Hawaiian Memorial Park Cemetery Expansion

Final Environmental Impact Statement

Kāneʻohe, Oʻahu, Hawaiʻi

September 2008
Volume 2
Appendices

Hawaiian Memorial Park Cemetery Expansion

Final Environmental Impact Statement

Kāneʻohe, Oʻahu, Hawaiʻi

Prepared for:
Hawaiian Memorial Life Plan Ltd.

Prepared by:
Helber Hastert & Fee, Planners

Accepting Authority:
State of Hawaiʻi Land Use Commission

September 2008
Volume 2
Appendices

A. Market Need for Hawaiian Memorial Park Cemetery Expansion

(Clark & Green Associates)

Market Need for Hawaiian Memorial Park Cemetery Expansion Project

Clark & Green Associates

March 2008

Market Need for Cemetery Expansion

Hawaiian Memorial Park (HMP) has developed inventory scattered throughout the park's eighty (80) developed acres. The park currently completes almost 700 interments and 200 inurnments per year on average. As discussed below, this number is expected to increase.

Memorial parks need to maintain a significant inventory of developed inventory, especially ground burial spaces, for many reasons, in order to adequately service the community. Although there are 6,000 to 7,000 ground burial spaces currently developed and available at HMP (with in excess of 30,000 spaces already utilized), these spaces fulfill very different needs for the community are not universally desired. Since the park needs to be able to satisfy all of these different demands, it is necessary to have many more spaces available than a simple mathematical formula or projected rate of use might imply. Some of the different demands are described below.

"Heritage" Gardens: Just as there is a societal tendency for families and friends to settle in the same neighborhood or community, many families desire to have burial space in the same garden area at the cemetery as their parents and other relatives. This is called "heritage" and is an important part of the end of life experience and choices. This places long-term demands on the memorial park to fulfill these important desires. As a result, space management for the cemetery requires that vacant burial plots be scattered throughout the park, to allow families to locate close to other family members as a final resting place.

Religious and Ethnic Gardens: Another form of "Heritage" is the very important desire for religious and ethnic groups in the greater community to have special affinity gardens tailored to their customs, rituals and symbolism. These gardens also need to plan for the inevitable expansion required over time to accommodate these groups and their members. Our melting pot community is constantly changing and new groups or communities often approach the memorial park for their own special garden areas.

Personal Choice and Selection Opportunities: The personal choice of type of interment often includes an intense desire for a place in the memorial park that has a special attribute or meaning to the specific family members, such as a special tree, or view, or location.

Pre-Need Inventory: Many families plan ahead for this inevitable occurrence and will purchase space years in advance of need. This requires inventory to be developed and ready for use in the event of an untimely passing once it has been purchased.

At the current annual rate of ground burial and the expected increase in numbers of burials associated with Hawaii's aging population, Hawaiian Memorial Park will need to expand its inventory in order to meet the increasing demand while maintaining these vital heritage opportunities. The park will have significantly constrained inventory resources over the next 5 years. Given the length of land use entitlement processes, and subsequent construction design and implementation schedules, it is critical for

Hawaiian Memorial Park to begin to ensure adequate space beyond this period. New inventory must be available well in advance of using the last remaining burial spaces within the current inventory.

In addition to addressing the current rate of use, there are a number of demographic factors that will influence the demand for new burial space in the future. A first level of analysis focuses on the change in age cohorts, as the population of Hawai‘i gets older. Table 1 presents how these numbers are projected to change between 1990 and 2030.

Table 1
Resident Aging Population Projections

Year	Total Population State of Hawai‘i	55+ State of Hawai‘i	55+ as % of Total Population	70+ State of Hawai‘i	70+ as % of Total Population
1990	1,108,220	219,108	19.8%	79,421	7.1%
2000	1,212,670	266,943	22.0%	117,467	9.7%
2010*	1,346,000	358,600	22.6%	134,000	10.0%
2020*	1,489,550	442,300	29.7%	176,500	11.8%
2030*	1,630,450	**499,550**	30.6%	**239,150**	14.7%

*Projected
Source: 2006 State of Hawai‘i Date Book

As can be seen from Table 1, the total of Hawai‘i residents that are 55+ years of age is projected to increase from 19.8% of the population in 1990 to 30.6% of the population in 2030. In real numbers, this means the total number of Hawai‘i residents over 55 years of age increase from 219,108 in 1990 to 499,550, more than doubling in 40 years. Numbers for cohorts age 70 and over are even more dramatic. As a percentage of the overall population, this group will grow from 7.1% of the population in 1990 to a projected 14.7% of the population in 2030. In real numbers, this translates to a **300% increase**, from 79,421 in 1990 to a projected 239,150 in 2030.

If we examine the actual number of deaths, and the death rate, over time, it is easy to appreciate the future demand for burial space.

Table 2
Resident Deaths in Hawai‘i
(Annual average for the period)

Period	# of deaths
1980-1985	5,200
1985-1990	6,100
1990-1995	7,000
1995-2000	8,000
2000-2005	8,400
2005-2010*	9,300
2010-2015*	10,000
2015-2020*	10,900
2020-2025*	11,700
2025-2030*	12,500
2030-2035*	13,600

*Projected
Source: DBEDT 2035 Series, 2008

Table 3
Resident Death Rate in Hawai‘i
(Annual average for the period)

Period	Death Rate (per 1,000 population)
1980	5.1
1985	5.5
1990	6.0
1995	6.3
2000	6.7
2004	7.0

Source: State of Hawaii Data Book, 2005

Overall, the annual average number of deaths is projected to increase by 62% between 2000-2005 and 2030-2035.

Even if we factor in a trend to a higher percentage of cremations, the number of casketed burials will still rise dramatically.

Table 4
Deaths by Method of Disposition for Hawai‘i

Method	1980	1990	2000	2003	2004	2005
Burial	2,343	2,798	2,767	2,800	2,696	2,667
% of total	45%	40%	33%	31%	29%	29%
Cremation	2,241	3,564	5,092	5,778	5,900	5,964
% of total	43%	51%	60%	63%	64%	64%
Removal*	567	656	591	540	599	634
Other	53	37	21	14	8	9
All methods	5,204	7,055	8,511	9,179	9,252	9,330

*Removed from Hawaii
Source: 2006 State of Hawai‘i Date Book

Although the cremation rate in Hawaii has increased to over 60% of all deaths, this growth in cremation has slowed in recent years so, the community desire for casketed ground burial should at least continue at current rates. HMP is currently the cemetery of choice for more than 25% of all interments on Oahu.

In addition to the very real demographic trends which support the need for more burial space, a critical reason for this need for expansion is based on the personal nature of the decisions surrounding the final passage of human life. There are two moments in

an individual's life that family, friends, acquaintances and business associates come together to celebrate that life: weddings and funerals. There will continue to be a slow transformation towards more land efficient interment options like cremation, but the community desire for casketed ground burial is a decision based on family tradition and heritage, and religious and cultural beliefs. Demand will remain strong for the foreseeable future. At the base of the Koolau Mountains, HMP provides a convenient location for Windward and Leeward communities for both the initial interment and subsequent visitations to the burial site. Many of these visitors will be elderly, and ease of travel is a vital aspect of their need for this expansion. Also, there is a significant community heritage (i.e., existing interments of family members) with the built-up demand that accrues as a result of families' desire to have a final resting place near other family members, who are already interred at HMP.

If this current and future demand for a full range of interment options is not provided at HMP, some families may choose cremation due to economic or travel constraints but many will travel to further reaches of the island for the personal choice reasons described above. This will, in many cases, require economic hardships and impact the mourning process that is so critical to many members of our community. The need for new interment space will not disappear if HMP cannot expand its facilities. Instead, new facilities will need to be built in other areas of Oahu. Support facilities already exist at HMP, which might have to otherwise be constructed elsewhere. It makes sense to capitalize on the availability of these facilities, in a location already known for its burial facilities with easy and convenient access for the greater Honolulu area.

In summary, the need for the proposed expansion is based on the following items:

- The annual interment demand will amortize the remaining inventory opportunities within HMP in the next few years.

- The interment demand will probably increase to at least approximately 800 per year due to population growth and the aging population, and recognized demand for HMP as a final resting place.

- There is a significant built-up heritage demand that will continue to grow as family members request interment space within the cemetery.

- The proximity and ease of access to the major population centers of Oahu is economically and socially desirable for the major part of the community.

B. Report Assessment of Hazard from Rockfall and Slope Stability

(Shinsato Engineering, Inc.)

REPORT
ASSESSMENT OF HAZARD
FROM ROCKFALL AND SLOPE STABILITY

HAWAIIAN MEMORIAL PARK CEMETERY EXPANSION
KANEOHE, HAWAII
TMK: 4-5-033:001

for

CLARK AND GREEN ASSOCIATES

Project No. 08-0043
May 15, 2008

SHINSATO ENGINEERING, INC.
98-747 KUAHAO PLACE, #E
PEARL CITY, HI 96782

SHINSATO ENGINEERING, INC.
CONSULTING GEOTECHNICAL ENGINEERS

98-747 KUAHAO PLACE, SUITE E
PEARL CITY, HAWAII 96782
PHONE: (808) 487-7855
FAX: (808) 487-7854

May 15, 2008
Project No. 08-0043

Clark and Green Associates
Attention: Mike Green
150 Paularino Avenue, Suite 160
Costa Mesa, California 92626

SUBJECT: **GEOTECHNICAL ENGINEERING REPORT**
Hazards Associated with Slope Stability and Rockfall
Hawaiian Memorial Park Cemetery Expansion
Kaneohe, Hawaii
TMK: 4-5-033: 011

Gentlemen:

This report presents the results of a geotechnical investigation for the subject project.

1.0 INTRODUCTION

This report was prepared for the purpose of addressing comments made by the City and County of Honolulu, Department of Planning and Permitting letter dated February 14, 2008 relative to "whether there are any hazards associated with rockfall and/or slope stability that may impact the project site". The comments were made with regard to the Hawaiian Memorial Park Environmental Impact Statement Preparation Notice (EISPN), Kane'ohe, O'ahu, Hawai'i, prepared by Helber, Hastert & Fee, Planners, dated November 2007.

2.0 SCOPE OF WORK

The project is in a preliminary phase and a full soils investigation (including borings and/or test pits) was not deemed necessary at this time. The scope of work was described in our proposal dated March 18, 2008. In general, the services included the following:

a. Perform a site reconnaissance to visually observe soil and geologic features of the property.

b. Review soil and geologic information of the area.

c. Analyze the data to determine the stability of the existing slope and the impact that the proposed development may have on the overall stability of the site, and assess the potential hazards in the area of the site from rockfalls.

3.0 FIELD WORK

The field work consisted of performing a site reconnaissance to observe existing surface features and to map particular points of interest as they relate to soil and geologic conditions. The locations of the site reconnaissance path and points of interest were determined by using a GPS device.

Two site reconnaissance paths were made - one along the lower elevations of the property and the other along the uphill side. At various path points, lateral paths were taken to observe the adjacent surface features. The locations of the reconnaissance path, path points and points of interest are shown on Plate 2.

Samples were taken of the near surface soils for visual observation and laboratory testing.

3.0 SITE CONDITIONS

3.1 Geology

The site is located on the southwesterly flank of the Oneawa Hills that separates Kailua from Kaneohe. The area lies within the caldera of the old Koolau Volcano which is an elongated shield that is believed to have formed during late Tertiary/early Pleistocene time (between 1 and 12 million years ago) by lavas flowing from rift zones along a northwest-trending rift zone.

The caldera of the volcano is presumed to have extended from near Waimanalo at the southeast to beyond Kaneohe at the northwest, at the base of the Pali to the southwest and somewhere between the hills of Lanikai and the Mokulua Islands (offshore) to the east. This eastern side was probably destroyed by erosion.

The Oneawa Hills is capped with coarse breccia that consists of subangular and angular basalt fragments 3 feet or less in diameter that are green, lavender, white, red and brown in color. The formation is part of the Kailua Volcanic Series which consists of eroded rocks of the Koolau caldera that have been altered by hydrothermal action caused by steam rising in the vent area (Stearns and Vaksvik, 1935, pg. 97).

3.2 Soil Conditions

From the USDA Soil Conservation Service "Soil Survey of the Islands of Kauai, Oahu, Maui, Molokai and Lanai, State of Hawaii, dated 1972, and as described in the EISPN, the near surface soils on the property are classified into four soil types from two different soil series (Kaneohe and Alaeloa). The Kaneohe soils generally occur along the west and northwest portion of the property. The Alaeloa soils occur along the east and southeast portions of the site

The four soil types are as follows:

Alaeloa silty clay, 15 to 35 percent slopes, (AeE)
Alaeloa silty clay, 40 to 70 percent slopes (ALF)
Kaneohe silty clay, 8 to 15 percent slopes (KgC)
Kaneohe silty clay, 30 to 65 percent slopes (KHOF)

For engineering purposes, both soil types are described as MH - elastic SILT based on the Unified Soil Classification System (USCS). Estimated properties and engineering interpretations include the following:

Soil Series	Suitability as a source of Road Fill	Shrink-Swell Potential	Depth to Bedrock
Alaeloa	Good	Moderate	>5'
Kaneohe	Good	Moderate	>5'

4.0 LABORATORY TESTING

Laboratory tests were performed on the soil samples to determine the in-situ moisture content and Atterberg Limits.

a. Unit Weight and Moisture Content

The in-place moisture content of the samples were determined by weighing the sample, placing the sample into an oven then weighing to determine the moisture loss. The data is used to determine the in-place moisture content.

b. Classification Tests

The soil materials were visually classified in the field using the Unified Soil Classification System. An Atterberg Limits test was performed in the laboratory to determine the liquid limit, and plasticity index for further soil classification.

c. Results of Laboratory Tests

The results of the laboratory tests are as follows:

Sample Location	Sample Depth	In-situ Moisture Content	Atterberg Limits		
			LL	PL	PI
#1	4'	42.6%	87	48	35
#2	4'	22.4%			
#3	4.5'	40.6%			
#4	3'	30.9%			

5.0 SLOPE STABILITY ANALYSIS

Slope stability analyses of the property were performed using topographic maps, information on the subsurface materials developed from interpretations of the site reconnaissance, and data from nearby test boring logs.

A computer program (SLOPE/W), developed by Geo-Slope International, was used for the analysis. The work consisted of developing a generalized geometric/geologic cross section that is set to scale in a grid pattern (X-Y coordinates). Grid points corresponding to changes in the geometric shape and/or geologic profile are entered into the program to simulate the hand drawn cross section. Estimated soil shear strength parameters for the various soil/rock layers are also entered into the program. The program then calculates the factors of safety using either the ordinary method of slices or modified Bishop Method.

Long term stability analysis was performed using effective stress analysis with pore pressure. Short term analysis was performed using total stress analysis. A seismic coefficient of 0.10g was also used in the analyses.

The lowest factor of safety for each condition was as follows:

Existing Slopes:

Section 1	Effective Stress (Plate SE.1)	1.824
	Total Stress (Plate ST.1)	1.552
Section 2	Effective Stress (Plate SE.2)	1.905
	Total Stress (Plate ST.2)	1.543
Section 3	Effective Stress (Plate SE.3)	2.207
	Total Stress (Plate ST.3)	3.964

New Cut and Fill Slopes

2H:1V Slope with 8' wide Bench		
	Effective Stress (Plate SE.4)	2.762
	Total Stress (Plate ST.4)	6.521
3H:1V Slope with 8' wide Bench		
	Effective Stress (Plate SE.4)	2.989
	Total Stress (Plate ST.4)	6.386

A factor of safety of 1.0 is considered at the verge of failure. The generally accepted minimum factor of safety is 1.5.

Graphic plots of the analysis showing the slope geometry, soil profile, the center of circle with the lowest factor of safety and the calculated factor of safety are included at the end of this report.

6.0 ROCKFALL HAZARD

6.1 Observation of Site Conditions

Large boulders (up to 6-feet in diameter) were observed on the ground surface along the east and northeast sides of the proposed expansion area. There are also exposed rock outcrops along the easterly perimeter of the proposed expansion area. The boulders were generally more numerous within the existing gullies and ravines (See attached Point of Interest photos).

6.2 Rockfall Hazard Analysis

An analysis of the potential hazard from rockfall was performed using the Colorado Rockfall Simulation Program (CRSP) developed by the Colorado School of Mines and the Colorado Department of Transportation. The program was developed to model rockfall and to provide a statistical analysis of the probable rockfall behavior at a given site.

Various values such as the slope geometry, slope material properties, rock geometry and rock material properties are input into the program which then simulates the rockfall behavior. The information can then be used to determine the need for rockfall mitigation.

Three profiles were drawn across the site for analysis (see Plate 2). The analysis indicates that the limits of the potential rockfall zone is 860 to 1080 feet downhill from the top of the ridge line above the property. This encroaches into the proposed expansion area (see Plates RF.1, RF.2, RF.3).

6.3 Interpretation of Rockfall Hazard Analysis

Based on the results of the site reconnaissance and the rock hazard analysis, there are four (4) areas with the potential for hazard due to rockfall. These areas are located along the east and northeast edges of the property (see Plate 2.1).

Mitigative measures may include one or a combination of the following:

a. Securing the existing boulders using netting or chaining.
b. Removal of the boulders.
c. Installation of fencing uphill from proposed improvements.
d. Constructing a buffer zone between the rockfall hazard source and the proposed improvement.

The choice of mitigative measure will depend on the specific site condition.

7.0 SUMMARY

Based on our site inspection and analyses, it is concluded that

a. There is no apparent potential for hazards to the proposed expansion site that may be associated with slope stability. The factor of safety for the existing slopes and newly graded slopes (up to 2 horizontal to 1 vertical in gradient) exceed 1.5. Therefore, no mitigative measures are deemed necessary to protect the development from slope stability issues.

b. There is a potential for hazards associated with rockfall. These hazards can be mitigated using available technology.

Should you have any questions or require any further information, please do not hesitate to contact us.

Very truly yours,

SHINSATO ENGINEERING, INC.

Lawrence S. Shinsato, P.E.
President

LAWRENCE S. SHINSATO
LICENSED PROFESSIONAL ENGINEER
No. 4169-C
HAWAII, U.S.A.

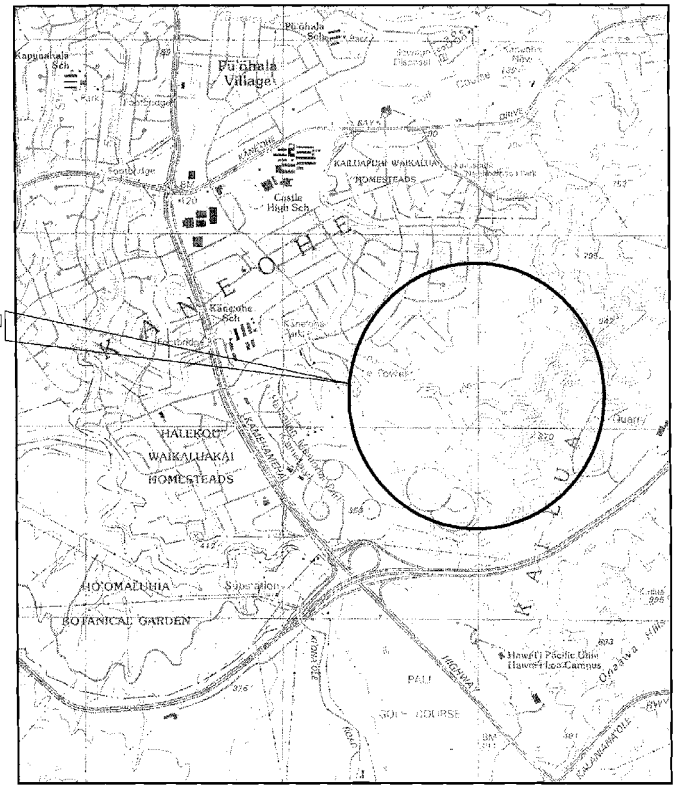
LSS:ls

This work was prepared by me
or under my supervision.
License Expires 04/30/10

Attachments/

Vicinity Map	Plate 1
Plot Plan	Plate 2
Rockfall Hazard Plan	Plate 2.1
Table 1: Description of Points of Interest	Plate 2.2
Points of Interest	Plates P.1, P.2, P.3
Graphic Plots of the Slope Stability Analysis	Plates SE.1, ST.1, SE.2, ST.2, SE.3, ST.3, SE.4, ST.4, SE.5, ST.5
Rockfall Hazard Analysis	Plates RF.1, RF.2, RF.3

VICINITY MAP



SITE LOCATION

TRUE NORTH

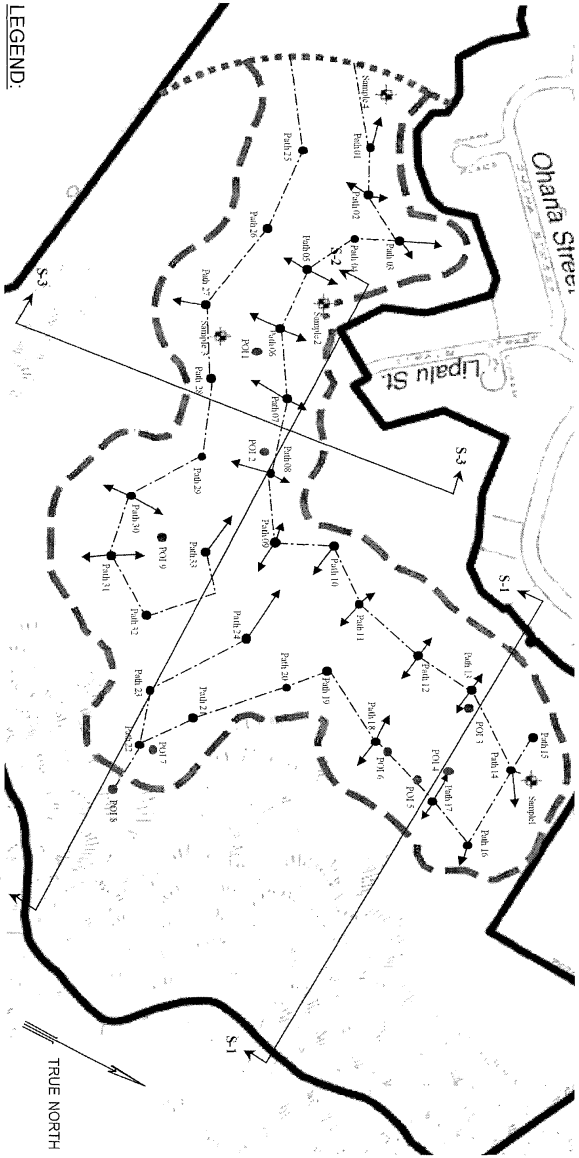
REFERENCE:
USGS TOPOGRAPHIC MAP
KANEOHE QUADRANGLE
DATED 1998

HAWAIIAN MEMORIAL PARK

SHINSATO ENGINEERING, INC.
CONSULTING GEOTECHNICAL ENGINEERS

98-747 KUAHAO PL. PEARL CITY, HI 96782

PROJECT NO	08-0043
DATE	05/08
SCALE	1"=2000'
PLATE	1



LEGEND:

SITE RECONNAISSANCE PATH

POINTS OF INTEREST (SEE TABLE 1)

SOIL SAMPLE LOCATIONS

PLOT PLAN
SCALE: 1" = 500'

Project: HAWAIIAN MEMORIAL PARK
HAZARD ASSESSMENT
Project No.: 08-0043

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PLATE 2.0

LEGEND:

APPROXIMATE ZONES OF ROCKFALL HAZARD

ROCKFALL HAZARD PLAN

NOT TO SCALE

Project: HAWAIIAN MEMORIAL PARK

Project No.: 08-0043

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PLATE 2.1

Point of Interest	Notes
1	Stream with cobbles and boulders
2	Stream with cobbles and boulders
3	Stream with cobbles and boulders
4	Surface boulders up to 4 feet
5	Large surface boulders up to 6 feet
6	Stream with cobbles and boulders
7	Surface boulders up to 5 feet
8	Rock outcrops
9	Large surface boulders up to 6 feet Plus boulders embedded into ground
Path 22	Large surface boulders

TABLE 1
Description at Points of Interest

Project: HAWAIIAN MEMORIAL PARK

Project No.: 08-0043

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PLATE 2.2

POI # 4 BOULDER
SECTION 1

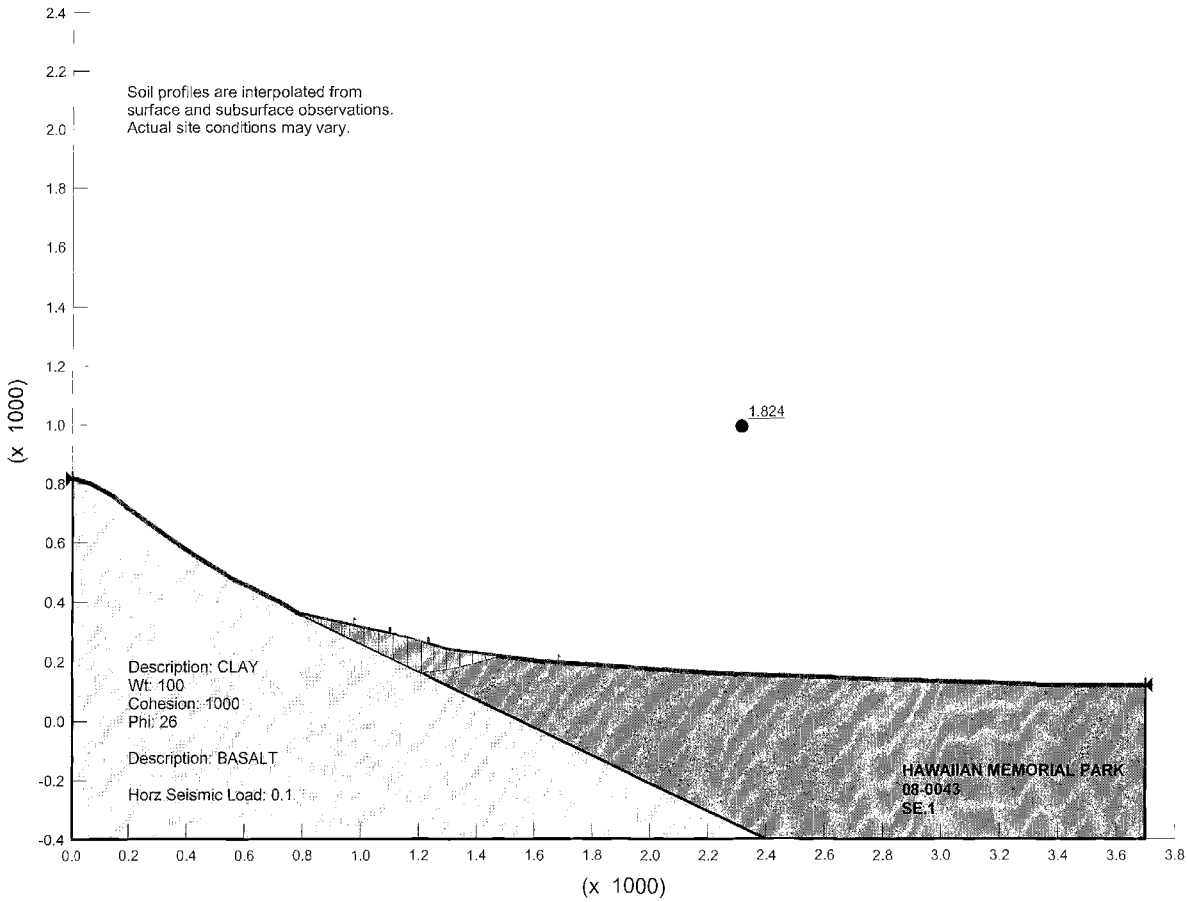
POI # 5 BOULDER
SECTION 1

Project: HAWAIIAN MEMORIAL PARK HAZARD ASSESSMENT Project No.: 08-0043	*SHINSATO ENGINEERING, INC.* *CONSULTING GEOTECHNICAL ENGINEERS* *98-747 KUAHAO PL. PEARL CITY, HI 96782*	**PLATE P.1**

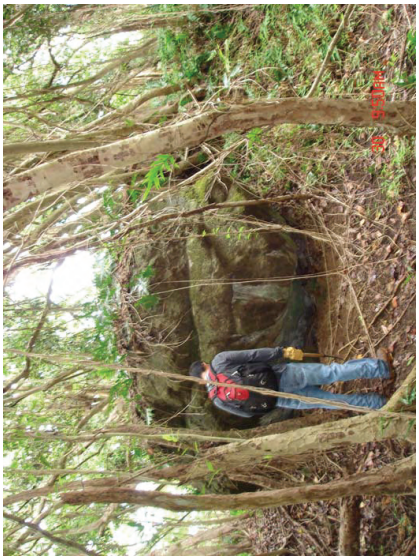
POI # 7 BOULDER
SECTION 2

PATH #22 BOULDER
SECTION 2

Project: HAWAIIAN MEMORIAL PARK HAZARD ASSESSMENT Project No.: 08-0043	*SHINSATO ENGINEERING, INC.* *CONSULTING GEOTECHNICAL ENGINEERS* *98-747 KUAHAO PL. PEARL CITY, HI 96782*	**PLATE P.2**

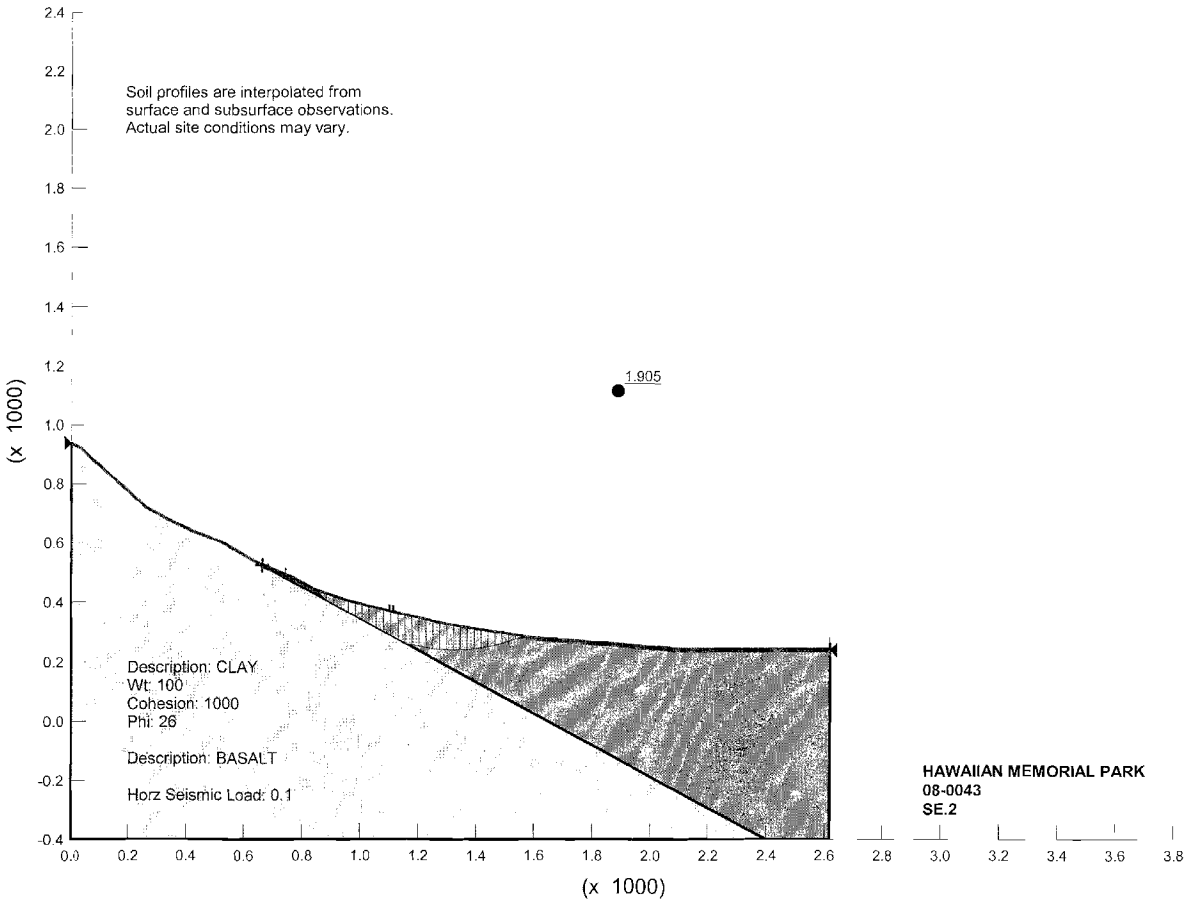


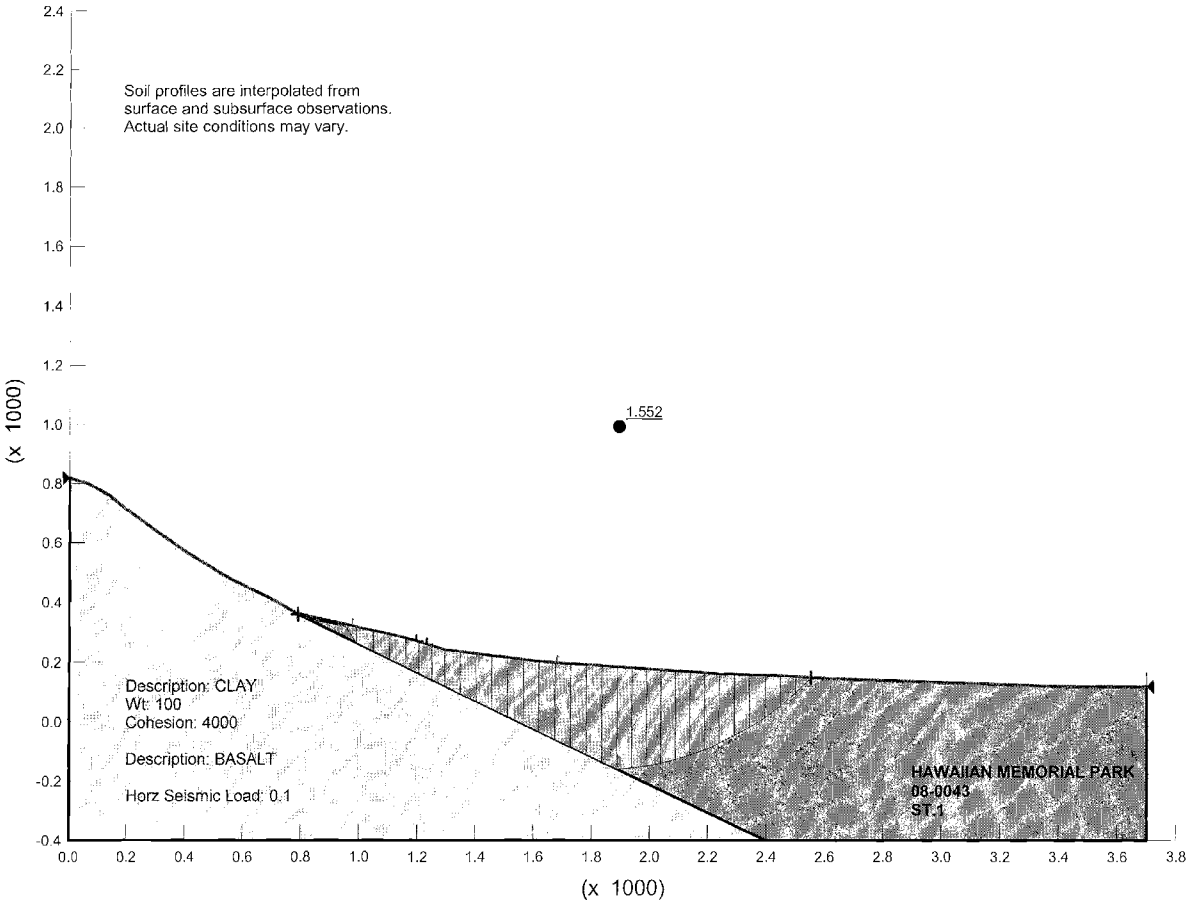
POI #8 EXPOSED ROCK
SECTION 2



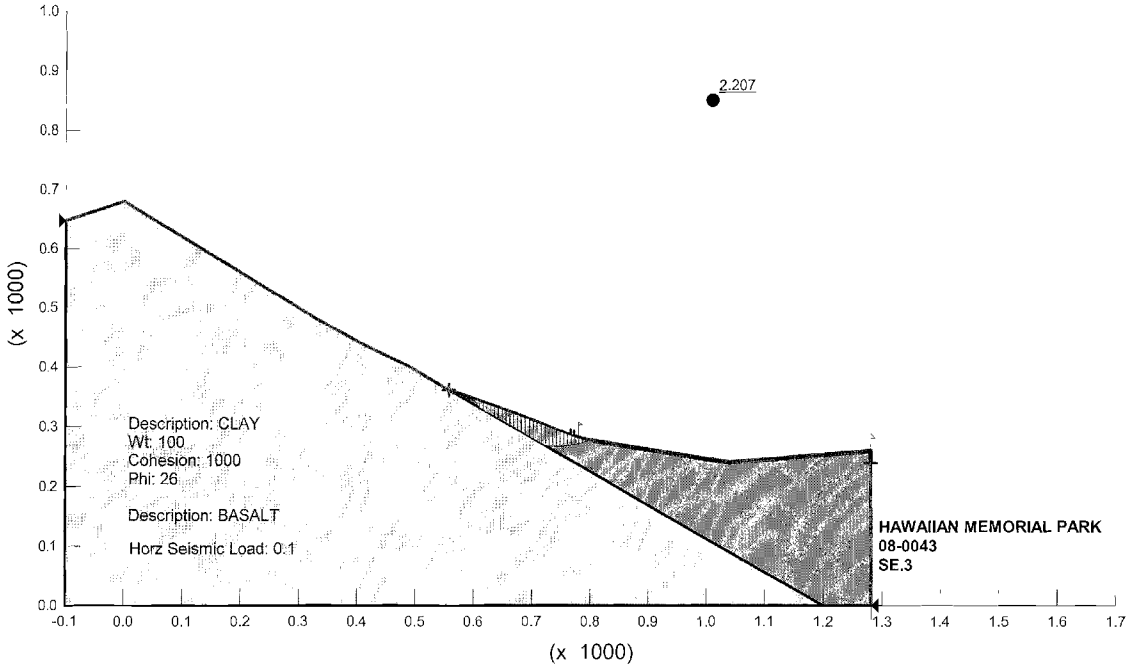
POI#9 BOULDER
SECTION 2

Project: HAWAIIAN MEMORIAL PARK HAZARD ASSESSMENT Project No.: 08-0043	SHINSATO ENGINEERING, INC. CONSULTING GEOTECHNICAL ENGINEERS 98-747 KUAHAO PL. PEARL CITY, HI 96782	**PLATE P.3**

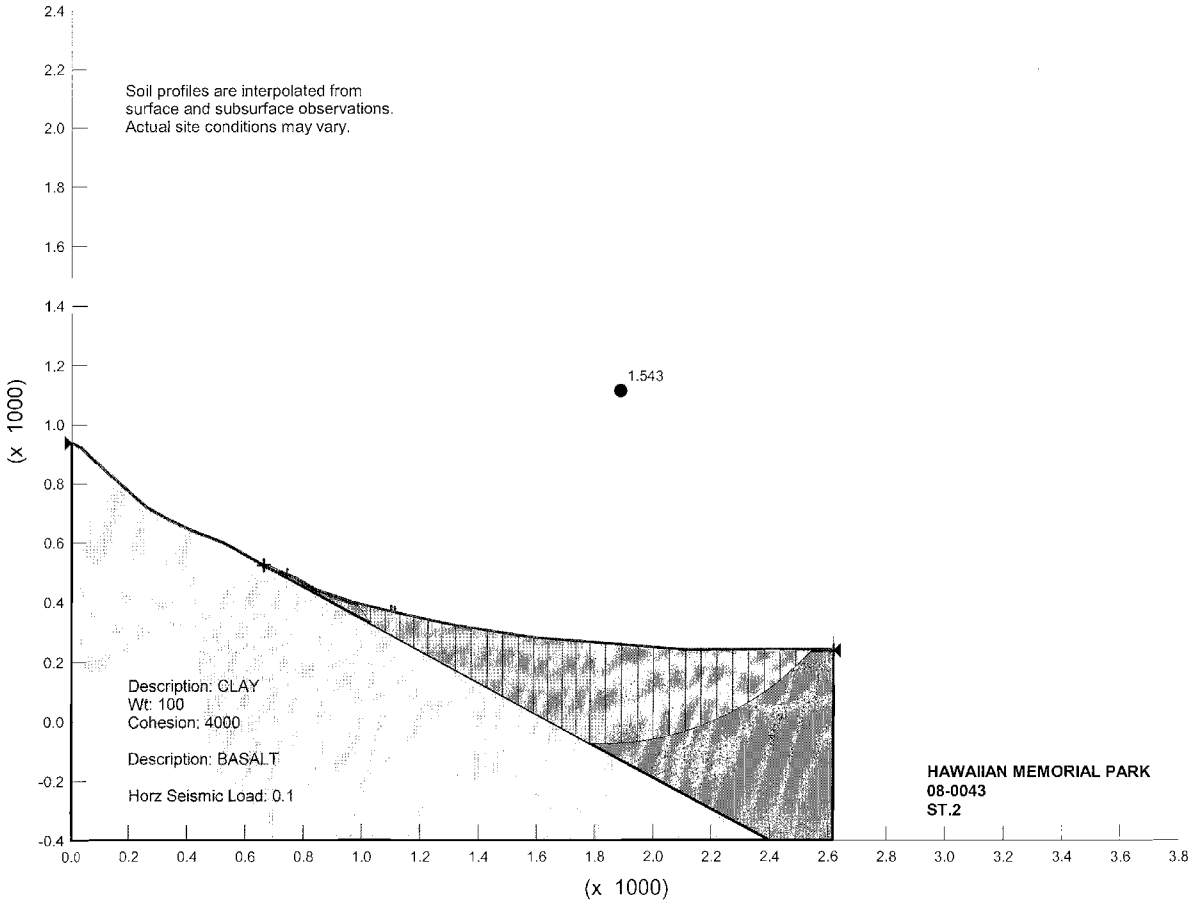

Soil profiles are interpolated from
surface and subsurface observations.
Actual site conditions may vary.
1.905
Description: CLAY
Wt: 100
Cohesion: 1000
Phi: 26
Description: BASALT
Horz Seismic Load: 0.1
HAWAIIAN MEMORIAL PARK
08-0043
SE.2
(x 1000)
(x 1000)

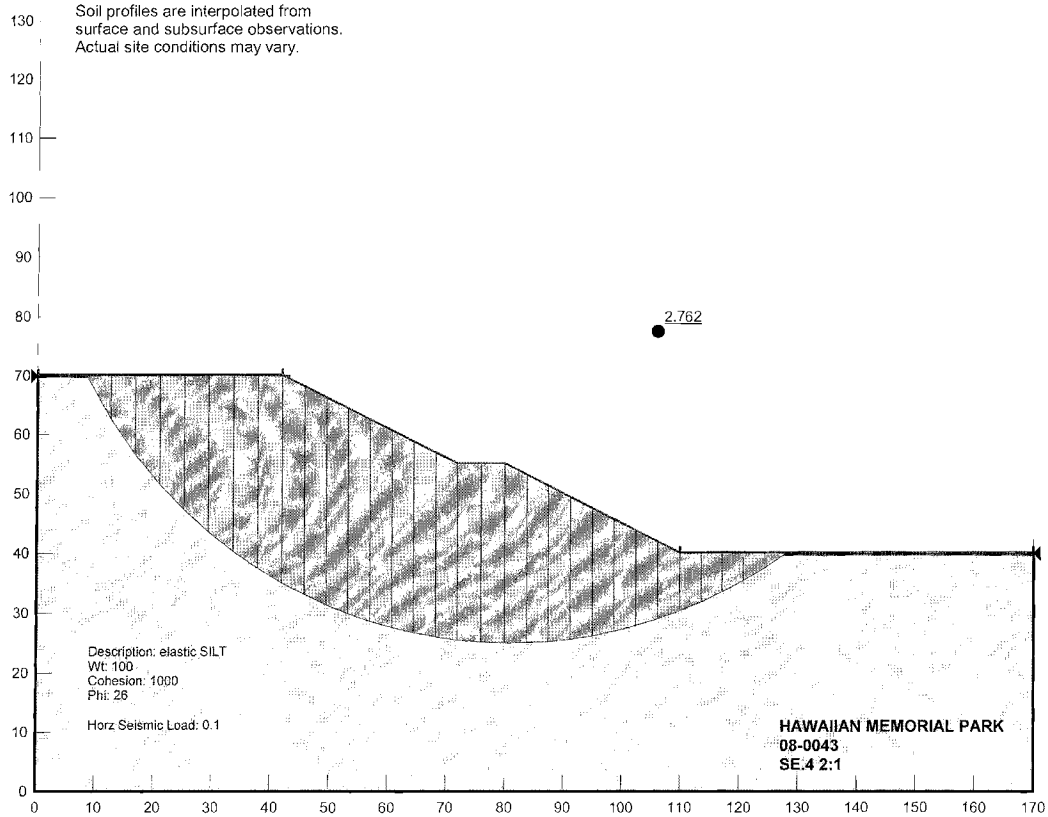

Soil profiles are interpolated from
surface and subsurface observations.
Actual site conditions may vary.
1.552
Description: CLAY
Wt: 100
Cohesion: 4000
Description: BASALT
Horz Seismic Load: 0.1
HAWAIIAN MEMORIAL PARK
08-0043
ST.1
(x 1000)
(x 1000)

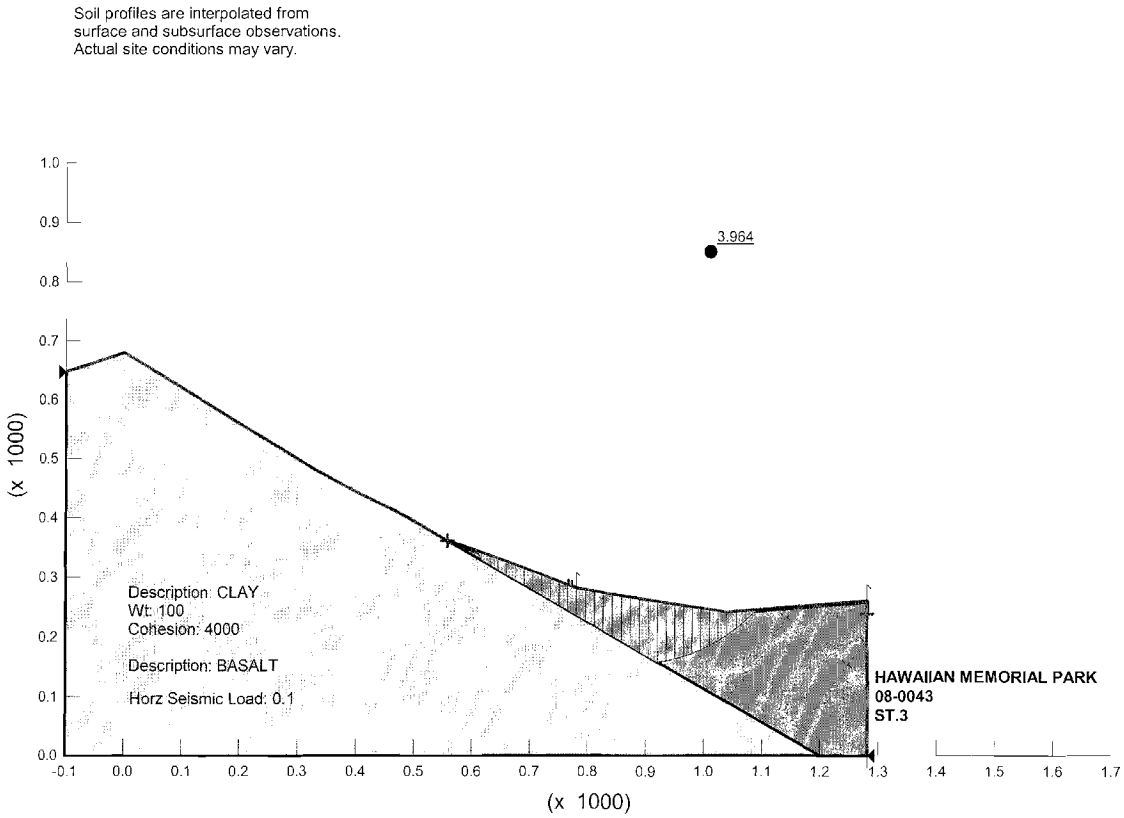
Soil profiles are interpolated from
surface and subsurface observations.
Actual site conditions may vary.

