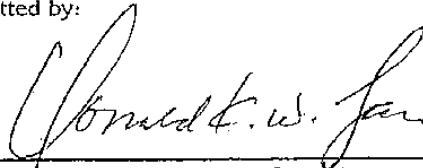


EAST KAPOLEI **MASTER PLAN**

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

DRAFT REPORT for the

**EAST KAPOLEI DRAINAGE MASTER
PLAN**
Ewa, Oahu, Hawaii

JUNE 1998

PREPARED FOR:

Housing Finance and Development Corporation
State of Hawaii

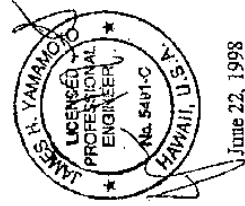
RMTC

R. M. Towill Corporation
420 Waiakamilo Rd., Suite 411
Honolulu, Hawaii 96817-4941
(808) 842-1133 • Fax: (808) 842-1937

EAST KAPOLEI
DRAINAGE MASTER PLAN
Ewa, Oahu, Hawaii

Prepared for:
Housing Finance and Development Corporation
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Prepared by:
R. M. Towill Corporation
420 Waiakamilo Road, Suite 411
Honolulu, Hawaii 96817



June 22, 1998

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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

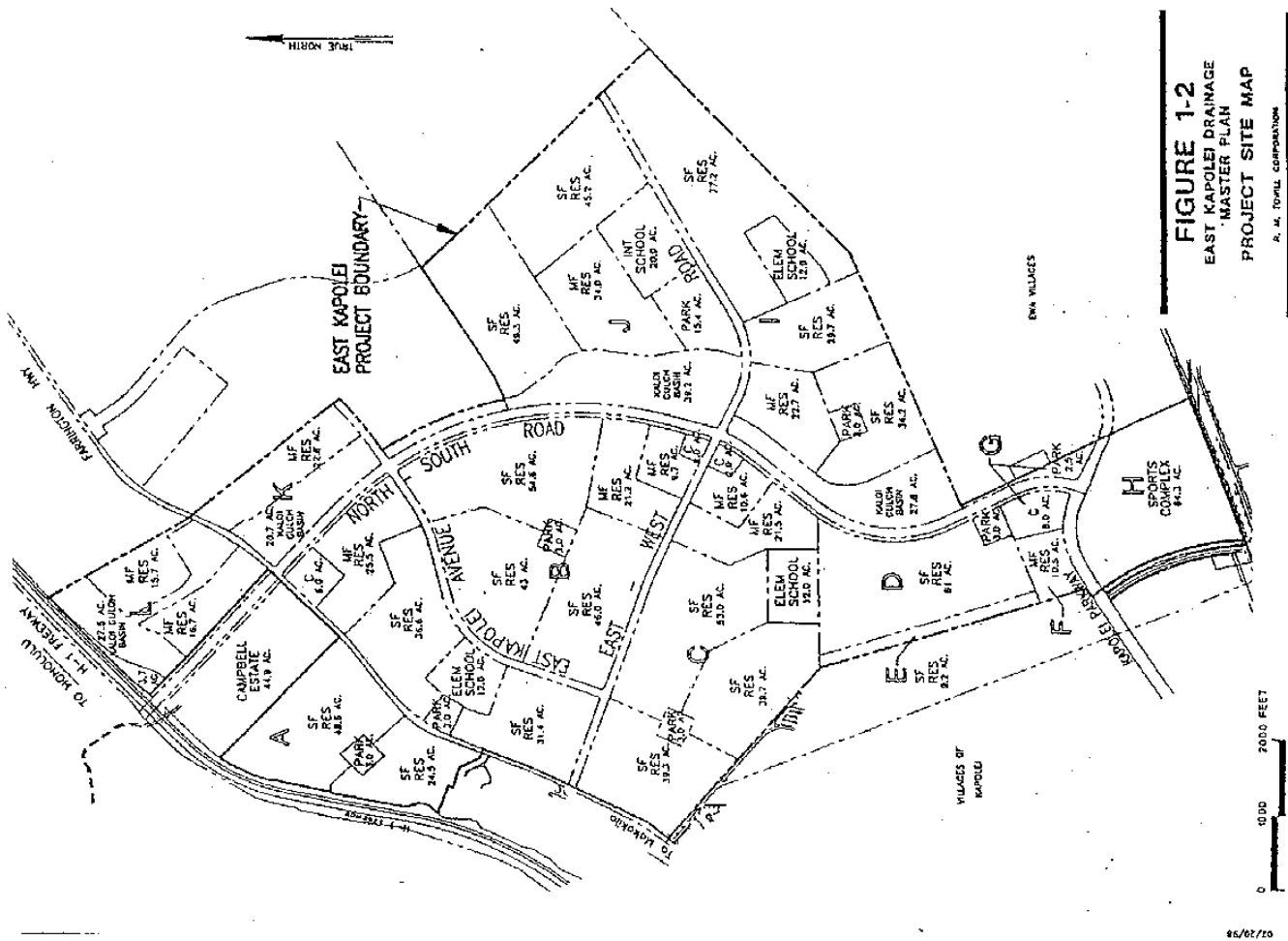


FIGURE 1-2
 EAST KAPOLEI DRAINAGE
 MASTER PLAN
 PROJECT SITE MAP
 P. M. TOMM CORPORATION

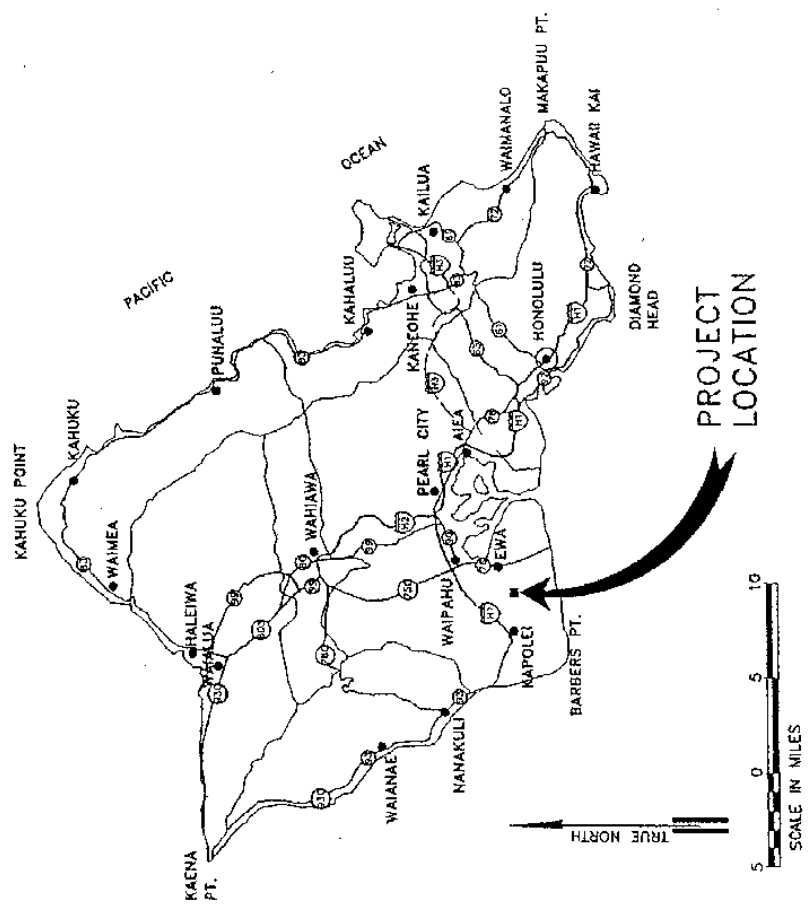
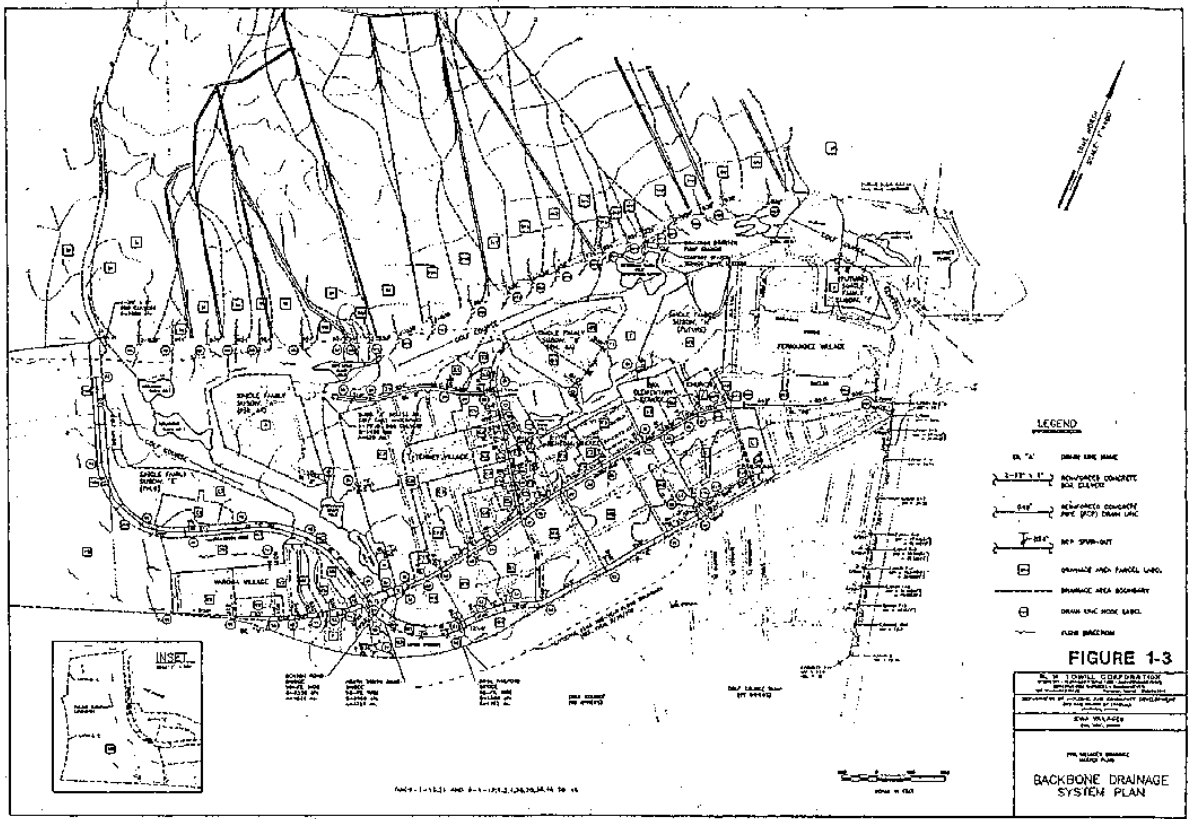


