Attachment A
Drainage Report

DRAINAGE REPORT

INTERSTATE ROUTE H-1 ADDITION AND MODIFICATION OF FREEWAY ACCESS PALAILAI IC TO MAKAKILO INTERCHANGE (KAPOLEI IC COMPLEX) -- PHASE 2

Prepared by;

Wilson Okamoto Corporation
1907 South Beretania St., Suite 400
Honolulu, HI 96826

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INTRODUCTION

The purpose of this drainage report is to define the nature and characterize the proposed drainage system of Kapolei Interchange and improvements on Interstate Route H-1 and Farrington Highway (see Figure 1 - Phase 2 Improvements).

Proposed improvements under Phase 2 includes: the construction of Ramp KA (2-lane roadway) and KA-2 (4-lane roadway) which connects Interstate Route H-1 to Wakea Street, the construction of Ramp KA-1 (2-lane roadway) which connects Ramp KA-2 to Farrington Highway, and an access road which connects Ramp KA-2 to a future proposed road.

The criteria used in the design of the proposed drainage system are based on the 5/15/2006 update to the *State of Hawaii Department of Transportation Highways Division Design Criteria for Highway Drainage*.

EXISTING CONDITIONS

The project site generally decreases in elevation from north to south and east to west. Existing elevations range from approximately 176 feet above mean sea level (MSL) at Makakilo Drive to 72 feet at the intersection of Kamokila Boulevard and Wakea Street in Kapolei City.

The soil classifications in the project vicinity are indicated on Figure 2 – Soils Map as referenced from the Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai.

Ewa silty clay loam, 3 to 6 percent slopes (EaB), and Ewa stony silty clay, 0 to 2 percent slopes (EwA). The Ewa series consists of well-drained soils in basins and on alluvial fans, developed in alluvium derived from basic igneous rock. The EaB soil type occurs on alluvial fans and terraces, with a surface layer of dark reddish-brown silty clay loam (about 18 inches thick) and dark reddish-brown and dark red silty clay loam subangular blocky structure subsoil (about 42 inches thick). Permeability is moderate, runoff is slow and the erosion hazard is slight. The EwA soil type has a similar profile, except that the depth to coral limestone is 20 to 50 inches. Runoff is very slow and the erosion hazard is very slight.

Honouliuli clay, 0 to 2 percent slopes (HxA). The Honouliuli series consists of well-drained soil in coastal plains, developed in alluvium derived from the basic igneous material. The HxA soil type occurs in the lowlands along coastal plains. The Soil Survey described a representative profile of HxA as dark reddish-brown, very sticky and very plastic clay throughout. Permeability is moderately slow, runoff is slow, and the erosion hazard is no more than slight.

Kawaihapai clay loam, 0 to 2 percent slopes (KlA). The Kawaihapai series consists of well-drained soils in drainageways and on alluvial fans on coastal plains, formed in alluvium derived from igneous rock in humid uplands. The KlA soil type occupies smooth slopes. The surface layer is dark brown clay loam (about 22 inches thick) underlain with dark brown stratified sandy loam (32 inches thick). Permeability is moderate, runoff is slow, and the erosion hazard is no more than slight.

Mamala stony silty clay loam, 0 to 12 percent slopes (MnC). The Mamala series consists of shallow, well-drained soils along coastal plains formed in alluvium deposited over coral limestone and consolidated calcareous sand. The MnC soil type has a dark reddish-brown stony silty clay loam surface layer about 11 inches thick. Stones, mostly coral fragments, are common throughout the representative profile. Permeability is moderate, runoff is very slow to medium, and the erosion hazard is slight to moderate.

Molokai silty clay loam, 3 to 7 percent slopes (MuB), 7 to 15 percent slopes (MuC), and 15 to 25 slopes (MuD). The Molokai series consists of well-drained upland soils, developed in material weathered from basic igneous rock. Conditions may be nearly level to moderate steep, with elevations ranging from near sea level to 1,000 feet. Characteristics of the MuB soil type is slow to medium runoff potential and slight to moderate erosion hazard. The MuC soil type occurs on knolls and sharp slope breaks. Runoff is medium and the erosion hazard is moderate.

Waialua stony silty clay, 3 to 8 percent slopes (WIB). The Waialua series consists of moderately well-drained soils on alluvial fans, developed in alluvium weathered from basic igneous rock. For the WIB soil type, runoff is slow and the erosion hazard is slight.