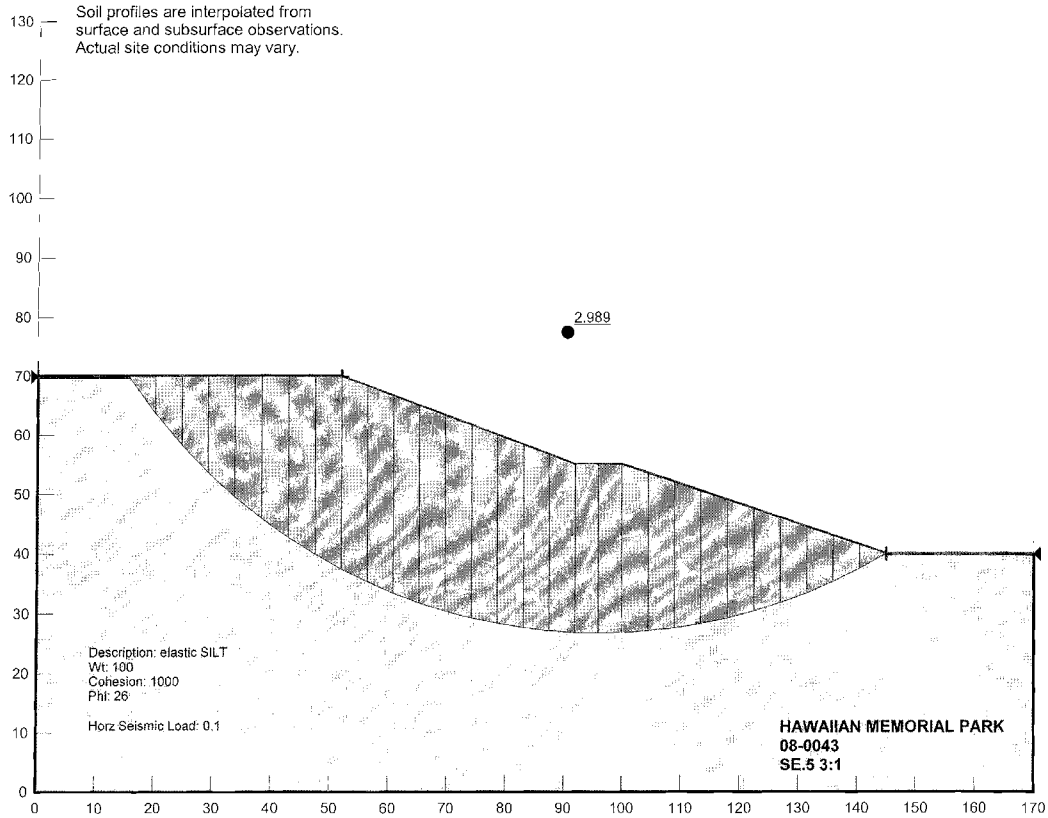


Soil profiles are interpolated from
surface and subsurface observations.
Actual site conditions may vary.




Soil profiles are interpolated from
surface and subsurface observations.
Actual site conditions may vary.
2.762
Description: elastic SILT
Wt: 100
Cohesion: 1000
Phi: 26
Horz Seismic Load: 0.1
HAWAIIAN MEMORIAL PARK
08-0043
SE.4 2:1


Soil profiles are interpolated from
surface and subsurface observations.
Actual site conditions may vary.
3.964
Description: CLAY
Wt: 100
Cohesion: 4000
Description: BASALT
Horz Seismic Load: 0.1
HAWAIIAN MEMORIAL PARK
08-0043
ST.3
(x 1000)
(x 1000)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Actual site conditions may vary.
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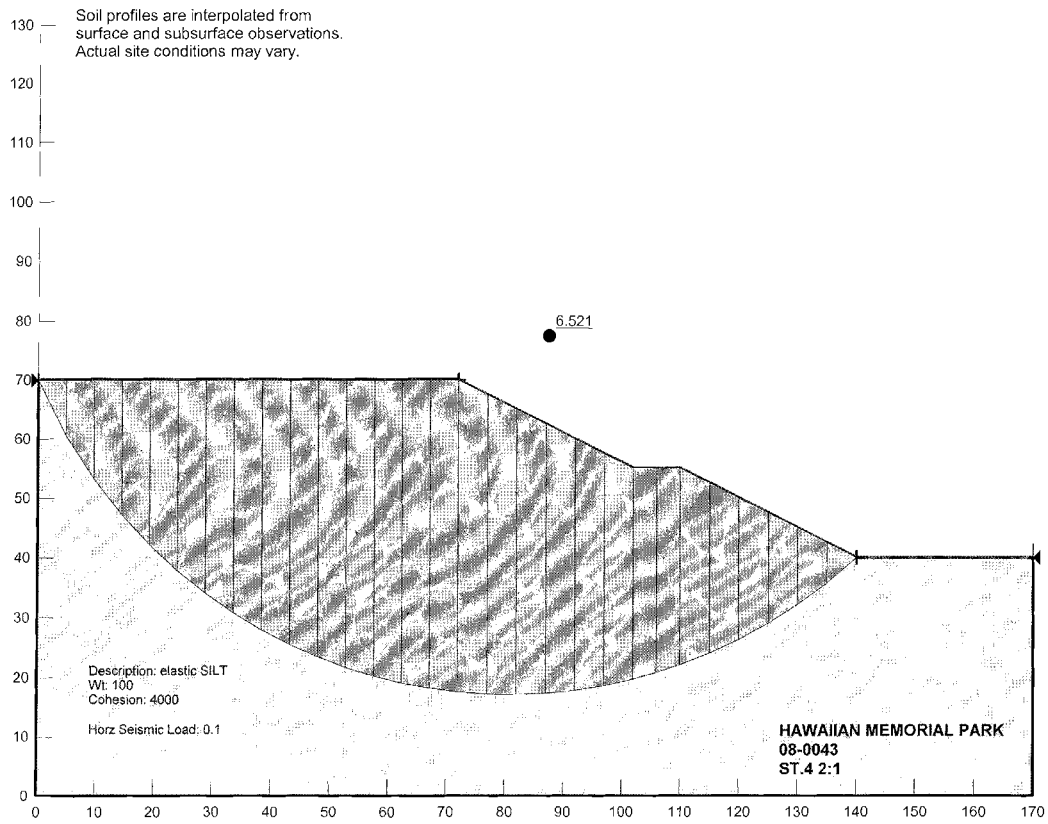
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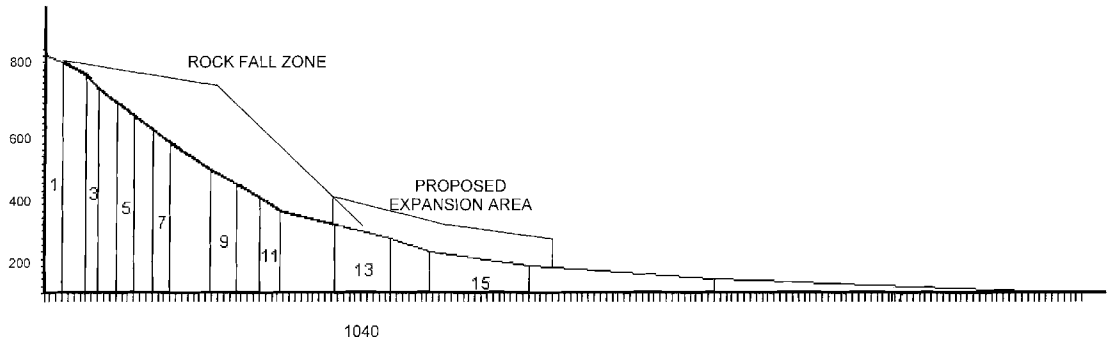
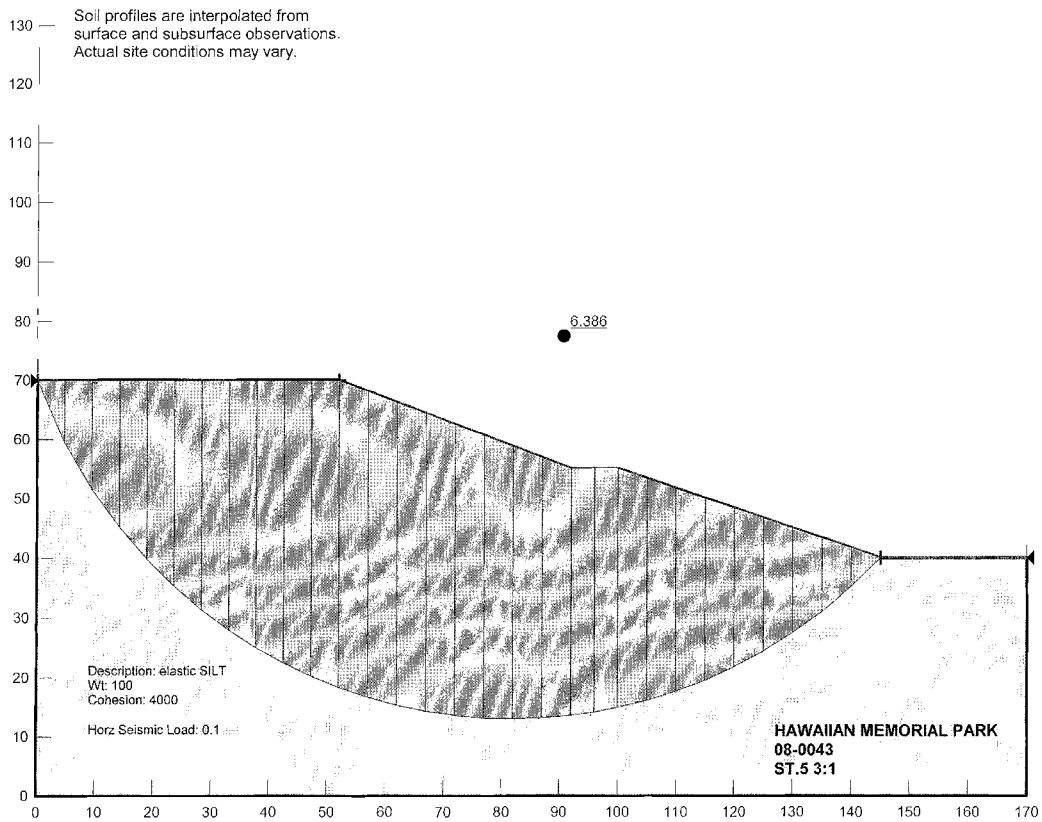
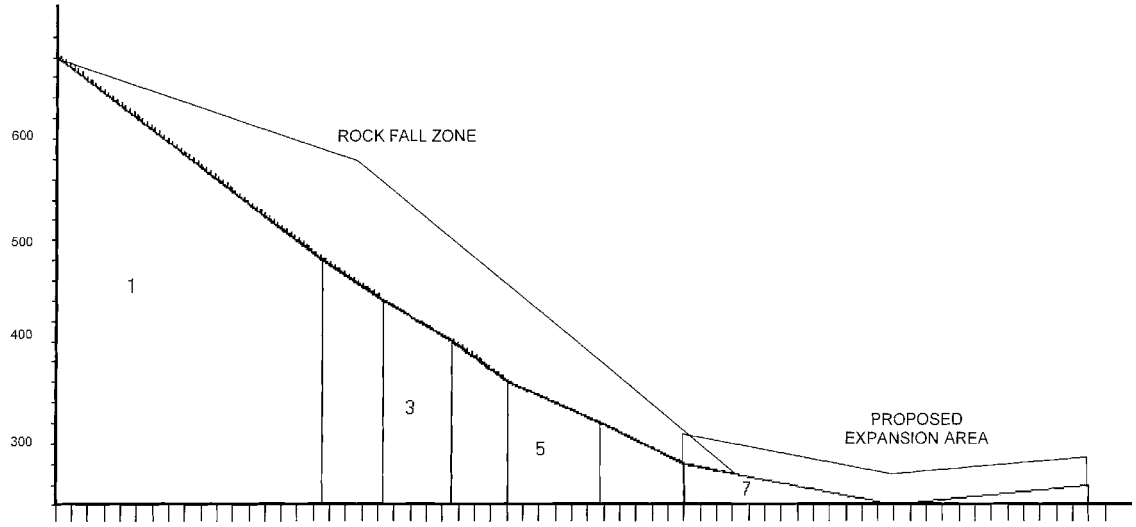


ROCK FALL -SECTION 1
NOT TO SCALE

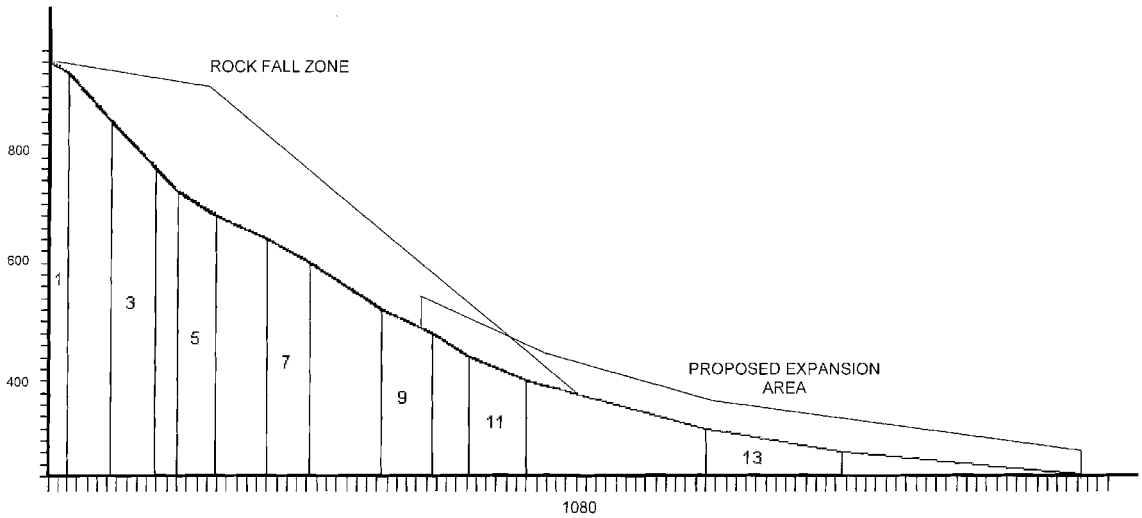
Project:	HAWAIIAN MEMORIAL PARK HAZARD ASSESSMENT	SHINSATO ENGINEERING, INC. CONSULTING GEOTECHNICAL ENGINEERS 98-747 KUAHAO PL. PEARL CITY, HI 96782	PLATE RF.1
Project No.:	08-0043		





ROCK FALL - SECTION 3
NOT TO SCALE

Project: HAWAIIAN MEMORIAL PARK HAZARD ASSESSMENT Project No.: 08-0043	SHINSATO ENGINEERING, INC. CONSULTING GEOTECHNICAL ENGINEERS 98-747 KUAHAO PL. PEARL CITY, HI 96782	PLATE RF.3



ROCK FALL -SECTION 2
NOT TO SCALE

Project: HAWAIIAN MEMORIAL PARK HAZARD ASSESSMENT Project No.: 08-0043	SHINSATO ENGINEERING, INC. CONSULTING GEOTECHNICAL ENGINEERS 98-747 KUAHAO PL. PEARL CITY, HI 96782	PLATE RF.2

C. Final Preliminary Engineering Report

(SSFM International, Inc.)

Hawaiian Memorial Cemetery Expansion
Final Preliminary Engineering Report

Prepared for: Hawaiian Memorial Park
Prepared by: SSFM International, Inc.
September 2008

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American Council of Engineering Companies, Member

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The Preparation of This Report Was The Responsibility Of and Completed By:

signature

9/25/08
date

The Quality Review of This Report Was The Responsibility Of and Completed By:

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CHAPTER 1 – INTRODUCTION

1.1 GENERAL OVERVIEW

This Preliminary Engineering Report has been prepared for Hawaiian Memorial Life Plan Limited. The purpose of this report is to evaluate the engineering requirements for two proposed options: (1) Expanding the existing Hawaiian Memorial Park (HMP), an existing privately owned and operated cemetery, and (2) expanding the existing HMP combined with the construction of a 20-lot residential subdivision. The cemetery only expansion is hereinafter referenced as the "Revised Proposed Action". The cemetery expansion with the 20-lot residential subdivision is hereinafter referenced as the "Former Proposed Action".

The existing developed area of the HMP will approach full capacity within the next five to ten years. In order to continue to serve Oahu's community, HMP must expand beyond its existing developed area and is planning for the long term expansion of a portion of its remaining undeveloped property. The expansion of the existing HMP will consist of a variety of land burial plots and up to four mausoleums. Each mausoleum will be up to 3,500 square feet in size. One mausoleum may contain a restroom facility for the use by park visitors. The approximate size of each residential lot will be between 7,500 and 8,000 square feet.

This Preliminary Engineering Report presents a description of the land identified for the expansion of the cemetery and the residential subdivision, and identifies potential infrastructure and/or site development issues. Once identified, this report will detail the requirements associated with these issues for the cemetery expansion and residential subdivision. Improvements assessed include site grading, erosion control, roadways, potable and irrigation water, wastewater and storm water infrastructure.

There are two main engineering issues affecting this site's future development; (1) meeting the City and County of Honolulu drainage requirements; and (2) identifying a water source for irrigation and domestic uses. The adjacent residential areas' storm water systems, at the base of the mountain ridge, have been sized to meet existing conditions with little excess capacity available. Therefore, all increased runoff generated by the proposed development must be retained onsite. The grading plan for each phase of the project will incorporate these retention areas. Also, the City and County of Honolulu Board of Water Supply prefers that the irrigated area within the project site (approximately 30 acres of landscaping area within the cemetery expansion) utilize non-potable well water prior to consideration of additional connections to the city's potable water supply. Well water is often used for cemetery irrigation purposes and is, in fact, used for the irrigation of the adjacent Hawaii State Veterans Cemetery. Also, the existing potable water source in Lipalu Street (the nearest connection point to the residential subdivision) is inadequate to provide domestic water up to the subdivision. Constructing an on-site water system or connecting to another water source are alternatives. These issues are discussed in more detail in the following sections of this report.

A conceptual site grading and drainage layout has been developed for preliminary assessment purposes based on available GIS information. A rough order of magnitude "opinion of probable construction cost" of site development, based upon limited information, is also provided.

Table 1 provides a summary of the pertinent parcel information.

TABLE 1 - PROJECT AREA SUMMARY INFORMATION

Project Location:	The physical address is 45-425 Kamehameha Hwy, Kaneohe, HI 96744. The project area is located between H3, Kamehameha Hwy, Kaneohe Bay Drive and Mokapu Saddle Road in the Kaneohe District on the Island of Oahu.
Tax Map Key:	4-05-033: Portion of tax parcel 001
Total Land Area of Project:	"Former Proposed Action": 56.65 acres of the 164 acre parcel (35%) "Revised Proposed Action": 56.46 acres of the164 acre parcel (34%)
Existing Use:	Portions of the parcel are currently used as a cemetery; the project area is currently undeveloped.
Land Ownership:	Hawaii Memorial Life Plan LTD.
State Land Use:	Conservation
City Zoning:	P-1 Restricted Preservation
SMA District:	The project area is not located within the Special Management Area as established by the City and County of Honolulu
Flood Zone:	Zone X and Zone D

For vicinity map, courtesy of Helber, Hastert & Fee, see Figure 1 in Appendix A.

1.2 PROJECT LOCATION

HMP is in the Kaneohe community on the Island of Oahu, and consists of three separate Tax Map Key Parcels. Two of the parcels, TMK 4-5-034:13 and TMK 4-5-035:08, are situated along Kamehameha Highway, and are currently in cemetery use. A third parcel, TMK 4-5-033:001 (Parcel 1), is separated from the first two parcels by the Hawaii State Veteran's Cemetery, and is located to the north of the Hawaii State Veterans Cemetery, to the east of Mokulele Drive, and south of the Pohai Nani Retirement Community. A portion of this parcel (approximately 8 acres) is also currently in cemetery use, bringing the gross land area of the cemetery use for HMP to about 80 acres. The total area of Parcel 1 is 164 acres. A portion of Parcel 1(56.65 acres for "Former Proposed Action", 56.46 acres for "Revised Proposed Action") is intended for the future expansion of HMP and is hereinafter referenced as the "project area." For clarification of land ownership, see the Tax Map Key Figures 2-4 located in Appendix A.

The residential subdivisions to the northwest of the project area are known as "Pikoiloa 9," "Pikoiloa 10" and the "Parkway Subdivision."

1.3 EXISTING LAND USE DESIGNATION

Under Chapter 205, Hawaii Revised Statutes (HRS), all lands in the State of Hawaii are classified into four land use districts (State Land Use Districts) which are Urban, Rural, Agricultural, and Conservation. Land use district classifications are defined in HRS Section 205-2 and regulated by the State Land Use Commission (State LUC). The project area is classified Conservation and falls under the jurisdiction of the State Department of Land and Natural Resources.

For State Land Use and City and County of Honolulu Zoning, see Figures 5 and 6 in Appendix A, courtesy of Helber, Hastert & Fee.

Under Chapter 205A (Coastal Zone Management), HRS, the City is granted authorization to regulate land uses located within established Special Management Areas (SMA) for the Island of Oahu. Review of the City's SMA map for the Kaneohe area reveals that the subject property is not located within a SMA and not subject to its requirements.

Since the project area is designated "Conservation", a State Land Use District boundary amendment to Urban is required for each of the proposed actions. Also, County zoning changes to P-2 General Preservation District and R-7.5 Residential District are required for the "Former Proposed Action". The "Revised Proposed Action" will only require County zoning changes to P-2 General Preservation District. This preliminary engineering report is intended to support the requests for the land use entitlements.

1.4 DESIGN CRITERIA AND REFERENCES

The following documents and references were used to formulate the conceptual design and assumptions of this preliminary engineering report.

The City and County of Honolulu, Rules Relating To Storm Drainage Standards (dated January 2000) was used to analyze the existing and proposed drainage conditions in the proposed development. Per the City and County of Honolulu Drainage Standards, a 10-year recurrence interval is used in the storm drainage analysis. Based upon the Storm Drainage Standards, the Rational Method is used to calculate storm water runoff flow quantities.

The City and County of Honolulu, Water System Standards (dated 2002) is used to analyze and prepare a conceptual layout of the proposed water system. This project will adhere to fire protection requirements of the City and County of Honolulu Fire Department.

The City and County of Honolulu, Design Standards of the Department of Wastewater Management, Vol. 1 (dated July 1993) is used to analyze and prepare a conceptual layout of the proposed wastewater collection system.

The State of Hawaii, Soil Survey of Islands of Kauai, Oahu, Maui, Molokai and Lanai (dated August 1972) is used to formulate general soil properties, permeability rates and other assumptions to be discussed in a later chapter.

CHAPTER 2 – EXISTING SITE CONDITIONS

A preliminary assessment of existing site conditions was conducted of the parcel identified as Tax Map Key: 4-05-033:001 which contains the area of the expansion of the existing Hawaiian Memorial Park and the residential subdivision. This assessment consisted of a field inspection of the property and nearby neighborhoods, preliminary research of available information on infrastructure facilities in the area, and discussions with various City agencies.

2.1 EXISTING PHYSICAL CONDITIONS

Topography

The proposed project area is currently undeveloped with various ridges, ravines and valleys as topographic features. The ridge line of the parcel separates Kapaa Quarry from the Hawaiian Memorial Park ownership. At the base of the mountain, the parcel is bordered by the Pikoiloa 9, Pikoiloa 10 and Parkway residential subdivisions to the west. The parcel is bordered on the north by the Pohai Nani Retirement Community. The Hawaii State Veterans Cemetery is to the south.

The general terrain of this parcel consists of moderate to severe slopes. The severe slopes are found near the ridgelines. Elevations of the parcel range from 945 feet above mean sea level (MSL) near the ridgeline to 100 feet MSL at the lower boundary.

Topographic data for this site was obtained from the City's GIS website which provides contour lines at 5 foot intervals. This topographic data is not intended for the design of construction documents but reflects adequate information for conceptual planning purposes. Exact elevations and slopes will be confirmed when an aerial and/or ground topographic survey is performed for the design of construction documents.

For Slope Analysis and Elevation Analysis, see Figures 7 and 8, respectively, in Appendix B.

Soils

According to the United States Department of Agriculture, Soil Conservation Service's soil survey report for the Island of Oahu, existing soils on the parcel consist of Alealoa Silty Clay (AeE & ALF), Helemano Silty Clay (HLMG), and Kaneohe Silty Clay (KgC & KHOF).

Alealoa Silty Clay is the predominant soil located within the project site. Helemano Silty Clay is mainly located near the ridgeline. Kaneohe Silty Clay also is located in a portion of the project site.

The Alealoa Series consist of well-drained soils on the uplands of Oahu. One form of Alealoa Silty Clay, AeE, has typical slopes of 15-35% with moderately rapid permeability, medium runoff, and moderate erosion. This soil is typically found on smooth side slopes and the toe slopes of upland areas. The other version present, ALF, has typical slopes of 40-70% with rapid to very rapid runoff and severe erosion. This soil is typically found in stony areas and rock outcrops.

The Helemano Series consist of well-drained soils on alluvial fans and alluvial slopes usually found on the sides of gulches on the Island of Oahu. The type of Helemano Silty Clay found, HLMG, has typical slopes of 30-90% with moderately rapid permeability, medium to very rapid runoff, and severe to very severe erosion. This soil is typically found on the sides of V-shaped gulches, small areas of rock outcrop, steep stony land, and eroded spots.

The Kaneohe Series consists of well-drained soils on terraces and alluvial fans on the windward side of Oahu. The Kaneohe Silty Clay found on site is KgC and KHOF. KgC has medium runoff and moderate erosion. KHOF has medium to rapid runoff and moderate to severe erosion. Both soils are typically found in small eroded spots and gravelly areas.

For the Soil Conservation Survey Analysis refer to Figure 9 in Appendix B. A more detailed soils investigation will be required in conjunction with the design of construction documents for the project.

Flood Hazards

According to the September 30, 2004, Flood Insurance Rate Map (FIRM) Community Panel 15001 0270F, the project site is located in Zone D and Zone X. Zone D represents an area in which flood hazards are undetermined but possible. Zone X represents an area to be outside of the 500-year flood plain. Accordingly, the property appears to be situated outside of any flood designated boundaries. Furthermore, the project site is not situated along the shoreline at an elevation making it subject to coastal flooding.

For the Flood Insurance Rate Map, see Figure 10 in Appendix B.

2.2 EXISTING INFRASTRUCTURE FACILITIES

Drainage Conditions and Facilities

Present storm water runoff from the project site sheet flows into various valleys, channels, etc., following the existing topography. This runoff is collected and flows in storm drains within the residential areas and then discharges into Kawa Stream or various storm drain systems eventually flowing into Kaneohe Bay.

Previous hydrology studies of the immediate area were acquired through Drainage Master Plans obtained from the City & County of Honolulu's Department of Planning and Permitting (DPP), Civil Engineering Branch, Drainage Division. An approved Drainage Master Plan is required to address all storm water prior to the development of any subdivision including both existing flows onto the site and flows from the subdivision's development. Based on these documents and discussions with DPP, it appears that the collection of the existing storm water runoff quantities from the Hawaiian Memorial Park parcel were already addressed in the development of Pikoiloa 9, Pikoiloa 10, and Parkway Subdivisions via various collection points in the residential areas. Sizing of the storm drain lines from runoff of the upland area were based on the City & County of Honolulu's Standard Rational Method. The Rational Method will be further discussed and explained in Chapter 3.

Upon further evaluation of the existing storm drain infrastructure through construction documents recorded with the City and County of Honolulu's Data Accessing and Imaging Branch, a hydraulic analysis of the system was done. This system analysis, based on the existing storm water runoff quantities referenced from Drainage Master Plans and full system hydraulic flow calculations, shows that the existing drainage system is adequate for the current, undeveloped conditions within the project area but may have little excess capacity to accommodate additional peak runoff from the proposed development. For hydraulic calculations, see "Existing Hydraulic Capacity Analysis" table in Appendix C.

As stated above, the downstream system was designed to meet current, undeveloped conditions within the project area for the 10-year, 1-hour storm. The existing undeveloped conditions produce a runoff of approximately 478 cfs.

For Existing Drainage Calculations, see Appendix C.

Water Facilities

Irrigation

The irrigation system for the existing Hawaiian Memorial Park is served by the City's potable water system. The connection point is located at the entrance to HMP in the vicinity of Mahinui Road and Kamehameha Hwy. A 6" meter located on Kamehameha Highway is servicing the existing Hawaiian Memorial Park Cemetery and has a capacity of 1,000 gpm.

There is another waterline in Kumakua Place serving the irrigation system for the Ocean View Garden (a small cemetery area within the Hawaiian Memorial Park ownership). This system includes a 5/8" meter located on Kumakua Place and a 1" lateral coming off of the 5/8" meter. In discussions with the City & County of Honolulu Board of Water Supply (BWS), water quantities and pressure may be currently available to fully service approximately 30 acres of grass landscaping requiring 550 gallons per minute for the expansion area from the waterline.

There is another waterline in Lipalu Street. However, the BWS has indicated that connecting to the existing water stub out along Lipalu Street will not be possible. BWS has determined that the existing system will not have the required pressure to meet the 100+ foot elevation difference, as the existing 272' windward reservoir service limit serving the area will not be high enough to support the proposed cemetery elevations of 200'-375'. The highest elevation that can adequately receive water from the existing system is one hundred feet below the reservoir spillway at elevation 172'.

Before the project can utilize the City's potable water supply for irrigation purposes, non-potable water sources must be investigated for possible use. The BWS has indicated that non-potable wells are present near the project expansion area. According to BWS, three non-potable wells are located on State property along Kamehameha Highway near the H-3 interchange as shown in Figure 11 in Appendix D. The adjacent Hawaii State Veteran's Cemetery uses these non-potable wells as a source for their irrigation but it is unknown whether all three wells are being utilized. According to conversations with a local well driller and BWS, the non-potable well(s) servicing the Hawaii State Veteran's Cemetery were drilled in 1983. One well was test pumped at 27 gpm and the main well at 570 gpm. One well was drilled 62 feet deep. Further research and discussion with Miles Okamura, Operations Manager at the Hawaii State Veterans Cemetery, indicates that these wells have operated satisfactorily Based on the above information, it should be feasible to provide adequate water for irrigation using new wells developed by Hawaiian Memorial Park.

Domestic Water

In addition to irrigation, domestic water will be required for both the "Former Proposed Action" (residential subdivision and comfort station) and "Revised Proposed Action" (comfort station). There are no existing water lines within the proposed project area. The ideal connection point for a water system to serve the residential subdivision and comfort station would be at the existing water line stub out at the end of Lipalu Street. As stated above, since the project topography is located at higher elevations, BWS has indicated that their existing system serving the Lipalu Street area is unable to provide domestic water for both the "Former Proposed Action" and "Revised Proposed Action". However, BWS does allow residential subdivisions to be located above their service limit if the property has frontage and the meter is placed 100' below the required service limit. These conditions cannot be met at the end of Lipalu Street, as the existing elevations are approximately 190', which will not be 100' below the 272' service limit. As a result an on-site water system will be developed to provide domestic water service to the residential subdivision and comfort station.

The existing connection point at Kumakua Place will not be a possible connection point. BWS stated they will not allow the connection because they do not want to take on the burden of maintaining the transmission line from the meter to the residential subdivision due to liability concerns such as a water main break.

For communications from the Board of Water Supply, see Appendix D.

Wastewater Facilities

There are existing wastewater lines within Hawaiian Memorial Park and an 8" municipal transmission line located in Lipalu Street. There are currently no sewer lines within the project area.

Roadway Facilities

There are existing private roadways within the existing Hawaiian Memorial Park, Hawaii State Veteran's Cemetery, and Ocean View Gardens. Also, Lipalu Street (a public right of way) ends at the property line of the Hawaiian Memorial Park ownership in which the project is located.

A traffic assessment will be prepared by Perazim Consulting, LLC to discuss the impacts of the cemetery expansion and residential component.

2.3 KEY ISSUES ASSOCIATED WITH EXISTING INFRASTRUCTURE FACILITIES

Based upon the preliminary assessment of the existing site conditions, infrastructure and facilities, the major engineering issues affecting the proposed development will be: (1) retaining increases in storm water runoff onsite; (2) investigating non-potable water sources for irrigation to avoid using the City's potable water; and (3) investigating a source to provide domestic water to the proposed residential subdivision.

Based on the City's Storm Water Standards, the proposed project must be designed to handle the increased storm water runoff from a 1-hour, 10-year recurrence interval storm. There are two options to mitigate the increase of discharged runoff due to a property development, renovation, alteration, etc. The first option is to convey the increased runoff to a collection system which has adequate capacity to accept the additional flows. This would require adding storm drains below the project site or upgrading the existing storm drain system as the existing system is at or near capacity. The second option is to retain the additional storm water created from the development onsite for the duration of the 10-year, 1-hour storm. This is the most cost effective and reasonable approach to mitigating the additional runoff. Further drainage details are explained in Section 3.2 "Proposed Drainage Alternatives".

Addressing the BWS requirements for a thorough and conclusive investigation of a non-potable water source for irrigation purposes will be difficult without drilling exploratory wells. The drilling of exploratory wells will be performed in future phases of this project. As the results of drilling these wells are not available at this time, the next chapter will provide various alternatives for water availability to be further researched.

Providing a domestic water system for the proposed residential subdivision due to the existing inadequacies of the existing BWS systems to meet the flow requirements will be another key issue to be discussed in subsequent chapters.

CHAPTER 3 - SITE DEVELOPMENT ASSESSMENT

The results of this preliminary engineering analysis suggest that development of the 56.65 acre ("Former Proposed Action") and 56.46 acre ("Revised Proposed Action") project is feasible and practicable.

A conceptual site plan was prepared based on the criteria discussed in the following sections. Prior to this Final PER, a conceptual design was prepared that consisted of a cemetery expansion and 20-lot residential subdivision, also known as the "Former Proposed Action". Since then, a "Revised Proposed Action" has been implemented to incorporate a cemetery only expansion. For the conceptual site plan for both actions, see Conceptual Site Plans in Appendix F and G, respectively.

3.1 PROPOSED EROSION CONTROL MEASURES

The existing soils are classified as having moderate to severe erosion, therefore temporary and permanent erosion control measures need to be implemented as best management practices (BMP's) during construction. An additional BMP would be to begin construction during dry months of the year. Temporary erosion control measures include using silt fences, stabilized construction entrances, catch basin and inlet protection, and dust control. Permanent erosion control measures include grading to provide proper drainage. Exposed areas will be paved or grassed and/or landscaped to match adjacent landscaping. Grass sod will be planted to minimize erosion.

Proper grading, pavement and permanent grassing and landscaping over all open areas created by the grading operations will minimize soil loss from the site to acceptable levels.

The above mentioned proposed erosion control measures will minimize potential sediment runoff to existing drainage facilities, reducing the soil loss to acceptable levels. During construction, the contractor will use mulching to provide the necessary erosion control as they proceed. The permanent erosion control measures proposed will protect the site against future soil erosion.

3.2 PROPOSED INFRASTRUCTURE AND FACILITIES

Proposed Grading Concept

This PER has been prepared without a geotechnical report or detailed topographic survey. Thus, the following assumptions have been made during this planning phase:

1) All soils are identical and useable for landscaping, cemetery activities, and cut/fill,
2) All areas are gradable except the area within the cultural preservation area and historical sites including any rock crop areas,
3) Maximum slopes for the project are equal to existing slopes. Thus the maximum slopes will be established at 50% (2 Horizontal:1 Vertical),
4) All soils are ideal and will not swell or compact during grading activities,
5) Grading activities will not create any type of landslides, rock falls, erosion, flooding or dangerous situations which may affect downhill parcels, and
6) Grading will not severely alter the natural drainage ways for the project area affecting downhill residents.

This PER has been prepared with certain criteria provided by HMP for cemetery activities:

1) The maximum slope for usable cemetery plots is equal to or less than 20% (5 Horizontal :1Vertical),
2) The maximum distance to a cemetery plot is 150 feet from the roadway,
3) The overall earthwork quantity must be approximately 70,000 cubic yards of net fill, and
4) Each phase of the project must roughly equalize cut and fill quantities. Development phasing will be determined in the design phase of this project and not during the planning phase. This will allow for the detailed analysis to create a cut/fill balance with each phase.

During the grading phase, there will be no import or export of any soil during the expansion process. All soil will come from within HMP and will entirely balance within the overall HMP property. The source of the backfill will

come from the 2-3 cubic yards of soil that will be generated by each future burial in the new and existing cemetery areas.

For the proposed grading concept, see Conceptual Grading Plans in Appendix F and G.

Proposed Drainage Alternatives

The existing storm water system within the adjacent subdivisions is already at or near full capacity. Thus the volume of increased drainage runoff attributable to the expansion of the cemetery and residential subdivision will be retained onsite. The following discussion will present two alternatives to retain the increased runoff onsite.

Since the cemetery expansion is replacing "natural" vegetation with landscape material (primarily turf), there is no difference in runoff quantities other than the increase in runoff quantities generated from the impervious roadway and mausoleums within the cemetery expansion. There will also be increased runoff from the roadway and structures to be built within the residential lots. The increase in runoff was estimated using the Rational Method.

The Rational Method is used to calculate the increase in runoff based on the storm intensity, runoff coefficient, and area. The method then provides an additional safety factor by including the time of concentration. The time of concentration is the amount of time it would take a drop of water from the farthest point in a drainage basin to reach the discharge point. The maximum discharge during a storm event is at the time of concentration. The time of concentration then correlates to a correction factor giving the Rational Method the following equation:

Water Discharge Quantity, cubic feet per second = (Pavement Coefficient) x (Rainfall Intensity, in/hr) x (Area, acres) x (Correction Factor based on the Time of Concentration).

$Q=CIA(CF)$

In calculating the increased runoff, the same rainfall intensity and area boundaries were used as in the previous Drainage Master Plans to maintain consistency. This provides a layer of conservatism as some of the drainage areas were addressed in multiple Master Drainage Plans. The proposed runoff quantities are considered conservative because the maximum correction factor was used to calculate the amount of runoff needing to be retained onsite. Thus it was assumed for all drainage basins that the time of concentration was 3 minutes and a correction factor of 3 was used for the proposed calculations, which resulted in higher Q's.

Cemetery Expansion and 20-Lot Residential Subdivision

Once the conceptual site plan was established, the increased runoff from the roadways, mausoleums, and impervious portions of the residential subdivision was calculated. For calculation purposes, the assumptions are 50% of the residential lots will consist of 4000 square feet of impervious area (3000 sf one-story unit, 500 sf driveway, and 500 sf garage) and the other 50% will consist of 2500 square feet of impervious area (3000 sf two-story unit, 500 sf driveway, and 500 sf garage). A 10-year 1-hour duration storm has the potential to discharge a total of approximately 520 cfs from the contributory drainage areas in the previous Master Plans. As a result, of the proposed cemetery expansion and residential subdivision, the total runoff will be increased by approximately 42 cfs (from 478 cfs) from the 9 drainage areas. This increased runoff is approximately 153,000 cubic feet (assuming the increased runoff must be stored for one hour). See "Proposed Drainage Analysis" for hydrology calculations in Appendix C. Drainage Area "A-6" produced the largest increase in runoff and will require the most on site retention volume. Drainage Areas "D-4" and "B-7" did not produce additional increased runoff and therefore will not need on site retention systems in their drainage area.