FIGURE 1-1
 EAST KAPOLEI DRAINAGE
 MASTER PLAN
 LOCATION AND VICINITY MAP
 P. M. TOMM CORPORATION

LOCATION & VICINITY MAP

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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 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.

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 (Reference 5)
 - 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 Kalo'i 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.

3.3 Topography

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

3.4 Soil Type and Ground Cover

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

Ground cover conditions within the project site are primarily agricultural. The area was previously used for the cultivation of sugar cane. In the mountainous areas above the H-1 Freeway, ground cover consists of thin stand trees and fallow sugarcane fields.

3.5 Pre-developed Drainage Patterns

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

A portion of the East Kapolei project is located in the West Loch basin. Another portion of the project is located in the Kapolei basin, to the west. A smaller portion of the project lies between Varoua Village and the Villages of Kapolei, and runoff from this portion flows into the Varoua 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 34-inch RCP culverts at Fort Weaver Road and shallow box drains. The culverts have a capacity of approximately 500 cfs. Discharge from the basins sheet flow into Pearl Harbor. Existing runoff volume is calculated to be 690 acre-feet, with a Plate 6 peak discharge of 1,100 cfs at the top of the Ewa Villages Golf Course.

3.5.2 Kaloi Watershed

The Kaloi Stream enters the northern portion of the site and continues down into the western corner of the Ewa Villages Golf Course. It is a small ditch with a full bank capacity of less than 1,000 cfs. Numerous road crossings further restrict flow to less than 500 cfs in some locations. Overflows are generally not able to return to the channel. Kaloi Stream was used by Oahu Sugar Company (OSCo) to carry irrigation water down to the lower fields and therefore has built-up banks which are higher than the adjacent ground. The HEC-1 computations incorporate flow diversions caused by restrictions (e.g., culverts at roadways) as well as flow routing in the natural depressions. The existing Kaloi watershed has approximately 3,850 acres. The existing 100-year, 24-hour runoff volume at the upper boundary of the Ewa Villages Golf course is calculated to be 2,816 acre-feet, and the Plate 6 peak discharge is calculated to be 7,075 cfs.