EXISTING HYDROLOGY

The project area is within the James Campbell Industrial Park (JCIP) watershed (see Figure 2 - JCIP Channel Watershed) that has existing drainage comprising of inlets, catch basin, swales and culverts. Surface runoff from existing storm drains flows to the JCIP channel which discharges into the Pacific Ocean.

DESIGN CRITERIA

The design criteria used for this project are based on the 5/15/2006 update to the *State of Hawaii Department of Transportation Highways Division Design Criteria for Highway Drainage* with highlighted criteria italicized below.

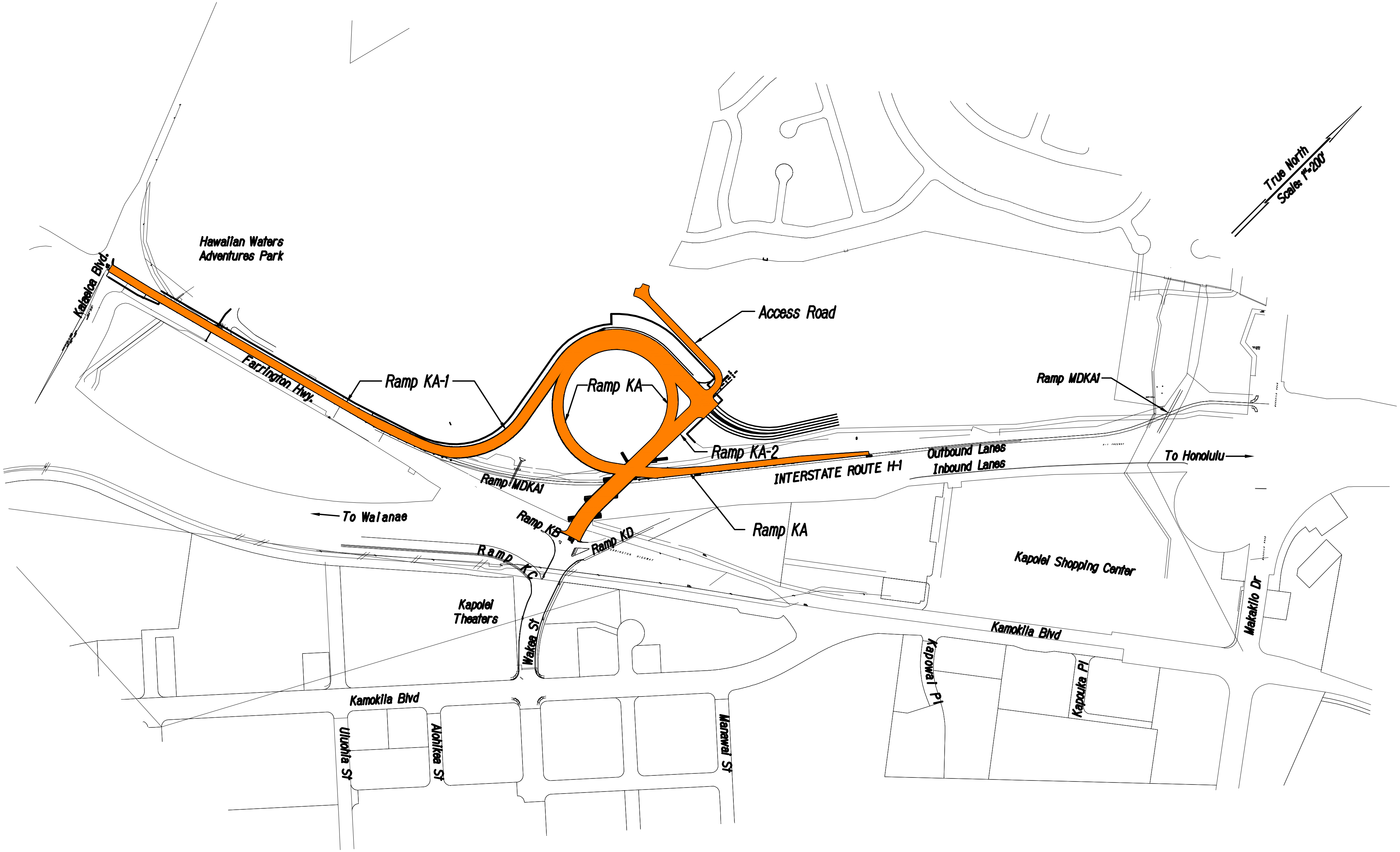
HYDROLOGIC DESIGN CRITERIA

1.1.0 RECURRANCE INTERVAL

1.1.1 Bridges and Culverts

1.1.1.1 Freeway and Arterial Highways

a. 50 years to maximum storm of record.