Cemetery Expansion Only

For the "Revised Proposed Action", the only increase in runoff would come from the impervious internal cemetery roadway and mausoleums. A 10-year storm has the potential to discharge a total of approximately 520 cfs from the contributory drainage areas in the previous Master Plans. As a result of the "Revised Proposed Action", the total runoff will be increased by approximately 22 cfs (from 478 cfs) from the 9 drainage areas. The increase of approximately 22 cfs is a decrease of 20 cfs from the "Former Proposed Action". This increase in runoff from the

existing conditions generates a volume of approximately 84,450 cubic feet (assuming the increased runoff must be stored for one hour). See "Proposed Drainage Analysis" for hydrology calculations in Appendix C. Drainage Area "A-6" produced the largest increase in runoff and will require the most on site retention volume. Similar to the "Former Proposed Action", Drainage Areas "D-4" and "B-7" did not produce additional increased runoff and therefore will not need on site retention systems in their drainage area. After the increased runoff was determined, two options were considered for onsite retention: drywells and retention areas.

Drywell Alternative

Drywells are large storm drainage chambers of various sizes. Their purpose is to retain storm water and discharge it through infiltration. They would be located in the roadway and appear like storm drain inlets from the surface. The main advantage of this alternative is the fact that they would not consume any "usable" land.

For calculation purposes, we assumed a drywell with a 5' radius and 5' depth. Through a cost analysis using a typical percolation rate found in the Soil Conservation Service's soil survey report of 4 inches per hour, the number of drywells required will likely exceed 10,000. At a cost of $10,000 per drywell, this alternative is not feasible and retention areas were considered.

Retention Area Alternative - Cemetery Expansion and 20-Lot Residential Subdivision

Retention areas or basins are the most common means of controlling runoff from new development areas. For the proposed cemetery, the retention areas would consist of depressed turf or grassy planted areas that will be designed into the cemetery grounds in a manner to blend in with the general landscape appearance. The retention areas will be scattered throughout the cemetery to provide the required amount of storage while avoiding larger and deeper basins. These areas also act as a treatment process to improve water quality, as they allow the settling of fine particles and pollutants associated with storm water runoff, which is considered a measure for improving water quality per City and County of Honolulu Standards. During the design phase, the objective will be to have retention areas with a maximum depth of no more than 18" of water. However, two retention areas located northeast of the proposed cemetery grounds within the cut/fill slope may have depths up to 3'. Approximately 1.93 acres scattered throughout the development will be needed for the retention areas. The cemetery grounds will lend themselves well to incorporation of retention areas and will provide the opportunity to maximize surface area and therefore percolation and evaporation opportunities of the retained water. The final design and locations of retention areas will be prepared during the grading plan phase of the project. For the proposed drainage concept, please see the Conceptual Drainage Plan in Appendix F.

Retention Area Alternative - Cemetery Expansion Only

The retention areas will be scattered throughout the cemetery to provide the required amount of storage while avoiding larger and deeper basins. During the design phase, the objective will be to have retention areas with a maximum depth of no more than 18" of water. With an approximate required storage volume of 84,450 cubic feet to capture the increase in runoff for one hour, approximately 1.33 acres scattered throughout the development will be needed for the retention areas. The required storage volume of 84,450 cubic feet is a 45% reduction in storage volume from the "Former Proposed Action". The cemetery grounds will lend themselves well to incorporation of retention areas and will provide the opportunity to maximize surface area and therefore percolation and evaporation opportunities of the retained water. The final design and locations of retention areas will be prepared during the grading plan phase of the project.

Routine monitoring and management shall be conducted throughout all retention areas to ensure maximum storage. Also, in order to prevent a suitable habitat for mosquito breeding, all retention areas shall be dry within three (3) days. Other measures for maintenance include annual removal of emergent vegetation, chemical pesticide treatment, aeration, etc.

For the proposed drainage concept, please see the Conceptual Drainage Plan in Appendix G.

Proposed Wastewater Disposal Alternatives

Cemetery Expansion and 20-Lot Residential Subdivision

The proposed expansion of the Hawaiian Memorial Park and residential subdivision will generate wastewater from the public restroom and the 20-lot residential subdivision. Therefore, added wastewater lines and a collection system will be needed within the project area to handle this wastewater. The proposed restroom facility within the cemetery expansion area will generate approximately 13,430 gallons per day or 0.013 mgd (Million Gallons per day) of wastewater at a design flow average while the proposed 20 lot residential subdivision would generate 52,061 gallons per day (0.05 mgd). The existing 8" sanitary sewer line in Lipalu Street has the capacity to accommodate these flows. This connection has been approved by the City and County of Honolulu Department of Planning and Permitting (see Appendix E for sewer connection approval and sewer flow calculation).

For proposed sewer line alignment, see Conceptual Utility Plan in Appendix F.

Cemetery Expansion Only

The proposed "cemetery only" expansion of the existing Hawaiian Memorial Park will generate wastewater from the public restroom only. According to DOH, the only restrictions for a septic tank and leach field is that it shall be located at least five (5) feet away from the property line and proposed structure. There are no restrictions on the distance from a burial plot. Therefore, added wastewater lines and a collection system will be needed within the project area to handle this wastewater. The proposed restroom facility within the cemetery expansion area will generate approximately 13,430 gallons per day or 0.013 mgd (Million Gallons per day) of wastewater at a design flow average (based on a total capita of 100 people). The proposed septic tank and leach field shall be designed to handle these proposed flows. See Appendix E for sewer flow calculation.

For proposed sewer line alignment, see Conceptual Utility Plan in Appendix G.

Proposed Water System Alternatives for Irrigation

Irrigation

Windward Oahu receives sufficient precipitation to minimize the need for supplemental irrigation of landscaping. During dry hot periods, particularly during establishment of new landscaping, irrigation will be required. In a worst case scenario, an irrigation flow of up to 500 plus gallons per minute (gpm) could be required to keep the cemetery grounds adequately watered at full build out for both the "former" and "revised" proposed actions.

Construction of Onsite Wells

The Board of Water Supply (BWS) requires investigation of the feasibility of non-potable water sources prior to the use of potable water sources for irrigation. Cemeteries are often irrigated with well water and HMP would also prefer this method and source. The Veterans cemetery is irrigated through wells located near the intersection of the H-3 freeway and Kamehameha Highway. Additional wells could be added in this area to also supply the proposed HMP expansion per conversations with Chester Lao of BWS and local area drillers. However, the length of the pipe run to the HMP expansion area from this location would be costly. Investigations into the feasibility of drilling wells on HMP property and within or near the proposed expansion area indicate a reasonable probability of developing sufficient water supply. If several wells are required, they can be drilled coincident with the various new phases of the cemetery expansion. This will also allow continued analysis of the ongoing irrigation water needs of the expanding cemetery. Exploratory wells will be drilled prior to commencing construction of the first phase of development to determine final feasibility. See proposed waterline alignment in Appendix F and G, "Conceptual Utility Plan".

Connecting to Existing Water Alternatives

The existing Ocean View Garden area of HMP adjacent to the proposed expansion is irrigated through a potable water meter located on Kumakua Place. If a non-potable water source is found to be unavailable or infeasible, a

connection to Kumakua Place or another available BWS source may be a possible option. The BWS pressure zone for the Kumakua meter is sufficient to provide adequate pressure to the entire expansion area . If approved by BWS, the existing meter would need to be enlarged from the current 5/8" size to a 3" or 4" meter size. The supply main from the meter into the cemetery would also need to be increased to deliver the required flow if approved by BWS. There is also a potable water supply at Lipalu Street but it has insufficient pressure and size to provide water into the expansion area for irrigation purposes.

The supply system within the existing HMP area are serviced off of Kamehameha Highway could also be extended into the expansion area. This would be less cost effective since it would entail long and expensive pipe runs through the existing cemetery and across the Ocean View Garden section to the expansion area.

Proposed Water System Alternatives for Domestic Usage

Domestic Water - Cemetery Expansion and 20-Lot Residential Subdivision

Domestic water will be required for the 20 lot residential subdivision and also the proposed cemetery comfort station. The subdivision and comfort station is expected to generate a maximum daily demand of 15,000 gpd and a peak hour demand of 30,000 gpd (See Appendix D for water calculations.)

The only option for providing potable water to the residential subdivision and the cemetery restroom will be to build an onsite water system. As stated previously, connection to the existing water systems along Lipalu Street and Kumakua Place will not be possible due to water pressure, liability and maintenance issues.

Onsite Water System

The proposed onsite well systems constructed to supply irrigation water could also provide the necessary potable water supply if the water tests successfully for potability and/or if additional treatment onsite can improve minor deficiencies in the water to potable quality levels.

This potable water would be stored in an 80,000 gallon tank located in the upper developed cemetery grounds at approximately the 330 foot elevation. This will allow adequate storage and gravity pressure for domestic and fire flow volumes in the subdivision. The water treatment facility and tank will be serviced by a small paved road from the internal cemetery road network. The storage tank will be set into grade and landscaped to reduce or eliminate visibility from offsite areas.

Domestic Water - Cemetery Expansion Only

For the cemetery only expansion, domestic water will be required for the proposed cemetery comfort station. Contrary to the residential subdivision option, the domestic water servicing the comfort station will be non-potable water instead of potable water. Based on the 16.8 fixture units, the comfort station is expected to need 33 gallons/minute (See Appendix D for water calculations).

Fire Protection

The proposed mausolea structures located in the proposed expansion area are Type IV cast-in-place non-combustible structures with no assembly areas. As such, they will not require fire protection.

Proposed Roadway Access

Cemetery Expansion and 20-Lot Residential Subdivision

A proposed access road from the end of Lipalu Street will be provided for access to the residential subdivision. The proposed residential access road will have a 44' right-of-way with two 12' wide travel lanes. Also, 6" curbs will be provided on each side of the roadway. Within the residential subdivision, a cul-de-sac design is proposed and will be provided at each dead end.

Internal cemetery roadways will be provided throughout the cemetery portion of the project site. The internal roadways will be 26' wide with a 1 foot rolled curb on each side. The proposed connection point will be at the existing Ocean View Garden roadway. Also, a 12' wide road will be provided from the internal cemetery roadway to the proposed 80,000 gallon water tank located within the cemetery.

For the proposed roadway system, see Conceptual Site Plan in Appendix F.

Cemetery Expansion Only

Access to the proposed cemetery expansion area will be through the private road system through the existing Hawaiian Memorial Park, Hawaii State Veterans Cemetery, and Ocean View Garden.

Internal roadways will be provided throughout the cemetery portion of the project site. The internal roadways will be 26' wide with a 1 foot rolled curb on each side. The proposed connection point will be at the existing Ocean View Garden roadway.

For the proposed roadway system, see Conceptual Site Plan in Appendix G.

CHAPTER 4 - OPINION OF PROBABLE CONSTRUCTION COST

The following is the opinion of probable construction cost for both the "Former Proposed Action" and "Revised Proposed Action". The estimated cost for the "Former Proposed Action" and "Revised Proposed Action" totaled approximately $8,483,000 and $6,087,000, respectively.

TABLE 2 – OPINION OF PROBABLE CONSTRUCTION COST "FORMER PROPOSED ACTION"

Opinion of Probable Construction Cost – Cemetery Expansion and 20-Lot Residential Subdivision				
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**
Erosion Control & Grading				
Mobilization/Demobilization	1	LS	$50,000	$50,000
Construction Equipment	1	LS	$80,000	$80,000
Silt Fence	2,000	LF	$5	$10,000
Dust Fence	2,000	LF	$25	$50,000
Construction Ingress/Egress	1	EA	$3,000	$3,000
Clearing & Grubbing	56	AC	$10,000	$557,500
Relocated Earthwork (Excavation/Cut)	500,865	CY	$5	$2,504,325
Fill	37,459	CY	$5	$187,295
Compaction	37,459	CY	$1	$37,459
Grading	269,830	SY	$1	$269,830
Sub-Total (Erosion Control & Grading)				**$3,749,409**
Road Improvements				
Residential				
6" Base Course	13,716	SY	$25	$342,898
2" AC Pavement	13,716	SY	$25	$342,898
6" Concrete Curb and Gutter	4,987	LF	$50	$249,365
4' Wide Concrete Sidewalk	2,217	SY	$65	$144,078
Cemetery				
6" Base Course	19,170	SY	$25	$479,255
2" AC Pavement	19,170	SY	$25	$479,255
Rolled Curbs/Gutters	4,000	LF	$50	$200,000
Sub-Total (Road Improvements)				**$2,237,747**
Utility Lines				
Residential				
Trench Excavation for Water	362	CY	$3	$1,087
Trench Backfill for Water	54	CY	$6	$326
Pipe Bedding for Water	308	CY	$50	$15,406
Compaction for Water	362	CY	$3	$1,087
8" PVC Waterline	1,409	LF	$27	$38,053
Trench Excavation for Sewer	795	CY	$3	$2,386
Trench Backfill for Sewer	477	CY	$6	$2,863
Pipe Bedding for Sewer	318	CY	$50	$15,906
Compaction for Sewer	795	CY	$3	$2,386
8" HDPE Sewerline	2,494	LF	$75	$187,024

SMH, cover & frame	5	EA	$1,600	$8,000
Warning Tape (Sewer)	2,494	LF	$0.10	$249
Fire Hydrants	4	EA	$2,500	$10,000
Fittings	1,000	LB	$3	$3,000
Testing & Chlorination	1	LS	$1,500	$1,500
Cemetery				
Trench Excavation for Water	1,325	CY	$3	$3,976
Trench Backfill for Water	199	CY	$6	$1,193
Pipe Bedding for Water	1,126	CY	$50	$56,324
Compaction for Water	1,325	CY	$3	$3,976
8" PVC Waterline	391	LF	$27	$10,553
6" PVC Waterline	4,409	LF	$19	$83,773
Trench Excavation for Sewer	88	CY	$3	$264
Trench Backfill for Sewer	53	CY	$6	$317
Pipe Bedding for Sewer	35	CY	$50	$1,762
Compaction for Sewer	88	CY	$3	$264
6" HDPE Sewerline	317	LF	$75	$23,784
Warning Tape (Sewer)	317	LF	$0.10	$32
80,000 Gallon Water Tank	1	EA	$180,000	$180,000
Booster Pump	3	EA	$3,000	$9,000
Water Treatment System	1	EA	$10,000	$10,000
Non-Potable Well	3	EA	$40,000	$120,000
Fittings	1,000	LB	$3	$3,000
Testing & Chlorination	1	LS	$1,500	$1,500
Sub-Total (Utilities)				**$798,991**
Total				**$6,786,147**
Contingency (25%)				$1,696,537
Grand Total				$8,482,684
Grand Total (Rounded)				**$8,483,000**

TABLE 3 – OPINION OF PROBABLE CONSTRUCTION COST "REVISED PROPOSED ACTION"

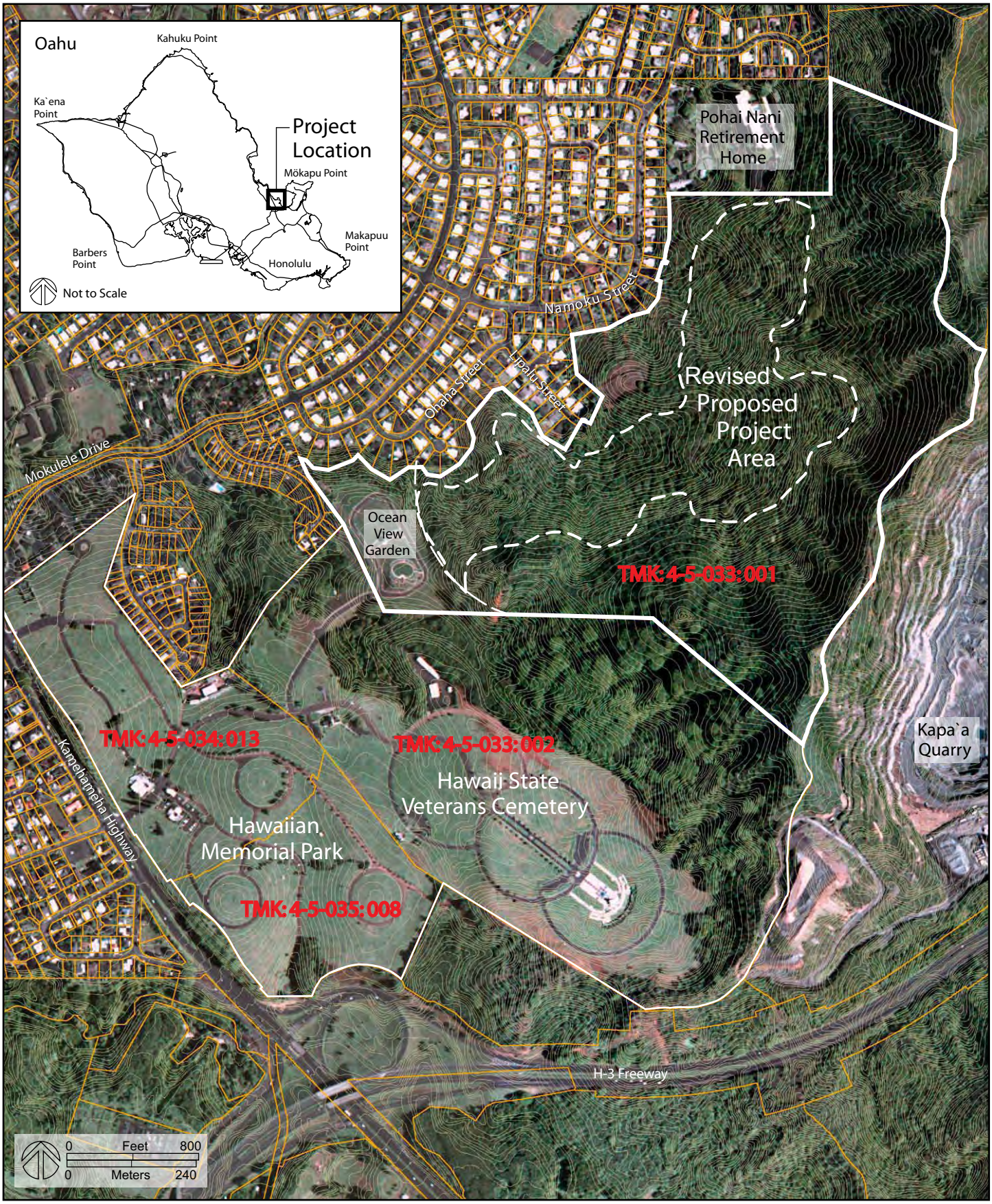
Opinion of Probable Construction Cost – Cemetery Expansion Only				
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**
Erosion Control & Grading				
Mobilization/Demobilization	1	LS	$50,000	$50,000
Construction Equipment	1	LS	$80,000	$80,000
Silt Fence	2,000	LF	$5	$10,000
Dust Fence	2,000	LF	$25	$50,000
Construction Ingress/Egress	1	EA	$3,000	$3,000
Clearing & Grubbing	45	AC	$10,000	$450,000
Relocated Earthwork (Excavation/Cut)	363,251	CY	$5	$1,816,255
Fill	56,525	CY	$5	$282,625
Compaction	56,525	CY	$1	$56,525

Grading	217,800	SY	$1	$217,800
Sub-Total (Erosion Control & Grading)				**$3,016,205**
Road Improvements				
Cemetery				
6" Base Course	23,280	SY	$25	$582,000
2" AC Pavement	23,280	SY	$25	$582,000
Rolled Curbs/Gutters	6,850	LF	$50	$342,500
Sub-Total (Road Improvements)				**$1,506,500**
Utility Lines				
Cemetery				
Trench Excavation for Water	1,176	CY	$3	$3,527
Trench Backfill for Water	176	CY	$6	$1,058
Pipe Bedding for Water	999	CY	$50	$49,961
Compaction for Water	1,176	CY	$3	$3,527
6" PVC Waterline	5,290	LF	$19	$100,510
Booster Pump	3	EA	$3,000	$9,000
Non-Potable Well	3	EA	$40,000	$120,000
Septic Tank w/ Leach Field	1	EA	$55,000	$55,000
Fittings	1,000	LB	$3	$3,000
Testing & Chlorination	1	LS	$1,500	$1,500
Sub-Total (Utilities)				**$347,082**
Total				**$4,869,787**
Contingency (25%)				$1,217,447
Grand Total				$6,087,234
Grand Total (Rounded)				**$6,087,000**

APPENDICES

APPENDIX A

General Information



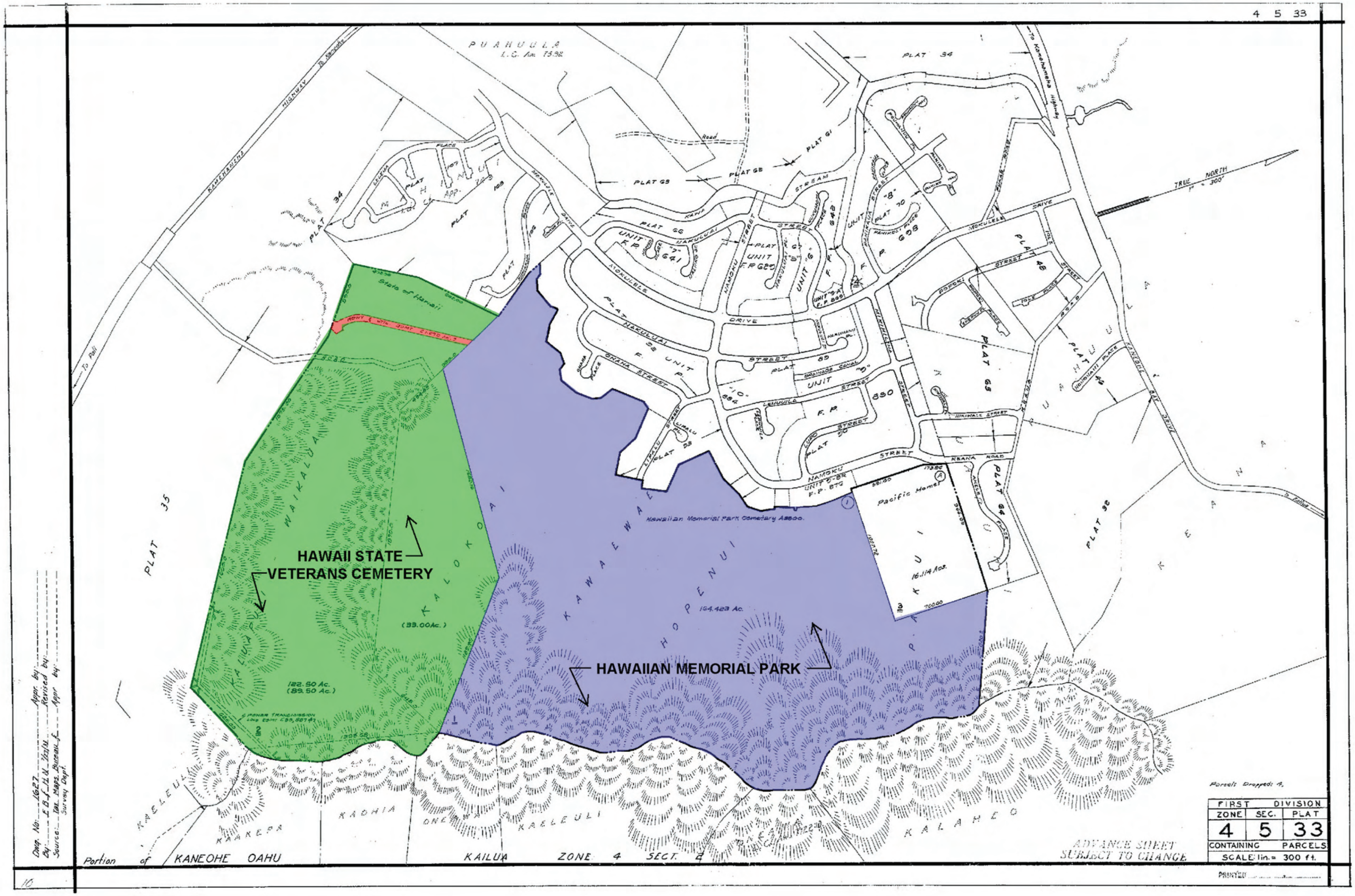
Vicinity Map

Figure 1

Hawaiian Memorial Park Cemetery Expansion

Kaneohe, Oahu

Figure 2



4 5 33
HAWAII STATE VETERANS CEMETERY
HAWAIIAN MEMORIAL PARK
Pacific Homes
PLAT 35
PLAT 34
PLAT 63
PLAT 32
Portion of KANEOHE OAHU
KAILUA ZONE 4 SECT. 2
ADVANCE SHEET SUBJECT TO CHANGE
FIRST DIVISION
ZONE 4
SEC. 5
PLAT 33
CONTAINING PARCELS
SCALE: 1in.= 300 ft.
TRUE NORTH

Figure 3

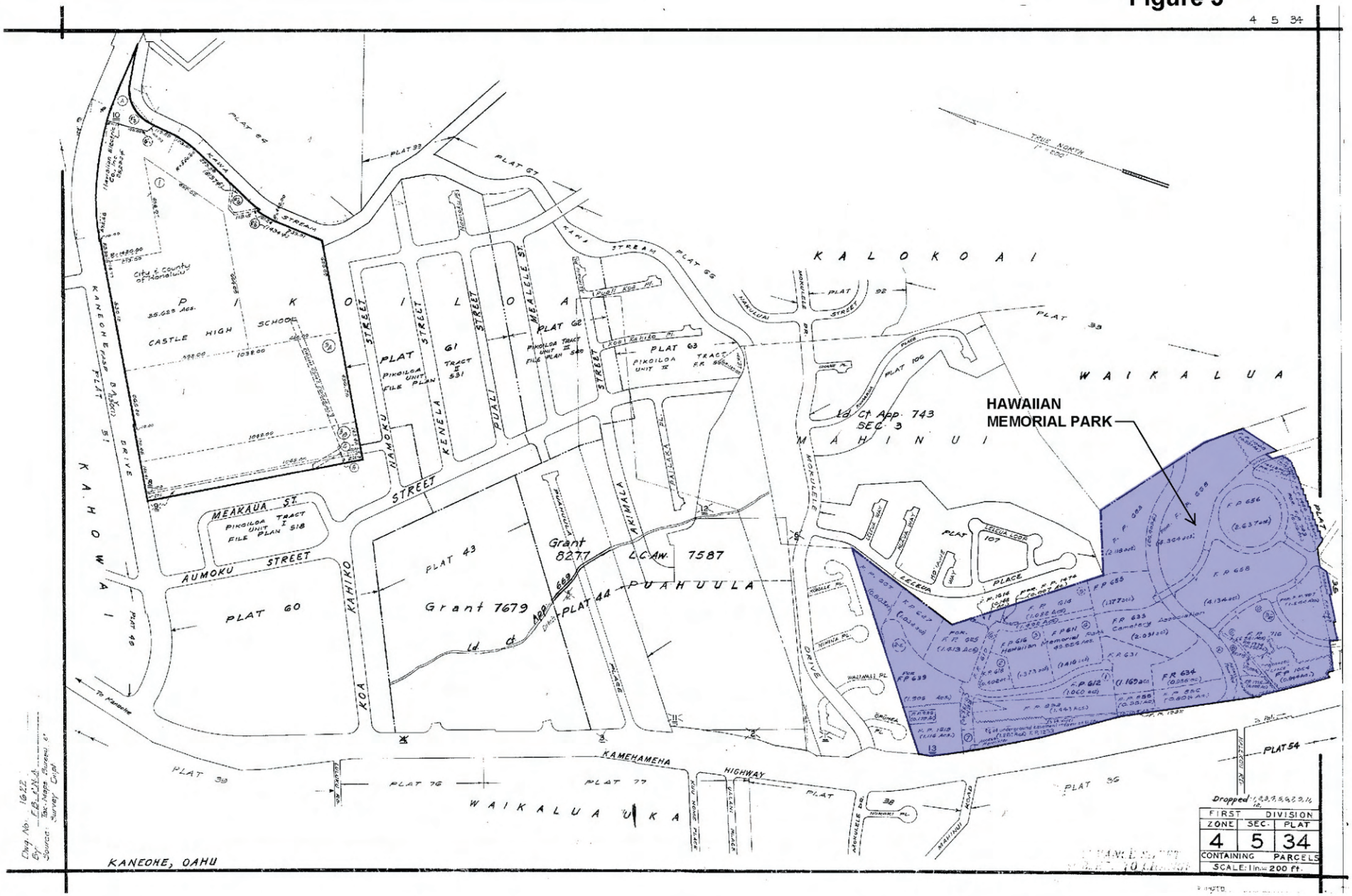
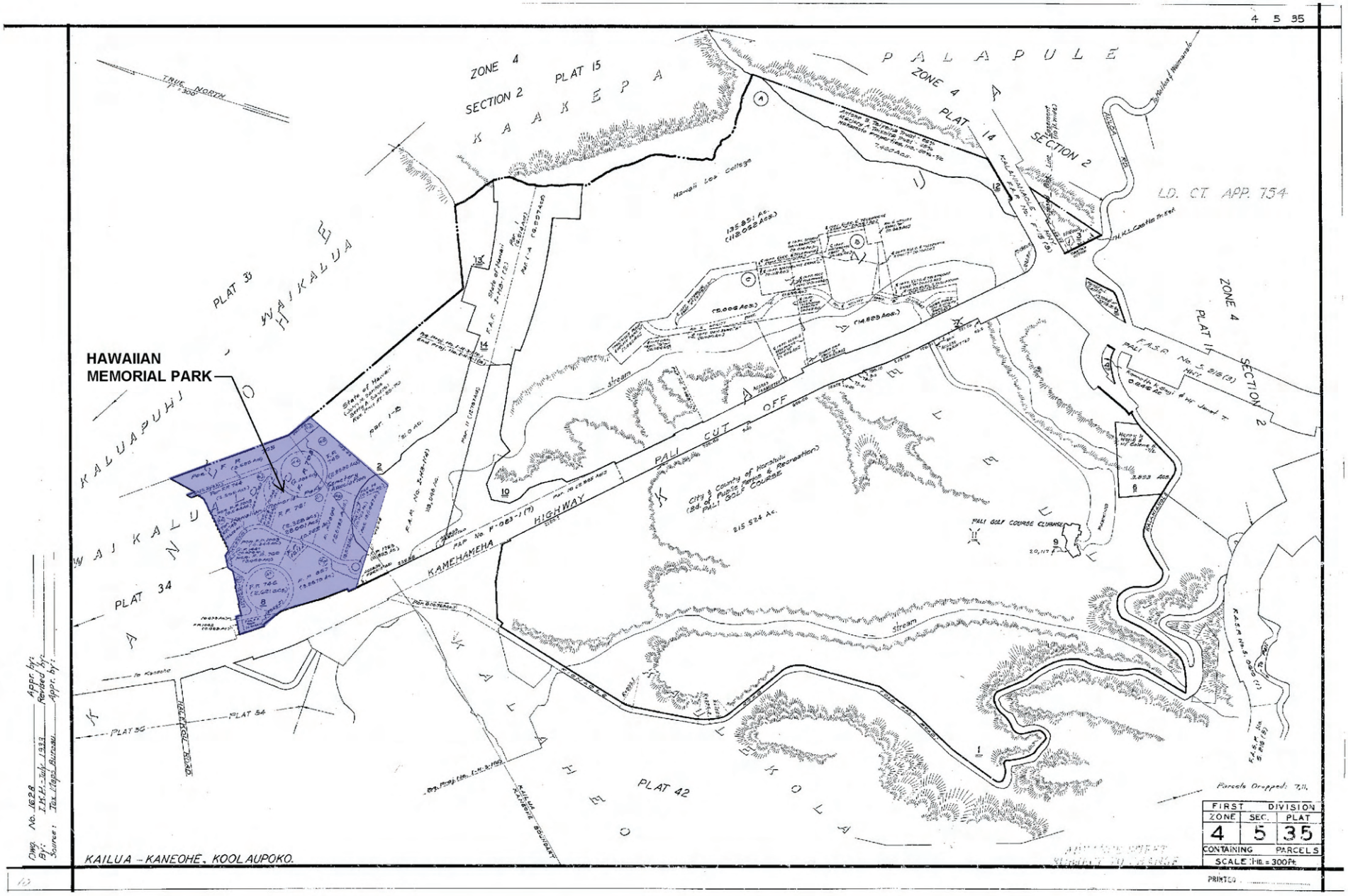
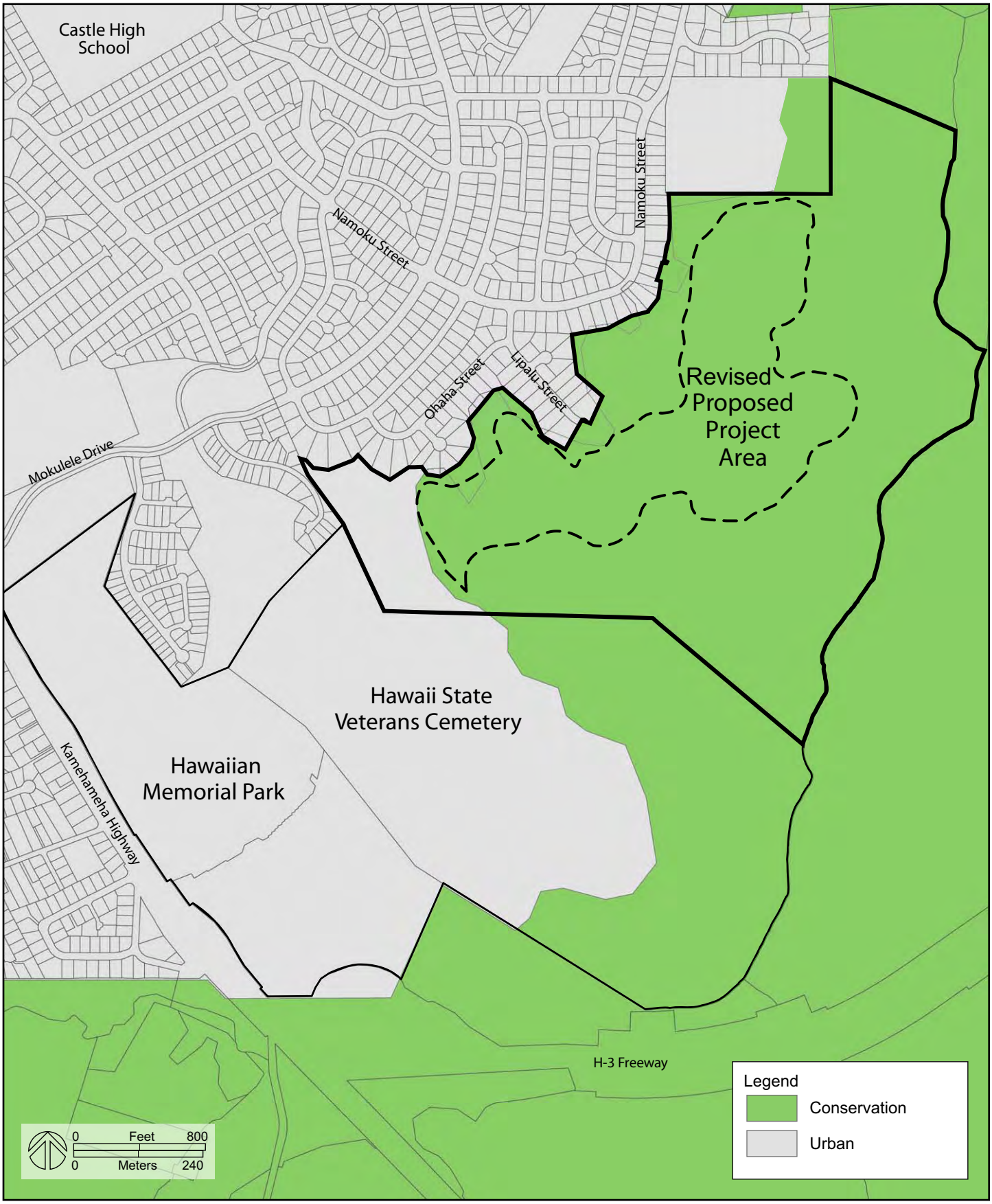

HAWAIIAN MEMORIAL PARK
KALOKOAI
WAIKALUA
MAHINUI
PIKOILOA
CASTLE HIGH SCHOOL
City & County of Honolulu
35.629 Acs.
PLAT 61
PLAT 62
PLAT 63
PLAT 60
PLAT 43
PLAT 44
PUAHUULA
Grant 8277
L.C.Aw. 7587
Grant 7679
Ld. Ct. App. 743 SEC. 3
MEAKAUA ST.
AUMOKU STREET
KAHIKO
KOA
NAMOKU STREET
KENELA STREET
PUALI STREET
MEALELE ST.
AKIMALA
KAMEHAMEHA HIGHWAY
KANEOHE BAY DRIVE
KAHOWAI
MOKULELE DRIVE
KEELEUA PLACE
PLAT 107
PLAT 92
PLAT 33
PLAT 100
PLAT 66
PLAT 67
PLAT 93
PLAT 65
PLAT 39
PLAT 76
PLAT 77
PLAT 56
PLAT 54
PLAT 36
PLAT 49
PLAT 51
To Kaneohe
TRUE NORTH
Dropped: 1,2,3,7,8,9,10,11,12.
FIRST DIVISION
ZONE 4 SEC. 5 PLAT 34
CONTAINING PARCELS
SCALE: 1in.= 200 ft.
KANEOHE, OAHU

Figure 4

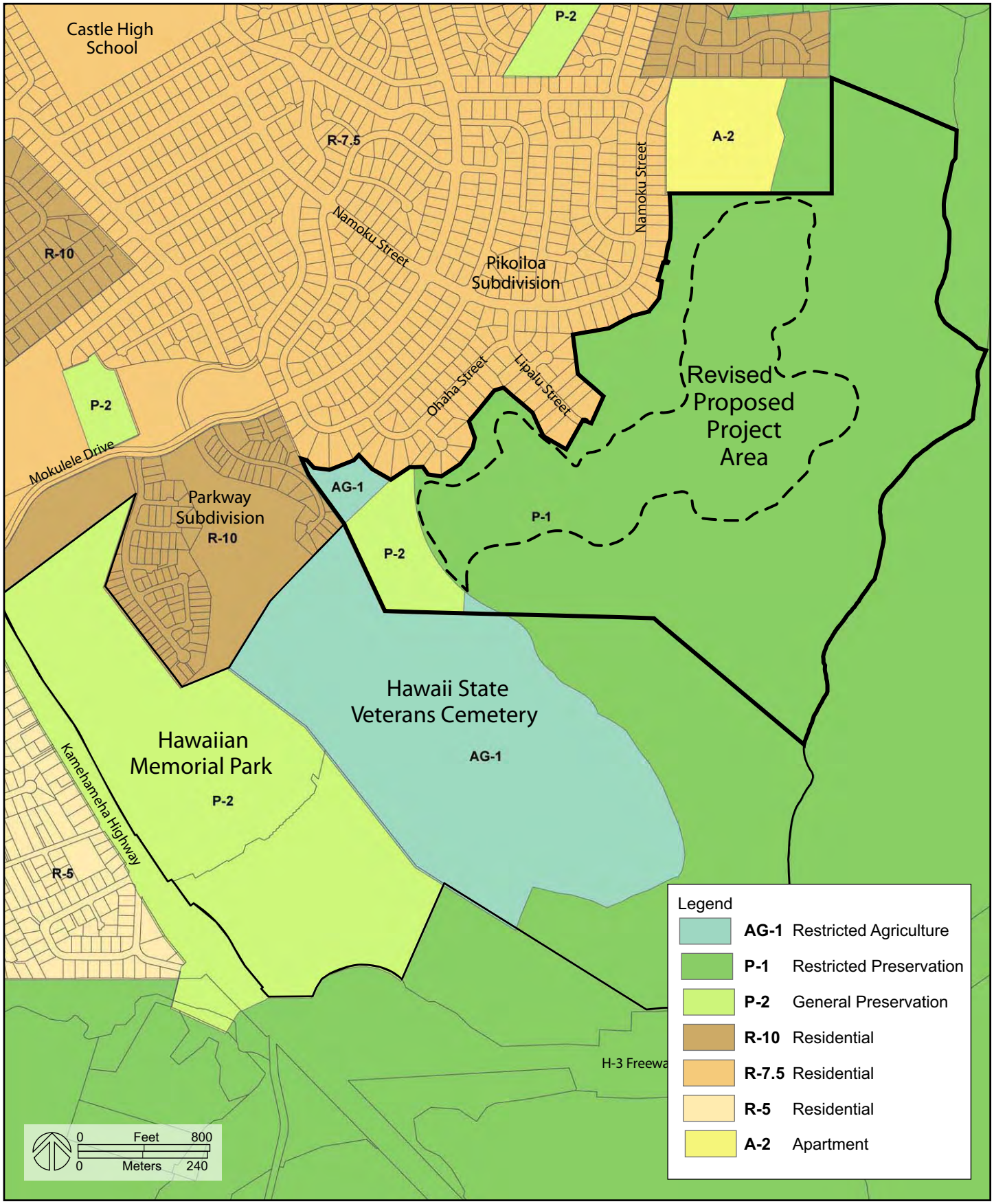

HAWAIIAN MEMORIAL PARK
ZONE 4
SECTION 2
PLAT 15
KAAKEPA
PALAPULE
ZONE 4
PLAT 14
SECTION 2
L.D. CT. APP. 754
PLAT 33
KALUAPUHI
WAIKALUA
PLAT 34
KANEOHE
PALI CUT OFF
KAMEHAMEHA HIGHWAY
City & County of Honolulu (Dept. of Parks & Recreation) PALI GOLF COURSE
PALI GOLF COURSE CLUBHOUSE
Hawaii Loa College
ZONE 4
PLAT 11
SECTION 2
PLAT 54
PLAT 56
PLAT 42
KALIHI
Parcels Dropped: 7,11.
FIRST DIVISION
ZONE 4
SEC. 5
PLAT 35
CONTAINING PARCELS
SCALE: 1 in. = 300 Ft.
KAILUA - KANEOHE, KOOLAUPOKO.
Owng. No. 1628
By: T.M.H. - July 1933
Source: Tax Mapt. Bureau
Appr. by:
Revised by:
Appr. by:
PRINTED



State Land Use Districts

Figure 5

Hawaiian Memorial Park Cemetery Expansion
Kaneohe, Oahu



City and County of Honolulu Zoning

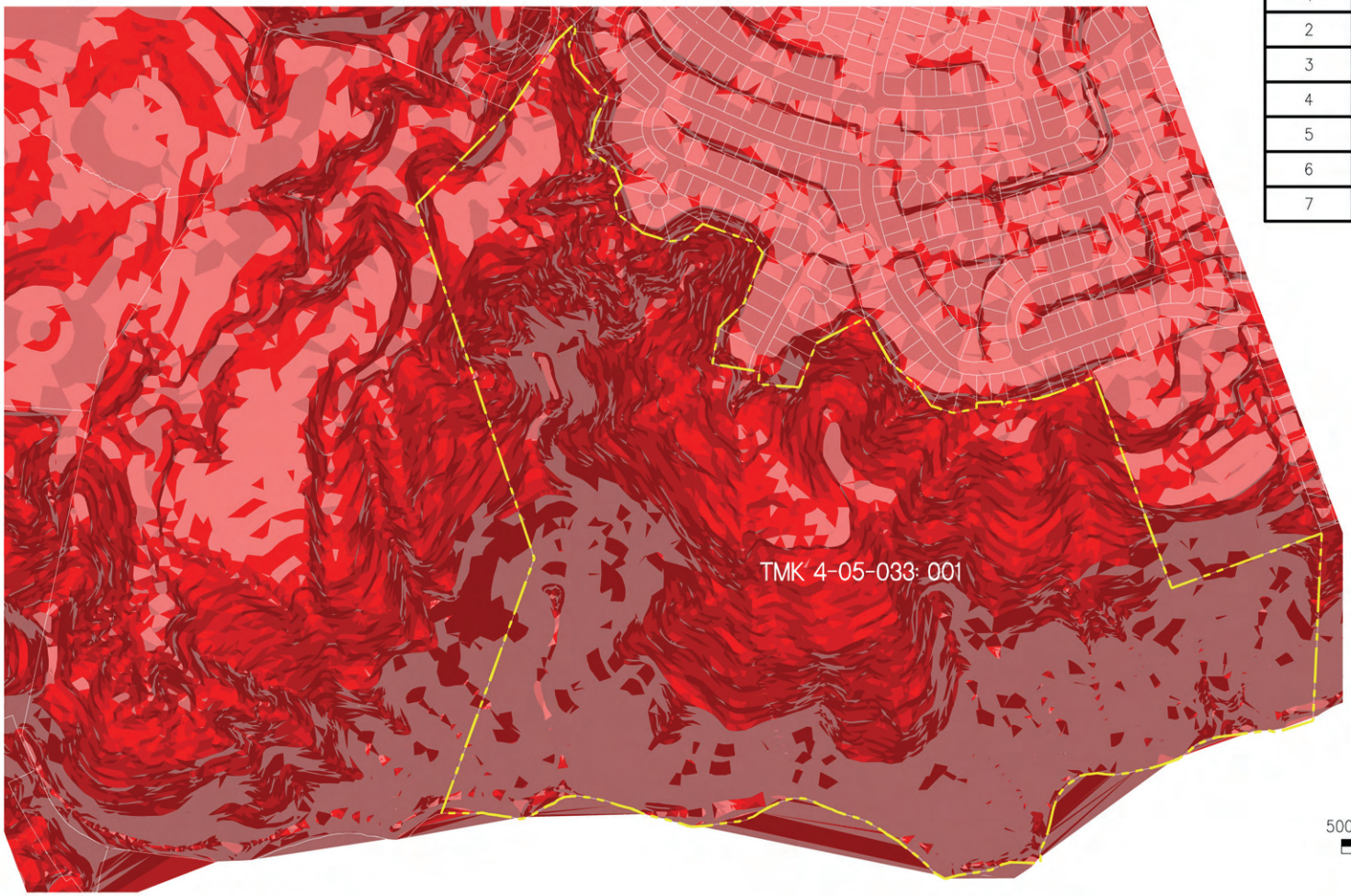
Figure 6

Hawaiian Memorial Park Cemetery Expansion
Kaneohe, Oahu

APPENDIX B

Existing Site Figures

TRUE NORTH
SCALE: 1 In. = 500 Ft.