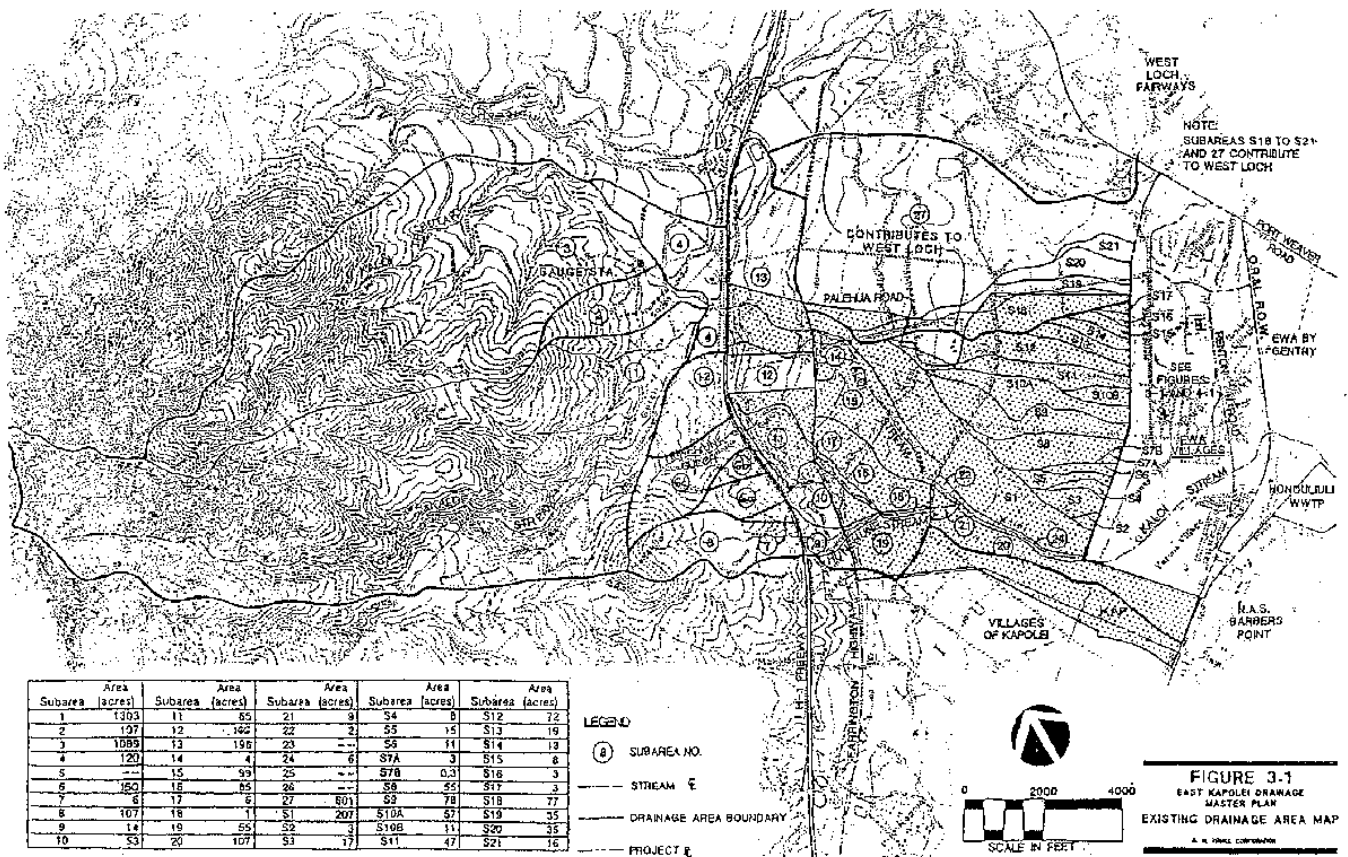
Kaloi Stream is gauged above the H-1 Freeway by the U.S. Geological Survey (Gauge No. 16212450 Drainage Area = 1,70 sq. mi.).

3.5.3 Kaloi-Ewa Villages Watershed
 Drainage subareas S3 through S17 (Figure 3-1) consists of approximately 420 acres and contribute to the runoff into central Ewa Villages, and ultimately to Kaloi Stream. Runoff enters the golf course through several small culvert crossings in the relocated Mango Tree Road, as well as overtopping the road. The calculated 100-year, 24-hour runoff volume is 374 acre-feet and the Plate 6 peak discharge is 1,400 cfs at the top of the golf course.

3.5.4 Varona Village Sub-Watershed
 The Varona Village sub-watershed is a part of the Kaloi Watershed, but runoff from this drainage area does not enter the Ewa Villages Golf Course. Drainage subarea 20 contributes to the runoff into Varona Village and ultimately back to Kaloi Stream. The *Ewa Villages Drainage Master Plan* includes the drainage area of the proposed sports complex (Figure 1-2) in its backbone drainage system calculations for Varona Village. The master plan calls for the construction of an 8' x 6' box culvert along Renton Road to convey the tributary offsite flow. In 1996, construction plans for the proposed box drain were approved, but construction was deferred indefinitely. Presently, runoff in this area continues to inundate the unimproved Varona Village.