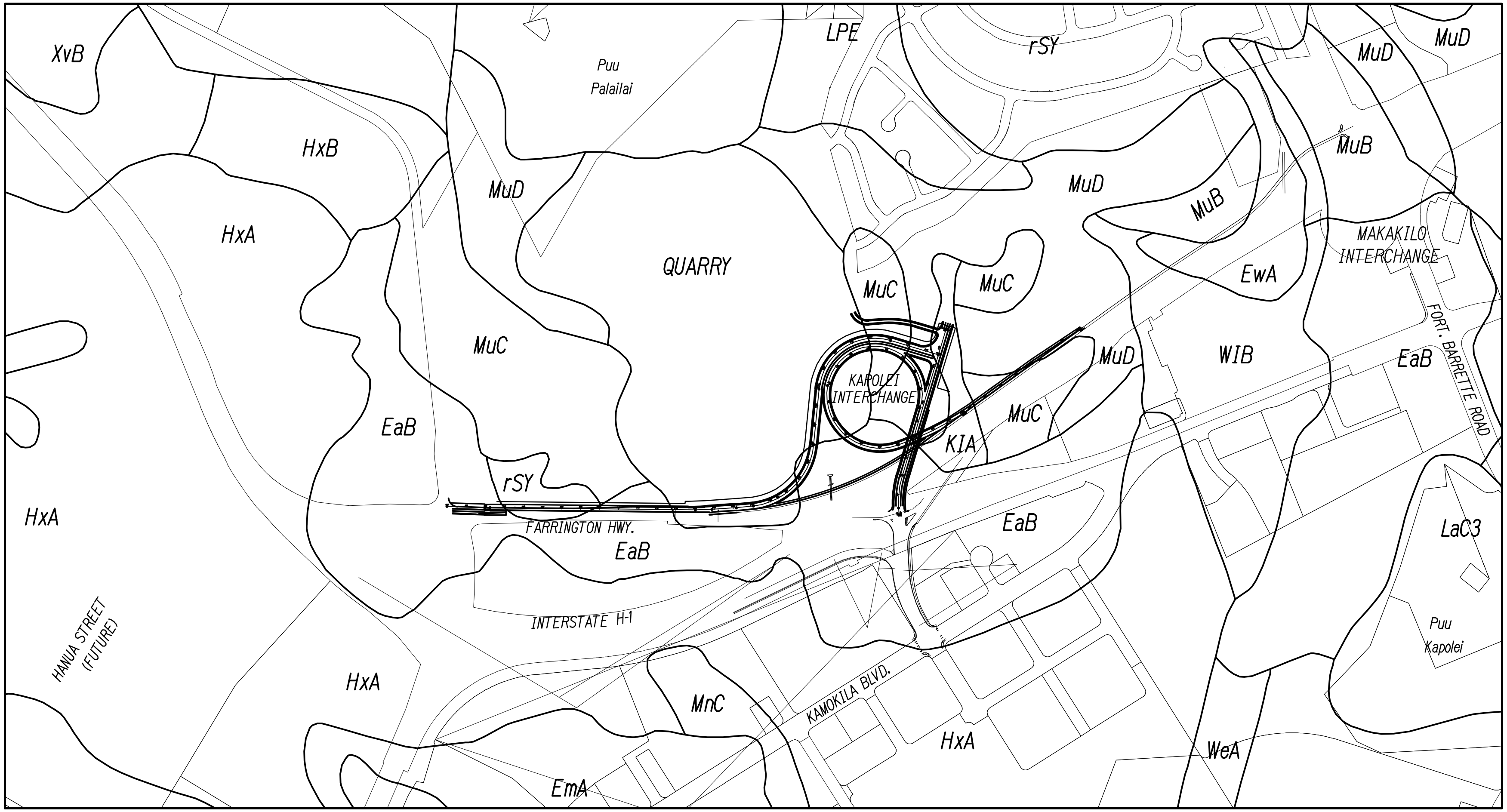
LEGEND:

PROPOSED IMPROVEMENTS

INTERSTATE ROUTE H-1, ADDITION AND MODIFICATION OF FREEWAY ACCESS
Palailai Interchange to Makakilo Interchange (Kapolei Interchange Complex)
Phase 2

PHASE 2 IMPROVEMENTS

FIGURE 1



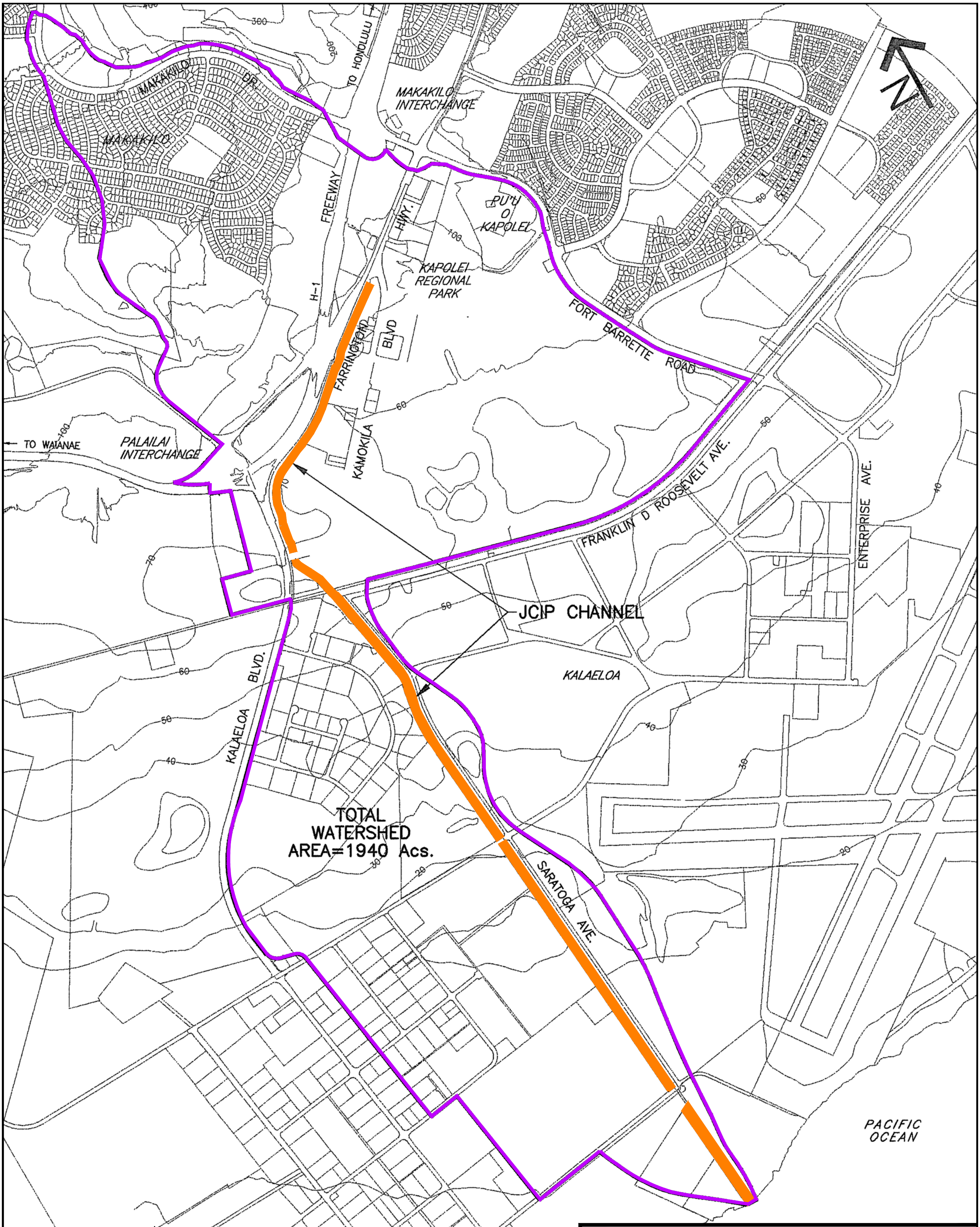
HxA	HONOULIULI CLAY, 0-2% SLOPES
EaB	EWA SILTY CLAY LOAM, 3-6% SLOPES
MnC	MAMALA STONY SILTY CLAY LOAM, 0-12% SLOPES
MuD	MOLOKAI SILTY CLAY LOAM, 15-25%
KIA	KAWAIHAPAI CLAY LOAM, 0-2% SLOPES
MuC	MOLOKAI SILTY CLAY LOAM, 7-15%
WIB	WAIALUA STONY SILTY CLAY, 3-8% SLOPES
EwA	EWA STONY SILTY CLAY, 0-2% SLOPES
MuB	MOLOKAI SILTY CLAY LOAM, 3-7% SLOPES
rSY	STONY STEEP LAND