SLOPES TABLE			
NUMBER	MINIMUM SLOPE	MAXIMUM SLOPE	COLOR
1	0%	5%	
2	5%	10%	
3	10%	15%	
4	15%	20%	
5	20%	30%	
6	30%	50%	
7	> 50%		

500' 250' 0 500' 1000'
SCALE: 1" = 500'

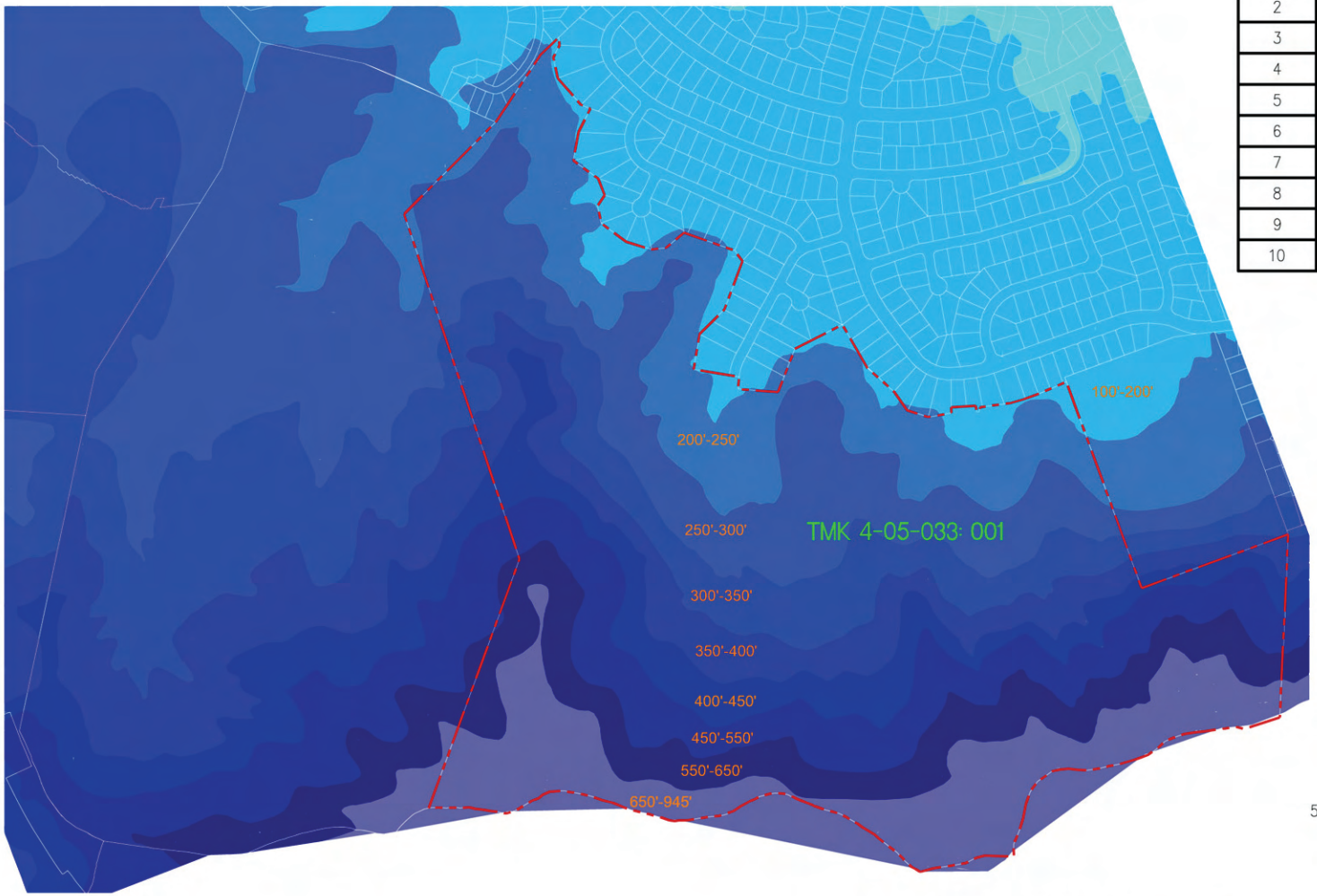
SSFM INTERNATIONAL
SSFM INTERNATIONAL, INC.
501 Sumner Street, Suite 620
Honolulu, Hawaii 96817

Hawaiian Memorial Cemetery Expansion
Kaneohe, Oahu
SLOPE ANALYSIS

SCALE: 1" = 500'
DATE: JUNE 2007

FIGURE
7

TRUE NORTH
SCALE: 1 In. = 500 Ft.



ELEVATIONS TABLE			
NUMBER	MINIMUM ELEVATION	MAXIMUM ELEVATION	COLOR
1	0'	100'	
2	100'	200'	
3	200'	250'	
4	250'	300'	
5	300'	350'	
6	350'	400'	
7	400'	450'	
8	450'	550'	
9	550'	650'	
10	650'	945'	

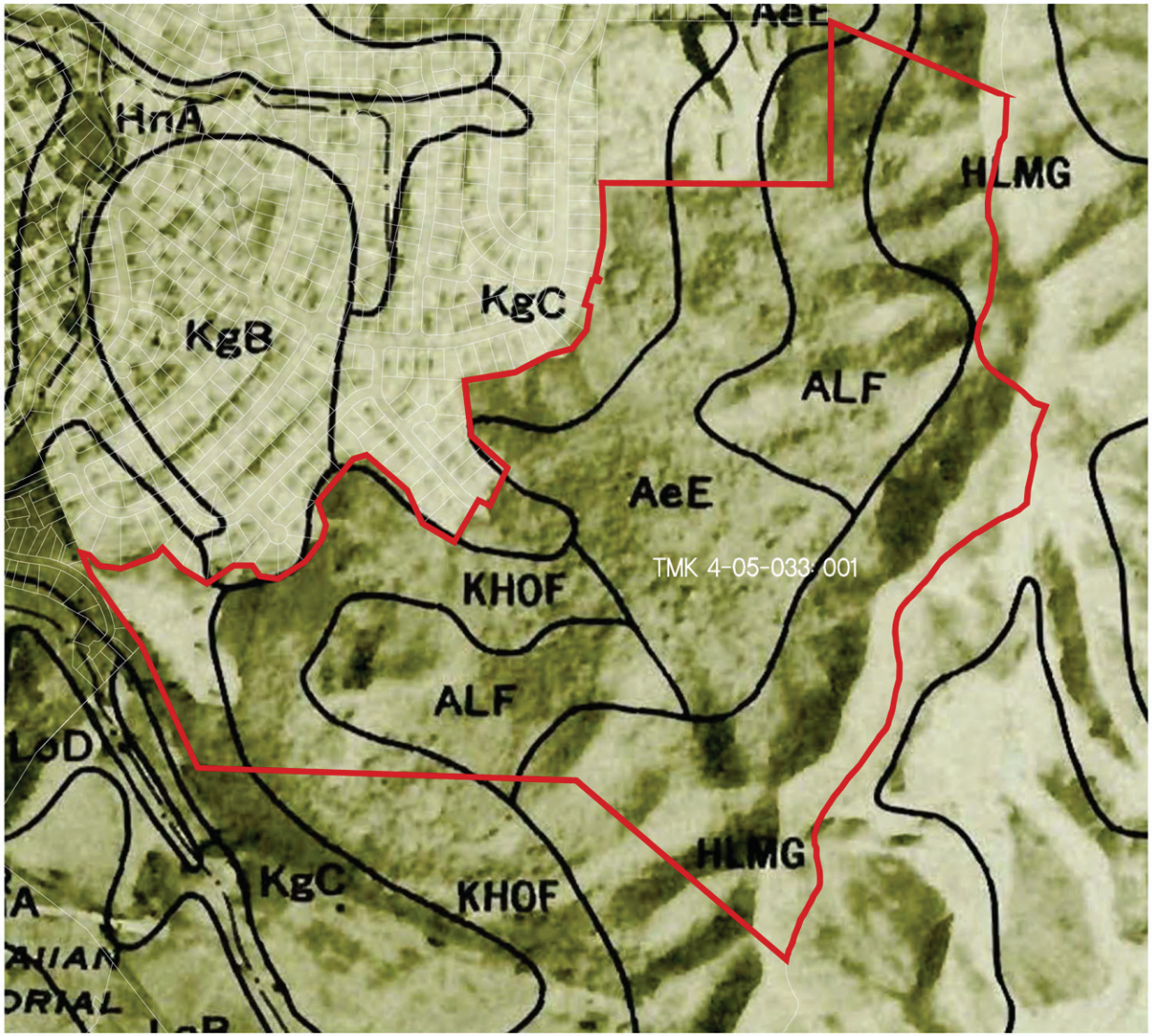
500' 250' 0 500' 1000'
SCALE: 1" = 500'

SSFM INTERNATIONAL
SSFM INTERNATIONAL, INC.
501 Sumner Street, Suite 620
Honolulu, Hawaii 96817

Hawaiian Memorial Cemetery Expansion
Kaneohe, Oahu
ELEVATION ANALYSIS

SCALE: 1" = 500'
DATE: JUNE 2007

FIGURE
8



TRUE NORTH
SCALE: 1 In. = 500 Ft.

LEGEND:

AeE	ALEALOA SILTY CLAY, 15 TO 35 PERCENT SLOPES
ALF	ALEALOA SILTY CLAY, 40 TO 70 PERCENT SLOPES
HLMG	HELEMANO SILTY CLAY, 30 TO 90 PERCENT SLOPES
KgC	KANEOHE SILTY CLAY, 8 TO 15 PERCENT SLOPES
KHOF	KANEOHE SILTY CLAY, 30 to 65 PERCENT SLOPES

500' 250' 0 500' 1000'
SCALE: 1" = 500'

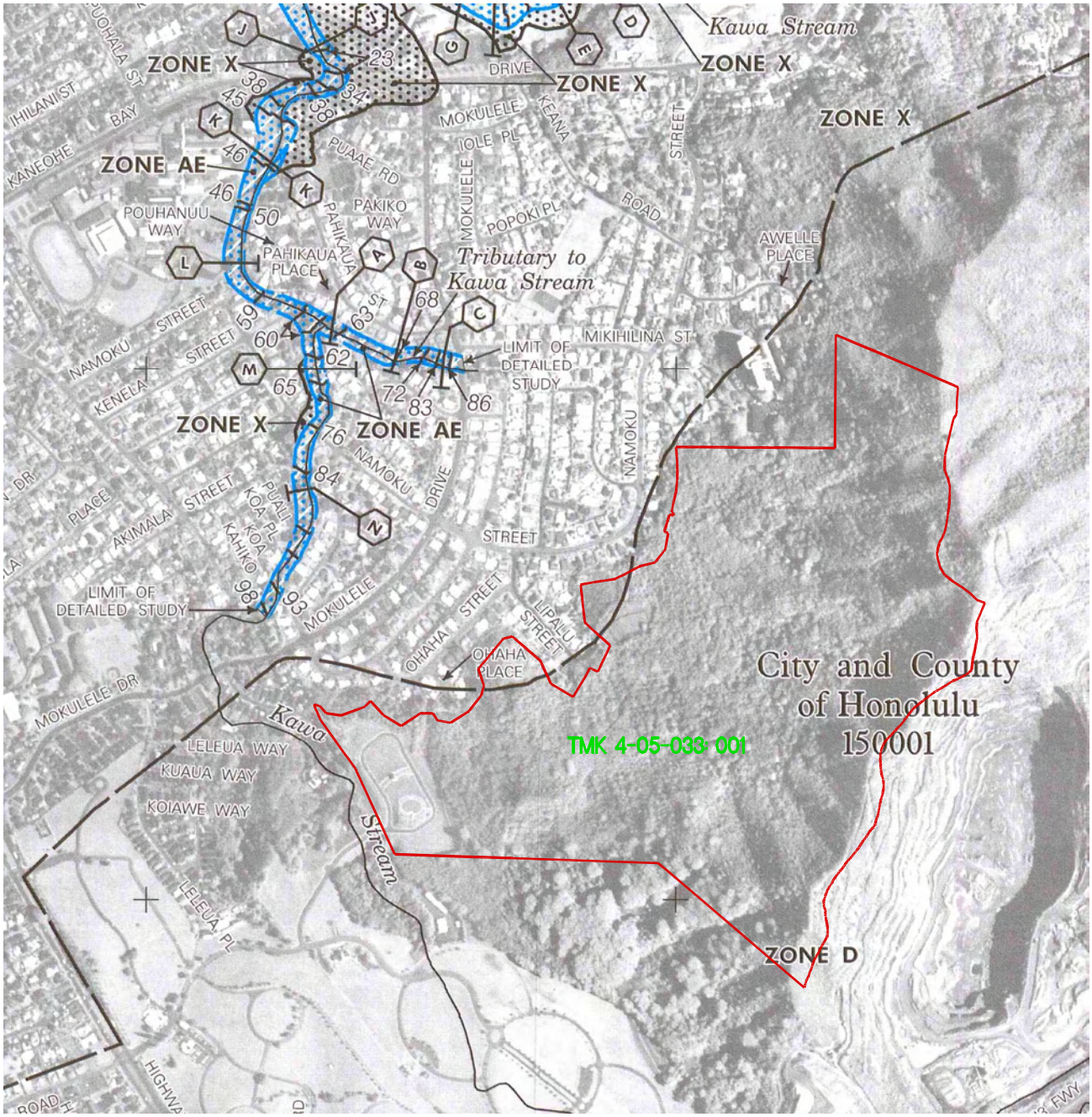
SSFM INTERNATIONAL
SSFM INTERNATIONAL, INC.
501 Sumner Street, Suite 620
Honolulu, Hawaii 96817

Hawaiian Memorial Cemetery Expansion
Kaneohe, Oahu

SOIL SURVEY ANALYSIS

SCALE: 1" = 500'
DATE: JUNE 2007

FIGURE
9



LEGEND:

— — — —	ZONE D BOUNDARY
ZONE D	AREAS IN WHICH FLOOD HAZARDS ARE UNDETERMINED BUT POSSIBLE.
ZONE X	AREAS DETERMINED TO BE OUTSIDE THE 0.2% ANNUAL CHANCE FLOODPLAIN.

1000' 500' 0 1000' 2000'

SCALE: 1" = 1000'

MAP NUMBER 15003C0270F

SSFM INTERNATIONAL

SSFM International, Inc.
501 Sumner Street, Suite 620
Honolulu, Hawaii 96817

Hawaiian Memorial Cemetery Expansion
Kaneohe, Oahu

FLOOD INSURANCE RATE MAP

SCALE: 1" = 1000'

DATE: JUNE 2007

FIGURE 10

APPENDIX C

Drainage Calculations

SSFM International, Inc.
Hawaiian Memorial Cemetery Park Expansion
SSFM 2006_095.000
November 27, 2006

Pikoiloa 10

Existing Capacity Analysis

Ohana Place

Inlet	Drainage	Pipe Size	Existing Q	Length	Inv_up	Inv_Down	Slope	Cross-Sectional Area	n	Rh	Q_full_flow	% Full	Q_excess_capacity
(Number)	Master Plan	(inches)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(sf)	(-)	(-)	(cfs)		(cfs)
FI C-12					168.00								
	Pikoiloa 10	24	25.2	208.3333			0.034	3.142	0.013	0.500	42	61%	16
SDMH C-11					161.00	161.00							
	Pikoiloa 10	30	36.1	87.34			0.059	4.909	0.013	0.625	99	36%	63
CB C-9					155.89	155.89							
	Pikoiloa 10	30	41.4	68.24			0.010	4.909	0.013	0.625	41	101%	0
CB C-8					155.21	154.37							
	Pikoiloa 10	30	43.5	126.25			0.011	4.909	0.013	0.625	43	101%	0
SDMH C-7					152.98	150.98							
	Pikoiloa 10	30	43.5	102.75			0.098	4.909	0.013	0.625	129	34%	85
SDMH C-6					140.88	140.88							

Drainline "C" (Near Ohana Place)

Inlet	Drainage	Pipe Size	Existing Q	Length	Inv_up	Inv_Down	Slope	Cross-Sectional Area	n	Rh	Q_full_flow	% Full	Q_excess_capacity
(Number)	Master Plan	(inches)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(sf)	(-)	(-)	(cfs)		(cfs)
FI C-13					163.90								
	Pikoiloa 10	18	10.9	130			0.030	1.767	0.013	0.375	18	60%	7
SDMH C-11					160.00	160.00							

Portion of Drainline "C" (Near Ohana Place)

Inlet	Drainage	Pipe Size	Existing Q	Length	Inv_up	Inv_Down	Slope	Cross-Sectional Area	n	Rh	Q_full_flow	% Full	Q_excess_capacity
(Number)	Master Plan	(inches)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(sf)	(-)	(-)	(cfs)		(cfs)
CB C-10					158.50								
	Pikoiloa 10	18	4.2	42			0.012	1.767	0.013	0.375	11	37%	7
CB C-9					158.00	158.00							

Drainline "D"

Inlet	Drainage	Pipe Size	Existing Q	Length	Inv_up	Inv_Down	Slope	Cross-Sectional Area	n	Rh	Q_full_flow	% Full	Q_excess_capacity
(Number)	Master Plan	(inches)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(sf)	(-)	(-)	(cfs)		(cfs)
FI D-4					187.00								
	Pikoiloa 10	18	6.8	37			0.486	1.767	0.013	0.375	73	9%	67
FI D-3A					169.00	166.50							
	Pikoiloa 10	18	7.8	37			0.416	1.767	0.013	0.375	68	11%	60
SDMH D-3					151.10	151.10							
	Pikoiloa 10	18	7.8	95			0.005	1.767	0.013	0.375	8	102%	0
SDMH D-2					150.60	150.60							
	Pikoiloa 10	18	7.8	103			0.011	1.767	0.013	0.375	11	72%	3
CB D-1					149.50	148.73							
	Pikoiloa 10	18	11.4	153			0.030	1.767	0.013	0.375	18	63%	7
SDMH C-6					144.20	140.88							
	Pikoiloa 10	36	34.9	135			0.007	7.069	0.013	0.750	54	65%	19
CB C-5					140.00	133.71							
	Pikoiloa 10	36	61	38			0.008	7.069	0.013	0.750	61	99%	0
CB C-4					133.39	133.39							
	Pikoiloa 10	36	63.7	100			0.009	7.069	0.013	0.750	63	100%	0
SDMH C-3					132.49	132.49							
	Pikoiloa 10	36	67	43			0.196	7.069	0.013	0.750	296	23%	229
SDMH C-2					124.08	124.08							
	Pikoiloa 10	36	67	93			0.010	7.069	0.013	0.750	67	100%	0
CB C-1A					123.15	123.15							
	Pikoiloa 10	36	68.9	45			0.010	7.069	0.013	0.750	67	103%	-2
CB C-1					122.7	120.27							
	Pikoiloa 10	36	69.7	115			0.098	7.069	0.013	0.750	209	33%	140
Existing FI					109.00	109.00							

Drainline "A"

Inlet	Drainage	Pipe Size	Existing Q	Length	Inv_up	Inv_Down	Slope	Cross-Sectional Area	n	Rh	Q_full_flow	% Full	Q_excess_capacity
(Number)	Master Plan	(inches)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(sf)	(-)	(-)	(cfs)		(cfs)
FI A-6					158.89								

	Pikoiloa 10	48	204.0	397			0.020	12.566	0.013	1.000	205	100%	1
CB A-3					159.40	150.87							
	Pikoiloa 10	48	229.8	237.27			0.025	12.566	0.013	1.000	229	100%	0
SDMH A-2					144.85	142.85							
	Pikoiloa 10	48	236.6	216			0.027	12.566	0.013	1.000	236	100%	0
SDMH A-1					137.04	134.13							
	Pikoiloa 10	48	267.5	537			0.035	12.566	0.013	1.000	268	100%	1
Special SDMH					115.48	107.20							

Portion of Drainline "A"

Inlet	Drainage	Pipe Size	Existing Q	Length	Inv_up	Inv_Down	Slope	Cross-Sectional Area	n	Rh	Q_full_flow	% Full	Q_excess_capacity
(Number)	Master Plan	(inches)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(sf)	(-)	(-)	(cfs)		(cfs)
FI A-7					171.00								
	Pikoiloa 10	24	18.7	31.89			0.343	3.142	0.013	0.500	133	14%	114
SDMH A-7A					160.07	160.07							
	Pikoiloa 10	24	18.7	90			0.006	3.142	0.013	0.500	18	104%	-1
CB A-3					159.50	159.50							

Portion of Drainline "A"

Inlet	Drainage	Pipe Size	Existing Q	Length	Inv_up	Inv_Down	Slope	Cross-Sectional Area	n	Rh	Q_full_flow	% Full	Q_excess_capacity
(Number)	Master Plan	(inches)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(sf)	(-)	(-)	(cfs)		(cfs)
CB A-4					160.29								
	Pikoiloa 10	18	4.6	32			0.009	1.767	0.013	0.375	10	46%	5
CB A-3					160.00	160.00							

Drainline "B"

Inlet	Drainage	Pipe Size	Existing Q	Length	Inv_up	Inv_Down	Slope	Cross-Sectional Area	n	Rh	Q_full_flow	% Full	Q_excess_capacity
(Number)	Master Plan	(inches)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(sf)	(-)	(-)	(cfs)		(cfs)
FI B-6					167.53								
	Pikoiloa 10	24	14.6	38			0.004	3.142	0.013	0.500	14	102%	0
SDMH B-5					167.38	167.38							
	Pikoiloa 10	24	14.6	103			0.004	3.142	0.013	0.500	14	102%	0
SDMH B-4					166.97	166.97							
	Pikoiloa 10	24	14.6	283.2			0.023	3.142	0.013	0.500	35	42%	20
CB B-2					160.40	159.00							
	Pikoiloa 10	24	20.5	118.14			0.043	3.142	0.013	0.500	47	44%	27
SDMH B-1					153.92	153.92							
	Pikoiloa 10	24	20.5	236			0.048	3.142	0.013	0.500	50	41%	29
SDMH A-1					142.50	142.50							

Portion of Drainline "B"

Inlet	Drainage	Pipe Size	Existing Q	Length	Inv_up	Inv_Down	Slope	Cross-Sectional Area	n	Rh	Q_full_flow	% Full	Q_excess_capacity
(Number)	Master Plan	(inches)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(sf)	(-)	(-)	(cfs)		(cfs)
CB B-3					161.18								
	Pikoiloa 10	18	2.2	38			0.005	1.767	0.013	0.375	7	30%	5
CB B-2					161.00	161.00							

Drainline "E"

Inlet	Drainage	Pipe Size	Existing Q	Length	Inv_up	Inv_Down	Slope	Cross-Sectional Area	n	Rh	Q_full_flow	% Full	Q_excess_capacity
(Number)	Master Plan	(inches)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(sf)	(-)	(-)	(cfs)		(cfs)
FI E-2					121.88								
	Pikoiloa 10	18	2.4	81			0.043	1.767	0.013	0.375	22	11%	19
CB E-1A					118.40	118.40							
	Pikoiloa 10	18	5.7	65			0.003	1.767	0.013	0.375	6	98%	0
CB E-1					118.20	118.20							
	Pikoiloa 10	18	7.9	124			0.005	1.767	0.013	0.375	7	106%	0
CB "E"					117.58	116.48							

Drainline "G"

Inlet	Drainage	Pipe Size	Existing Q	Length	Inv_up	Inv_Down	Slope	Cross-Sectional Area	n	Rh	Q_full_flow	% Full	Q_excess_capacity
(Number)	Master Plan	(inches)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(sf)	(-)	(-)	(cfs)		(cfs)
CB G-3					141.42								
	Pikoiloa 10	18	3.5	180			0.021	1.767	0.013	0.375	15	23%	12
CB G-2					137.60	137.60							
	Pikoiloa 10	18	5.6	42			0.024	1.767	0.013	0.375	16	34%	11
CB G-1					136.60	135.50							

Drainline "F"

Inlet	Drainage	Pipe Size	Existing Q	Length	Inv_up	Inv_Down	Slope	Cross-Sectional Area	n	Rh	Q_full_flow	% Full	Q_excess_capacity
(Number)	Master Plan	(inches)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(sf)	(-)	(-)	(cfs)		(cfs)
CB F-8					128.47								

	Pikoiloa 10	18	4.2	97.2			0.012	1.767	0.013	0.375	11	37%	7
CB F-7					127.34	127.34							
	Pikoiloa 10	18	5.7	222			0.021	1.767	0.013	0.375	15	38%	9
SDMH F-6					122.77	122.77							
	Pikoiloa 10	18	5.7	143.5			0.026	1.767	0.013	0.375	17	33%	11
CB F-5					119.00	117.60							

Portion of Drainline "F"

Inlet	Drainage	Pipe Size	Existing Q	Length	Inv_up	Inv_Down	Slope	Cross-Sectional Area	n	Rh	Q_full_flow	% Full	Q_excess_capacity
(Number)	Master Plan	(inches)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(sf)	(-)	(-)	(cfs)		(cfs)
CB F-9					120.00								
	Pikoiloa 10	18	2.1	55			0.004	1.767	0.013	0.375	6	33%	4
CB F-5					119.80	117.60							

Pikoiloa 9

Drainline "C"

Inlet	Drainage	Pipe Size	Existing Q	Length	Inv_up	Inv_Down	Slope	Cross-Sectional Area	n	Rh	Q_full_flow	% Full	Q_excess_capacity
(Number)	Master Plan	(inches)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(sf)	(-)	(-)	(cfs)		(cfs)
FI C-1					153.47								
	Pikoiloa 9	36	92.0	185			0.021	7.069	0.013	0.750	97	95%	5
Drop DMH C-6					149.60	149.60							
	Pikoiloa 9	36	103.5	47			0.028	7.069	0.013	0.750	111	93%	8
DMH C-3					148.30	148.30							
	Pikoiloa 9	36	103.5	141			0.025	7.069	0.013	0.750	105	98%	2
DMH C-4					144.80	144.80							
	Pikoiloa 9	36	103.5	189			0.063	7.069	0.013	0.750	168	62%	64
CB C-1					132.90	130.10							
	Pikoiloa 9	42	108.3	89			0.015	9.621	0.013	0.875	122	89%	14
DMH C-3					128.80	128.80							
	Pikoiloa 9	36	108.3	34			0.032	7.069	0.013	0.750	120	90%	12
DMH C-2					127.70	127.70							
	Pikoiloa 9	36	108.3	132			0.033	7.069	0.013	0.750	121	90%	12
DMH C-1					123.40	123.70							
	Pikoiloa 9	36	108.3	129			0.116	7.069	0.013	0.750	228	47%	120
Drain "C" Outlet					108.70	108.70							

Portion of Drainline "C"

Inlet	Drainage	Pipe Size	Existing Q	Length	Inv_up	Inv_Down	Slope	Cross-Sectional Area	n	Rh	Q_full_flow	% Full	Q_excess_capacity
(Number)	Master Plan	(inches)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(sf)	(-)	(-)	(cfs)		(cfs)
CB C-2					136.40								
	Pikoiloa 9	18	1.5	34			0.006	1.767	0.013	0.375	8	19%	7
CB C-1					136.20	136.20							

Portion of Drainline "C"

Inlet	Drainage	Pipe Size	Existing Q	Length	Inv_up	Inv_Down	Slope	Cross-Sectional Area	n	Rh	Q_full_flow	% Full	Q_excess_capacity
(Number)	Master Plan	(inches)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(sf)	(-)	(-)	(cfs)		(cfs)
C-B C-4					151.4								
	Pikoiloa 9	18	8.5	48			0.006	1.767	0.013	0.375	8	102%	0
CB C-3					151.10	150.72							
	Pikoiloa 9	24	11.5	98			0.003	3.142	0.013	0.500	11	100%	0
Drop DMH C-6					150.47	150.47							

Drainline "B"

Inlet	Drainage	Pipe Size	Existing Q	Length	Inv_up	Inv_Down	Slope	Cross-Sectional Area	n	Rh	Q_full_flow	% Full	Q_excess_capacity
(Number)	Master Plan	(inches)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(sf)	(-)	(-)	(cfs)		(cfs)
Existing FI B-2					155.50								
	Pikoiloa 9	42	100.0	135			0.028	9.621	0.013	0.875	167	60%	67
CB B-6					153.95	151.78							
	Pikoiloa 9	42	102.6	47			0.010	9.621	0.013	0.875	102	101%	-1
CB B-5					151.30	151.30							
	Pikoiloa 9	42	104.0	82			0.015	9.621	0.013	0.875	122	85%	18
DMH B-5					150.10	150.10							
	Pikoiloa 9	36	104.0	33			0.252	7.069	0.013	0.750	335	31%	231
FI B-1					141.80	141.80							
	Pikoiloa 9	36	104.8	32			0.369	7.069	0.013	0.750	406	26%	301
DMH B-4					130.00	130.00							
	Pikoiloa 9	36	104.8	87			0.031	7.069	0.013	0.750	117	90%	12
Drop CB B-4					127.34	127.34							
	Pikoiloa 9	36	106.9	37			0.028	7.069	0.013	0.750	113	95%	6

Drop CB B-3					126.29	126.29							
	Pikoiloa 9	36	108.5	105			0.028	7.069	0.013	0.750	113	96%	4
DMH B-3					123.30	123.30							
	Pikoiloa 9	36	108.5	27			0.537	7.069	0.013	0.750	490	22%	382
DMH B-2					108.80	108.80							
	Pikoiloa 9	36	108.5	86			0.034	7.069	0.013	0.750	123	88%	14
Drop DMH B-1					105.90	104.73							
	Pikoiloa 9	42	120.8	162			0.014	9.621	0.013	0.875	121	100%	0
Drain "B" Outlet					102.40	102.40							

Drainline "A"													
Inlet	**Drainage**	**Pipe Size**	**Existing Q**	**Length**	**Inv_up**	**Inv_Down**	**Slope**	**Cross-Sectional Area**	**n**	**Rh**	**Q_full_flow**	**% Full**	**Q_excess_capacity**
(Number)	Master Plan	(inches)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(sf)	(-)	(-)	(cfs)		(cfs)
CB A-2					121.40								
	Pikoiloa 9	18	4.2	34			0.001	1.767	0.013	0.375	4	104%	0
CB A-1					121.35	121.35							
	Pikoiloa 9	18	6.9	200			0.071	1.767	0.013	0.375	28	25%	21
DMH A-1					107.20	107.20							
	Pikoiloa 9	18	6.9	150			0.064	1.767	0.013	0.375	27	26%	20
Drain "A" Outlet					97.60	97.60							

Drainline "D"													
Inlet	**Drainage**	**Pipe Size**	**Existing Q**	**Length**	**Inv_up**	**Inv_Down**	**Slope**	**Cross-Sectional Area**	**n**	**Rh**	**Q_full_flow**	**% Full**	**Q_excess_capacity**
(Number)	Master Plan	(inches)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(sf)	(-)	(-)	(cfs)		(cfs)
CB D-1					102.00								
	Pikoiloa 9	18	5.3	124			0.058	1.767	0.013	0.375	25	21%	20
Drain "D" Outlet					94.80	94.80							

SSFM International, Inc.
Hawaiian Memorial Cemetery Park Expansion
Draft Preliminary Engineering Report
SSFM 2006_095.000
May 4, 2007

Proposed Drainage Analysis								
Inlet	**Impervious Area**	**Rainfall "I"**	**Runoff "C"**	**Time of Conc "Tc"**	**Correction Factor**	**Q_increase**	**Q_existing**	**V_store**
(Number)	(acres)	(in/hr)	(cfs)	(min)	(-)	(cfs)	(cfs)	(cf)
D-4	0	2.5	0.95	3	3.00	0.00	6.8	0
C-13	0.006	2.5	0.95	3	3.00	0.03	10.9	105
C-12	0.783	2.5	0.95	3	3.00	3.82	25.2	13,734
A-7	0.416	2.5	0.95	3	3.00	2.03	18.7	7,307
A-6	3.426	2.5	0.95	3	3.00	16.70	204.3	60,122
B-7	0	2.5	0.95	3	3.00	0.00	5.4	0
B-6	0.268	2.5	0.95	3	3.00	1.31	14.6	4,705
C-6	2.854	2.5	0.95	3	3.00	13.91	92.0	50,085
Exist. B-1	0.791	2.5	0.95	3	3.00	3.86	100.0	13,886
					Totals	**42**	**478**	**149,944**

Method:
Inlet Number and Q_Existing is based on Drainage Master Plans fror the Parkway, Pikoiloa 9, and Pikoiloa 10 Subdivisions
Impervious Area was based off of the Conceptual Site Plan
Rainfall "I" is coordinated with the "I" used in the Drainage Master Plans of the 10-year, 1 hour storm
Time of Concentration "Tc" is conservatively estimated to generate a maximum Correction Factor for all basins
Q_increase is based on the Rational Method
The Rational Method is Q=CIA(SF)
V_store is the volume required to hold the flows of Q_paved for one hour
Assumed 50% of the residential lots will consist of two-story dwelling units
One story dwelling, assumed 3000 sf house, 500 sf driveway, 500 sf garage, for a total of 4000 sf impervious area
Two story dwelling, assumed 3000 sf house (1500 sf footprint), 500 sf driveway, 500 sf garage, for a total of 2000 sf impervious area

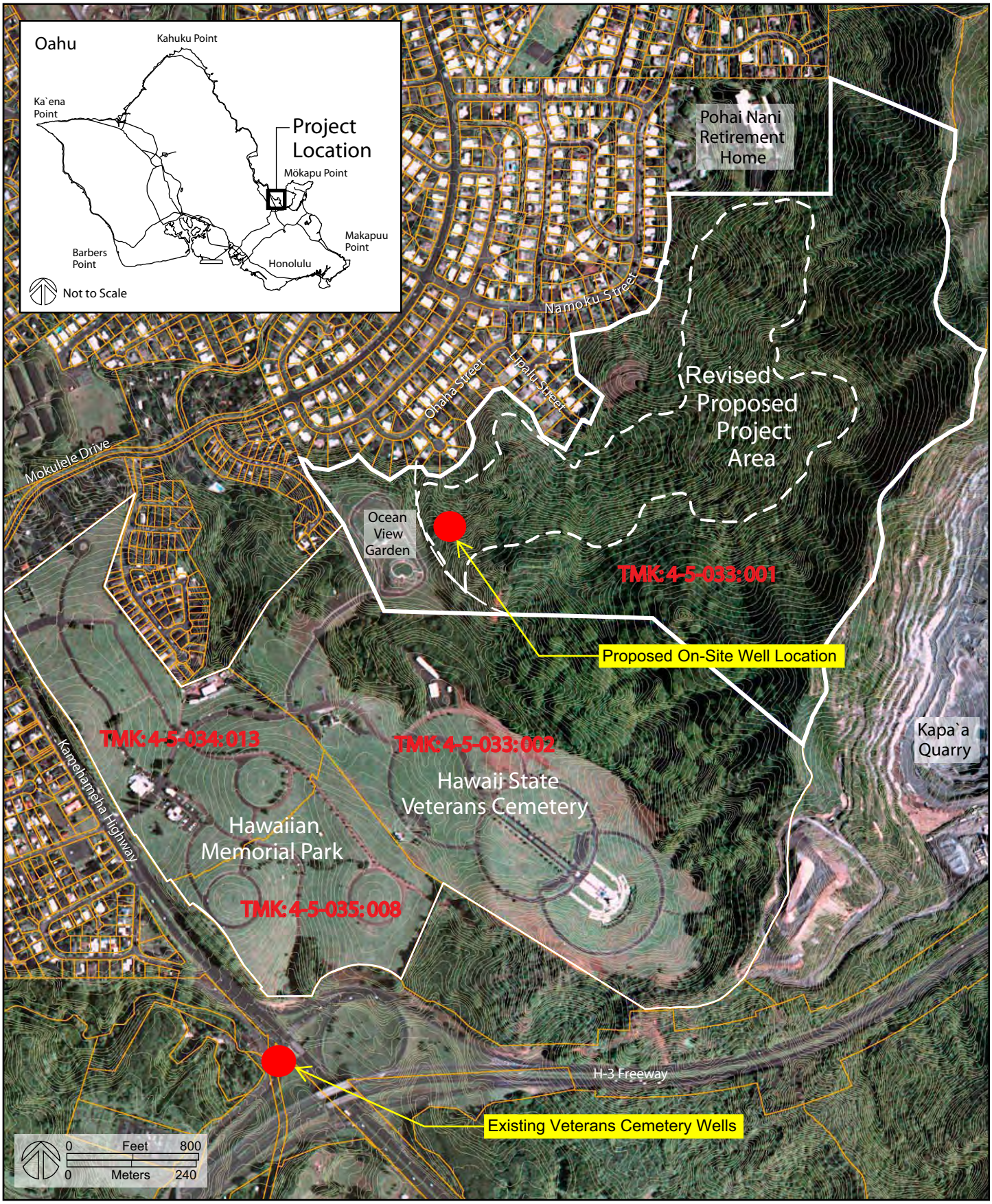
SSFM International, Inc.
Hawaiian Memorial Cemetery Park Expansion
Draft Preliminary Engineering Report
SSFM 2006_095.000
September 8 2008

Proposed Drainage Analysis Per Alternative III revised 9/04/08 from HHF - Cemetery Only Option								
Inlet	**Impervious Area**	**Rainfall "I"**	**Runoff "C"**	**Time of Conc "Tc"**	**Correction Factor**	**Q_increase**	**Q_existing**	**V_store**
(Number)	(acres)	(in/hr)	(cfs)	(min)	(-)	(cfs)	(cfs)	(cf)
D-4	0	2.5	0.95	3	3.00	0.00	6.8	0
C-13	0.006	2.5	0.95	3	3.00	0.03	10.9	105
C-12	0.783	2.5	0.95	3	3.00	3.82	25.2	13,734
A-7	0.416	2.5	0.95	3	3.00	2.03	18.7	7,307
A-6	2.265	2.5	0.95	3	3.00	11.04	204.3	39,742
B-7	0	2.5	0.95	3	3.00	0.00	5.4	0
B-6	0.063	2.5	0.95	3	3.00	0.30	14.6	1,098
C-6	1.214	2.5	0.95	3	3.00	5.92	92.0	21,306
Exist. B-1	0.066	2.5	0.95	3	3.00	0.32	100.0	1,157
					Totals	**23**	**478**	**84,449**

Method:
Inlet Number and Q_Existing is based on Drainage Master Plans fror the Parkway, Pikoiloa 9, and Pikoiloa 10 Subdivisions
Impervious Area was based off of the Conceptual Site Plan
Rainfall "I" is coordinated with the "I" used in the Drainage Master Plans of the 10-year, 1 hour storm
Time of Concentration "Tc" is conservatively estimated to generate a maximum Correction Factor for all basins
Q_increase is based on the Rational Method
The Rational Method is Q=CIA(SF)
V_store is the volume required to hold the flows of Q_paved for one hour

APPENDIX D

Non-Potable Well Figures, Board of Water Supply Documents
&
Water/Fire Flow Calculations



Proposed and Existing Well Locations

Figure 11

Hawaiian Memorial Park Cemetery Expansion

Kaneohe, Oahu

BOARD OF WATER SUPPLY

CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET
HONOLULU, HI 96843

October 20, 2006

SSFM INTERNATIONAL, INC.
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MUFI HANNEMANN, Mayor

RANDALL Y. S. CHUNG, Chairman
HERBERT S. K. KAOPUA, SR.
SAMUEL T. HATA
ALLY J. PARK
ROBERT K. CUNDIFF

RODNEY K. HARAGA, Ex-Officio
LAVERNE T. HIGA, Ex-Officio

CLIFFORD P. LUM
Manager and Chief Engineer

FILE

FILE COPY

Mr. Edward Sakai, P.E.
SSFM International
501 Sumner Street #620
Honolulu, Hawaii 96817

Dear Mr. Sakai:

Subject: Your Letter of October 16, 2006 Requesting the Availability of Water to the Proposed Hawaiian Memorial Cemetery Expansion, TMK:4-5-33:1

Thank you for your letter on the proposed cemetery expansion.

The existing water system is presently adequate to accommodate the domestic water requirements of the proposed cemetery expansion. However, please be advised that this information is based upon current data and, therefore, the Board of Water Supply reserves the right to change any position or information stated herein up until the final approval of your building permit. The final decision on the availability of water will be confirmed when the building permit is submitted for approval.

The developer should investigate the feasibility of using non-potable water for irrigation of the proposed cemetery expansion. If non-potable water is either unavailable or infeasible, a report of the investigation including proposed irrigation demands should be submitted to us before we will consider the use of potable water.

When water is made available, the applicant will be required to pay our Water System Facilities Charges for resource development, transmission and daily storage.

The on-site fire protection requirements should be coordinated with the Fire Prevention Bureau of the Honolulu Fire Department.

If you have any questions, please contact Robert Chun at 748-5443.

Very truly yours,

K. Shida

KEITH S. SHIDA
Principal Executive
Customer Care Division

BOARD OF WATER SUPPLY

CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET
HONOLULU, HI 96843

December 15, 2006

SSFM INTERNATIONAL, INC.
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MUFI HANNEMANN, Mayor

RANDALL Y. S. CHUNG, Chairman
HERBERT S. K. KAOPUA, SR.
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ROBERT K. CUNDIFF

RODNEY K. HARAGA, Ex-Officio
LAVERNE T. HIGA, Ex-Officio

CLIFFORD P. LUM
Manager and Chief Engineer

FILE

FILE COPY

Ms. Robyn M. deHay
SSFM International, Incorporated
501 Sumner Street, Suite 620
Honolulu, Hawaii 96817

Dear Ms. deHay:

Subject: Your Letter Dated December 4, 2006 Requesting the Availability of Irrigation Water to the Proposed Hawaiian Memorial Park Cemetery Expansion, TMK: 4-5-33:1

Thank you for your letter on the proposed Hawaiian Memorial Cemetery Expansion.