3.6 Existing Runoff Concerns
 The flat topography between the Ewa Villages property line and Farrington Highway make it difficult to determine a clear delineation between watersheds. For purposes of computing Plate 6 flows, the small ridges of high ground as shown on the topographic maps are used to divide the watershed (USGS 1"=2000' and C&C 1"=200'). A photogrammetric topographic survey was prepared in 1996 by R.M. Tovill 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.



SECTION 4
PROPOSED DRAINAGE PLAN

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 Reinton 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.

4.1 Drainage Plan Concept

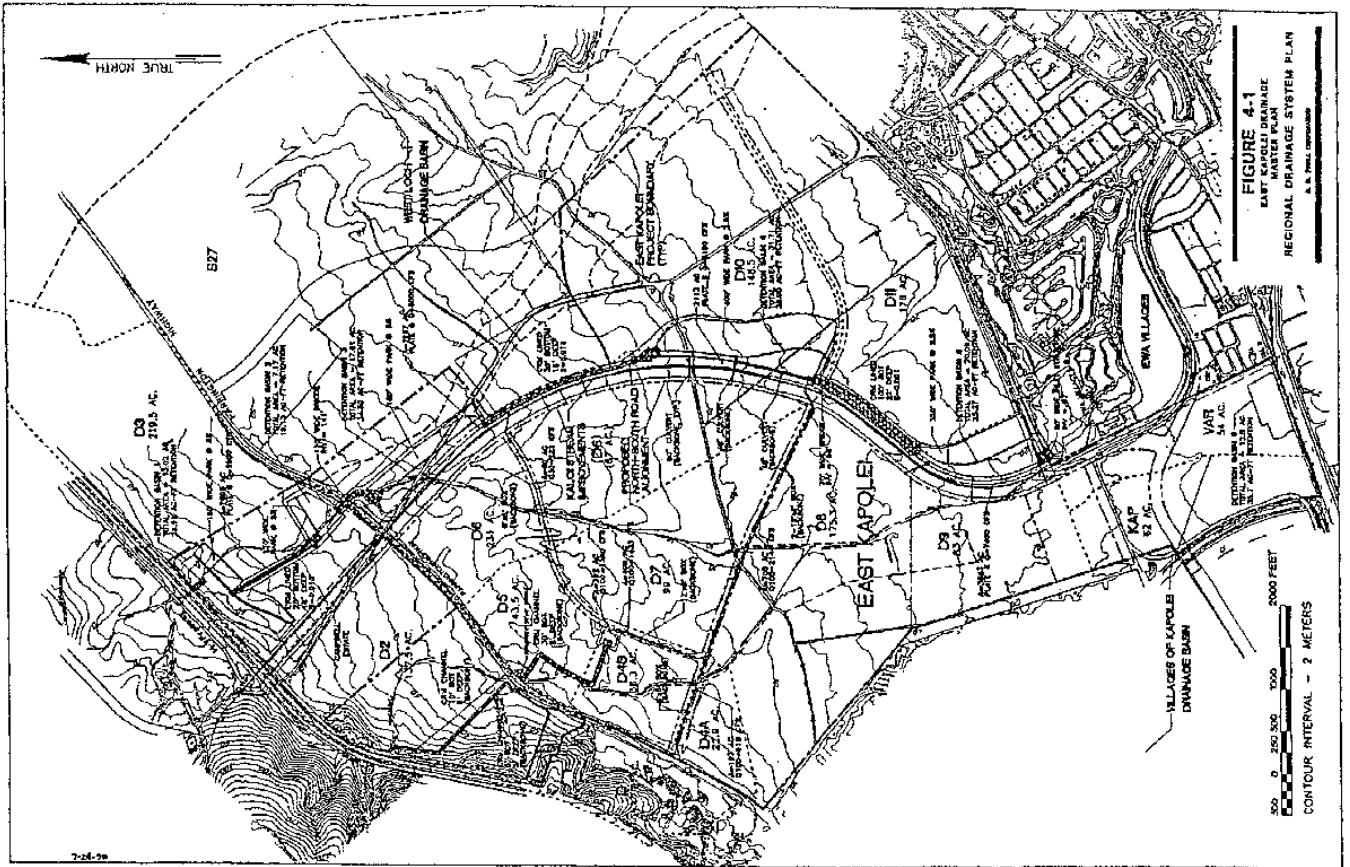
The intent of the drainage plan is to control flooding and provide adequate storm water disposal for on-site and off-site generated runoff.