Reference: Soil Survey of the Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii (http://www.ctahr.hawaii.edu/soilsurvey/5is/oahu.htm)

INTERSTATE ROUTE H-1, ADDITION AND MODIFICATION OF FREEWAY ACCESS
Palailai Interchange to Makakilo Interchange (Kapolei Interchange Complex)
Phase 2

SOIL MAP

FIGURE 2



Ref: I-H1 Addition & Modification of Highway Access
Palailai IC/Makakilo IC (Kapolei IC Complex) - Phase 1

1000 0 2000 4000
GRAPHIC SCALE IN FEET

INTERSTATE ROUTE H-1, ADDITION AND MODIFICATION OF FREEWAY ACCESS
Palailai Interchange to Makakilo Interchange (Kapolei Interchange Complex)
Phase 2

JCIP CHANNEL WATERSHED

FIGURE 3

b. 100 years for sites covered by National Flood Insurance Program if practicable.
1.1.1.2 Collector Streets and Roads – 25 years
1.1.1.3 Local Roads – 10 years

1.1.2 Roadway Drainage

1.1.2.1 Travel way at sumps

a. Freeways- 50 years
b. Arterial Highways – 25 years
c. Collector Streets and Roads – 10 years
d. Local Roads – 10 years

1.1.2.2 Freeways and Arterial Highways – 25 years
1.1.2.3 Collector Streets and Roads – 10 years
1.1.2.4 Local Roads – 10 years

The minimum time of concentration shall be 10 minutes.

Note: Refer to the "Hawaii Statewide Uniform Design Manual for Streets and Highways" for the definitions of the different types of highways.

1.2.0 DESIGN DISCHARGE

To strengthen the estimate of runoff and to aid in the selection of the design discharge for watersheds, the use of several appropriate hydrologic methods is recommended. Of the many methods for estimating runoff, there are several which, by experience, have proven convenient and reliable. These include, but are not limited to the following used methods:

1.2.1 ***Rational Method*** *– The rational method is used to predict peak flows for small drainage areas up to 200 acres, and can be used for culvert design, pavement drainage design, and storm drain design.*

1.2.5 ***City and County of Honolulu Method*** *– Plate 6, Design Curves For Peak Discharge Vs. Drainage Area from the City and County of Honolulu's Rules Relating To Storm Drainage Standards may be used to determine peak runoff for checking purpose only.*

The estimated runoff to be used in drainage design shall be supplemented with field investigation to determine flood marks, amount and type of debris, effect of ponding, streambed evaluation and size of existing culverts.

All hydrologic data and computations shall be submitted and retained in the design files.

HYDRAULIC DESIGN CRITERIA

2.1.0 CROSS DRAINAGE

2.1.1 Culverts

2.1.1.1 Headwater Elevation

a. *Head at the culvert entrance shall be kept below the pavement subgrade or the H/D ratio under 1.2, whichever is less. Where levels can be tolerated with minimal damages, the H/D ratio may be higher than 1.2.*
b. *Wherever the embankment may be subject to erosion or scouring, slope protection shall be provided to a height 2 feet above the headwater elevation of the design flood.*
c. *Ponding shall not be allowed above the elevation, which will cause damage to abutting improvements, unless mitigation is provided.*

2.1.1.2 Improved inlet shall be provided wherever the economy of such a design permits.

2.1.1.3 Outlet Design – Where culvert discharge may cause erosion and scour problems, energy dissipaters shall be installed to return the flow to the downstream channel in a condition which approximates the natural flow regime.

