. Steve Thomas
June 17, 1998
Page 2

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. GERTLAND
DIRECTOR



STATE OF HAWAII
DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM
HOUSING AND COMMUNITY DEVELOPMENT CORPORATION OF HAWAII

877 GREEN STREET, SUITE 302
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FAX (808) 531-5000

DONALD K. W. LAU
EXECUTIVE DIRECTOR

BENJAMIN J. GERTLAND
DIRECTOR

98:DEV/160

Randall Ogata, Administrator
July 15, 1998
Page 2

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.

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 Hawaiian 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.

BRUNNEN & CARTER
601/7400



DONALD K. W. LAU
EXECUTIVE DIRECTOR
SHARON L. WATSON
EXECUTIVE ASSISTANT

STATE OF HAWAII
DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM
HOUSING AND COMMUNITY DEVELOPMENT CORPORATION OF HAWAII
417 QUEEN STREET, SUITE 200
HONOLULU, HAWAII 96813
713 (808) 551-4900

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
Executive Director

CITY AND COUNTY OF HONOLULU

BUILDING DEPARTMENT
HONOLULU MUNICIPAL BUILDING
439 SOUTH KING STREET
HONOLULU, HAWAII 96813



May 12, 1998

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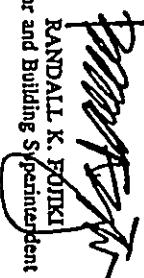
RANDALL K. FOLKI
DIRECTOR AND BUILDING SUPERINTENDENT
1500 N. MAQUILA
1500 N. MAQUILA
HONOLULU, HAWAII 96813

PB 98-280

Mr. Steve Thomas
Page 2
May 12, 1998

Should there be any questions, please contact Douglas Collinson at 527-6375.

Very truly yours,


RANDALL K. FOLKI
Director and Building Superintendent

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)
TRM: 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.