To carry out the plan, "regional" facilities are proposed to address off-site runoff and mitigate flooding from Kaloi Stream. "Backbone" facilities are proposed to address the on-site generated runoff, and feed into the regional facilities. Project areas above Farrington Highway as well as areas west of the proposed North-South Road are planned to feed the regional drainage system. Due to existing topography constraints, project areas below Farrington Highway and east of the proposed North-South Road are not planned to contribute to the "regional" system. These areas are proposed to discharge runoff into the Ewa Villages Golf Course, as they currently do, via on-site backbone facilities. "Backbone" facilities for these areas east of the North-South Road are left as subdivision design items and are not discussed in this master plan.

4.2 Regional Drainage System

Flood control along Kaloi Stream and conveyance of major runoff are handled by the regional drainage system. The primary facilities include the Kaloi Stream channel improvements, detention and retention structures and roadway bridges. Figure 4-1 illustrates the regional drainage system.

The regional facilities were sized using criteria in Section 2. HEC-1 analyses were conducted to determine the increases in runoff and peak flow between the undeveloped and developed conditions as well as to determine detention basin sizes. HEC-2 analyses were performed to determine the size of the proposed Kaloi channel, in order to convey runoff from the entire Kaloi-Huonahuu watershed.



4.2.1 Kaloi Channel Improvements

The Kaloi Channel is the main regional facility. The channel is planned to be constructed along the east-side of the proposed North-South Road, within portions of the right-of-way, from the upper boundary of the Ewa Villages Golf Course to the H-1 Freeway. The channel will be owned and maintained by the State of Hawaii, and improved to convey the City & County's Plate 6 (estimated 100-year storm) flows. Using the City's standards will allow future proposed City drainage facilities to utilize the channel. Improvements include a combination of grass and CRM-lined channels and detention basins to attenuate the peak flows and to store the increase in runoff due to the East Kapolei development. The detention basins will also serve as water features, with the adjacent gradually sloping shoulders serving as a linear parks (Figure 4-2).

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

4.2.2 Proposed Bridge Structures and Culverts

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

A 70-foot wide bridge is proposed to be constructed at the master planned East-West Road to allow the Kaloi channel to cross the intersecting road. A 30-foot wide (minimum) bridge is required to replace the existing Kaloi Stream structure on Farmington 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 Hunchune 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

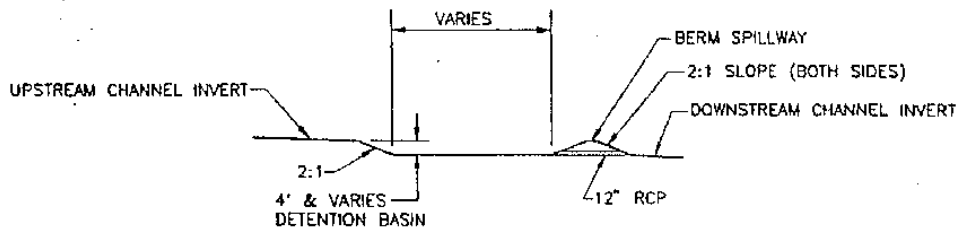
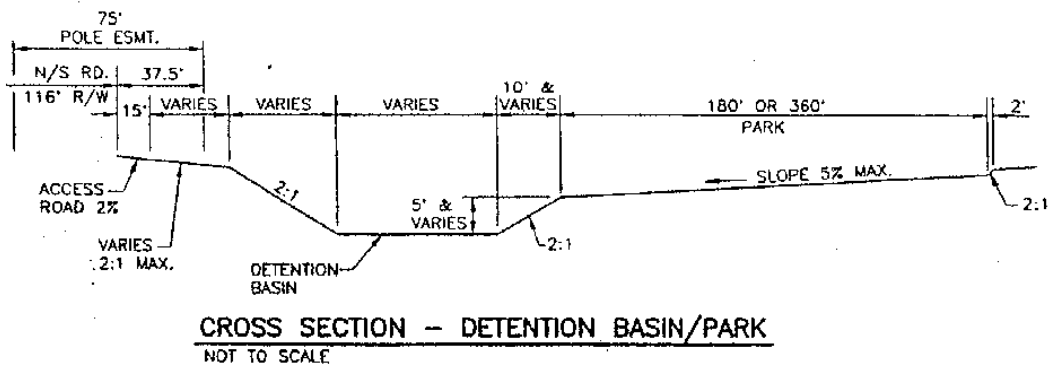


FIGURE 4-2
EAST KAPOLEI DRAINAGE
MASTER PLAN
PROPOSED DETENTION BASIN SECTIONS

approximately 0.45-feet within the golf course due to the additional 325 cfs used in this study.