Our Hydrology-Geology Section has indicated the existence of non-potable wells in the vicinity of the of the proposed cemetery expansion. We request the developer investigate the feasibility of using these non-potable wells for irrigation of the proposed cemetery expansion. If non-potable water is either unavailable or infeasible, a report of the investigation, including the proposed irrigation demands, should be submitted to us before we will consider the use of potable water.

If you have any questions, please contact Robert Chun at 748-5443.

Very truly yours,

K. Shida

KEITH S. SHIDA
Principal Executive
Customer Care Division

cc: Water Resources Division

BOARD OF WATER SUPPLY

CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET
HONOLULU, HI 96843

March 1, 2007

SSFM INTERNATIONAL, INC
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MUFI HANNEMANN, Mayor

RANDALL Y. S. CHUNG, Chairman
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ROBERT K. CUNDIFF

LAVERNE T. HIGA, Ex-Officio
BARRY FUKUNAGA, Ex-Officio

CLIFFORD P. LUM
Manager and Chief Engineer

DEAN A. NAKANO
Deputy Manager and Chief Engineer

FILE COPY

Mr. Winston Taniguchi
SSFM International, Incorporated
501 Sumner Street, Suite 620
Honolulu, Hawaii 96817

Dear Mr. Taniguchi:

Subject: Your Letter of January 18, 2007 Requesting the Availability of Potable Water for Irrigation of the Proposed Hawaiian Memorial Park Cemetery Expansion, TMK: 4-5-33:1

Thank you for your letter requesting water for irrigation of the proposed cemetery expansion in Kaneohe.

We request that additional research be conducted to determine the feasibility of developing a non-potable water source for irrigation of the cemetery expansion. Our Water Resources Division has indicated the possibility of developing a new non-potable source in the vicinity of the proposed cemetery expansion. Chester Lao of the Board of Water Supply may be contacted at 748-5931 concerning possible non-potable well locations.

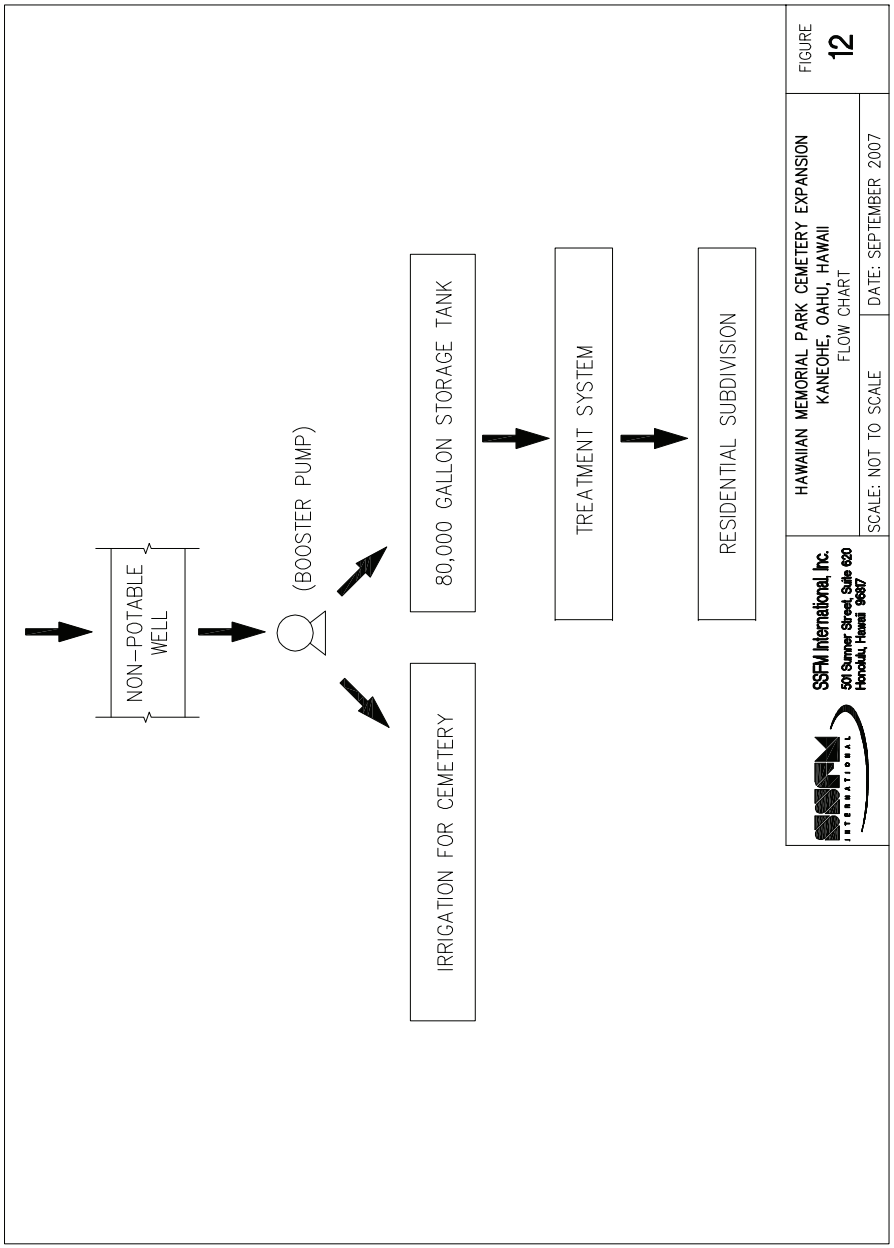
If you have any questions, please contact Robert Chun at 748-5443.

Very truly yours,

KEITH S. SHIDA
Principal Executive
Customer Care Division

cc: Chester Lao, Water Resources Division

Water for Life . . . Ka Wai Ola



"Former Proposed Action"
Domestic Water Demand
Cemetery Expansion and 20-Lot Subdivision

Hawaiian Memorial Park

Proposed Domestic Water Demand - "Former Proposed Action"

	Dwelling Units	Acres	Demand (gal/unit)	Average Daily Demand (gpd)	Maximum Daily Demand (gpd)	Peak Hour (gpd)	Notes:
Residential	20	---	500	10,000	15,000	30,000	Not included is 33 gpm accounted for the cemetery bathroom. Very minimal and therefore not included in preliminary calcs
TOTAL				**10,000**	**15,000**	**30,000**	

"Revised Propsed Action"
Domestic Water Demand
Cemetery Only Expansion

Hawaiian Memorial Park

Proposed Domestic Water Demand (Non-Potable Water) - "Revised Proposed Action"

Fixture	FU/Fixture	Quantity	Total FU		
W.C (valve)	3.40	3	10.2		
Sink	1.60	2	3.2		
Urinals	1.70	2	3.4		
			16.8	FU	
			33.0	gpm →	1" meter (31-50gpm)

"Former Proposed Action"
Residential Fireflow Calculations (Uphill Road)

Hawaiian Memorial Park
SSFM International, Inc.
Proposed Fire Hydrants on Uphill Road

FH near Cul-de-sac
FLOW CALCULATIONS

EQUIVALENT LENGTH IN SERIES:

Le	
L1 (ft)	800
De (in)	8
D1 (in)	8
Ce	110
C1	110
Le =	800
say	
Le =	**800.00 ft.**
Equivalent length	

FORMULA:
Le = L1*(De/D1)^4.8704 * (Ce/C1)^1.852

EQUIVALENT LENGTH IN PARALLEL:

Le	
L1	400
De	12
D1	8
Ce	110
C1	110
L2	6392
D2	12
C2	110
Le =	1139.4645
say	
Le =	**1139.46 ft.**

TOTAL LENGTH OF PIPE:
LENGTHS:
800.00
TOTAL: **800.00** FT

FLOW IN GPM

Res top	360
Res bot	340
Res 3/4	355
fh ele	264
Hf	45
Lt	800.00
C	110
D (in)	8
Q =	1553.548231
say	
Q =	**1554 gpm w/o consumption**

STATIC PRESSURE (res 3/4 - fh ele)/2.31

Static Pressure = 39.39394
say
Static Pressure = 39 psi

FH# W-0690

Q = 448.895*(((D/12)^4.8704*(C^1.852)*Hf)/(4.727*L))^(1/1.852))

FH near Residential Lot 20
FLOW CALCULATIONS

EQUIVALENT LENGTH IN SERIES:

Le	
L1 (ft)	415
De (in)	8
D1 (in)	8
Ce	110
C1	110
Le =	415
say	
Le =	**415.00 ft.**
Equivalent length	

FORMULA:
Le = L1*(De/D1)^4.8704 * (Ce/C1)^1.852

EQUIVALENT LENGTH IN PARALLEL:

Le	
L1	400
De	12
D1	8
Ce	110
C1	110
L2	6392
D2	12
C2	110
Le =	1139.4645
say	
Le =	**1139.46 ft.**

TOTAL LENGTH OF PIPE:
LENGTHS:
415.00
TOTAL: **415.00** FT

FLOW IN GPM

Res top	360
Res bot	340
Res 3/4	355
fh ele	263
Hf	46
Lt	415.00
C	110
D (in)	8
Q =	2240.727829
say	
Q =	**2241 gpm w/o consumption**

STATIC PRESSURE (res 3/4 - fh ele)/2.31

Static Pressure = 39.82684
say
Static Pressure = 40 psi

FH# W-0690

"Former Proposed Action"
Residential Fireflow Calculations (Downhill Road)

Hawaiian Memorial Park
SSFM International, Inc.
Proposed Fire Hydrants on Downhill Road

FH near Cul-de-sac
FLOW CALCULATIONS

EQUIVALENT LENGTH IN SERIES:

Le	
L1 (ft)	850
De (in)	8
D1 (in)	8
Ce	110
C1	110
Le =	850
say	
Le =	**850.00 ft.**
Equivalent length	

FORMULA:
Le = L1*(De/D1)^4.8704 * (Ce/C1)^1.852

EQUIVALENT LENGTH IN PARALLEL:

Le	
L1	400
De	12
D1	8
Ce	110
C1	110
L2	6392
D2	12
C2	110
Le =	1139.4645
say	
Le =	**1139.46 ft.**

TOTAL LENGTH OF PIPE:
LENGTHS:
850.00
TOTAL: **850.00** FT

FLOW IN GPM

Res top	360
Res bot	340
Res 3/4	355
fh ele	230
Hf	79
Lt	850.00
C	110
D (in)	8
Q =	2037.424692
say	
Q =	**2037 gpm w/o consumption**

Q = 448.895*(((D/12)^4.8704*(C^1.852)*Hf)/(4.727*L))^(1/1.852))

STATIC PRESSURE (res 3/4 - fh ele)/2.31

Static Pressure = 54.11255
say
Static Pressure = 54 psi

FH# W-0690

FH near Residential Lots 8 & 9
FLOW CALCULATIONS

EQUIVALENT LENGTH IN SERIES:

Le	
L1 (ft)	650
De (in)	8
D1 (in)	8
Ce	110
C1	110
Le =	650
say	
Le =	**650.00 ft.**
Equivalent length	

FORMULA:
Le = L1*(De/D1)^4.8704 * (Ce/C1)^1.852

EQUIVALENT LENGTH IN PARALLEL:

Le	
L1	400
De	12
D1	8
Ce	110
C1	110
L2	6392
D2	12
C2	110
Le =	1139.4645
say	
Le =	**1139.46 ft.**

TOTAL LENGTH OF PIPE:
LENGTHS:
650.00
TOTAL: **650.00** FT

FLOW IN GPM

Res top	360
Res bot	340
Res 3/4	355
fh ele	250
Hf	59
Lt	650.00
C	110
D (in)	8
Q =	2011.576128
say	
Q =	**2012 gpm w/o consumption**

STATIC PRESSURE (res 3/4 - fh ele)/2.31

Static Pressure = 45.45455
say
Static Pressure = 45 psi

FH# W-0690

APPENDIX E

Sewer Calculations

DEPARTMENT OF PLANNING AND PERMITTING

CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET * HONOLULU, HAWAII 96813
Phone: (808) 527-5827 * Fax: (808) 523-4210

SSFM INTERNATIONAL, INC
RECEIVED
MAY 0 4 2007
Wmt

FILE COPY

SEWER CONNECTION APPLICATION

APPLICATION NO.: **2007/SCA-0256** STATUS: **Approved with conditions**

DATE RECEIVED: **04/23/2007** IWDP APP. NO.:

PROJECT NAME: **Hawaiian Memorial Park Cemetery Expansion / Subdivision/Dwelling Unit/Cemetery**

$110,275.20
Estimated Wastewater System Facility Charge*

LOCATION:

Zone	Section	Plat	Parcel
4	5	033	001

45-425 KAM HWY **7,162,266** Sq. Ft.

SPECIFIC LOCATION: **45-425 Kamehameha Hwy**

APPLICANT: **SSFM International, Inc., Winston Taniguchi**
501 Sumner St Suite 620
Honolulu, Hawaii 96817

DEVELOPMENT TYPE: **Dwelling, Single-family** SEWER CONNECTION WORK DESIRED: **New**

OTHER USES: **Cemetery-100 people/day**

NON-RESIDENTIAL AREA: s.f. APPROXIMATE DATE OF CONNECTION:

PROPOSED UNITS		EXISTING UNITS		UNITS TO BE DEMOLISHED	
No. of New Units:	**20**	No. of Existing Units:	**0**	No. of Units to be Demolished:	**0**
Studios:		Studios:		Studios:	
1-Bedroom:		1-Bedroom:		1-Bedroom:	
2-Bedroom:		2-Bedroom:		2-Bedroom:	
3-Bedroom:	20	3-Bedroom:		3-Bedroom:	
4-Bedroom:		4-Bedroom:		4-Bedroom:	
5-Bedroom:		5-Bedroom:		5-Bedroom:	
6-Bedroom:		6-Bedroom:		6-Bedroom:	

REMARKS **Approval is for a 20-lot subdivision (one dwelling unit per lot) and a comfort station for the cemetery expansion project. Also, submit construction plans for review and approval.**

APPROVAL DATE: **05/02/2007**

EXPIRATION DATE: **05/01/2009**

Valid 2-years after approval date. Construction plans shall be completed and approved within this 2-year period. Construction shall commence within 1-year after approval of plans.
** Applicable WSFC shall be collected at the prevailing rate in accordance with ROH 1990, Chapter 14, Sections 14-10.3, 14-10.4, 14-10.5 and Appendix 14-D.*

REVIEWED BY: ***Arturo Saavedra Jr.***

A. Saavedra, Jr.
Site Development Division, Wastewater Branch

ExternalID: **026118988-001** JobId: **26118988**

Initial Print Date: Wednesday May 2, 2007 10:52 am

Sewer Design Peak Flow Calculations
(Cemetery Expansion and 20-Lot Residential Subdivision)

MGD = millions of gallons per day
CPA = capita per acre
GPCD = gallon per capita per day
GAD = gallon per acre per day
GPD = gallons per day

Average daily per capita flow	average flow of wastewater: 80 gpcd					
			Total Capita	GPD		
Residential (home)	no. of homes =	20	80	6400	no. of acres =	4.98
Residential (apartment)	no. of units =	0	0	0	no. of acres =	0
Central Business	no. of acres =	0	0	0		
Community Business	no. of acres =	0	0	0		
Neighborhood Business	no. of acres =	0	0	0		
Resort	no. of acres =	0	0	0		
Apartment (high density)	no. of acres =	0	0	0		
Apartment (medium density)	no. of acres =	0	0	0		
Apartment (low density)	no. of acres =	0	0	0		
General Industry	no. of acres =	0	0	0		
Waterfront Industry	no. of acres =	0	0	0		
School/Comfort Station			100	2500	no. of acres =	0.34435
Institution (hospital, etc.)			0	0	no. of acres =	0
	Total acres =	5.33	180.00			
Average Wastewater Flow				8900.00 GPD		
				0.01 MGD		
Maximum Wastewater Flow	Flow factor (Figure 22.2.4)		5	0.045 MGD		
Dry Weather Infiltration/Inflow						
Sewers laid above or below the	above		5	900.00 GPD		
normal ground water table?			(gpcd)	0.001 MGD		
Design Average Flow	0.0098 MGD					
Design Maximum Flow	0.0454 MGD					
Wet Weather Infiltration/Inflow						
Sewers laid above or below the			1250	6661.39 GPD		
normal ground water table?			(gad)	0.007 MGD		
Design Peak Flow				**52061.387 GPD**		
				0.052 MGD		

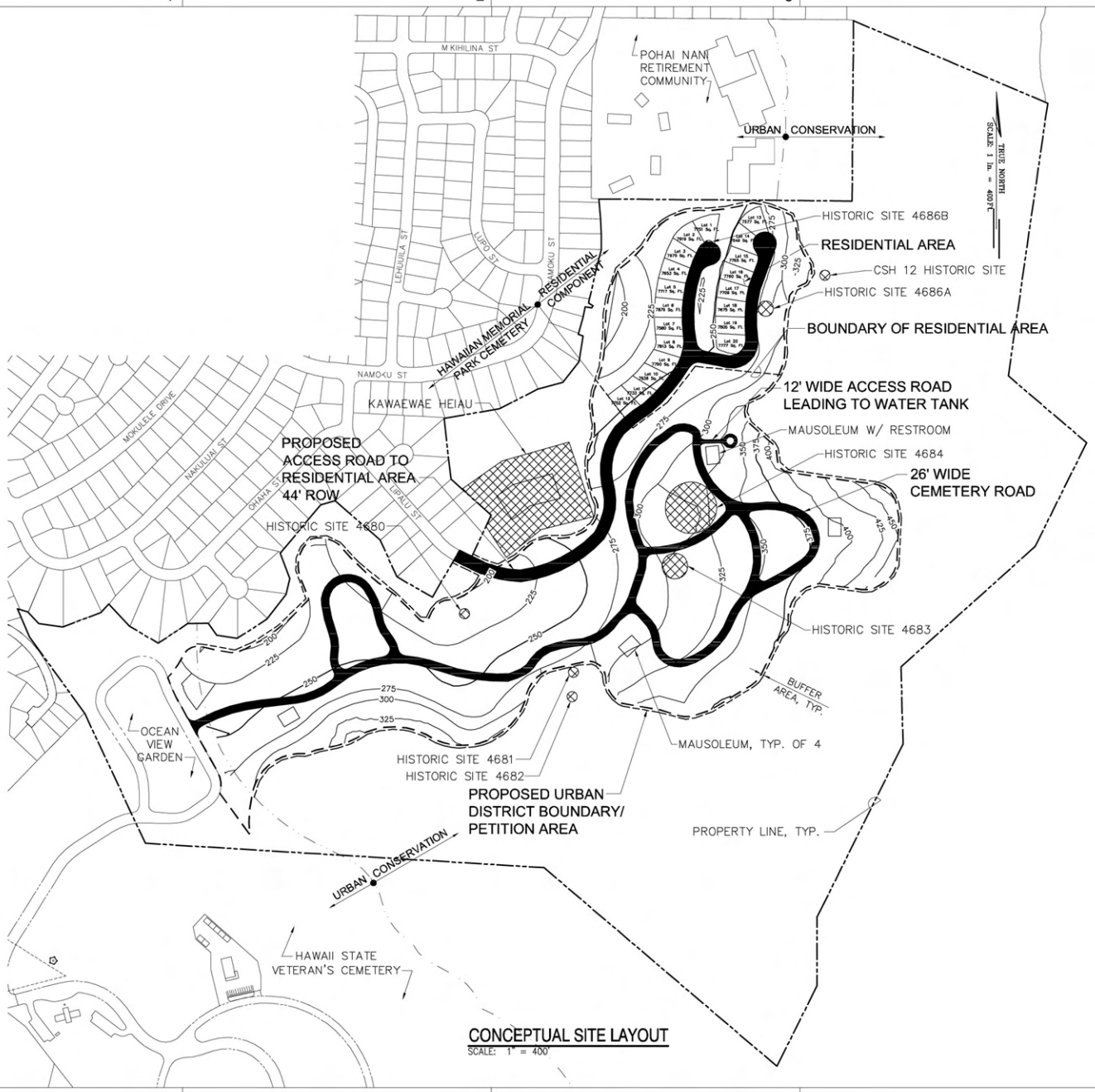
Sewer Design Peak Flow Calculations
(Cemetery Expansion Only)

MGD = millions of gallons per day
CPA = capita per acre
GPCD = gallon per capita per day
GAD = gallon per acre per day
GPD = gallons per day

Average daily per capita flow	average flow of wastewater: 80 gpcd					
			Total Capita	GPD		
Residential (home)	no. of homes =	0	0	0	no. of acres =	0.00
Residential (apartment)	no. of units =	0	0	0	no. of acres =	0
Central Business	no. of acres =	0	0	0		
Community Business	no. of acres =	0	0	0		
Neighborhood Business	no. of acres =	0	0	0		
Resort	no. of acres =	0	0	0		
Apartment (high density)	no. of acres =	0	0	0		
Apartment (medium density)	no. of acres =	0	0	0		
Apartment (low density)	no. of acres =	0	0	0		
General Industry	no. of acres =	0	0	0		
Waterfront Industry	no. of acres =	0	0	0		
School/Comfort Station			100	2500	no. of acres =	0.34435
Institution (hospital, etc.)			0	0	no. of acres =	0
	Total acres =	0.34	100.00			
Average Wastewater Flow				2500.00 GPD		
				0.00 MGD		
Maximum Wastewater Flow	Flow factor (Figure 22.2.4)		5	0.013 MGD		
Dry Weather Infiltration/Inflow						
Sewers laid above or below the	above		5	500.00 GPD		
normal ground water table?			(gpcd)	0.001 MGD		
Design Average Flow	0.003 MGD					
Design Maximum Flow	0.013 MGD					
Wet Weather Infiltration/Inflow						
Sewers laid above or below the			1250	430.44 GPD		
normal ground water table?			(gad)	0.000 MGD		
Design Peak Flow				**13430.441 GPD**		
				0.013 MGD		

APPENDIX F

Conceptual Plans – Cemetery Expansion and 20-lot Residential Subdivision (Former Proposed Action)



CONCEPTUAL SITE LAYOUT

SCALE: 1" = 400'

LAND USE SUMMARY	
DESCRIPTION	AREA (ACRE)
CEMETERY AREA	
TOTAL NET BURIAL AREAS	27.76
CEMETERY INTERNAL ROADWAY	3.940
Q10 RETENTION AREAS	1.934
MAUSOLEUMS	0.321
SUB-TOTAL CEMETERY AREA	33.95
HISTORIC/ARCHAELOGICAL SITES	
HISTORIC SITE 4680	0.029
HISTORIC SITE 4683	0.180
HISTORIC SITE 4684	0.721
HISTORIC SITE 4686A	0.065
HISTORIC SITE 4686B	0.029
SUB-TOTAL HISTORIC/ARCHAELOGICAL SITE	1.02
RESIDENTIAL AREA	
RESIDENTIAL SUBDIVISION	3.561
RESIDENTIAL ACCESS ROAD	2.848
SUB-TOTAL RESIDENTIAL AREA	6.41
TEMPORARILY DISTURBED AREA (LANDS TO BE REVEGETATED)	
CUT/FILL SLOPE	11.513
BUFFER AREA	2.143
OTHER	1.607
SUB-TOTAL TEMPORARILY DISTURBED AREA	15.26
TOTAL PETITION AREA	56.65

LEGEND

- 300 — PROPOSED MINOR CONTOURS
- 250 — PROPOSED MAJOR CONTOURS
- PROPOSED ROADWAY
- EXISTING PROPERTY LINE
- ARCHAEOLOGICAL SITES
- PROPOSED MAUSOLEUMS
- GRADING LIMITS
- EXISTING STATE LAND USE DISTRICTS
- PROPOSED URBAN DISTRICT BOUNDARY/PETITION AREA

200' 100' 0 200' 400'
SCALE: 1" = 400'

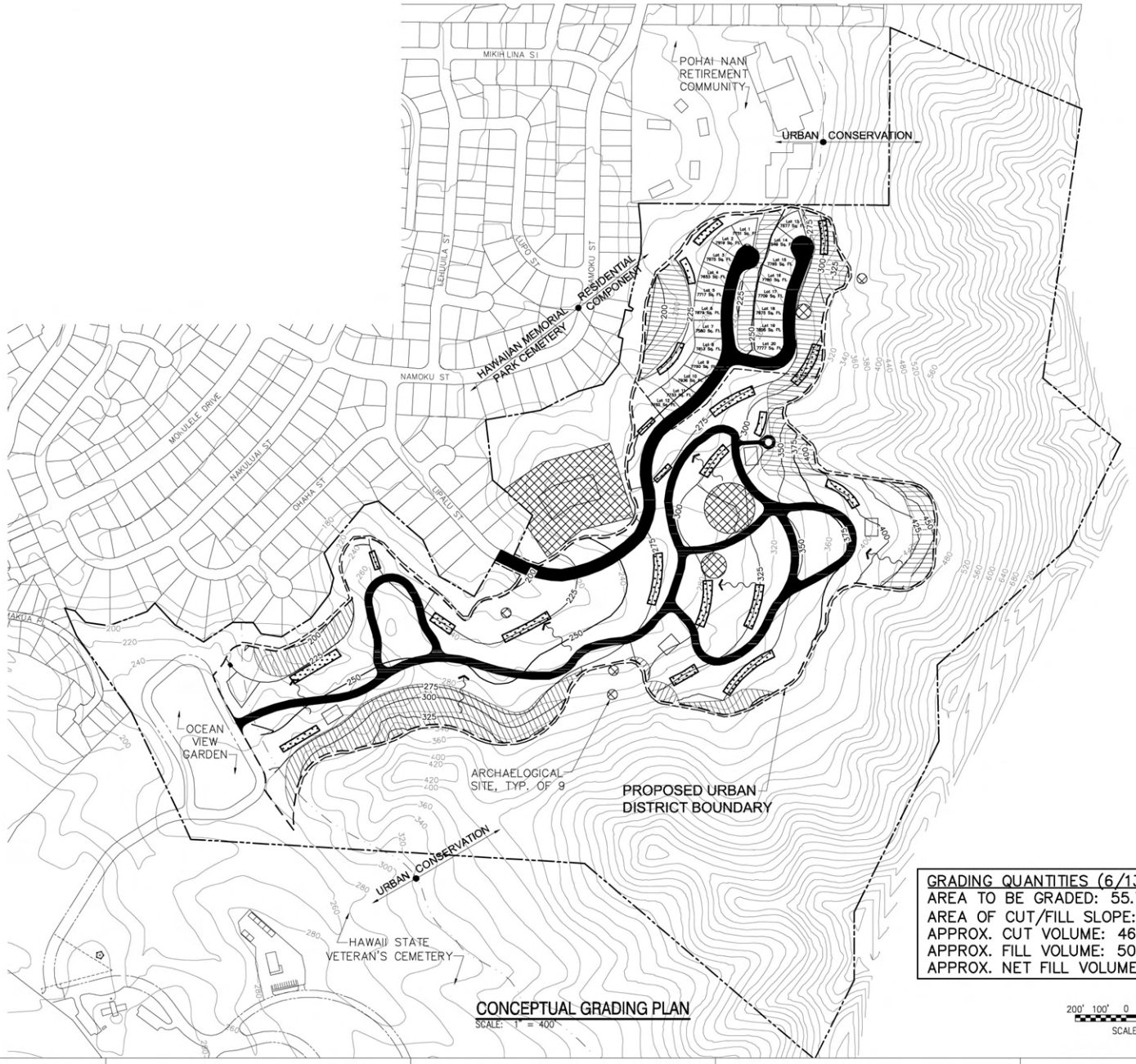
SSFM INTERNATIONAL, INC.
501 SUMMER STREET, SUITE 620
HONOLULU, HAWAII 96817

HAWAIIAN MEMORIAL CEMETERY EXPANSION
PRELIMINARY ENGINEERING REPORT

CONCEPTUAL SITE PLAN

DESIGNED BY: WMT	CHECKED BY: EMS	PROJECT NO.	CLIENT
DRAWN BY: WMT	APPROVED BY: EMS	2006_095.000	CLARK & GREEN
SCALE: AS NOTED ON SHEET		DATE 9/11/2007	FIGURE 13

DRAWING NAME: E:\2006\2006 095.000 HHPP HAWAIIAN MEMORIAL CEMETERY EXPANSION PERVC DRAWINGS\CONTRACT DOCUMENTS\OLD\080905\SITE PLAN.DWG EDIT TIME: 09-25-08, 1:11 PM EDITED BY: WTANGUCHI



CONCEPTUAL GRADING PLAN
SCALE: 1" = 400'

TRUE NORTH
SCALE: 1 in. = 400ft

LEGEND

- 320 EXISTING CONTOURS
- 300 PROPOSED MINOR CONTOURS
- 250 PROPOSED MAJOR CONTOURS
- PROPOSED ROADWAY
- GRADING LIMITS
- EXISTING PROPERTY LINE
- CUT/FILL SLOPE
- ARCHAEOLOGICAL SITES
- PROPOSED RETENTION AREAS
- PROPOSED MAUSOLEUMS
- FLOW DIRECTION
- EXISTING STATE LAND USE DISTRICTS

GRADING QUANTITIES (6/13/07)

AREA TO BE GRADED: 55.75 ACRES
AREA OF CUT/FILL SLOPE: 11.58 ACRES
APPROX. CUT VOLUME: 463,405 CY
APPROX. FILL VOLUME: 500,865 CY
APPROX. NET FILL VOLUME: 37,460 CY

200' 100' 0 200' 400'
SCALE: 1" = 400'

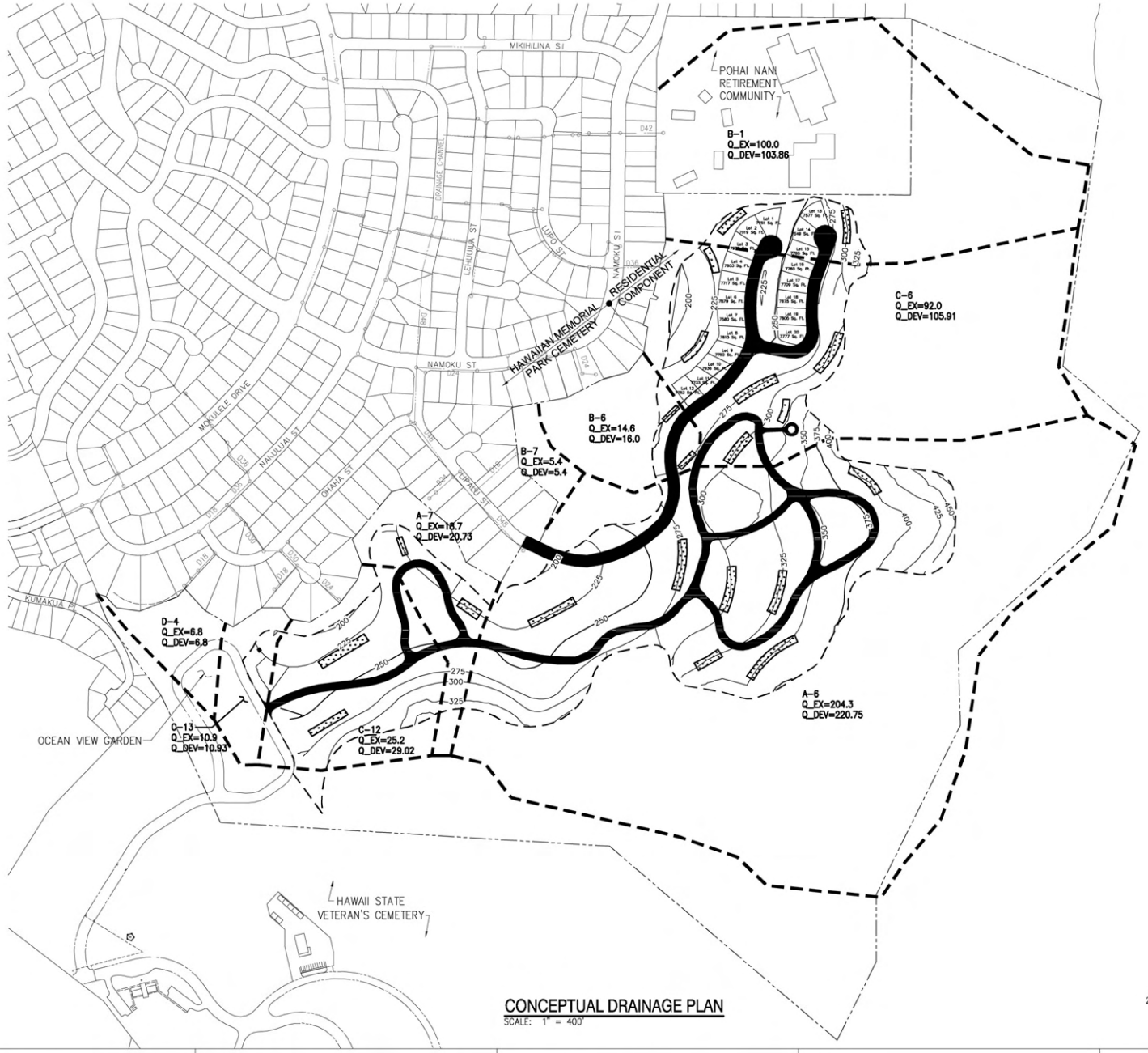
SSFM INTERNATIONAL, INC.
501 SUMMER STREET, SUITE 620
HONOLULU, HAWAII 96817

HAWAIIAN MEMORIAL CEMETERY EXPANSION
PRELIMINARY ENGINEERING REPORT

CONCEPTUAL GRADING PLAN

DESIGNED BY: WMT	CHECKED BY: EMS	PROJECT NO.	CLIENT
DRAWN BY: WMT	APPROVED BY: EMS	2006_095.000	CLARK & GREEN
SCALE: AS NOTED ON SHEET		DATE 9/11/2007	FIGURE 12

DRAWING NAME: I:\2006\2006 095.000 HHPP-HAWAIIAN MEMORIAL CEMETERY EXPANSION PERVO DRAWINGS\CONTRACT DOCUMENTS\OLD\060905\GRADING PLAN.DWG EDIT TIME: 09-25-08, 1:11 PM EDITED BY: WTANIGUCHI



CONCEPTUAL DRAINAGE PLAN

SCALE: 1" = 400'

NOTES:

1. EXISTING DRAINAGE LINES OBTAINED FROM DRAINAGE REPORTS ON FILE AT DEPARTMENT OF PLANNING & PERMITTING
2. RETENTION BASINS TO BE PROVIDED TO RETAIN INCREASED RUNOFF FROM SUBDRAINAGE AREAS.

ABBREVIATIONS

Q_EX = EXISTING FLOW RATE
Q_DEV = DEVELOPED FLOW RATE

LEGEND

- EXISTING PROPERTY LINE
- D18 EXISTING DRAIN LINES
- DRAINAGE SUBASINS
- PROPOSED RETENTION AREAS
- GRADING LIMITS

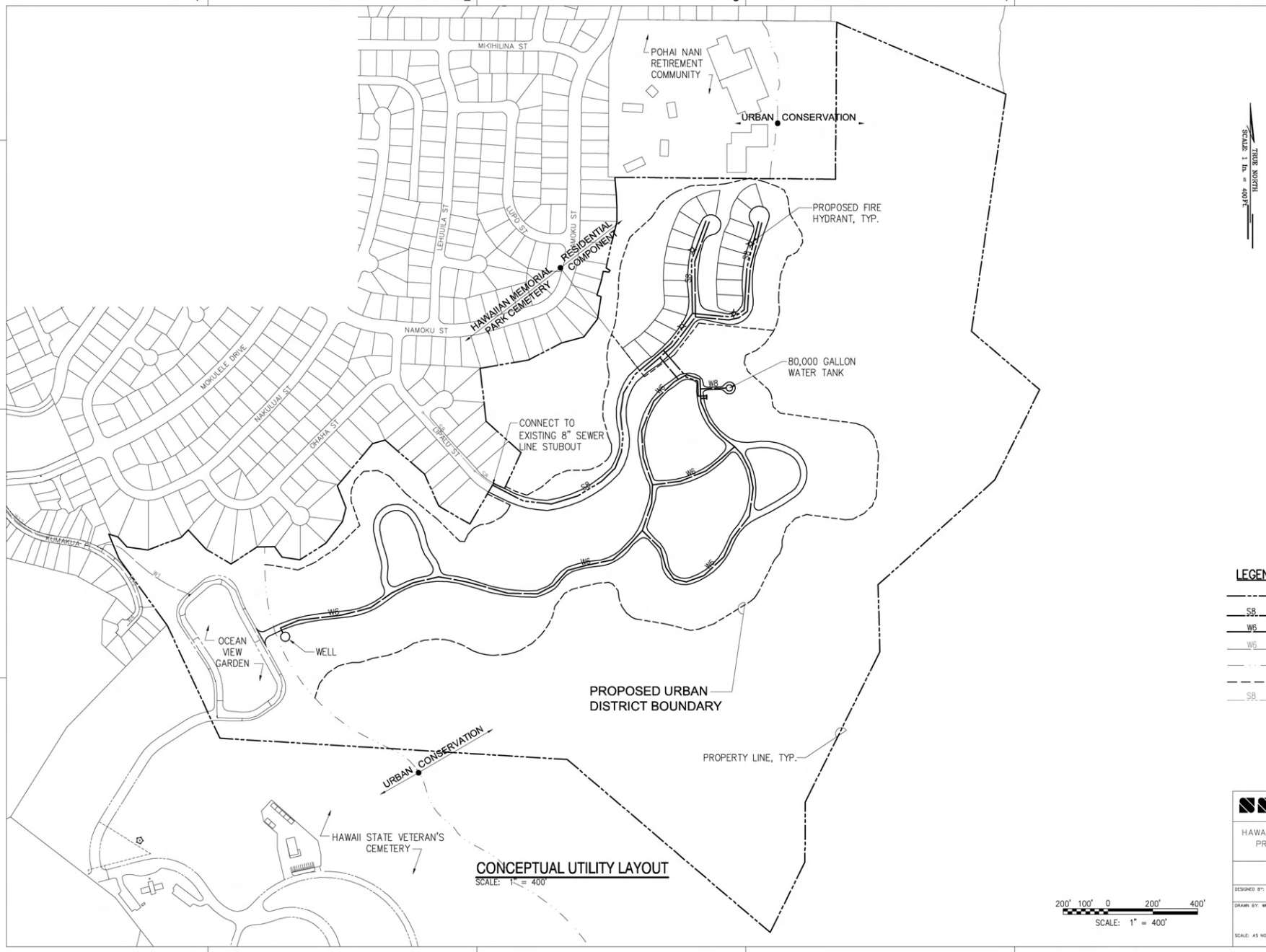
SSFM INTERNATIONAL, INC.
501 SUMMER STREET, SUITE 620
HONOLULU, HAWAII 96817

HAWAIIAN MEMORIAL CEMETERY EXPANSION
PRELIMINARY ENGINEERING REPORT

CONCEPTUAL DRAINAGE PLAN

DESIGNED BY: WMT	CHECKED BY: EMS	PROJECT NO.	CLIENT
DRAWN BY: WMT	APPROVED BY: EMS	2006_095.000	CLARK & GREEN
SCALE: AS NOTED ON SHEET		DATE 9/25/2008	FIGURE 15

DRAWING NAME: E:\2006\2006 095.000 HMPP HAWAIIAN MEMORIAL CEMETERY EXPANSION PERVIO DRAWINGS\CONTRACT DOCUMENTS\OLD\080905\DRAINAGE PLAN.DWG EDIT TIME: 09-25-08, 1:12 PM EDITED BY: WTANGUCHI



CONCEPTUAL UTILITY LAYOUT

SCALE: 1" = 400'

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HAWAIIAN MEMORIAL CEMETERY EXPANSION
PRELIMINARY ENGINEERING REPORT

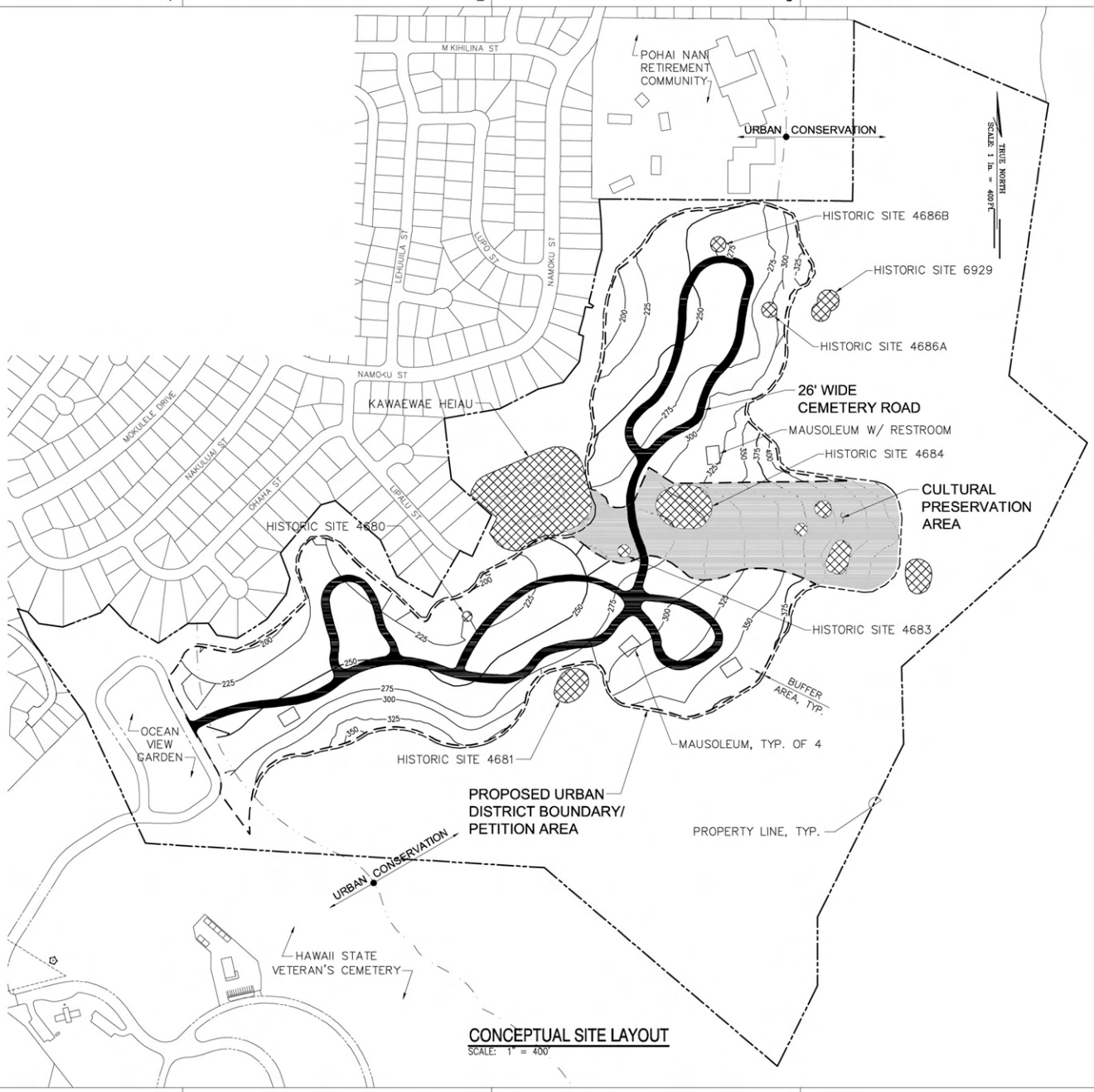
CONCEPTUAL UTILITY PLAN

DESIGNED BY: WMT	CHECKED BY: EMS	PROJECT NO.	CLIENT
DRAWN BY: WMT	APPROVED BY: EMS	2006_095.000	CLARK & GREEN
SCALE: AS NOTED ON SHEET		DATE 9/25/2008	FIGURE 16