2.1.1.4 Minimum pipe cover shall be 2 feet measured from the crown of the pipe to the outer edge of the shoulder or the pipe shall be beneath the pavement structure, whichever is greater. If the minimum cannot be achieved, the pipe shall be concrete jacketed.

2.2.0 ROADWAY DRAINAGE

2.2.1 Catch Basins and Inlets

2.2.1.1 Design Criteria

a. *Curb inlets and grated inlets located on a continuous slope shall be designed for a minimum of 70% catch and 30% by-pass. The width of flow on the pavements shall not exceed 1/3 the width of the travel lane measured from the edge of pavement adjacent to the gutter or shoulder.*
b. *Catch basins and inlets located at the low or sag points in the gutter profile shall be designed for no encroachment on the travel way. Flanker inlets on each side of the low point inlet shall be installed when in a depressed area that has no outlet except through the system.*
c. *Inlets shall be located at:*
    a) *Upstream corner of intersections.*
    b) *Sag point in the gutter.*
    c) *Immediately upgrade of bridge approaches.*

d) Immediately upstream of median breaks and entrance and exit of ramps.
e) Upgrade of cross slope reversals.

2.2.1.2 Spacing – Spacing of catch basins, inlets and manholes shall be based on hydraulic requirements, economy and ease of maintenance. However, maximum spacing of each catch basin, inlet and manhole for pipes 36 inches or less in diameter shall be 250 feet. For larger pipe diameters, the maximum spacing shall be 500 ft.

2.2.1.3 Types –

a. The standard curb-inlet type of catch basins and grated inlets shall be used in general.
b. Where additional capacity is required, the standard catch basin may be modified either by lengthening the inlet or by addition of a gutter grate.
c. Bicycle, Pedestrian or ADA type grates shall be provided as required.

2.2.1.4 Culvert Slope –

a. The minimum slope for culverts shall be 0.5 percent.
b. Exceptions to the above may be made wherever maintenance operations in the culvert can be easily performed and in areas restricted by physical parameters.

2.2.1.5 Pipe Cover –

a. Minimum cover for concrete and metal pipes shall be 2 feet measured from the crown of the pipe to the finished grade.
b. Minimum cover for high density polyethylene pipe shall be according to Table 12 and be measured from the crown of the pipe to the finished grade.

2.2.2 Roadside Gutters and Ditches

2.2.2.1 All V-ditches in new construction areas within the clear zone shall be designed with 6:1 side slopes on both slopes.

2.2.2.2 V-ditches outside of the clear zone may be designed with a 2:1 back slope.

2.2.2.3 V-ditches in resurfacing projects within the clear zone may remain provided it is not located in a high accident area.

2.2.3 ***Subsurface Drainage –*** *Subsurface drains shall be installed wherever recommended by the Materials Testing and Research Engineer.*

PHYSICAL STANDARD

When more than one material meets the structural, corrosive, abrasive and design service life expectancy requirements, alternatives should be specified on the basis of optional selection by the contractor.

3.1.0 Reinforced Concrete Pipe (n=0.012)

3.1.1 The minimum pipe culvert shall be 24 inches.

3.1.2 Under certain conditions, 18-inch pipe culverts will be permitted, but the culvert length shall not exceed 50 feet.

3.1.3 The minimum strength requirement shall be Class III.

3.8.0 High Density Polyethylene Pipe – Type C (n=0.020) and Type S (n=0.012)

3.8.1 The minimum pipe culvert size shall be 24 inches and the maximum shall be 48 inches.

3.8.2 Under certain conditions, 18-inch pipe culverts will be permitted, but the culvert length shall not exceed 50 feet.

3.8.3 The maximum height of the cover is determined from Table 12.

Maximum Height of Cover for High Density Polyethylene Pipe – Type C and Type S

Diameter (Inches)	*Maximum Height of Cover (Feet)*
18	*11*
24	*11*
30	*10*
36	*9*
42	*8*
48	*7*

Table 12

PROPOSED DRAINAGE SYSTEM

Proposed drainage improvements consist of swales, catch basins, drainage pipes, grated inlets, and culverts. Runoff will be collected in the proposed drainage system and conveyed through underground drainage pipes that will connect to the existing system that services the area. The existing system will transport the storm water to the Pacific Ocean.