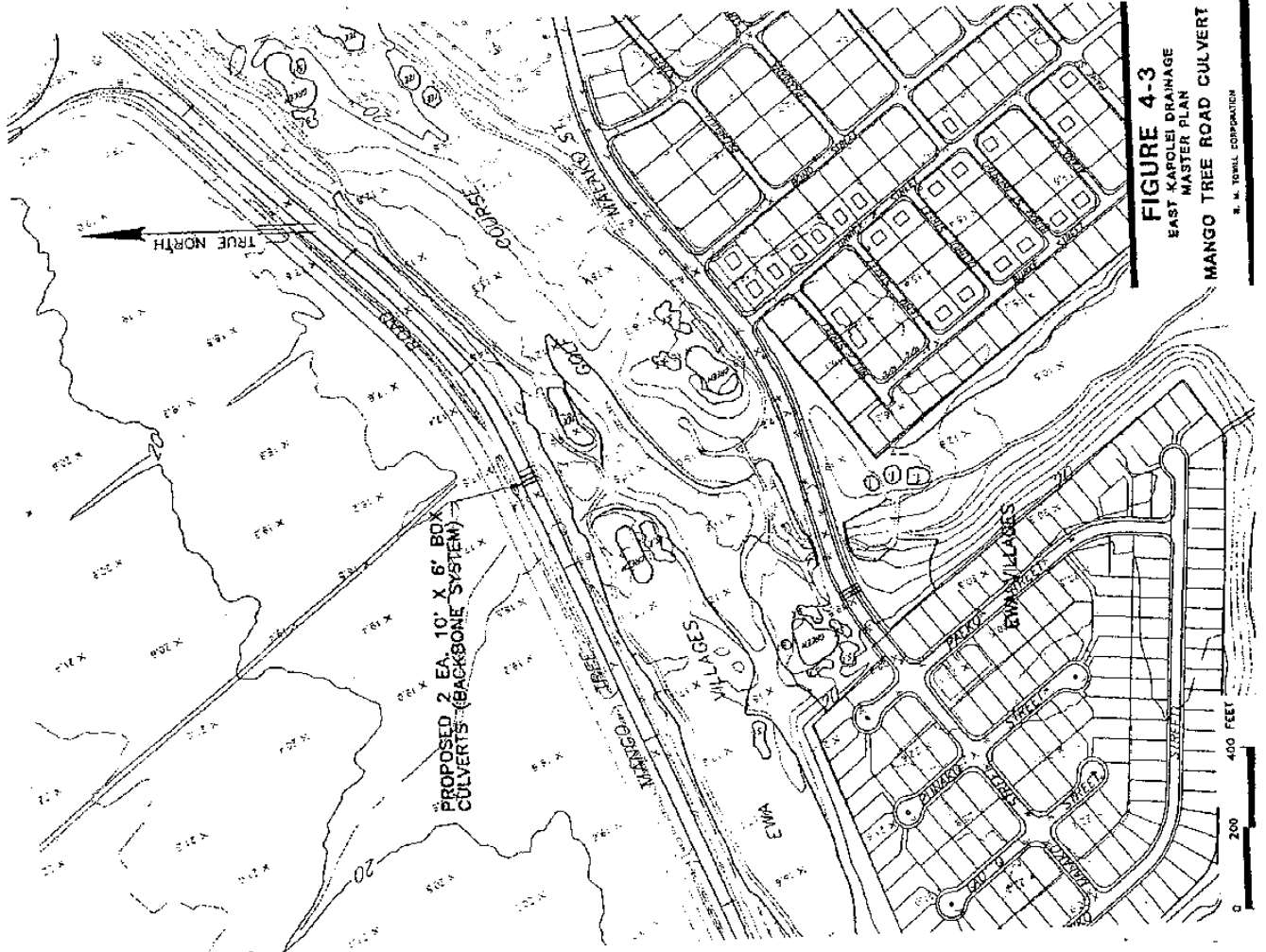
4.2.4 Sports Complex Detention Basin

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. It is anticipated that in the future, the existing stream beds will be realigned to accommodate future development of the immediate area. For the purpose of this master plan, a 5' wide and a 10' wide channel is calculated to carry the flows from the east and west branches, respectively. The actual alignments of these channels are to be determined during the design phase of the project. The flow from the west Hunehune crossing at Farrington Highway is proposed to be carried by a 30' 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.