DRAWING NAME: I:\2006\2006 095.000 HHPP-HAWAIIAN MEMORIAL CEMETERY EXPANSION PERVG DRAWINGS\CONTRACT DOCUMENTS\OLD\080905\UTILITY PLAN.DWG EDIT TIME: 09-25-08, 1:12 PM EDITED BY: WTANGUCHI

APPENDIX G

Conceptual Plans – Cemetery Expansion Only
(Revised Proposed Action)



CONCEPTUAL SITE LAYOUT

SCALE: 1" = 400'

LAND USE SUMMARY	
DESCRIPTION	AREA (ACRE)
CEMETERY AREA	
TOTAL NET BURIAL AREAS	29.50
CEMETERY INTERNAL ROADWAY	4.44
Q10 RETENTION AREAS	1.330
MAUSOLEUMS	0.321
SUB-TOTAL CEMETERY AREA	35.59
HISTORIC/ARCHAELOGICAL SITES	
HISTORIC SITE 4680	0.029
HISTORIC SITE 4686A	0.066
HISTORIC SITE 4686B	0.066
CULTURAL PRESERVATION AREA	9.346
SUB-TOTAL HISTORIC/ARCHAELOGICAL SITE	9.51
TEMPORARILY DISTURBED AREA (LANDS TO BE REVEGETATED)	
CUT/FILL SLOPE	9.612
BUFFER AREA	1.744
SUB-TOTAL TEMPORARILY DISTURBED AREA	11.36
TOTAL PETITION AREA	56.46

LEGEND

- 300 — PROPOSED MINOR CONTOURS
- 250 — PROPOSED MAJOR CONTOURS
- PROPOSED ROADWAY
- EXISTING PROPERTY LINE
- ARCHAEOLOGICAL SITES
- PROPOSED MAUSOLEUMS
- GRADING LIMITS
- EXISTING STATE LAND USE DISTRICTS
- PROPOSED URBAN DISTRICT BOUNDARY/PETITION AREA
- CULTURAL PRESERVATION AREA

200' 100' 0 200' 400'

SCALE: 1" = 400'

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HAWAIIAN MEMORIAL CEMETERY EXPANSION
PRELIMINARY ENGINEERING REPORT

CONCEPTUAL SITE PLAN

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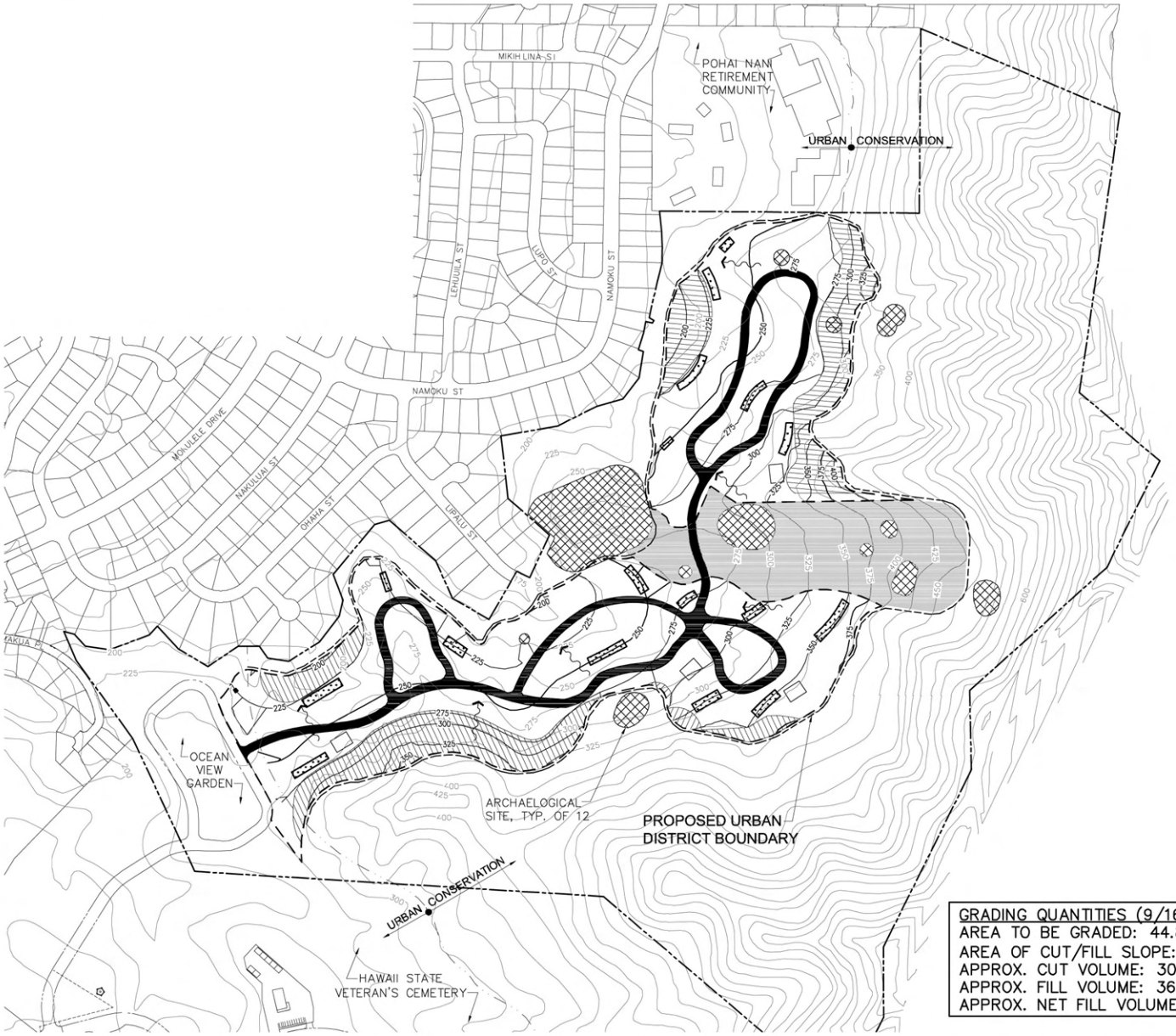
DRAWN BY: WMT	APPROVED BY: EMS	2006_095.000	CLARK & GREEN
SCALE: AS NOTED ON SHEET		DATE 9/25/2008	FIGURE 17

DRAWING NAME: I:\2006\2006 095.000 HHFP HAWAIIAN MEMORIAL CEMETERY EXPANSION PERVIO DRAWINGS\CONTRACT DOCUMENTS\SITE PLAN.DWG EDIT TIME: 09-25-08, 2:46 PM EDITED BY: WTANIGUCHI



TRUE NORTH
SCALE: 1 in. = 400 ft

LEGEND

- EXISTING CONTOURS
- PROPOSED MINOR CONTOURS
- PROPOSED MAJOR CONTOURS
- PROPOSED ROADWAY
- GRADING LIMITS
- EXISTING PROPERTY LINE
- CUT/FILL SLOPE
- ARCHAEOLOGICAL SITES
- PROPOSED RETENTION AREAS
- PROPOSED MAUSOLEUMS
- FLOW DIRECTION
- EXISTING STATE LAND USE DISTRICTS
- CULTURAL PRESERVATION AREA

GRADING QUANTITIES (9/16/08)

AREA TO BE GRADED: 44.85 ACRES
AREA OF CUT/FILL SLOPE: 9.32 ACRES
APPROX. CUT VOLUME: 306,726 CY
APPROX. FILL VOLUME: 363,251 CY
APPROX. NET FILL VOLUME: 56,525 CY

CONCEPTUAL GRADING PLAN

SCALE: 1" = 400'

200' 100' 0 200' 400'
SCALE: 1" = 400'

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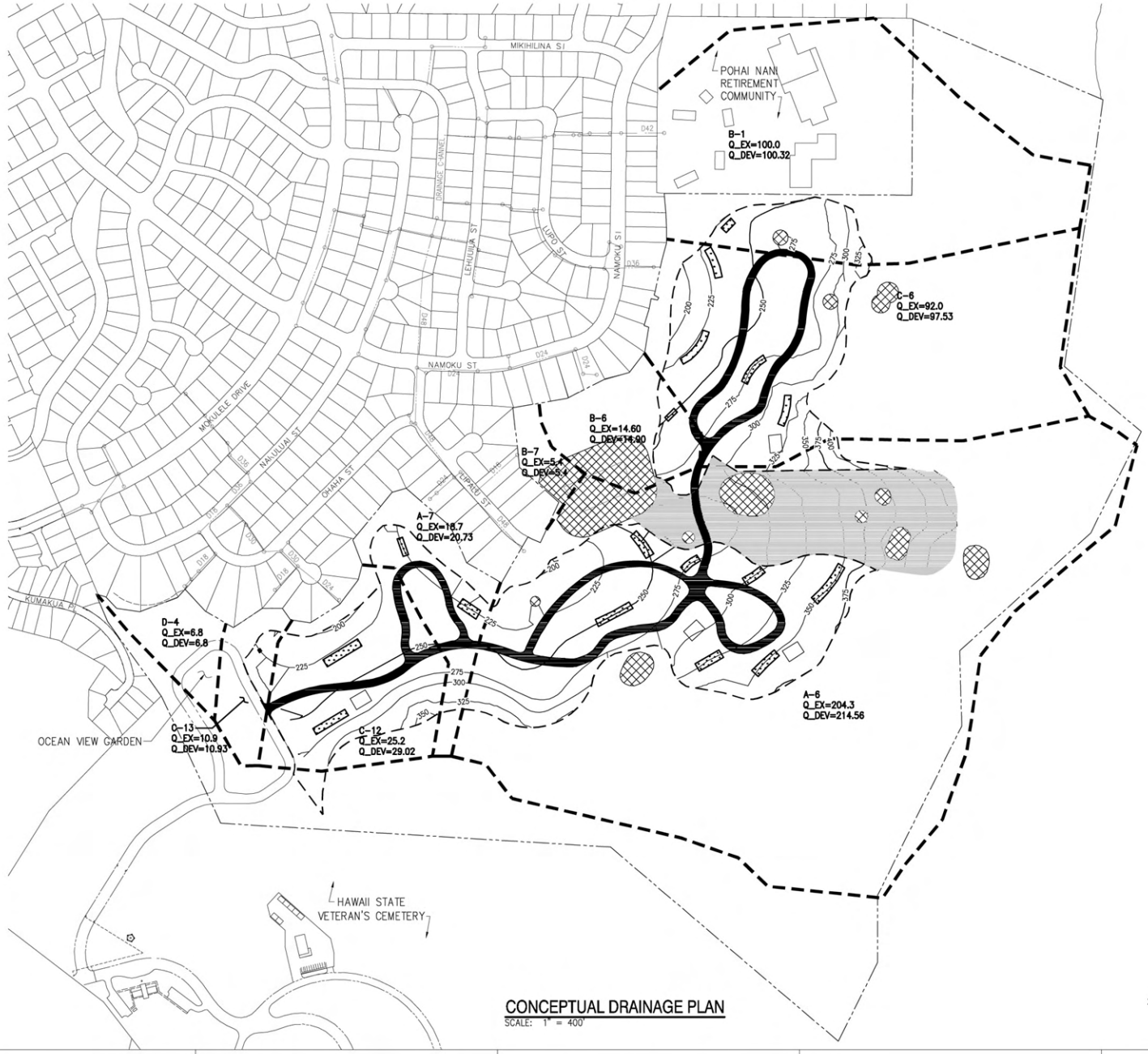
PRELIMINARY ENGINEERING REPORT

CONCEPTUAL GRADING PLAN

DESIGNED BY: WMT	CHECKED BY: EMS	PROJECT NO.	CLIENT
DRAWN BY: WMT	APPROVED BY: EMS	2006_095.000	CLARK & GREEN
SCALE: AS NOTED ON SHEET		DATE 9/25/2008	FIGURE 18

DRAWING NAME: I:\2006\2006 095.000 HHFP I-HAWAIIAN MEMORIAL CEMETERY EXPANSION PER\C DRAWINGS\CONTRACT DOCUMENTS\GRADING PLAN.DWG EDIT TIME: 09-25-08, 1:05 PM EDITED BY: W'ANIGUCHI



CONCEPTUAL DRAINAGE PLAN

SCALE: 1" = 400'

NOTES:

1. EXISTING DRAINAGE LINES OBTAINED FROM DRAINAGE REPORTS ON FILE AT DEPARTMENT OF PLANNING & PERMITTING
2. RETENTION BASINS TO BE PROVIDED TO RETAIN INCREASED RUNOFF FROM SUBDRAINAGE AREAS.

ABBREVIATIONS

Q_EX = EXISTING FLOW RATE
Q_DEV = DEVELOPED FLOW RATE

LEGEND

- EXISTING PROPERTY LINE
- D18 EXISTING DRAIN LINES
- DRAINAGE SUBASINS
- PROPOSED RETENTION AREAS
- GRADING LIMITS
- CULTURAL PRESERVATION AREA

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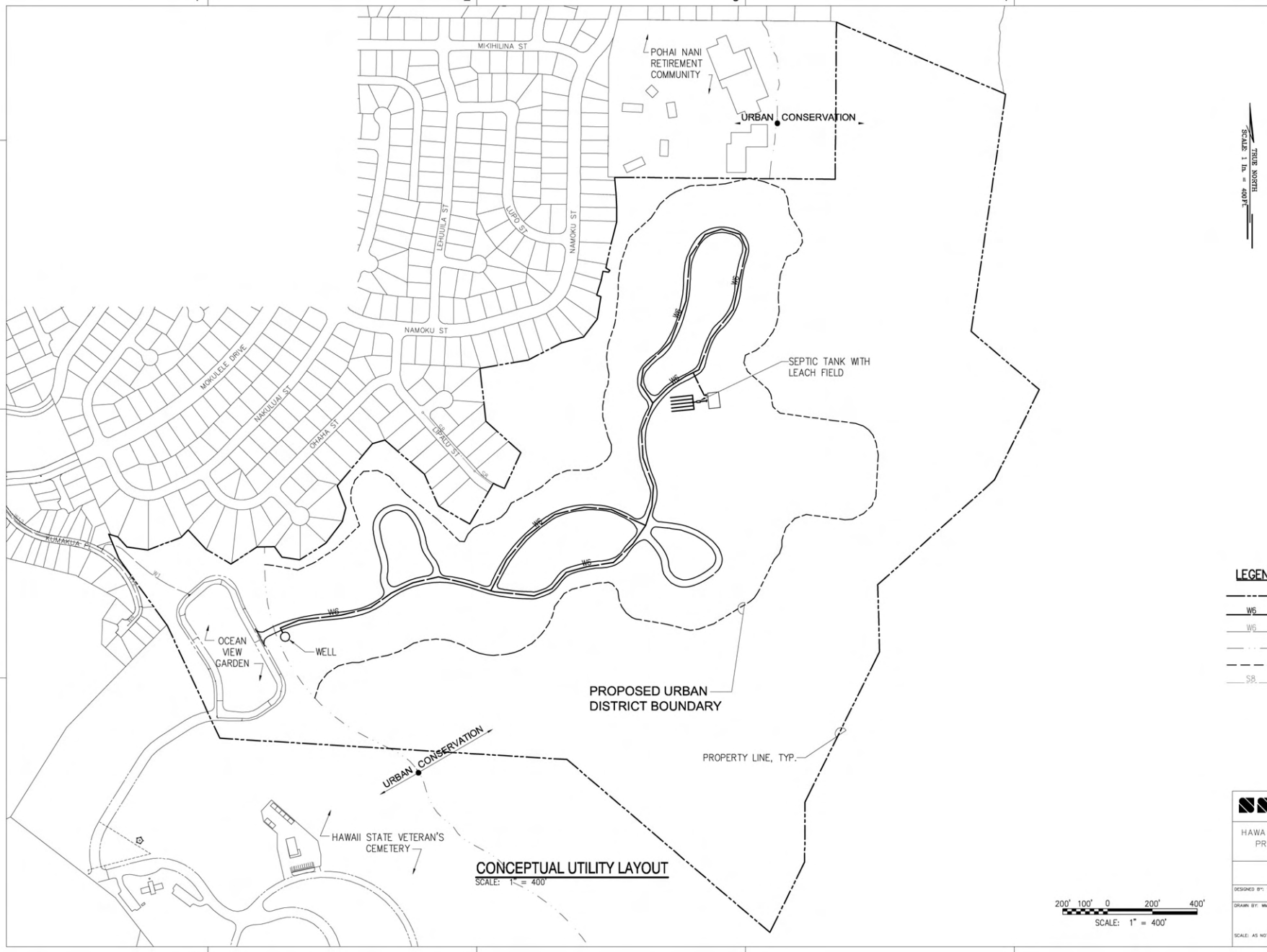
HAWAIIAN MEMORIAL CEMETERY EXPANSION
PRELIMINARY ENGINEERING REPORT

CONCEPTUAL DRAINAGE PLAN

DESIGNED BY: WMT	CHECKED BY: EMS	PROJECT NO.	CLIENT
DRAWN BY: WMT	APPROVED BY: EMS	2006_095.000	CLARK & GREEN
SCALE: AS NOTED ON SHEET		DATE 9/25/2008	FIGURE 19

DRAWING NAME: I:\2006\2006 095.000 HHFP I-HAWAIIAN MEMORIAL CEMETERY EXPANSION PERVIO DRAWINGS\CONTRACT DOCUMENTS\DRAINAGE PLAN.DWG EDIT TIME: 09-25-08, 1:06 PM EDITED BY: WTANIGUCHI



CONCEPTUAL UTILITY LAYOUT
SCALE: 1" = 400'

LEGEND

- EXISTING PROPERTY LINE
- W6 PROPOSED WATERLINE
- W6 EXISTING WATERLINE
- EXISTING STATE LAND USE DISTRICTS
- PROPOSED URBAN DISTRICT BOUNDARY
- SB EXISTING SEWERLINE

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HAWAIIAN MEMORIAL CEMETERY EXPANSION
PRELIMINARY ENGINEERING REPORT

CONCEPTUAL UTILITY PLAN

DESIGNED BY: WMT	CHECKED BY: EMS	PROJECT NO.	CLIENT
DRAWN BY: WMT	APPROVED BY: EMS	2006_095.000	CLARK & GREEN
SCALE: AS NOTED ON SHEET		DATE 9/25/2008	FIGURE 20

DRAWING NAME: I:\2006\2006 095.000 HHFP HAWAIIAN MEMORIAL CEMETERY EXPANSION PERVG DRAWINGS\CONTRACT DOCUMENTS\UTILTY PLAN.DWG EDIT TIME: 09-25-08, 1:07 PM EDITED BY: WTANGUCH

D. Botanical Resources Assessment

(LeGrande Biological Surveys, Inc.)

BOTANICAL RESOURCES ASSESSMENT FOR THE
HAWAII MEMORIAL PARK EXPANSION
KANEOHE, OAHU

Prepared by:

Maya LeGrande
LeGrande Biological Surveys Inc
68-310 Kikou Street
Waialua HI 96791

Prepared for:

CLARK & GREEN ASSOCIATES
150 Paularino Avenue, Suite 160
Costa Mesa CA 92626

September 2006

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SURVEY METHODS……..3

DESCRIPTION OF THE VEGETATION……....4

DISCUSSION AND RECOMMENDATIONS……...…..5

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PLANT SPECIES LIST……7

INTRODUCTION

This report includes the findings of a botanical study conducted at the proposed site for the Hawaii Memorial Park Expansion Project on the island of Oahu, Hawaii. LeGrande Biological Surveys Inc. carried out a botanical field survey of the above location on September 19 & 21, 2006. The primary objectives of the field studies were to:

1) provide a general description of the vegetation on the project site;
2) inventory the flora; and
3) search for threatened and endangered species as well as species of concern.

Federal and State of Hawaii listed species status follows U.S. Fish and Wildlife (USFWS) (1999a and 1999b, 2004) and Federal Register (2002).

GENERAL SITE DESCRIPTION

The area proposed for expansion includes approximately 60 acres of undeveloped land makai or northeast of the existing Hawaii Memorial Park in Kaneohe. The survey area is bounded by residential housing to the west and a natural ridgeline to the east. The northernmost boundary is near the Pohai Nani Retirement Home.

The property consists of relatively steep cliff areas to the east descending from a natural ridgeline that drops in elevation and levels out creating several small gulches that run east to west. The majority of the parcel is characterized by a Lowland Alien Wet Forest. The subject property is at 942 ft elevation at its highest point along the ridge that divides Kaneohe and Kailua Districts and at approximately 200 ft at its lowest elevations at the northwest boundaries. The parcel has been disturbed historically and alteration of native plant habitat has been in place for some time with very few of the natural plant elements remaining. Feral pigs (*Sus scrofa*) continue to degrade the vegetation and understory plants by rooting, resulting in soil disturbance.

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. Information from the Hawaii Biodiversity and Mapping Program database was reviewed. Topographic maps were examined to determine terrain characteristics, access, boundaries, and reference points.

A walk-through survey method was used. The parcel boundaries were surveyed by foot. Transects through the interior of the property were walked at 20 foot intervals. The survey area included the area proposed for the park expansion as well as a buffer that extends mauka up to an elevation of 600 feet. Notes were made on plant associations and distribution, disturbances, topography, substrate types, exposure, drainage, etc. Plant identifications were made in the field; plants that were not positively identified were collected for later determination, and for comparison with the recent taxonomic literature.

DESCRIPTION OF THE VEGETATION

The entire survey area is a highly disturbed Schefflera/Java Plum Forest. A total of 95 plant species were observed within the survey area. 84 are alien (introduced), five are Polynesian introductions, five are indigenous (native to the Hawaiian Islands and elsewhere), and two endemic (native to the Hawaiian Islands and found nowhere else on earth). Therefore, 88% of the plant species observed are alien, 5% are Polynesian introductions, and 7% native.

An inventory of all the plants observed within the survey site is presented in the species list at the end of the report.

The existing Ocean View section of HMP is dominated by mowed grass and landscaping plantings. The edges of the area consists of weedy sections that are dominated either by tall trees such as Java plum (*Syzygium cumini*), *Falcataria moluccana* and mango (*Mangifera indica*), or smaller shrubs like koa haole (*Leucaena leucocephala*), sourbush (*Pluchea carolinensis*), Hilo holly (Ardisia crenata), castor bean (*Ricinus communis*), and golden crown-beard (*Verbesina encelioides*). Grass species include sourgrass (*Digitaria insularis*), broomsedge (*Andropogon virginicus*), molasses grass (*Melinis minutiflora*), and swollen fingergrass (*Chloris barbata*).

The remaining undeveloped section of the survey area is dominated by an alien forest of octopus tree (*Schefflera actinophylla*) and java plum. Other scattered trees include African tulip (*Spathodea campanulata*), date palm (*Phoenix dactylifera*), Chinese banyan (*Ficus microcarpa*), Coconut (*Cocos nucifera*), and Christmas berry (*Schinus terebinthifolius*). Shrub species include slender mimosa (*Desmanthus pernambucans*), shoebutton ardisia (*Ardisia elliptica*), and kolomona (*Senna surattensis*). In open areas vines such as *Ipomoea obscura*, little bell (*I. triloba*), and ivy gourd (*Coccinea grandis*) were observed climbing along the ground or in trees in shrubs. Groundcover consisted mainly of fern species such as laua`e (*Phymatosorus grossus*) and pala`a (*Sphenomeris chinensis*), and an alien grass species; basket grass (*Oplismenus hirtellus*).

An area not planned for HMP expansion, but included in the plant survey is a portion of an open sloping ridge that harbors the Kawaewae Heiau (Sterling & Summers, 1988). The main section of the heiau is cleared of most plant species. Some of the weedy plants still growing within the heiau structure include ti (*Cordyline fruticosa*), papaya (*Carica papaya*), Spanish needle (*Bidens pilosa*), and balsam pear (*Momordica charantia*). Two juvenile koa (*Acacia koa*) trees were observed at the southern end of the heiau, they appear to have been planted.

Five Polynesian introduced plant species were observed within the survey area. They include ti (*Cordyline fruticosa*), niu or coconut (*Cocos nucifera*), kukui (*Aleurites moluccana*), mai`a or banana (*Musa* sp,) and hau (*Hibiscus tiliaceus*). The kukui and hau were observed scattered throughout the survey area especially in the small gulches and ravines. Ti plants were observed along the boundary of the existing memorial park and scrub vegetation as well as along several of the ridges within the area proposed for the

new cemetery expansion. A few coconut trees were observed near the gulch bottom at the end of Lipalu Street.

Five indigenous plant species were observed infrequently in the area; `uhaloa (*Waltheria indica*), hala (*Pandanus tectorius*), ka`e`e or sea bean (*Mucuna gigantea*), pala`a (*Sphenomeris chinensis*), and moa (*Psilotum nudum*). The two endemic species include the two koa trees observed near the heiau and `akia (Wikstroemia oahuensis var. oahuensis) which was mainly observed near the edges of the Ocean View section and the upper elevations near the ridgeline.

DISCUSSION AND RECOMMENDATIONS

None of the plant species observed on the project site is a threatened and endangered species or a species of concern (U.S. Fish and Wildlife Service, 1999a, 1999b, 2004; Wagner et. al., 1999). A concerted effort was made in surveying for `ohi`a lehua (*Metrosideros sp.*) within the subject property, as it is usually more likely to find native species near pockets of extant `ohi`a lehua plants. None were located during the two-day survey.

The Kawaewae Heiau is actively being cared for and maintained and would make an appropriate area for outplanting some of the native and Polynesian introduced plants that are found within the proposed expansion area. This in addition to using native plants in the landscaping of the future memorial park would help to perpetuate these extant taxa in the immediate area.

No wetlands were encountered during this survey. None of the three essential criteria for defining a federally recognized wetland were present within the study site. Those being: hydrophytic vegetation, hydric soils, and wetland hydrology.

The proposed expansion of the Hawaii Memorial Park is not expected to have significant negative impacts on the botanical resources of the site or the general region.

Literature Cited

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PLANTS SPECIES LIST – Hawaii Memorial Park Expansion, Oahu, Hawaii

The following checklist is an inventory of all the plant species observed within the survey site for the proposed Hawaii Memorial Park Expansion. The plant names are arranged alphabetically by family and then by species into each of four groups: Gymnosperms, Ferns and Fern Allies (Pteridophytes), Monocots, and Dicots. The taxonomy and nomenclature of the Ferns and Fern Allies follow Palmer (2002), while the gymnosperms and flowering plants, Monocots and Dicots, are in accordance with Wagner *et al*. (1990) and Wagner and Herbst (1999) and Staples and Herbst (2005). Recent name changes are those recorded in the Hawaii Biological Survey series (Evehuis and Eldredge, eds, 1999-2002).

For each species, the following name is provided:

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 elsewhere.

P=Polynesian introduced=species that were introduced by the Polynesian migration to Hawaii, either intentionally or unintentionally, and are now naturalized.

X=introduced or alien = all those plants brought to the Hawaiian Islands by humans, intentionally or accidentally, after Western contact, that is Cook's arrival in the islands in 1778.

HAWAII MEMORIAL PARK PLANT SPECIES LIST
SEPTEMBER 2006

SCIENTIFIC NAME	COMMON NAME	STATUS
GYMNOSPERMS		
ARAUCARIACEAE		
Araucaria columnaris (G.Forst.) Hook.f.	Cook pine	X
PTERIDOPHYTES		
NEPHROLEPIDACEAE		
Nephrolepis multiflora (Roxb.) F.M. Jarrett ex C.V. Morton		X
LINDSAEACEAE		
Sphenomeris chinensis (L.) Maxon	Pala`a	I
POLYPODIACEAE		
Phymatosorus grossus (Langsd. & Fisch.) Brownlie	Laua`e	X
PSILOTACEAE		
Psilotum nudum (L.) P. Beauv.	Moa, upright whiskfern	I
THELYPTERIDACEAE		
Christella parasitica (L.) Lev.		X
MONOCOTS		
AGAVACEAE		
Cordyline fruticosa (L.) A.Chev.	Ti, ki	P
ALOEACEAE		
Aloe vera (L.) N.L.Burm.	Aloe	X
ARACEAE		
Dracaena sp. L.	dracaena	X
ARECACEAE		
Cocos nucifera L.	coconut	P
Phoenix dactylifera L.	Date palm	X
COMMELINACEAE		
Commelina diffusa Burm.f,	honohono	X

SCIENTIFIC NAME	COMMON NAME	STATUS
HELICONIACEAE		
Heliconia sp.	heliconia	X
IRIDACEAE		
Trimezia martinicensis (Jacq.) Herbert	Yellow iris	X
MUSACEAE		
Musa sp. L.	banana	P
ORCHIDACEAE		
Arundina graminifolia (D.Don) Hochr.	Bamboo orchid	X
Spathoglottis plicata Blume	Philippine ground orchid	X
PANDANACEAE		
Pandanus tectorius Parkinson ex Z	hala	I
POACEAE		
Andropogon virginicus L.	broomsedge	X
Cenchrus ciliaris L.	Buffelgrass	X
Chloris barbata (L.) Sw.	Swollen fingergrass	X
Cynodon dactylon (L.) Pers	manienie	X
Digitaria insularis (L.) Mez ex Ekman	sourgrass	X
Melinis minutiflora P.Beauv.	Molasses grass	X
Oplismenus hirtellus (L.) P.Beauv.	Basketgrass, honohono	X
Panicum maximum L.	Guinea grass	X
Paspalum conjugatum P.J.Bergius	Hilo grass	X
Setaria verticillata (L.) P.Beauv.	Bristly foxtail	X
DICOTS		
ANACARDIACEAE		
Mangifera indica L.	mango	X
Schinus terebinthifolius Raddi	Christmas berry	X
APIACEAE		
Centella asiatica (L.) Urb.	Asiatic pennywort	X
ARALIACEAE		
Schefflera actinophylla (Endl.) Harms	Octopus tree	X
ASTERACEAE		
Bidens pilosa L.	Spanish needle	X
Crassocephalum crepidioides (Benth.) S.Moore	crassocephalum	X
Emilia fosbergii Nicolson	Red pualele	X

SCIENTIFIC NAME	COMMON NAME	STATUS
ASTERACEAE (cont.)		
Pluchea carolinensis (Jacq.) G. Don	sourbush	X
Sphagneticola trilobata (L.) Pruski	wedelia	X
Synedrella nodiflora (L.) Gaertn.	nodeweed	X
Verbesina encelioides (Cav.) Benth. & Hook	Golden crown-beard	X
BIGNONIACEAE		
Spathodea campanulata P. Beauv.	African tulip	X
Tabebuia heterophylla (DC.) Britton	Pink tecoma	X
CARICACEAE		
Carica papaya L.	papaya	X
CASUARINACEAE		
Casuarina equisetifolia L.	ironwood	X
CLUSIACEAE		
Clusia rosea Jacq.	Autograph tree	X
CONVOLVULACEAE		
Ipomoea cairica (L.) Sweet	koali ai	X
Ipomoea obscura (L.) Ker Gawl.		X
Ipomoea triloba L.	Little bell	X
CUCURBITACEAE		
Coccinea grandis (L.) Voigt	Ivy gourd	X
Momordica charantia L.	Balsam pear	X
EUPHORBIACEAE		
Aleurites moluccana (L.) Willd.	kukui	P
Chamaesyce hypercifolia (L.) Millsp.	graceful spurge	X
Ricinus communis L.	Castor bean	X
FABACEAE		
Acacia confusa Merr.	Formosan koa	X
Acacia koa A.Gray	koa	E
Acacia farnesiana (L.) Willd.	Klu, aroma, kolu	X
Chamaecrista nictitans (L.) Moench	Partridge pea	X
Desmanthus pernambucanus (L.) Thell.	Slender mimosa	X
Desmodium tortuosum (Sw.) DC.	Florida beggarweed	X
Desmodium triflorum (L.) DC.	Tick clover	X
Falcataria moluccana (Miq.) Barenby & J.W.Grimes		X

SCIENTIFIC NAME	COMMON NAME	STATUS
FABACEAE (cont.)		
Indigofera hendecaphylla Jacq.	Creeping indigo	X
Indigofera suffritocosa Mill.	Iniko	X
Leucaena leucocephala (Lam.) de Wit	Koa haole	X
Mimosa pudica L. var. *unijuga* (Duchass. & Walp.) Griseb.	Sensitive plant	X
Mucuna gigantea (Willd.) DC. ssp. *gigantea* Ohashi & Tateishi	Sea bean, ka`e`e	I
Samanea saman (Jacq.) Merr.	monkeypod	X
Senna surattensis (Burm.f.) H.S.Irwin & Barneby	kolomona	X
Senna pendula (Humb. & Bonpl. ex Willd.) Kunth var. *advena* (Vogel) H.S.Irwin & Barneby		X
LAMIACEAE		
Hyptis pectinata (L.) Poit.	Comb hyptis	X
Leonotis nepetifolia (L.) R.Br.	Lion's ear	X
LAURACEAE		
Cinnamomum sp.	cinnamon	X
MALVACEAE		
Abutilon grandifolium (Willd.) Sweet	Hairy abutilon	X
Hibiscus tiliaceus L.	hau	P
Malvastrum coromandelianum (L.) Garcke	False mallow	X
Sida rhombifolia L.		X
MELASTOMATACEAAE		
Clidemia hirta (L.) D.Don. var. *hirta*	Koster's curse	X
Dissotis rotundifolia (Sm.) Triana		X
Melastoma septemnervium Lour.	melastoma	X
MORACEAE		
Ficus microcarpa L.f.	Chinese banyan	X
MYRSINACEAE		
Ardisia crenata Sims	Hilo holly	X
Ardisia elliptica Thunb.	Shoebutton ardisia	X
MYRTACEAE		
Psidium cattleianum Sabine	Strawberry guava	X
Psidium guajava L.	Common guava	X
Syzygium cumini (L.) Skeels	Java plum	X

SCIENTIFIC NAME	COMMON NAME	STATUS
PASSIFLORACEAE		
Passiflora edulis Sims	Passion fruit	X
Passiflora suberosa L.	Huehue haole	X
RUBIACEAE		
Paederia foetida L.	Maile pilau	X
Spermacoce assurgens Ruiz. & Pav.	buttonweed	X
SAPINDACEAE		
Filicium decipiens (Whit & Arn.) Thwaites	Fern tree	X
STERCULIACEAE		
Waltheria indica L.	`uhaloa	I
TILIACEAE		
Heliocarpus popayanensis Kunth	White moho	X
THYMELAEACEAE		
Wikstroemia oahuensis (A.Gray) Rock var. *oahuensis*	`akia	E
VERBENACEAE		
Citharexylum caudatum L.	fiddlewood	X
Lantana camara L.	lantana	X
Stachytarpheta jamaicensis (L.) Vahl	Jamaican vervain	X

ADDENDUM

HAWAII MEMORIAL PARK BOTANICAL SURVEY

LeGrande Biological Surveys Inc carried out a laua`e (*Phymatosorus grossus*) delineation survey at the proposed Hawaii Memorial Park Expansion Project site on August 23, 2008. The goal was to map populations of laua`e fern with a GPS unit, focusing in an area planned for a cultural sites preservation corridor. Populations of laua`e were mapped in the field by walking the outside margins of monotypic stands of laua`e and taking GPS points at regular intervals. Maps were created using the GPS data. (Attached as page 2)

Fig 1. Flowers of the ka`e`e vine.

The delineated laua`e populations are dominated by a thick canopy of monkeypod (*Samanea saman*), java plum (*Syzygium cumini*), and octopus trees (*Schefflera actinophylla*). Several liana species were observed growing up into the canopy of the forest including, ka`e`e or sea bean (*Mucuna gigantea*), passion fruit (*Passiflora edulis*), and maile pilau (*Paederia foetida*). Ka`e`e is an indigenous species with stunning yellowish-green flowers that grows on all of the main Hawaiian Islands. The population observed here is robust but is being smothered by both of the other introduced vine species mentioned (passion fruit and maile pilau).

Several bird's-nest ferns or `ekaha (*Asplenium nidus*) were observed growing as an epiphyte in monkeypod trees. This indigenous fern as well and an ornamental croton (*Codiaeum variegatum*) [introduced] and noni (*Morinda citrifolia*) [Polynesian introduction] were overlooked on the previous Hawaii Memorial Park Expansion plant survey.

The understory is dominated by laua`e fern and an alien grass species; basket grass (*Oplismenus hirtellus*).

Figure 2. View of typical laua`e population in mapped corridor.

A
B
C
D
E
F
A1
A2
A3
A4
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
B11
B12
B13
B14
B15
B16
B17
B18
B19
B20
B21
B22
B23
C1
C2
C3
C4
C5
C6
D1
D2
D3
D4
D5
D6
D7
D8
D9
E1
E2
E3
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E9
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E11
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E13
E14
E15
E16
E17
E18
E19
E20
E21
E22
E23
1 inch equals 100 feet

E. Avifaunal and Feral Mammal Field Survey

(Philip L. Bruner)

AVIFAUNAL AND FERAL MAMMAL FIELD SURVEY FOR THE HAWAIIAN MEMORIAL PARK EXPANSION AREA, KANEOHE, OAHU, HAWAII

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11 October 2006

INTRODUCTION

This report presents the findings of a two day (26,27 September 2006) field survey of lands involved in the proposed Hawaiian Memorial Park Expansion in Kaneohe, Oahu, Hawaii. In addition to the field data this report also notes pertinent published and unpublished sources of birds and mammals to provide a broader view of the potential species known from this region of Oahu. The two objectives of the field survey were to:

1- Document the birds and mammals presently found on or near the property.

2- Locate and examine all habitats on the site and note their importance, if any, for native and migratory birds.

SITE DESCRIPTION

The area proposed for the Hawaiian Memorial park Expansion is presently covered in second growth forest. Some native trees such as Ohia (*Metrosideros polymorpha*) can be found along the higher ridges. Rainfall in this area promotes a dense tangle of vegetation. The surrounding lands include the existing Hawaiian Memorial Park and Veterans Cemetery as well as residential property (Fig.1).

METHODS OF THE FIELD SURVEY

The survey was conducted by walking the site using existing trails and an old road bed. Observations were focused during early morning, late afternoon and early evening hours when birds and mammals were most active and observable. The entire property was investigated. All birds seen and heard were tallied. Census stations were established throughout the site and eight minute counts of all birds seen or heard at these stations were tallied (Fig.1). These data were used to estimate the relative abundance of each bird species on the property. Rare or infrequently seen species were tallied whenever they were observed. Data on mammals were obtained by visual observations only. No trapping of mammals was conducted. The duration and nature of the field survey did not warrant trapping. A Pettersson Elecktronik AB Ultrasound Detector D-100 was used on the evening of 27 September to listen for the echolocation calls of the endangered Hawaiian Hoary Bat (*Lasiurus cinereus semotus*). The weather during the survey period was mixed with both clear skies and brief rain showers. The winds were light which resulted in excellent conditions for detecting vocalizing birds.

Scientific and common (vernacular) names of birds and mammals referred to in this report follow the taxonomy of Pyle (2002) and Honacki et al. (1982). Plant names are those given by Pratt (1998).

RESULTS OF THE FIELD SURVEY

Native Land Birds:

No native land birds were recorded on the survey. The elevation and available habitat at this site are not suitable for most native land birds. The Hawaiian Owl or Pueo (*Asio flammeus sandwichensis*) is listed by the State of Hawaii as endangered on Oahu but not elsewhere in the State. They hunt in grasslands, agricultural fields and forests (Pratt et al. 1987, Hawaii Audubon Society 2005). This species might on rare occasion forage in this area. The Oahu Amakihi (*Hemignathus flavus*) is seen in similar habitat on Tantalus and Lyon Arboretum in Honolulu and may also occur at this site (Pratt 1996).

Native Waterbirds:

No native waterbirds were recorded nor were any expected on this property due to an absence of suitable wetland habitat.

Seabirds:

No seabirds were recorded on the survey. None would be expected to nest at this location due to the presence of ground predators and human disturbance. Some species on occasion may fly over the property.

Migratory Birds:

The only species of migratory shorebird observed on lawns adjacent to the site was the Pacific Golden-Plover or Kolea (*Pluvialis fulva*). This abundant wintering shorebird forages on lawns, pastures and in agricultural fields as well as along shorelines. Kolea have been extensively studied both here in Hawaii and on their wintering grounds in western Alaska (Johnson et al. 1981, 1989, 1993, 2001a, 2001b). Radio telemetry studies on plover caught at Hawaiian Memorial Park have yielded important insights into the timing and location of their spring migration routes back to western Alaska (Johnson et al. 1997, 2006). Kolea are not listed as threatened or endangered.

Introduced (Alien) Birds:

Fourteen species of alien birds were tallied on the survey. Table One gives their names and relative abundance. None of these species are listed as threatened or endangered. The array of alien birds at this location is typical of this type of habitat in Windward Oahu (Hawaii Audubon Society 2005; Bruner 1989, 1993, 1994).

Mammals:

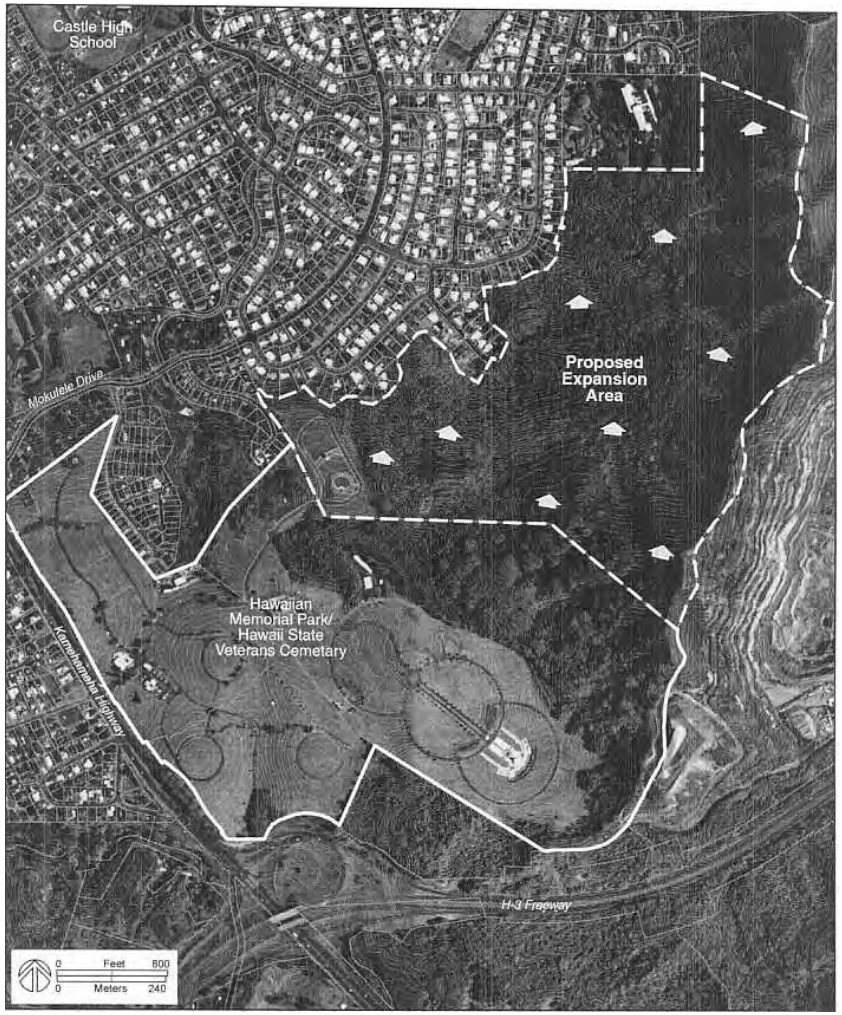
Eight cats (*Felis catus*), three Small Indian Mongoose (*Herpestes auropunctatus*), and four pigs (*Sus scrofa*) were observed over the duration of the survey. Pig tracks and areas rooted up by pigs were abundant throughout the site. Mice (*Mus musculus*) and rats

(*Rattus spp.*) undoubtedly occur on the site but were not observed. The native endangered Hawaiian Hoary Bat was not detected. This finding was not unexpected given the low numbers of bats reported to occur on Oahu (Tomich 1986, Kepler and Scott 1990). This species forages in a wide variety of habitats including: forests, agricultural lands, and urban areas. They are most abundant on Kauai and the Big Island. Jacobs (1991, 1993) and Reynolds et al. (1998) provide information on the occurrence and natural history of this species.

SUMMARY AND CONCLUSIONS

The purpose of this report was to present the findings of a bird and feral mammal field survey. No native land birds were recorded but the endangered Hawaiian Owl (Pueo) and the non-endangered Oahu Amakihi could on occasion forage at this site. No native waterbirds were recorded due to an absence of suitable habitat. No seabirds were seen. The migratory Kolea was observed on the lawn areas adjacent to the site. The array of alien birds recorded was typical of this region. No unusual species were recorded. The presence of feral mammals (cat, mongoose, pig) was expected at this site. The absence of the endangered Hawaiian Hoary Bat was not unexpected given the low numbers of bats reported to occur on Oahu. This second growth forest surrounded by developed property provides habitat for a variety of alien birds and mammals, none of

which are threatened or endangered. The clearing of this site and its subsequent conversion to lawn habitat will reduce the immediate, local populations of alien birds and mammals but will provide new foraging space for wintering Kolea (a migratory shorebird)



Aerial Photograph

Hawaiian Memorial Park Expansion
Kane'ohe, O'ahu

Fig. 1. Location of faunal survey. White arrows indicate approximate location of census stations.

TABLE 1

Relative abundance estimates: A=abundant (10+ on census stations; C=common (5-9 on census stations); U=uncommon (1-4 on census stations); R=recorded but not on census stations (number which follows is total found on the survey).

Common Name	Scientific name	Relative Abundance
Red Junglefowl	*Gallus gallus*	U
Spotted Dove	*Streptopelia chinensis*	A
Zebra Dove	*Geopelia striata*	C
Red-vented Bulbul	*Pycnonotus cafer*	A
Red-whiskered Bulbul	*Pycnonotus jocosus*	A
White-rumped Shama	*Copsychus malabaricus*	U
Red-billed Leiothrix	*Leiothrix lutea*	C
Japanese White-eye	*Zosterops japonicus*	A
Common Myna	*Acridotheres tristis*	C
Northern Cardinal	*Cardinalis cardinalis*	C
Red-crested Cardinal	*Paroaria coronata*	C
House Finch	*Carpodacus mexicanus*	A
House Sparrow	*Passer domesticus*	U
Java Sparrow	*Padda oryzivora*	R=16

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F. Survey of Native Invertebrate Resources

(Steven Lee Montgomery, Ph.D.)

Survey of Native Invertebrate Resources at site of future expansion of Hawaiian Memorial Park, Kāne'ohe, O'ahu

August 1, 2008

Prepared by:
Steven Lee Montgomery, Ph. D., Waipahu, Hawai'i

Submitted to:
Helber Hastert & Fee, Planners

For: Hawaiian Memorial Life Plan Ltd.

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SUMMARY

The Hawaiian Memorial Park Expansion, Kāne'ohe, O'ahu, project site sampled in this survey yielded predominantly adventive insect species, and four native arthropods. No native mollusks were observed. No invertebrate listed under either federal or state endangered species statutes was located within the survey area.

INTRODUCTION

This report summarizes the findings of an invertebrate[1] survey conducted at the site of the planned expansion of Hawaiian Memorial Park, Kāne'ohe, O'ahu (Figure 1). Hawaiian Memorial Life Plan Ltd. proposes a mixture of cemetery expansion, residential units, and preservation of historic sites on approximately 56.6 acres adjacent to the present Hawaiian Memorial Park. This survey was conducted by Steven Lee Montgomery, Ph. D., for Helber Hastert & Fee, Planners, Honolulu, Hawai'i.

The primary purpose of this survey was to determine the presence or absence on the property of any endemic or indigenous terrestrial invertebrates, especially any species with legal status under federal or state threatened and endangered species statutes (DLNR 1998, USFWS, 2008). Invertebrates are often dominant fauna in natural Hawaiian environments. Native Hawaiian plant, vertebrate, and invertebrate populations are interdependent. Invertebrates are the food of some birds and the pollinators of plants. Certain insects are obligatorily attached to specific host plants and are able to use only that plant as their food. Those insect - host relationships are ancient and intertwined. Native invertebrates have proven inventive in adapting to opportunities in changed ecosystems. A surprising number of native arthropod species survive even in degraded habitats. Nevertheless, the overall health of native Hawaiian invertebrate populations depends upon habitat quality and absence or low levels of predators introduced from the continents. Sufficient food sources, host plant availability, and the absence or low levels of introduced, continental predators and parasites comprise a classic native, healthy ecosystem. Consequently, where appropriate in the survey discussion, host plants, and some introduced arthropods are also noted.

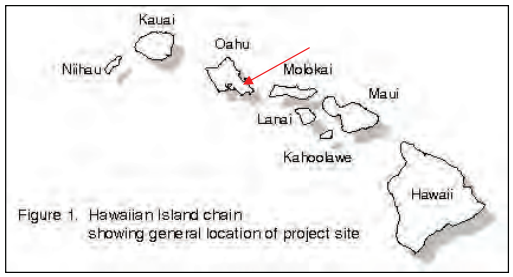


Figure 1. Hawaiian Island chain showing general location of project site

[1] Animals without backbones: insects, spiders, snails, shrimp, etc.

Figure 2: Typical sparse understory with alien canopy.

GENERAL SITE DESCRIPTION

The Hawaiian Memorial Park expansion site (HMPE) at Kāne'ohe, O'ahu, is a 56.6 acre (ac.) portion of a 164.4 ac. parcel TMK 4-5-33:001. The larger parcel is bound on the west by residential housing and a natural ridgeline on the east. A ridge separates the parcel from Kapa'a Quarry and the H-3 Freeway. Pohai Nani Good Samaritan Retirement Community is near the northern section of the proposed expansion. The south-southeastern boundary of the larger parcel is a steeply sloped, vegetated portion of the Hawaii State Veterans Cemetery.

The general area where the site is found has been through a variety of changes as first Polynesians, then Europeans adapted the area vegetation to their own needs. From early Hawaiian cultivation of crops and housing to rice cultivation and pineapple growing, feral grazing animals and formal cattle ranching (McCurdy and Hammatt 2008), the native vegetation - and native invertebrate population - was displaced by a succession of introduced plants or chewed and grubbed out by introduced mammals (Figure 2).

The parcel has been described by botanical consultants as a Lowland Alien Wet Forest where "with very few of the natural plant elements remaining… Feral pigs (*Sus scrofa*) continue to degrade the vegetation and understory plants by rooting, resulting in soil disturbance." (LeGrande 2006).

Figure 3

Although open, grassy areas (Figure 3) and large fields of fern (Figure 4) may seem pleasant to view, they are devoid of native Hawaiian plants to serve as hosts or shelter for native invertebrates.

Figure 4

Only two native Hawaiian plants were encountered: a small patch of 'uhaloa (*Waltheria indica*) (Figure 5) and a single 'ākia (*Wikstroemia* spp.) (Figure 6). Both species appear to be unpalatable to livestock, commonly surviving in pastures and being rejected by feral goats. Both were swamped by introduced species. See Figure 9 for location.

Figure 5: 'Uhaloa (*Waltheria indica*) may be protected from grazing by fuzzy leaves.

'

Figure 6: 'Ākia (*Wikstroemia* spp.)

Several introduced plants commonly substituted by native invertebrates for their native hosts, were not present. In comparison to less altered locations at similar elevations and with parallel rainfall, the introduced plants which remain provide very scant habitat for native invertebrates.

INVERTEBRATE SURVEY METHODS

Previous Surveys

Surveys for avian and mammalian (Bruner 2006) and botanical resources (LeGrande 2006) at the project area were very helpful in preparing for this study, but show no reference to previous invertebrate surveys nor did they note any invertebrate sightings during their surveys.

Fieldwork

Since 1968, I have taken part in field projects in environments similar to the project site, at other locations on the island of O'ahu, and throughout the island chain. Those experiences and the results of those surveys provided the basis for my study design and my analysis of results.

A field survey was conducted at the project site on July 26, 2008. I conducted a general assessment of terrain and habitats after reviewing maps and prior reports (above). Surveying efforts were conducted by day and night, a technique which is vital for a thorough survey. The property was traversed across all habitat types, alternately following established pathways to search for any native botanical resources and substitute host plant options for native invertebrates.

Collecting Methods

The following collecting methods for terrestrial invertebrates were used as appropriate to the terrain, botanical resources, and target species.

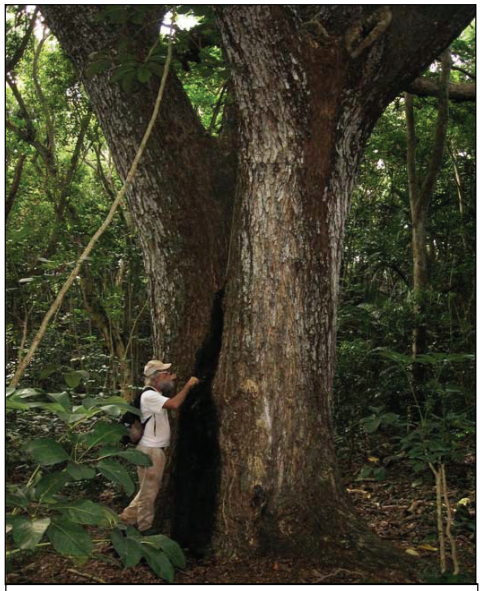


Figure 7: Monkeypod tree flux examined for *Drosophila*

Host plant searches: Host plants, both native and introduced, were sampled for arthropods that feed or rest on plants. Searches included visual inspection of resting sites and searching known feeding or breeding sites such as under dead bark.

A large Monkeypod tree sap exudate or flux was examined as a possible breeding site of *Drosophila* (Figure 7). Some native *Drosophila* flies are known to lay eggs only in sap fluxes where sweet, fermenting plant sap slowly leaks from a wound. Fermented by yeasts, the sap is made into a rich food for larval flies. Some introduced tree sap "tastes" enough like the native sap to entice some native flies to lay eggs at this resource when populations of the fly remain. This flux appeared devoid of larvae, even of *D. carbonaria*, which is known from Kailua since the 1990s. The flux is not a threat to the tree.

Sweep nets: This is a general method of censusing most flying and perching insects. A fine mesh net was swept across plants, leaf litter, etc. to sample any flying or perching insects. Transfer from the net was either by aspiration, or by placing the net contents into a holding container.

Visual observation: At all times, I was vigilant for any visual evidence of arthropod presence or activity. Visual observations provide valuable evidence and are a cross check that extends the reach of sampling techniques. Visual observation also included turning over rocks, dead wood, and other debris.

Light sampling: A survey of insects active at night is vital to a complete record of the fauna. Many insects are active only at night to evade birds, avoid desiccation and high temperatures, or to use night food sources, such as night opening flowers. Light sampling uses a bright light in front of a white cloth sheet. (Figure 8) Night active insects seem to mistake the collecting light for the light of the moon, which they use to orient themselves. In attempting to navigate by the entomologist's light, confused insects are drawn to circle the light and land on the cloth in confusion. This type of collecting is most successful during the dark phase of the moon, or under clouds blocking starlight. On level sites vegetation usually blocks the light from being seen over long distances, and moths and other night fliers are not drawn from distant locations outside the survey area.

Figure 8 : Light assists in surveying arthropods

The location for my light was chosen based on experience, potential host plant proximity, and terrain (Figure 9). Screening vegetation meant that the nearby housing areas contributed little competing light. The primary light source was a Mercury Vapor bulb. The sheet was monitored and visiting species observed. Light surveying was conducted for 4 hours in a location very near the only native plants seen during the survey.

Survey Limitations / Conditions

My ability to form advisory opinions is limited or influenced in the following ways:

Collecting conditions:

Weather: Weather was favorable for surveying during the entire field day with patchy clouds and light breezes during night light monitoring.

Seasons: Monitoring at a different time of the year might produce a longer or different arthropod list. Weather and seasonal vegetation changes play an especially important role in any survey of invertebrates. Many arthropods time their emergence and breeding to overlap or follow seasonal weather or to coincide with growth spurts of an important plant food. Host plant presence/absence, and seasonal changes, especially plant growth after heavy rains, affect the species collected. Given the short inventory of native plants at this site, seasonal factors are not an important factor in this instance.

Summer 2008 has seen several short rain events which put the vegetation in a better than normal summer condition to act as host to invertebrates. The low level of native plants found at the site, however, was a stronger factor in determining the invertebrates encountered.

Moon: The moon presented no competition to the collecting light. On July 26, 2008, the moon set at 1:54 p.m..[2] and did not rise again until July 27, 2008, 1:03 a.m. (USNO)

Limited duration:

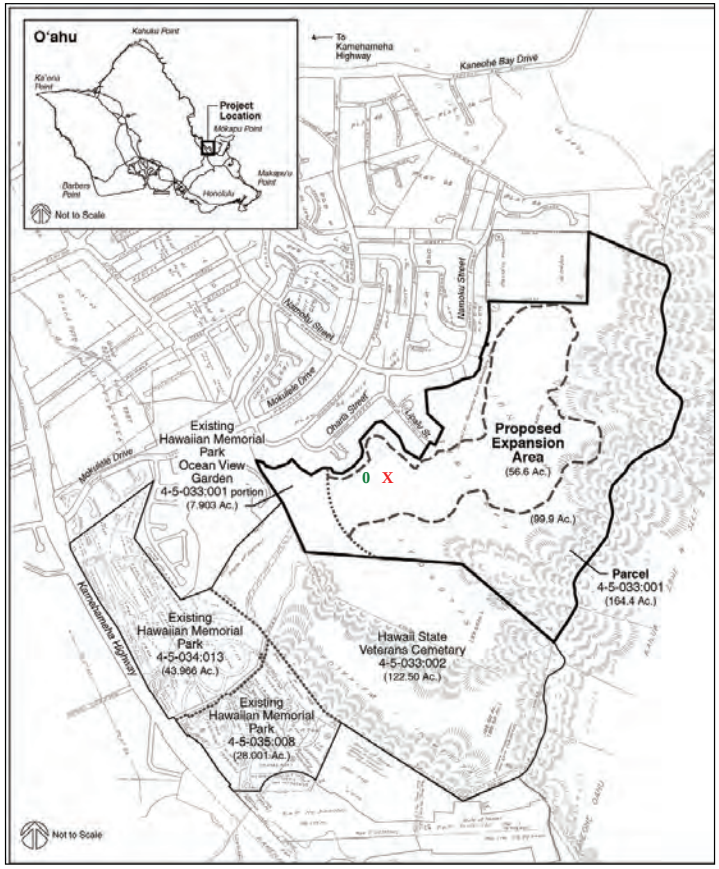
Surveying for a longer period of time might enlarge the list of species; however, given the size of the property, I believe the survey provides an adequate review of the property's resident native invertebrates. (See below: Invertebrates not present, page 12, for exceptions)

Physical limitations: The size of the property allowed the survey to cover the area adequately. The overall study strategy and light survey site selections were designed to achieve this aim. The resulting survey was representative and targeted in favor of locating and examining the few native host plants.

Selectivity: My survey was focused on finding any endemic and indigenous Hawaiian species. No attempt was made to collect or completely document the many common alien arthropod species present in the area.

[2] Times given are for Kāne'ohe, Honolulu County, Hawai'i (longitude W157.8, latitude N21.4).

Figure 9. Map of O'ahu project site and light survey location



X = site of night light monitoring
0 = general location of two native plants

From "Hawaiian Memorial Park Cemetery Expansion Environmental Impact Statement Prep Notice", Figure 2

INVERTEBRATE SURVEY RESULTS:

This discussion focuses on three native species encountered, on species that affect native invertebrate survival, and on adventive species of concern in human health.

ARTHROPODA: INSECTA

HEMIPTERA: HETEROPTERA (True bugs)

Miridae (Leaf bugs): ***Trigonotylus hawaiiensis***

This endemic bug, *Trigonotylus hawaiiensis* (Kirkaldy), 1902, is known from all the major islands, Laysan, and Nihoa. It is known from sea level to 5000 ft. and is widespread on O'ahu. It feeds on both native and alien grasses. (Zimmerman 1948)

LEPIDOPTERA (butterflies and moths)

Cosmopterigidae: ***Hyposmocoma*** sp.

Figure 10: *Hyposmocoma* sp.
Photo# starr-030724-0089
credit: "Forest & Kim Starr" (HEAR)

Adult *Hyposmocoma* or case bearer moths responded to the light survey. *Hyposmocoma* are called "case bearers" because after an early beginning inside a leaf curl or similar hiding place, the caterpillars create protection in an intricately constructed portable shell of their own silk. For camouflage, they add bits of their surroundings to the case using silk: snips of dry grass or leaves, flakes of bark, maybe a little dirt. The case is then easily mistaken by a predator as another part of their inedible landscape. These bunkers are fitted with a hinged lid (operculum), pulled shut by mandibles to defend them from enemies. Their relationship to the case is similar to that of a hermit crab to his shell. They are dependent on their case, and die if removed – even if protected from predators and given food. They don't move far, but feed while partly emerged from the case, dragging along their protective armor by their six true legs. Cases are sometimes attached to rocks or tree trunks and foliage. (Manning/Montgomery in Liittschwager & Middleton 2001) With over 500 kinds, *Hyposmocoma* micromoths are the greatest assemblage of Hawaiian Island moths, showing astonishing diversity. After writing 630 pages on them, Dr. Elwood Zimmerman lamented the inadequacy of his study. He noted an enormous cluster of species with explosive speciation and diverging radiation (Zimmerman 1978). Much remains to be learned about the life ways of this interesting group of insects now under study by University of Hawaii's Daniel Rubinoff and his graduate students (Rubinoff & Haines 2006).

Crambidae: ***Eudonia*** sp. (Moss moths)

There are 15 *Eudonia* species known from O'ahu, all Hawaiian endemics. Several O'ahu species are also known from other islands. None are considered rare, endangered, or threatened. Some species have been reared from moss where they build silken tunnels of protection in which to feed (Swezey 1910), but for many species the host plant is not recorded yet. (HBS 2002a, HOSTS, Zimmerman 1958)

Figure 11: *Mestolobes* sp.
Photo# starr-030825-0008
credit: "Forest & Kim Starr" (HEAR)

Crambidae: ***Mestolobes*** species (likely *minuscula*)

The commonest of the small moths or micro-moths, *Mestolobes* (Figure 11), responded to our light survey. It is known from every major island. Although a large genus of over 30 species, 10 known from O'ahu, it has not been studied in depth despite a 1906 plea to study its habits by R. C. L. Perkins (1907). It has been collected while visiting flowers for nectar diurnally and when responding to light. *Mestolobes* was reported to "often fly actively in cane fields" (Williams 1931). In the 1800s it was reported to fly in small groups and was seen at lower elevations (Perkins 1913). The host plant of this endemic is not certain. There is one record of one larvae reared from a host - the roots of sugar cane on O'ahu in 1930, yet it was never considered even a minor pest (Swezey 1931.) (HBS 2002a, HOSTS, Zimmerman 1958)

HYMENOPTERA (wasps, bees, ants)

Figure 13: Glaber ants were seen running trails on tree trunks

Formicidae: **Glaber ant**

Ochetellus glaber, a small black adventive ant, the Glaber ant, was seen on the property, but in much smaller numbers than the longlegged ant (see below). *O. glaber* seemed to occupy a different distribution from that used by the longlegged ant although it exhibited the same tree trail forming behavior. It may be nesting in dry wood and in old termite holes and should be naturally controlled by site clearing activity. It is known from all major islands (HBS 2002a). Both sweet and protein (i.e., native insects) are attractive foods. One authority states the ant "bites fiercely" (Tenorio and Nishida 1995). Use caution around nests in hollow stems and when near active ant trails.

Formicidae (ants): **Longlegged Ant**

The longlegged ant (*Anoplolepis gracilipes*) was seen on the property in great numbers. Nearly every tree had a column of these polyphagous ants marching up and down the trunk (Figure 12). Similarly, many areas on the ground were heavily patrolled. Alien ants are known to prey on other insects (Zimmerman 1948-80) and are well documented as a cause of low levels of native arthropods, especially in elevations up to 2000 ft. (Perkins 1913). Longlegged and bigheaded ants (*Pheidole megacephala*) do not seem to overlap in distribution. Rather they maintain separate territories, effectively apportioning the hunting grounds between themselves, offering few ant-free zones to native arthropods. Indeed, during daylight hours in the areas heavily infested with these predators, our travel through areas of dense vegetation created few of the typical flights or jumps of startled insects.

Figure 12: Longlegged ants were seen running up and down many trees on the property.

INVERTEBRATES NOT PRESENT:

Plant and invertebrate populations are interdependent; consequently, host plant availability is one way to review invertebrate health. As discussed in the botanical survey (LeGrande 2006) and archaeology report (McCurdy and Hammatt 2008), the area has a long history of human use, Hawaiian agriculture, rice and pineapple production, cattle ranching and coffee cultivation, with feral pigs currently present, all removed native plants. The resulting extremely low level of native plants serving as arthropod hosts leads to the absence of Hawaiian arthropods at this site.

Species not found

Any survey for federally protected species should include consideration of all native invertebrates (snails, spiders, and insects). A review of the archaeological survey of the area (McCurdy and Hammatt 2008) indicated no lava tubes at the project site which could support cave-adapted invertebrate species.

MOLLUSCA:

No native mollusks were observed during this survey.

Gastropoda Pulmonata

Achatinellidae: **Achatinella**

O'ahu does have protected snail species, the Oahu tree snails, but the flora, probable rats (Bruner 2006), and other factors now make this property unsuitable habitat for the native Hawaiian endemic snails listed as endangered.

LEPIDOPTERA

Sphingidae: *Manduca blackburni*

The Blackburn's sphinx moth[3] (Manduca blackburni), an endangered species (Fed Reg 1999-2000) was not found in this survey. Historically, the moth is known from drier locations and the critical habitat established for the moth on O'ahu is many miles distant from this property. Neither the moth's solanaceous native host plant, 'aiea (Nothocestrum sp.), nor the best alien host, tree tobacco (Nicotiana glauca), ever were observed on the property. In the project botanical survey (LeGrande 2006), no solanaceous plants, several of which can serve as hosts, were recorded.

DIPTERA

Drosophilidae: *Drosophila*

No native *Drosophila* were observed on the property. The property is now unsuitable habitat for the endemic *Drosophila* recently listed as endangered or threatened. These native Hawaiian picture wing flies require a much more native environment with host flora not offered at this property. (*Federal Register* 2006a, b). The location does not provide appropriate habitat now for any of the native *Drosophila* species

MEDICALLY IMPORTANT SPECIES

SEE Glaber ant on page 12

Centipedes, scorpions, black or brown widow spiders:

The piles of dead brush and the defensive structures built by the paint balling trespassers are classic habitat for centipedes, scorpions, black or brown widow spiders. Although these medically important species were not seen in this quick survey, they may be present in the area. Surveyors, crews clearing debris, etc should be alert for all these species which may pose a serious risk to some individuals. When moving stones or piled brush, wearing

[3] Blackburn hawk moth is the official common name recognized by the HES Committee on Common Names of Insects (1990). Blackburn's sphinx moth has come into popular usage.

gloves, covered shoes, long sleeves, and long pants will greatly reduce the risk of accidental contact and bites. Supervisors should be aware of any allergy by employees. Some individuals can experience anaphylactic reactions to venom of any of the mentioned arthropods, not just bees. Please see *What Bit Me?* (Nishida and Tenorio 1993) for additional information.

COLEOPTERA: Oedemeridae

Ananca bicolor (Fairmaire) 1849, or red-black false blister beetles responded to our light survey. The species is known from several major islands, including Oahu, and Midway. The beetles are attracted to lights, but also feed on flower pollen by day. When irritated or pressed (between clothing and skin, for example) they ooze a defensive irritating chemical causing blistering of skin. The susceptibility to blistering is reported to vary as do healing rates. Although irritating, uncomfortable, and very unpleasant, the blisters are not life threatening. Seek medical attention if blistering is widespread or does not heal promptly.

Figure 14: Red-black false blister beetle

See "*What's Bugging Me?*" (Tenorio and Nishida 1995) or for detailed discussion see University of Florida / Florida Dept. of Agriculture web site http://creatures.ifas.ufl.edu/urban/medical/blister_beetles.htm (Arnett 2008).

POTENTIAL IMPACTS

Potential Impacts on Native, Rare, Federally or State Listed Species

No federally or state listed endangered or threatened invertebrate species was found in this survey. No rare native Hawaiian invertebrate species were observed. The few native Hawaiian invertebrates observed are widespread in distribution. No anticipated actions related to the proposed project in the surveyed location will have a significant negative impact on an endemic or indigenous species. No part of the property is designated critical habitat for any threatened or endangered species.

RECOMMENDATIONS

Landscape with native plants:

The botanical survey recommended landscaping with native plants during the project (LeGrande 2006). In addition to their beauty and the positive cultural and social values communicated by the use of native plants, these plants would provide habitat for native arthropods while creating a more interesting area for walking and contemplation. Native plants will remain green and thus more fire resistant throughout the summer. Native plantings may have lower human maintenance costs when chosen to fit area needs. As native plants tend to reach a predicable height and foliage spread, well chosen plantings usually mean less hedge trimming and weed whacking. In the areas to be left without development or used to screen the HMP expansion from housing and traffic, native plants in a mix of ground cover, shrub, and tree heights will help slow run off and retain moisture when rains come while holding soil at very low on-going cost. The plantings will provide educational, visual, and aesthetic benefits to residents in the planned residential units as well. Native insects such as *Mestolobes* and other creatures will find this refuge over time.

With prior arrangement, native plants can be as convenient for mass plantings as the introduced plants commonly used to re-vegetate after new construction. A list of suppliers of native plants (see page 3 for O'ahu) is available at

http://hbs.bishopmuseum.org/botany/riparian/pdf/propagators.pdf

ACKNOWLEDGMENTS

Steven Lee Montgomery conducted all collecting and is responsible for all conclusions. Anita Manning assisted in the field and contributed to preparation of this report.

STANDARD NOMENCLATURE

Invertebrate names follow
Freshwater & Terrestrial Mollusk Checklist (HBS 2002b)
Common Names of Insects & Related Organisms (HES 1990)
Hawaiian Terrestrial Arthropod Checklist (HBS2002a; Nishida 2002)

Plant names follow
Manual of the Flowering Plants of Hawai'i (Wagner et al. 1999)
A Tropical Garden Flora (Staples and Herbst 2005)

Mammal names follow *Mammals in Hawai'i* (Tomich 1986).

Place name spelling follows *Place Names of Hawaii* (Pukui et al. 1976).

ABBREVIATIONS

DLNR Department of Land and Natural Resources, State of Hawai'i

HBS Hawai'i Biological Survey

n. new

sp. species

spp. more than one species

USFWS United States Fish and Wildlife Service

GLOSSARY[4]

Adventive: organisms introduced to an area but not purposefully.

Alien: occurring in the locality it occupies ONLY with human assistance, accidental or purposeful; not native. Both Polynesian introductions (e.g., coconut) and post-1778 introductions (e.g., guava, goats, and sheep) are aliens.

Arthropod: insects and related invertebrates (e.g., spiders) having an external skeleton and jointed legs.

Diurnal: active in the daylight hours

Endemic: naturally occurring, without human transport, ONLY in the locality occupied. Hawaii has a high percentage of endemic plants and animals, some in very small microenvironments.

Indigenous: naturally occurring without human assistance in the locality it occupies; may also occur elsewhere, including outside the Hawaiian Islands. (e.g., Naupaka kahakai (*Scaevola sericea*) is the same plant in Hawai'i and throughout the Pacific).

Insects: arthropods with six legs, and bodies in 3 sections

Invertebrates: animals without backbones (insects, spiders, snails / slugs, shrimp)

Larva/larval: an immature stage of development in offspring of many types of animals.

Mollusk: invertebrates in the phylum Mollusca. Common representatives are snails, slugs, mussels, clams, oysters, squids, and octopuses.

Native: organism that originated in area where it lives without human assistance. May be indigenous or endemic.

Naturalized: an alien organism that, with time, yet without further human assisted releases or plantings, has become established in an area to which it is not native.

Nocturnal: active or most apparent at night.

Pupa: the stage between larva and adult in insects with complete metamorphosis, a non-feeding and inactive stage often inside a case

Purposefully introduced: an organism brought into an area for a specific purpose, for example, as a biological control agent.

Polyphagous: eating many different types of food

Rare: threatened by extinction and low numbers.

Species: all individuals and populations of a particular type of organism, maintained by biological mechanisms that result in their breeding mostly with their kind.

4 Glossary based largely on definitions in *Biological Science: An Ecological Approach*, 7th ed., Kendall/Hunt Publishing Co., Dubuque, a high school text; on the glossary in *Manual of Flowering Plants of Hawai'i*, Vol.2, Wagner, et al., 1999, Bishop Museum Press, and other sources.

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G. Archaeological Inventory Survey

(Cultural Surveys Hawai‘i, Inc.)

LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

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CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

September 22, 2008

David Shideler
Cultural Surveys Hawai`i, Inc.
P.O. Box 1114
Kailua Hawai`i 96734

LOG NO: 2008.1594
DOC NO: 0807LM12
Archaeology

Dear Mr. Shideler:

SUBJECT: Chapter 6E-42 Historic Preservation Review –
Archaeological Inventory Survey for the Hawaiian Memorial Park Expansion
Kāne`ohe Ahupua'a, Ko`olaupoko District, Island of O'ahu
TMK: (1) 4-5-033:001

Thank you for the opportunity to review the aforementioned archaeological inventory survey report (McCurdy and Hammatt, 2008), which we received on April 28, 2008. We apologize for the delay in our review. The survey was performed in advance of proposed development of the parcel. The proposed development includes new burial internment areas, automobile circulation and a residential subdivision. The land alteration associated with the proposed development would include grubbing and grading, excavations associated with the installation of sub-surface utilities and landscaping.

The survey documented the presence of 11 historic properties within or adjacent to the petition area. Six of these sites were previously recorded, SIHP 50-80-10-354, 4680, 4681, 4683, 4684, and 4686, the remaining 5 sites, SIHP 50-80-10-6929, 6930, 6931, 6932 and 6933, are new discoveries. Seven of the sites are located within the petition area, SIHP 4680, 4683, 4684, 4686, 6930, 6932 and 6933. Four sites are located outside the petition area SIHP 354, 4681, 6929 and 6931 but are directly adjacent to the petition area and mitigation actions for the protection of these sites should be considered. One previously identified site, SIHP 4682, was determined to be non-cultural and eliminated from the study.

At this time we do not concur with the proposed mitigation recommendations suggested in the report. We believe that several of the sites identified, SIHP 354, 4684, 6939, 6932 and 6931, should be preserved as a complex, not individually. If the survey did not provide a reasonable association of the sites then provide justification as to why the sites should not be preserved as a complex. We do not concur with the proposed relocation of the grinding stone. The location of the feature provides for the integrity of the site complex as a whole.

Additionally per Hawai`i Administrative Rules (HAR) Chapter 13-276-5(g) 'the report shall contain information on the consultation process with individuals knowledgeable about the project areas history, if discussions with the SHPD, background research or public input indicate a need to consult with knowledgeable individuals'. "Consultation process'" as defined by HAR 'means notifying interested organizations and individuals that a project could affect historic properties of interest to them; seeking their views on the identification, significance evaluation, and mitigation treatment of these properties; and considering their views in a god faith and appropriate manner during the review process' (emphasis added). As several of the sites, in particular the complex including Sites 354, 4684, 6939, 6932 and 6931,

are significant under Criteria E consultation with the Hawaiian community is an integral part of the mitigation process. It has come to our attention from members of the group partaking in stewardship of Kawa`ewa`e Heiau that they have not been informed of or consulted about the findings of the Archaeological Inventory Survey. Additionally at the August 13, 2008 O`ahu Island Burial Council Meeting, members of the council requested a joint site visit of the sites identified during the survey.

Additionally HAR Chapter 13-284-6(5)c states that 'Prior to submission of significance evaluations for properties other than architectural properties, the agency shall consult with ethnic organizations or members of the ethnic group for whom some of the historic properties may have significance under criterion "e", to seek their views on the significance evaluations. For Native Hawaiian properties which may have significance under criterion "e", the Office of Hawaiian Affairs (OHA) also shall be consulted'. HAR also requires consultation under 284-8 (2) for properties evaluated under Criterion "e" relating to the proposed forms 'mitigation', OHA also shall be consulted. Please provide the relevant consultation from OHA in the report.

At this time Section 2.4 of the report does not contain accurate or sufficient information on the consultation process. The Cultural Impact Assessment (Gollin et al 2008) referenced contains information relevant to mitigation, however as the CIA occurred prior to the AIS no relevant consultation relating to the newly identified sites has been conducted. The information that concerns the identification and preservation recommendations for the historic properties identified in the survey should be presented in this and other appropriate sections of the inventory survey report.

At this time the inventory survey cannot be accepted as satisfying the requirements of HAR Chapter 13-276(5). SHPD has additional concerns relating to sufficient testing, or lack thereof. The methodology of testing should also be proposed during the consultation process and may be considered as a second phase of the inventory survey once more concrete details related to development impacts are available. As the consultation undertaken for the CIA (Gollin 2008) states that a number of cultural experts believe that there are 'a significant number of `iwi kūpuna (ancestral remains) contained within the project area' we believe that consultation in regards to the nature of and need for testing must be conducted. This level of testing will depend on the alternate selected by Hawaiian Memorial Park as outlined in the DEIS. Alternatives with little or no land disturbing activity will require appropriate amounts of testing in impacted areas. This level of testing will be determined via communication with SHPD once relevant details are made available by the project proponent and through the consultation process.

We do not concur with the significance evaluations. We believe that you should re-evaluate the sites, in particular SIHP 354, 4684, 6939, 6932 and 6931, as a complex and consider applying criterion "a", "b", "c", "d" and "e". Kawa`ewa`e Heiau and the associated complex have legendary associations with Kamapua`a. Additionally Kawa`ewa`e was reportedly constructed by Olopana, an ali`i who came to power during a period of expansion and social/political change in Hawaiian history, during the 12th century (Thrum 1906). These evaluations should be discussed as well during the consultation process.

Please contact Lauren Morawski (O'ahu Archaeologist) at (808) 692-8015 if you have any questions or concerns regarding this letter.

Aloha,

Nancy McMahon, Archaeology and Historic Preservation Manager
State Historic Preservation Division

LM

Archaeological Inventory Survey for the Hawaiian Memorial Park Expansion, Kāneʻohe Ahupuaʻa, Koʻolaupoko District, Island of Oʻahu

(TMK: [1] 4-05-033:001)

Prepared for

Helber, Hastert & Fee Planners

Prepared by

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and

Hallett H. Hammatt, Ph.D.

Cultural Surveys Hawaiʻi, Inc.

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(Job Code: KANEO 2)

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Management Summary

Reference	Archaeological Inventory Survey for the Hawaiian Memorial Park Expansion, Kāneʻohe Ahupuaʻa, Koʻolaupoko District, Island of Oʻahu TMK: [1] 4-05-033:001 (McCurdy and Hammatt 2008)
Date	January 2008
Project Number (s)	Cultural Surveys Hawaiʻi (CSH) Job Code: KANEO 2
Investigation Permit Number	Cultural Surveys Hawaiʻi, Inc. (CSH) completed the fieldwork component of the archaeological inventory survey under Hawaiʻi State Historic Preservation Division (SHPD) permit No. 07-19, per Hawaiʻi Administrative Rules (HAR) Chapter 13-13-282.
Project Location	The CSH project area is bordered on its *mauka* extent by the Hawaiian Memorial Park, and extends *makai* to the Pohai Nani Retirement Community, from the south and east by Kapaʻa Ridge, and the northwest by a housing development and Namoku Street. This project area is depicted on USGS 7.5 minute topographic quadrangle Kaneohe, HI (1998).
Land Jurisdiction	Private, Hawaiian Memorial Life Plan LTD
Agencies	State Historic Preservation Division
Project Description	Proposed development within the petition area is described as new burial areas, automobile circulation and a residential subdivision. Minimally, the land alteration would include surface grubbing and grading, excavations associated with the installation of sub-surface utilities, housing construction and landscaping.
Project Acreage	The CSH project area consisted of approximately 66 acres. The petition area, located within the project area is approximately 56.6 Acres
Area of Potential Effect (APE) and Survey Acreage	The APE is defined as the entire CSH project area, approximately 66 acres.
Historic Preservation Regulatory Context	At the request of Helber, Hastert & Fee Planners, CSH conducted this archaeological inventory survey. In consultation with SHPD, the inventory survey investigation was designed to fulfill the State requirements for an archaeological inventory survey per HAR Chapter 13-13-276 and Chapter 13-13-284.

Fieldwork Effort	The Fieldwork portion of this Archaeological Inventory Survey was carried out from October 17, 2006 to December 5, 2006 and from September 20, 2007 to October 10, 2007. The alternating CSH field crew consisted of David Shideler, M.A., Doug Borthwick, B.A., Todd D. McCurdy, M.A., Jon Tulchin, B.A., Nifae Hunkin, B.A., Matt Bell, B.A., Sean Barns, M.A., Lisa Gollin, Ph. D, Kulani Jones, B.S., Jennifer Olson, B.A., Sean Naleimaile, B.A., Auli‘i Mitchell, B.A., Kevin Dalton, B.A., and Kelly Uyeoka, B.A., under the general supervision of Hallett H. Hammatt, Ph.D. The field required approximately 62 person-days to complete. Fieldwork consisted of a 100% coverage pedestrian inspection of the project area and limited subsurface testing at select archaeological sites.
Number of Historic Properties Identified	A total of 11 historic properties were observed within or near the petition area. Six of these were previously recorded, SIHP #s 50-80-10-354, 50-80-10-4680, 50-80-10-4681, 50-80-10-4683, 50-80-10-4684 and 50-80-10-4686. The remaining five are new discoveries, SIHP #s 50-80-10-6929, 50-80-10-6930, 50-80-10-6931, 50-80-10-6932, and 50-80-10-6933. Seven of the historic properties are located within the petition area. They include, SIHP #s -4680, -4683,-4684,-4686, -6930, 6932 and 6933. Four of the properties (SIHP-354, -4681 -6929, and -6931) are located outside of the current petition area but close enough for consideration. Of these sites, six are considered pre-Contact and five historic. In addition SIHP # 50-80-10-4682, previously recorded by Szabian et al (1989), located in the vicinity of the petition area was determined to be non-Cultural in nature and therefore is not considered a historic property.
Historic Properties Within the Petition Area Recommended Eligible to the Hawai‘i Register of Historic Places (Hawai‘i Register)	Seven historic properties identified within the petition area are recommended eligible to the Hawai‘i Register: SIHP # 50-80-10-4680, a historic era terrace mound, has been evaluated as significant under Criterion D of the Hawai‘i Register of Historic Places. SIHP# s 50-80-10-4683 a historic era charcoal kiln, has been evaluated as significant under Criterion D of the Hawai‘i Register of Historic Places. SIHP # 50-80-10-4684, pre-contact habitation site consisting of a house structure, and terraces, has been evaluated as significant under Criterion D of the Hawai‘i Register of Historic Places.

	SIHP # 50-80-10-4686, a historic era rock alignment, has been evaluated as significant under Criterion D of the Hawai‘i Register of Historic Places. SIHP # 50-80-10-6930, a pre-Contact enclosure/potential ceremonial structure consisting of a rectangular shaped enclosure with an irregular notch in the east wall has been evaluated as significant under both Criterion D and E of the Hawai‘i Register of Historic Places. SIHP# 50-80-10-6932, a possible historic era storage area, has been evaluated as significant under Criterion D of the Hawai‘i Register of Historic Places. SIHP# 50-80-10-6933, a historic era charcoal kiln with an associated stone wall, has been evaluated as significant under Criterion D of the Hawai‘i Register of Historic Places.
Historic Properties in the Vicinity of the Petition Area Recommended Eligible to the Hawai‘i Register of Historic Places (Hawai‘i Register)	Four historic properties identified in the vicinity of the petition area are recommended eligible to the Hawai‘i Register: SIHP 50-80-10-354, Kawa‘ewa‘e Heiau, is located approximately 30 m (100 ft) west, outside of the current petition area on the Kaneohe side of the ridge that divides Kaneohe and Kailua (Oneawa Hills). It has been on the National Register of Historic Places (NHRP) since 1972. SIHP 50-80-10-354 has been evaluated as significant under both Criterion D and E of the Hawai‘i Register of Historic Places. SIHP# 50-80-10-4681, located approximately 15m (50 ft) southwest of the current petition area is a pre-Contact habitation site consisting of several c-shaped structures, a terrace wall and a circular rock feature has been evaluated as significant under Criterion D of the Hawai‘i Register of Historic Places. SIHP# 50-80-10-6929 is a pre-Contact site consisting of two concentrations of lithic debitage along an intermittent drainage approximately 20 m (66 ft) east of the project area. SIHP# 50-80-10-6929 has been evaluated as significant under Criterion D of the Hawai‘i Register of Historic Places. SIHP# 50-80-10-6931 located approximately 15m (50 ft) south of the current petition area is a possible pre-Contact ceremonial area. SIHP# 50-80-10-6931 has been evaluated as significant under both Criterion D and E of the Hawai‘i Register of Historic Places.

Project Effect	The archaeological inventory survey for the Hawaiian Memorial Park Expansion project identified eleven historic properties within or near the survey area that will likely, or potentially, be affected by the proposed project. They include SIHP #s 50-80-10-354, 50-80-10-4680, 50-80-10-4681, 50-80-10-4683, 50-80-10-4684, 50-80-10-4686, 50-80-10-6929, 50-80-10-6930, 50-80-10-6931, 50-80-10-6932, and 50-80-10-6933
Mitigation Recommendations for Historic Properties Located Within the Petition Area	Recommendations for the seven historic properties identified within the petition area include: SIHP# s 50-80-10-4680, -4686 and -6932 have been thoroughly documented with written descriptions, photographs, scale drawings, and recorded with GPS survey equipment. No further work is recommended for these as sufficient information regarding location, function, age, and construction methods of these historic properties has been generated by the current inventory survey investigation to mitigate any adverse effect caused by proposed development activities. SIHP# s 50-80-10-4683 and -6933 are historic charcoal kilns. No further work is recommended for these historic properties. Sufficient information regarding the location, function, age, and construction methods of these historic properties has been generated by the current inventory survey and other investigations (Meeker 1995, Dockall et al. 2003, and Allen 1987), to mitigate any adverse effect caused by proposed development activities. SIHP# 50-80-10-4684 is a pre-Contact habitation site . Preservation, in the form of avoidance and protection, is recommended for the SIHP # 50-80-10-4684. Additionally, a large grinding stone was discovered approximately 40 m south of SIHP# 50-80-10-4684. In the absence of any other cultural material and considering that it is a good example of its type, moving it within the preservation boundary for SIHP# 50-80-10-4684 is recommended. SIHP# 50-80-10-6930 is a pre-Contact enclosure/potential ceremonial structure. Preservation, in the form of avoidance and protection, is recommended for the SIHP # 50-80-10-6930.