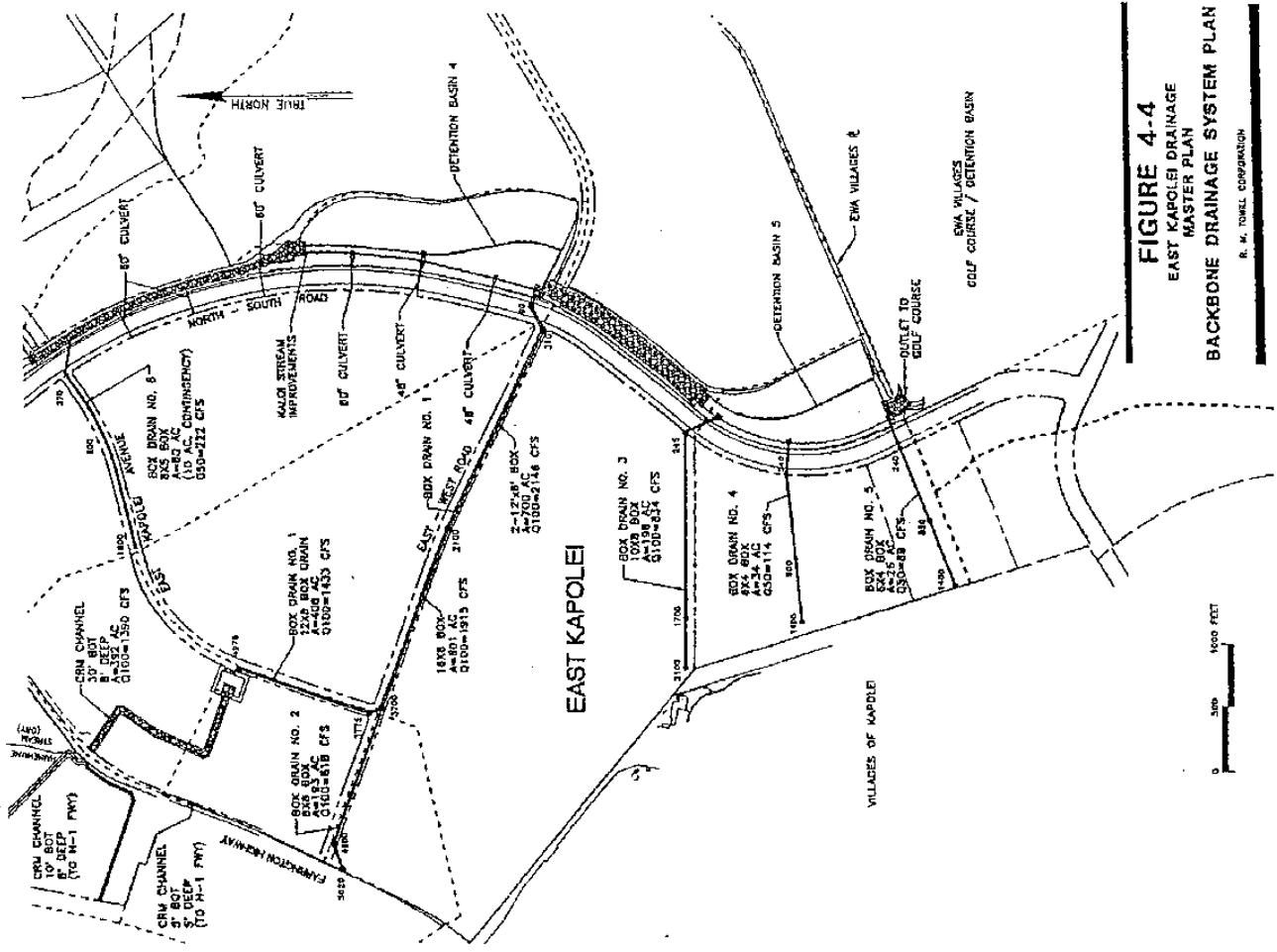


FIGURE 4-4
EAST KAPOLEI DRAINAGE
MASTER PLAN
BACKBONE DRAINAGE SYSTEM PLAN
 R. W. TOWEL CORPORATION

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 Kaioi 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 Kaioi 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 Kaiwi 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
Kalo'i Gulch (E. Kapolei)	4,273	4,375	102
Kalo'i Gulch (Varona)	107	54	-53
West Loch	764	762	-2
Villages of Kapolei	109	62	-47
Total	5,253	5,253	0

into the Kalo'i 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 Kalo'i watershed. In addition, with the proposed detention planned in the sports complex area, the runoff volume into Varona Village is further decreased by 31 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 Kalo'i-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 Kalo'i-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
Kalo'i Gulch (E. Kapolei)	3,190	3,359	169
Kalo'i 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
Kalo'i Gulch (E. Kapolei)	3,190	3,238	48
Kalo'i 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
Kalo'i Gulch (E. Kapolei)	5,643	5,674	31
Kalo'i 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)
Kalo'i Gulch (E. Kapolei)	3,850	7,075	4,051	7,400
Kalo'i - (Central Ewa Villages)	420	1,400	324	1,100
West Loch	764	2,100	762	2,100