Mitigation Recommendations for Historic Properties Located in the Vicinity of the Petition Area	Recommendations for the four historic properties identified in the vicinity of the petition area include: SIHP 50-80-10-354, Kawa‘ewa‘a Heiau, is located approximately 30 m (100 ft) west, outside of the current petition area. It has been on the National Register of Historic Places (NHRP) since 1972 and is maintained by the several concerned groups. The client has established a 100 ft. buffer around this historic property and continues to work with concerned “caretaker” groups. SIHP# 50-80-10-4681 located approximately 15m (50 ft) southwest of the current petition area is a pre-Contact habitation/agricultural site. Although sufficient data was observed to qualify SIHP# 50-80-10-4681 as a site, the vegetation, primarily *hau*, in the area was too dense to definitively establish the site boundaries. Preservation, in the form of avoidance and protection, is recommended for SIHP # 50-80-10-4681 with the understanding that the site boundaries be firmly established prior to interim protection measures. SIHP# 50-80-10-6929 is a pre-Contact quarry site located approximately 20 m (66 ft) east of the petition area. Preservation, in the form of avoidance and protection, is recommended. SIHP# 50-80-10-6931 located approximately 15m (50 ft) south of the current petition area is a possible pre-Contact ceremonial area. Preservation, in the form of avoidance and protection, is recommended for the SIHP # 50-80-10-6931.
Additional Recommendations	An archaeological monitoring program is recommended to address the potential of project related excavations impacting subsurface cultural material. Should SHPD require archaeological monitoring for the Hawaiian Memorial Park Expansion Project, an archaeological monitoring plan, written to fulfill the requirements of Hawai‘i Administrative Rules Chapter 13-279, will need to be reviewed and approved by SHPD prior to any land disturbing activities within the project area Additionally, it is recommended that a historic properties preservation plan be prepared for the proposed Hawaiian Memorial Park Expansion project, in accordance with Hawai‘i Administrative Rules (HAR) 13-277-3, to address buffer zones and protective measures for all historic properties recommended for preservation within and near the petition area. This preservation plan should detail the short and long term preservation measures that will safeguard the historic property during project construction and subsequent use of the petition area.

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Section 1 Introduction

1.1 Project Background

At the request of Helber, Hastert & Fee Planners, Cultural Surveys Hawai‘i, Inc. (CSH) conducted an archaeological inventory survey of approximately 66-acres of State Conservation land owned by Hawaiian Memorial Life Plan LTD. The initial project area consisted of approximately 53 acres. Following the pedestrian inspection, the boundaries of the Hawaiian Memorial Park Expansion project area were adjusted to include buffer zones for select archaeological resources identified along the periphery of the project area. As a result, an additional 13 acres was added to the project area to account for the lost acreage. The petition area defined for this report is approximately 56.6 acres (Figure 1). The current project area is located adjacent to the existing Hawaiian Memorial Park, Kāne‘ohe Ahupua’a, Ko‘olaupoko District, Island of O‘ahu (TMK: [1] 4-05-033:001) (Figure 2 and Figure 3). The *mauka* side the project area is bordered by the Hawaiian Memorial Park and extends *makai* to Pohai Nani Retirement Community. From the south and east it is bounded by Kapa‘a ridge, and to the northwest by a housing development and Namoku Street. The project area extends *mauka* to approximately 170 m (557 ft) elevation.

The project area consists of a privately owned, undeveloped area. Field survey work revealed that portions of the project area are being utilized for unauthorized hiking and paintball activities. Proposed developments within the project area include new internment areas, a residential subdivision and associated roadways. Minimally, the land alteration would include, surface grubbing and grading excavations associated with the installation of sub-surface utilities, housing construction, and landscaping.

In consultation with the Hawai‘i State Historic Preservation Division (SHPD), the inventory survey was designed to fulfill State requirements for an archaeological inventory survey per HAR Chapter 13-13-276 and Chapter 13-13-284. CSH completed the fieldwork component of the archaeological inventory survey under SHPD permit No. 07-19, per Hawai‘i Administrative Rules (HAR) Chapter 13-13-282.

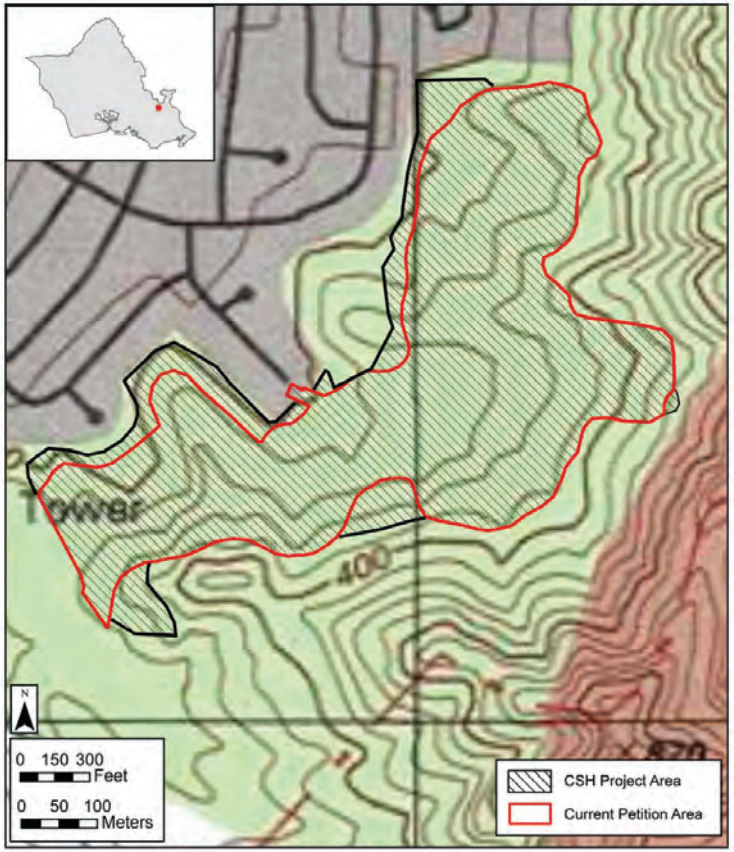

Figure 1. Portion of U.S. Geological Survey 7.5 Minute Series Topographic Map, Kaneohe, HI. Quadrangle (1998), showing the location of the project area.

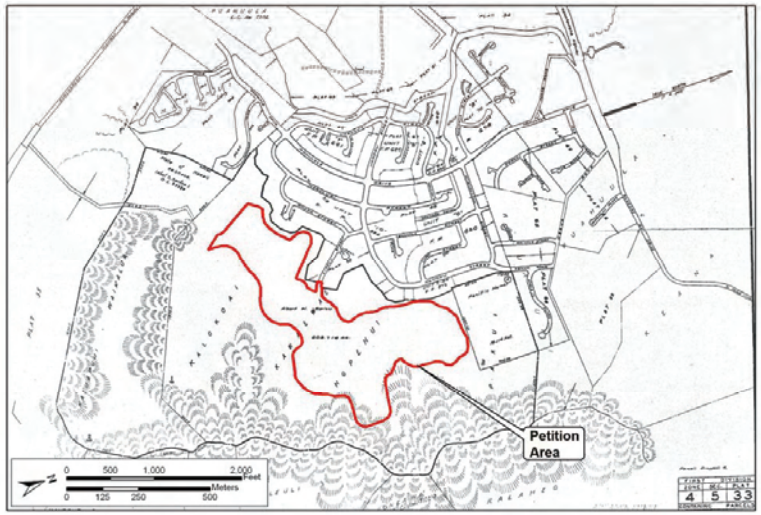

Figure 2. Tax Map Key (TMK: [1] 4-05-033:001) showing the current petition area.

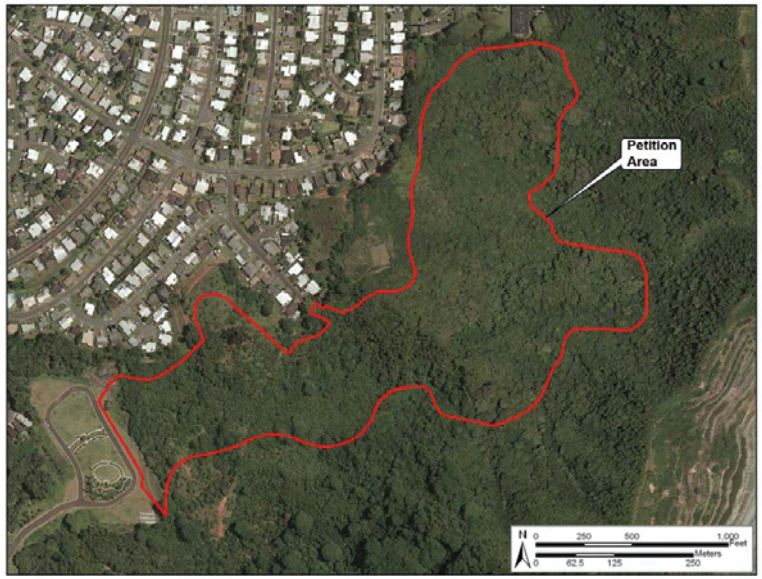

Figure 3. A 2005 aerial photograph showing the location of the current petition area (U.S. Geological Survey Orthoimagery 2005).

1.2 Scope of Work

The archaeological inventory survey and its accompanying report will document all historic properties within the subject parcel. The prepared inventory survey will be in compliance with state standards and will be submitted for review and approval to the State Historic Preservation Division/Department of Land and Natural Resources (SHPD/DLNR), and include the following elements.

1. A complete ground survey of the entire project area for the purpose of historic property identification and documentation. All historic properties would be located, described, and mapped with evaluation of function, interrelationships, and significance. Documentation will include photographs and scale drawings of selected historic properties. All historic properties will be assigned *Inventory of Historic Properties* numbers by the State.

2. Subsurface testing to determine if subsurface deposits are located in the project area, and, if so, evaluate their significance. If appropriate samples from these excavations are found, they will be analyzed for chronological and paleo-environmental information.

3. Research on historic and archaeological background, including search of historic maps, written records, and Land Commission Award documents. This research will focus on the specific area with general background on the *ahupua‘a* and district and will emphasize settlement patterns.

4. Consultation with community members as part of the inventory survey process. This consultation requires contacting knowledgeable members of the community and requesting information on historic and cultural issues related to the property.

5. Preparation of a survey report which will include the following:

    a. A topographic map of the survey area showing all historic properties;

    b. Results of consultation with knowledgeable community members about the property and its historical and cultural issues.

    c. Description of all historic properties with selected photographs, scale drawings, and discussions of function;

d. Historical and archaeological background sections summarizing prehistoric and historic land use as they relate to the project area's historic properties;

e. A summary of historic property categories and their significance in an archaeological and historic context;

f. Recommendations based on all information generated that will specify what steps should be taken to mitigate impact of development on the project area's significant historic properties - such as data recovery (excavation) and preservation of specific areas. These recommendations will be developed in consultation with the client and the State agencies.

This scope of work also includes full coordination with the State Historic Preservation Division (SHPD), and County, relating to archaeological matters. This coordination takes place after consent of the owner or representatives.

1.3 Environmental Setting

1.3.1 Natural Environment

The project area is located within the Windward O‘ahu district of Ko‘olaupoko, and is situated within the *ahupua‘a* (traditional land division) of Kāne‘ohe. Kāne‘ohe is a large *ahupua‘a* of approximately 11,000 acres, extending from Windward crest of the Ko‘olau Range to include most of the Mōkapu Peninsula and is bordered by the *ahupua‘a* of He‘eia to the west and Kailua to the east. Elevations range from 60 meters above sea level (MSL) to 122 MSL, and annual rainfall is high at approximately 1500 millimeters (50 inches) (Giambelluca et al. 1986).

Soils in the proposed project area include Kāne‘ohe silty clay (KgC), 8-15% slopes, Kāne‘ohe silty clay (KHOF), 30-65% slopes; Alaeloa silty clay (AeE), 15-35 % slopes; and Alaeloa silty clay (ALF), 40-70 % slopes; and Helemano silty clay (HLMG), 30-90% slopes; (Foote et al. 1972). Kaneohe series soils are generally well-drained soils on terraces and alluvial fans on the windward side of Oahu. These soils developed in alluvium and colluvium derived from basic igneous rock. In a few places they developed in volcanic ash and in material weathered from cinders. The soils are gently sloping to very steep. Elevations range from 100 to 1,000 feet (Soil Survey of the State of Hawaii 2007).

The Alaeloa series consists of well-drained soils on uplands on the islands of Maui, Molokai, and Oahu. These soils developed in material weathered from basic igneous rock. They are gently sloping to very steep. Elevations range from 100 to 1,500 feet. The Helemano series consists of well-drained soils on alluvial fans and colluvial slopes on the sides of gulches. These soils are on the island of Oahu. They developed in alluvium and colluvium derived from basic igneous rock. They are steep to extremely steep. Elevations range from 500 to 1,200 feet (Soil Survey of the State of Hawaii 2007).

Kawa Stream is approximately 120-175 meters west of the project area. It is a relatively short (~4.1 km), perennial stream located mostly in the Pikoiloa Tract of southern Kāne‘ohe Town. The central branch of the stream arises within the National Veterans Cemetery and the stream eventually discharges into the south basin of Kāne‘ohe Bay. Kawa Stream has a drainage area of 4.0 km^2 (1.56 sq. mile) that includes the National Veterans Cemetery and most of Hawaiian Memorial Park (cemetery), nearly all of the residential urban development's east of Kamehameha Highway from the cemetery down to Kāne‘ohe Bay Drive (Pikoiloa subdivision, and Kailuapuhi, Waikalua Homestead), and the Bay View Golf Course (Koolau.net 2007).

Vegetation in the forest in and around the project area is dominated by alien/introduced species such as albizia trees (*Paraserianthes falcataria*), Christmas berry (*Schinus terebinthifolius)*, *he‘e* - octopus tree (*Schefflera actinophylla)*, Java plum (*Syzygium cumini*) lemon and strawberry guava (*Psidium guajava, Psidium cattleianum*), ironwood (*Cauarina* spp.), Cook and/or Norfolk Island pine (*Auracaria* spp.), cinnamon trees (*Cinnamomum* sp.), African tulip tree (*Spathodea campanulata*), and cultivar fruit trees such as mango (*Mangifera indica*), to name a few. There are several Polynesian introductions such as *kukui* (*Aleurites moluccana*), (true) kamani (*Calophyllum inophyllum*), *hau* (*Hibiscus tiliaceus*), *ki* or *ti* (*Cordyline fruticosa*), *noni* (*Morinda citrifolia*),*‘ohe* (possibly *Bambusa vulgaris* and/or *Schizostachyum glaucifolium*), and *mai‘a* - banana (*Musa* spp., possibly *M. paradisiaca*). Some of these Hawaiian "canoe plants" (plants brought by the early Polynesians in their canoes) are indicators of former Hawaiian habitation, agriculture and cultural use therefore, potential historic properties. For example, *kamani* was often planted around *heiau* (temples), and considered a sacred tree in parts of Polynesia; the same is true of *ki/ti*; both *ki/ti* and *mai‘a* were planted around taro *lo‘i* (pondfields); and, the latter, *mai‘a*, was planted around dwellings (http://www.canoeplants.com/contents.html). Understory and groundcover plants include grasses such as *honohono* - basketgrass (*Oplismenus hirtellus*), a number of ferns such as *laua‘e* or *maile*-scented fern (*Phymatosorus grossus*), bamboo orchid (*Arundina graminifolia*), and more. There are also a number of native plants within the project area such as the indigenous fern *pala‘* (*Sphenomeris chinensis)*, *neke* fern (*Cyclosorus interruptus*), wood fern (*Dryopteris* sp.), *ohi‘a lehua* trees (*Metrosideros* spp.), and the shrub/bush *ulei* (*Osteomeles anthyllidifolia*), to name a few. Several of the plants listed above have past and present ethnobotanical applications (e.g., as medicinal, building, weaving, *hula*, and *lei* plants) for native Hawaiians. Most significantly, *pala‘* is a culturally and economically valued native *hula* and *lei* fern. Although *S. chinensis* is not listed as endangered or threatened, its availability is declining dramatically (Ticktin et al. 2006).

1.3.2 Built Environment

The project area consists of a privately owned, undeveloped area. Field survey work revealed that portions of the project area are being utilized for unauthorized hiking and paintball activities. The *mauka* side the project area is bordered by the Hawaiian Memorial Park and extends *makai* to the Pohai Nani Retirement Community. From the south and east it is bounded by Kapa‘a ridge, and to the northwest by a housing development and Namoku Street.

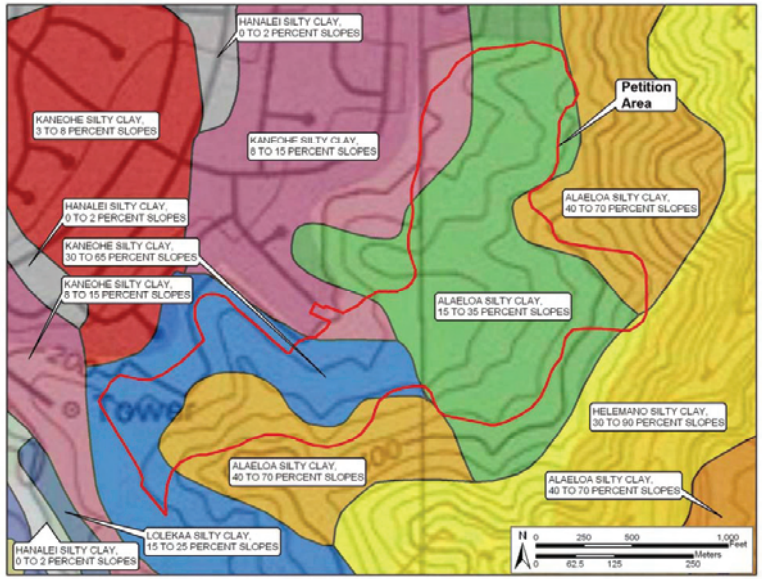

Figure 4. Overlay of Soil Survey of the State of Hawai‘i (Foote et al. 1972), indicating sediment types within the petition area (source: Soils Survey Geographic Database [SSUGRO] 2001, U.S. Department of Agriculture).

Section 2 Methods

2.1 Field Methods

The Fieldwork portion of this Archaeological Inventory Survey was carried out from October 17, 2006 to December 5, 2006 and from September 20, 2007 to October 10, 2007. The alternating CSH field crew consisted of David Shideler, M.A., Doug Borthwick, B.A., Todd D. McCurdy, M.A., Matt Bell, B.A., Jon Tulchin, B.A., Nifae Hunkin, B.A., Sean Barns, M.A., Lisa Gollin, Ph. D, Kulani Jones, B.S., Jennifer Olson, B.A., Sean Naleimaile, B.A., Auli‘i Mitchell, B.A., Kevin Dalton, B.A., and Kelly Uyeoka, B.A., under the general supervision of Hallett H. Hammatt, Ph.D. The field required 62 person-days to complete. Fieldwork consisted of a 100% coverage pedestrian inspection of the project area and limited subsurface testing at select archaeological sites

The pedestrian inspection of the project area was accomplished through systematic sweeps (transects) across the landscape. The spacing interval between archaeologists was 5-10 meters. All historic properties encountered were recorded and documented with a written field description, site map, photographs, and located utilizing the Global Positioning System technology of a Garmin GPSmap76S unit or a Trimble PRO XR GPS.

Subsurface testing consisted of the partial excavation, by hand, of selected surface archaeological features located during the pedestrian survey. The purpose of the subsurface testing was to aid in determining the function of located surface sites, as well as to possibly obtain datable materials for later radiocarbon dating. All excavated material was sifted through a 1/8 in. wire mesh screen to separate out the soil matrix; subsequently all cultural material was collected for analysis in the lab. Each test excavation was documented with a scale section profile, photographs, and sediment descriptions. Sediment descriptions included characterizations of Munsell color designations, compactness, texture, structure, inclusions, cultural material present, and boundary distinctness and topography.

2.2 Laboratory Methods

Laboratory analyses of material recovered from limited subsurface testing within the project area included:

1. Identification and cataloguing of traditional Hawaiian artifacts. Any artifacts collected *in situ* at the project area or contained within sediment samples were measured, weighed and classified by material type and artifact form. The analysis then focused on distinguishing artifact function.

2.3 Document Review

Historic and archival research included information obtained from the UH Hamilton Library, the State Historic Preservation Division Library, the Hawai‘i State Archives, the State Survey Office, and the Archives of the Bishop Museum. Previous archaeological reports for the area were reviewed, as were historic maps and primary and secondary historical sources. Information on Land Commission Awards was accessed through Waihona ‘Aina Corporation’s Māhele Data Base (<www.waihona.com>).

2.4 Consultation

Archaeologists from CSH have consulted and visited the project area at least two times with knowledgeable community members. On June 23, 2007, archaeologists from CSH, two principles of the Ko‘olaupoko Hawaiian Civic Club (KHCC), Donna Camvel and Mahealani Cypher, and a representative of Ka‘Ailehua, Wali Camvel, visited four of the historic properties identified during Archaeological Inventory Survey for the proposed Hawaiian Memorial Park Expansion project. Additionally, CSH archaeologists consulted Mr. Charlie Ogata, a member of the Queen Emma Hawaiian Civic Club, considered the club’s longstanding *kia‘i* (caretaker) of the Kawa‘ewa‘e Heiau. This included an onsite tour led by Mr. Ogata who pointed out features associated with the historic property. Mr. Ogata’s complete testimony is available in the Cultural Impact Assessment prepared as a companion study to this work (see Gollin et al 2008).

Section 3 Background Research

3.1 Traditional and Historical Background

3.1.1 Mythological and Traditional Accounts

There are several myths and legends associated with Kāne‘ohe. A few stories provide the origin of the name of the *ahupua‘a* of Kāne‘ohe. The word “Kāne” in Kāne‘ohe has been interpreted variously as “husband”, “man”, or as a reference to the god Kāne, the god of creation, while *‘ohe* means “bamboo”. One account attributes the name to a story about a woman who compared her husband’s cruelty to the cutting edge of a bamboo knife (Pukui and Elbert 1986, Clark 2002). Kāne‘ohe may also be derived from *‘ohe*, which is said to be one of the *kinolau* (body forms) of the god Kāne (Abbott 1992:15). Another account is as follows:

> In Kaneohe proper, the people learned a new use for the Ohe…In olden times anyone who did not conform to the way of life lived so industriously by the shore people, was called E-epa, or non-conformist. The E‘epa were not actually “touched in the head”, or lo-lo [crazy], but just different. They liked to wander off by themselves and dwell among the mysteries of the upland forests where they listened to the music of Nature, and often became poets or musicians.
>
> Those upland reaches, all unexplored territory and sacred to the Spirits or Akua of Nature, where referred to as the Wao (upland forest), or places of mystery. In order to keep children from wandering to the uplands, their elders told the little ones, “Do not go up there or the Bamboo Man may keep you. We would mourn your absence in loneliness. Remain at home and learn your useful duties.”
>
> Hano-ihu…longed to explore. Pu‘ili…longed to accompany her playmate, Hano-ihu, when he wandered far. But, being more timid, she contended herself during the boy’s absences and kept his secret of those upland trips he enjoyed.
>
> One sad day, Hano-ihu did not return. The people searched and could find no trace of the disobedient boy. Finally, the villagers decided the boy had died, and they told the other children that the Bamboo Man had taken the boy-wanderer.
>
> Pu‘ili…decided that he was not dead and she must search for him. Acting upon the thought, the little girl followed the direction often taken by the boy and was soon alone in the dark recesses of the forest lands of Wao, the Mysterious.
>
> She saw nothing to fear. Rather, she delighted in the beauty of the forests, the fragrance of the ferns and blossoms growing besides singing rills of sweet waters, and danced along happily to the whistling of the Wind Gods in the tree tops touching the blue sky far above.

> Soon she realized the whistling was not actual the Wind, for it had a bird-like note that repeated itself in a gentle rhythm. Also, she saw the bamboo moving in the breeze and heard how it rattled its branches. She found two lengths of a bamboo branch and, one in each hand, beat time on the two sticks while she followed the plaintive note calls.
>
> Before her…she saw her beloved playmate sitting on the bank. Beside him was a tall, thin man whose eyes watched the boy, while the child blew upon a bamboo length. The man’s lean hands waved to the rhythm of the notes, and the girl went dancing toward the pair, keeping time with her pair of bamboo sticks.
>
> Hano-ihu and the tall man finished their melody, then praised the little Pu‘ili for joining them….She sat with them and learned that the man was Kane‘ohe, the Bamboo Man who, as a child, had followed the lure of Wao and had invented a bamboo flute. Kindly, the old man explained to the children how the art of creativity often is lost unless those inspired do follow the call. He told them, “Now we shall return to the village, for I have answered the call and you two little ones will be musicians like me. In honor of this occasion, I shall name the flute after you, my boy...we shall name the time-keeping sticks for her.”
>
> Gaily, the three went down the forest trail of Wao the Inspiring. They were welcomed with feasting and joy. That is how we have the...Bamboo, instruments today. The Hano-ihu or Nose flute; and the Pu‘ili, or notched Bamboo sticks; and the hula named for these gifts of Kane‘ohe, the Bamboo Man. (Paki 1972:29-30)

Windward O‘ahu is famous for legends of Kamapua‘a; the half man, half pig demigod renown for making mischief and for his masterful escapes from retribution for his chicken and taro thievery as well as romantic escapades. One story centers on Kamapua‘a and the Kawa‘ewa‘e Heiau. Thrum (1906) reports that Kawa‘ewa‘e Heiau was erected in the beginning of the 12th century by the high chief ‘Olopana (Thrum 1906:48) and constructed by *menehune* (legendary race of small people who built structures by night) (Fornander 1878:23). In the version of the story presented by King David Kalakaua (1990), Kamapua‘a, embittered by his father/uncle (depending on which story is being told) the ‘Olopana’s rejection of this hog-child, retreats to the mountains where he attracts a band of like-minded thieves and commences to “harass the estates of Olopana”, stealing ‘Olopana’s pigs, fowls and fruits as well as taking pleasure in breaking his nets, cutting adrift his canoes and robbing his fish-ponds (Kalakaua 1990:143). Enraged by Kamapua‘a’s pillage and acts of rebellion, ‘Olopana orders his capture. After several battles and failed attempts to catch Kamapua‘a, ‘Olopana’s army succeeds in delivering Kamapua‘a to the high chief to the “great joy and relief of the people of Koolau” (p.145). Kalakaua relates the following:

> Olopana had erected a *heiau* at Kaneohe, Lonoaohi officiated as high priest, and thither he resolved to take his rebellious son or nephew, and offer him as a sacrifice to the gods. Hina [Kamapua‘a’s mother] pleaded for the life of Kamapuaa, but Olopana could not be moved. Satisfied that he would listen to no appeals for mercy, she determined to save her son, even at the sacrifice of her

> husband, and to that end secured the assistance of the high priest, through whose treachery to Olopana the life of Kamapuaa was saved.
>
> On the day fixed for the sacrifice Kamapuaa…was taken to the *heiau*, followed by Olopana, who was anxious to witness the ghastly ceremonies, and with his own eyes see that his troublesome enemy was duly slain and his body laid upon the altar. In offering human sacrifices the victim was taken without the walls of the *heiau* and slain with clubs by the assistants of the high-priest. The body was then brought in and placed upon the altar in front of the entrance to the inner court, or sanctuary, when the left eye was removed by the officiating priest, and handed…to the chief who had ordered the sacrifice….
>
> Standing with three or four attendants, at the door of his tabooed retreated…Olopana saw his victim preliminarily led to the place of sacrifice, and a few minutes after motion for the ceremonies to begin. Kamapuaa was taken without the walls of the temple to be slain….Passing beyond the outer wall the party entered a small walled enclosure adjoining, and the executioner raised his club and brought it down upon the head of his victim. Kamapuaa smiled, but did not move. Twice, thrice with mighty sweep the club descended upon the head of Kamaupua‘a, but scarcely bent the bristly hairs upon his crown.
>
> With a semblance of wonder the executioner, whose tender blows would have scarcely maimed a mouse, dropped his club and said:
>
> “Three times have I tried and failed to slay him! The gods refuse the sacrifice!”
>
> “It is so, it is so, it is so!” chimed his companions….
>
> Therefore, instead of slaying Kamapuaa, the assistants, as they had been secretly instructed to do by the high-priest, removed the cords from his limbs, smeared his hair, face and body with the fresh blood of a fowl, and on their shoulders bore him back and placed him upon the altar as if dead.
>
> The high-priest approached the apparently lifeless body, and bent for a moment over the face, as if to remove the left eye; then placing on a wooden tray the eye of a large hog, which had been procured for that purpose, he sent an assistant with it to Olopana, at the same time retiring within the inner court, and leaving by the side of Kamapuaa, and near his right hand, as if by accident, the sharp ivory pahoa, or dagger, with which he had, to all appearance, been operating.
>
> Giving but a single glance at the eye presented to him by the assistant of the high-priest, Olopana passed it to an attendant without the customary semblance of eating it, and approached the altar alone. Kamapuaa did not breathe. His face was streaked with blood, his eyelids were closed, and not a single muscle moved to indicate life.

> Olopana looked at the hated face for a moment, and then turned to leave the *heiau*….As he did so Kamapuaa clutched the dagger besides his hand, and, springing from the altar, drove the blade into the back of Olopana. Again and again he applied the weapon until the chief, with a groan of anguish, fell dead at the feet of his slayer. (Kalakaua 1990:145-146)

Kalakaua goes on to describe how Kamapua‘a is released from custody by the high-priest, and how as the people of the district had, “suffered through his plundering visitations, and hundreds of lives had been sacrificed in his pursuit and final capture, the people rose almost in a body to hunt him down and destroy him” (p.147). Kamapua‘a and his cohorts eventually sail off O‘ahu for the Windward islands in search of refuge.

3.1.2 Pre-Contact Period

In pre-contact times, the *ahupua‘a* of Kāne‘ohe offered fresh water from *mauka* (upland) springs watering extensive agricultural fields and a well developed fishpond system, making it both an agricultural and aquacultural center on O‘ahu (Devaney 1976). Handy and Handy (1972) described Kāne‘ohe as:

> …an area of little hills with many small streams between them. In 1935 it was still one of the most active communities in planting commercial taro. A goodly proportion of its lowland lo‘i, tucked away in pockets flanked and often hidden by low hills or near the town itself, was then still planted in taro by Hawaiians who owned the land and by Orientals who leased land or were hired to cultivate it (Handy and Handy 1972:455).

Pre-contact land use would have consisted mainly of *kalo* (wetland taro) and *kula* (dryland) cultivation of *hala* - pandanus (used for making household furnishings such as mats), *wauke* – paper mulberry (used for making *tapa/kapa* cloth), bananas and sweet potatoes (Handy and Handy 1972:456). Kāne‘ohe Bay, with about two-dozen walled fishponds, was a bountiful source of fish (Devaney et al. 1976:6).

3.1.3 Early Historic Period, 1778-1840

Kāne‘ohe has long been viewed as a “valuable” *ahupua‘a* both in terms of agricultural and fishery productivity. In 1830 the chiefs of Hawai‘i, Maui, and O‘ahu, in a council meeting concerning the “late doings on Oahu”, referred to Kāne‘ohe as the “most valuable part” of the district of Ko‘olaupoko (Kamakau 1992:303). Kāne‘ohe held a unique position in the history of *‘awa* (*Piper methysticum*) cultivation. The relaxant drink prepared from rootstock of the *P. methysticum* plant was regarded as immoral by missionaries who sought to restrict consumption of the “intoxicant” brew. In 1846 obliging lawmakers created licensing laws and set up a system of appointing “‘*awa* agents” to plant and sell *‘awa* on the various islands. The argument for this system was that, although *‘awa* was considered morally hazardous, it had medicinal value. There were 2 *‘awa* agents assigned to O‘ahu; one was William Harbottle who was authorized to grow *‘awa* on 2 acres of land in Kāne‘ohe (Greer 1970:66-67).

Describing the early historical times of Hawaiian *ali‘i* (monarchy) in Kāne‘ohe, Devaney et al. (1976) state:

> …when Kahanahana ruled O‘ahu [circa 1773-1783], he sometimes lived in Kaneohe. After defeating Kahanahana circa 1783, Maui Chief Kahekili and most of his famous warriors lived in Koolaupoko at Kailua, Kaneohe, and Heeia (Fornander 1969:225; Kamakau 1961:138). When Kamahameha I apportioned the conquered O‘ahu lands in 1795 to his warrior chiefs and counselors (Ii 1959:69-70), he retained as his personal property the ahupua‘a of Kaneohe… Much of Kaneohe and all of Kahaluu and Kualoa were inherited as personal lands by Kamehameha’s sons Liholiho and Kauikeaouli, Kamehameha II and III (Indices…1920:27-28). (Devaney et al. 1976:5)

Kamehameha III (Kauikeaouli) presided over the Māhele, the division of lands given to Hawaiian royalty and commoners. Kamehameha III, as mentioned above, had inherited Kāne‘ohe and retained the bulk of the *ahupua‘a* during the Māhele. After his death, his wife, Queen Kalama (Hakaleleponi), retained their portion of Kāne‘ohe (Barrère 1994, Kame‘eleihiwa 1992).

3.1.4 Mid 1800s – The Māhele

The Organic Acts of 1845 and 1846 initiated the process of the Māhele – the division of the Hawaiian lands, which introduced private property into Hawaiian society. In 1848, the crown and the *ali‘i* (chiefly class) received their land titles. The common people received their *kuleana* (individual parcels) in 1850. The Kuleana Act of 1850 allowed for private ownership of lands to “commoners,” the persons or families actually living and working on the land. As a result of the Kuleana Act of 1850, a total of 242 land claims were made for Kāne‘ohe Ahupua‘a, but only a bit more than half of those were awarded (www.waihona.com). The average *kuleana* award was 2.38 acres (Kelly 1976:8). However, these claims were not only for commoners, as chiefs and/or *konohiki* were also awarded lots. The bulk of Kāne‘ohe Ahupua‘a went to Queen Kalama, 11 *konohiki* (chiefs), and 3 non-*konohiki* (privileged awardees who received large parcels of land) (Kelly 1976:7). The primary type of land claimed in Kāne‘ohe was taro land, identified in the claims, testimony, and awards as *lo‘i*, but there was also fishponds and *kula* (dryland crops) as well. No individual *kuleana* (LCA’s) were awarded within the project area as it was a small portion of ahupua‘a and government awards for Kāne‘ohe Ahupua‘a (Figure 5).

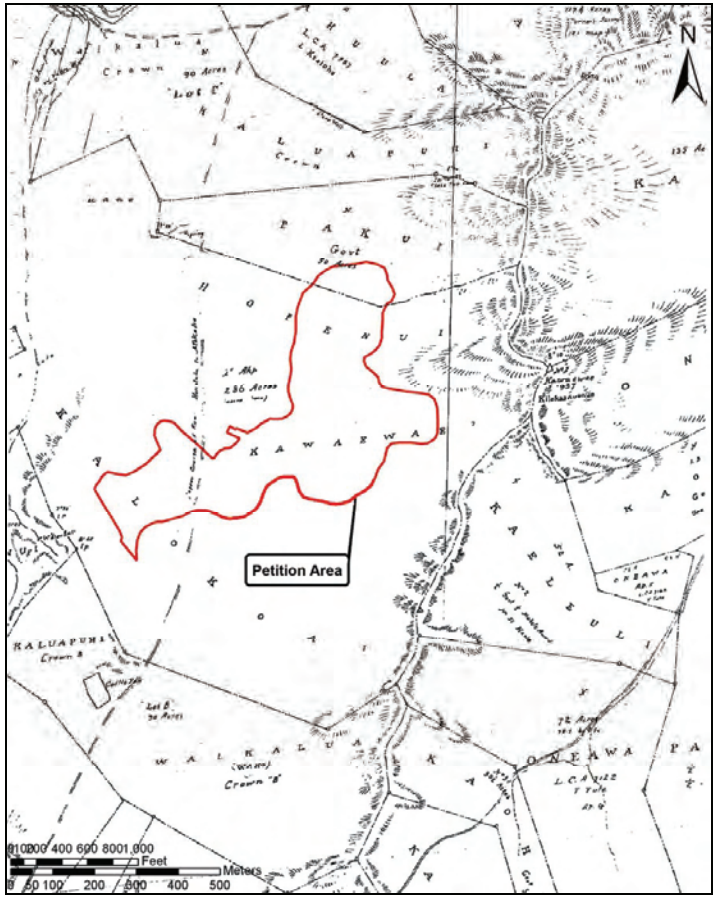

Figure 5. Portion of 1874 Lyons Map of Kāne‘ohe O‘ahu with West Kailua showing locations of LCAs in the vicinity of the petition area.

3.1.5 1860s to 1920, Sugar and Rice

In the 1860s, both commercial sugar cane and rice cultivation began in Kāne‘ohe. One of the earliest sugar plantations on O‘ahu was owned by Charles Coffin Harris, who came to Hawai‘i in 1850 with a plan to practice law. He established the Kaneohe Sugar Plantation Company (c. 1865) on 7,000 acres of Queen Kalama’s land with Harris as partner and manager (Dorrance and Morgan 2000:41). In 1871, C. C. Harris bought Queen Kalama’s Ko‘olaupoko properties from her heir, Charles Kanaina, as well as some land in Honolulu for $22,448. The sale included “…livestock, tool, fishponds, and fishing rights” (Bur. Of Conv. Book 34:53; in Devaney et al. 1976:29). C.C. Harris’s plantation shut down in 1891, when the yield was not enough to support the operation (Dorrance and Morgan 2000:41). Judge C.C. Harris’s daughter and heir, Mrs. David Rice, incorporated the lands as Kaneohe Ranch and converted it to stock farming, to be eventually purchased by James B. Castle in 1907 (Montgomery 1971 in Dorrance and Morgan 2000:42). Harold K.L. Castle, the only child of James B. Castle owned most of the *ahupua‘a* of Kāne‘ohe in the early 1900s (http://www.kaneoheranch.com). Eventually he purchased the remaining land from Harris’s daughter (Henke 1929:62).

Rice cultivation was to eventually supersede taro and dominate the lowlands of Kāne‘ohe. Rice was cultivated mainly by Chinese, who rented or leased the *lo‘i* lands from the Hawaiian landowners. By the late 1880s, virtually the entire floodplain areas of Kāne‘ohe were under rice cultivation. In 1890-92, the Kāne‘ohe Rice Mill was erected and put into production on property adjoining Kāne‘ohe Stream. The mill had a long flume coming to it from further up Kāne‘ohe Stream. It also had a short railway leading to a small landing in Kāne‘ohe Bay, north of Kāne‘ohe Stream.

During the height of rice cultivation (circa 1890-1920), Chinese dominated the business. “To a great extent the rice business, growing and milling was controlled by Chinese *hui* (firms), which recruited laborers from China, handled investment capital from rich absentee landlords, and tallied profits” (Devaney et al. 1976:49).

At the same time rice paddies were displacing the taro lo‘i along the coast, the *kula* (pasture) lands of He‘eia were utilized for grazing of cattle and other livestock. Thrum’s 1905 Hawaiian Annual notes a cattle ranch in He‘eia managed by George W. Rowan.

By the mid-1880s, grazing animals (cattle, sheep, and goats) were having an impact on the land and water of [Kane‘ohe]. Unfenced, the animals ate the crops of the Hawaiian farmers, forcing many to abandon their garden lands [Henry 1993:27].

By the 1920s, rice had gradually declined in importance due to a number of factors. Two of the primary reasons for this decline include the beginning of rice production in California as well as the “annexation of Hawaii by the United States in 1898 resulted in restrictions on the number of Chinese laborers arriving from the Far East.” (Devaney et al. 1976:53). However, rice as well as some taro cultivation continued up to c. 1960.

3.1.6 Ranching

In the mid 19th century, ranching became a major enterprise. Cattle and sheep had been left on O‘ahu by Vancouver in 1793, and the former had multiplied into a large herd by the 1840s (Devaney 1976:70). By the mid 1860s, the cattle were so numerous as to cause environmental

degradation. Kāne‘ohe Ranch was formed in 1876, on lands originally belonging to Queen Kalama. At its peak, the ranch included 12,000 acres and 2,000 head of cattle. Alien grasses and other species, such as pigeon peas, were introduced to the area as cattle fodder (Henke 1929:62). Much of the land modification in the upland and hilly portions of Kāne‘ohe may be the result of heavy cattle grazing over a long period of time.

3.1.7 1890s to Present

The commercial cultivation of pineapple began in the 1890s and the first decade of the 1900s in Kāne‘ohe. From approximately 1910 to 1925, pineapple cultivation was a major industry in this area. In 1911, the company of Libby, McNeill and Libby built a pineapple cannery in He‘eia. At its peak, 2,500 acres were under pineapple cultivation on Windward O‘ahu (Harper 1972) stretching from Kāne‘ohe to Kahalu‘u. A large percentage of this acreage was in the Kāne‘ohe Bay region, including He‘eia. A *heiau*, Kaualauki Heiau in He‘eia, was mostly destroyed by pineapple field clearance during this time – a likely fate of many archaeological sites. In 1919, the Kaneohe Ranch Company and He‘eia Agricultural Co., Ltd. leased 1000 acres of land in He‘eia, Kāne‘ohe, and Kailua, formerly planted in sugar, to the Libby company for a term of 17 years. In 1917, Libby leased an additional 600 acres in He’eia (Libby, McNeill & Libby Ms:2, cited in Kawachi 1990). While the rice fields that covered old taro lands were mainly located near streams and near the coast, the pineapple fields were also grown on the slopes of higher lands, usually on land subleased to individual Japanese farmers:

> Pineapples were planted by individual Chinese and Japanese farmers on moderately sloped hill land where rice and taro could not be grown . . . these areas included the dissected alluvial terraces and the lower slopes and spurs of the Ko‘olau range [Miyagi 1963:1151].

The change to the windward landscape due to pineapple cultivation is illustrated by the following passage:

> At last we reached the foot of the Pali. . . . Joe and I looked over the surrounding hills, but looked in vain for the great areas of guava through which but a few months ago we had fought and cut our way. As far as the eye could reach pineapple had taken the place of the forest of wild guava. The newest industry in Hawaii was beginning even to press upon the cane fields of this side of the island [Alexander 1914:318, cited in Devaney et al. 1976:62].

The pineapple fields were abandoned when Molokai and Lāna‘i pineapple cultivation began to boom, and Libby pulled out of the Ko‘olaupoko enterprise (Kelly 1976:47). The cannery closed in 1923 (Dorrance 1998:95). Most of [the former pineapple] land went to grass, and some of it was used to graze cattle. Many of the small farmers returned to rice cultivation. The area along He‘eia stream mauka of the viaduct continued to produce rice [Kelly 1976:47].

Rice cultivation again extended into former sugar cane lands after the demise of the He‘eia Agricultural Company. It flourished until about 1920, when it could no longer compete with the price of California grown rice (Dorrance 1998:94). Taro made a comeback (ca. 1920s - 1940s) coinciding with the decline in rice; and much of the former lo‘i land was returned to taro production.

The extensive salt marshes of He‘eia inland of the fishpond (loko) were not suitable for cultivation, but fringing them to the southward, flanking both sides of He‘eia Stream from which they are irrigated, lie the vast terraced lowland flats of this ahupua‘a, which were in 1935 still largely planted in commercial taro [Handy and Handy 1972:454-55].

By the end of World War II, ranching was no longer economically viable for the Kaneohe Ranch, and the ranch became primarily a landlord to other farmers (www.kaneoheranch.com). After World War II, residential developments changed the face of Kāne‘ohe Ahupua‘a. The opening of the Wilson Tunnel and the expansion of the Pali Highway in the 1950s and 60s — creating an easier passage from Honolulu thru the Ko‘olaua mountains to windward communities — led the way to a development boom on the windward side of O‘ahu. High tax rates on real estate sales forced many old-time landowners to lease their land to residential developers rather than sell on a fee-simple basis. Kaneohe Ranch at one time leased their land to over 5,000 single family residential lots in Kailua and Kāne‘ohe. The vast majority of the leaseholds were sold to the lessees (www.kaneoheranch.com).

The dairy industry rose to prominence over beef cattle ranching in the post-war years. The shortage of available land due to urban expansion, the shortage of fee simple land, and the high price of land leases forced farmers in the dairy districts near Honolulu (e.g., Koko Head) to relocate to more remote areas of O‘ahu (Durand Jr. 1959:241). In the 1950s Kailua-Kāne‘ohe was an important dairy district of Windward O‘ahu. Dairy farming was dominated by whites (Caucasians) particularly of Portuguese and Spanish ancestry, and secondarily Japanese, farmers (Durand Jr. 1959:235). “Among the names of island dairymen, illustrating the Portuguese-Spanish-Mainland importance…are…Brazil, Carlos, Campos, Costa, Ferreria, Foster, Freitas, Knowles, Medeiros, Moniz, Ornellas, Rapoza, Santos, Toledo, Vause and White” (Durand Jr. 1959:235). However, this period was relatively short-lived as the opening of the Pali route, exorbitant land prices in Honolulu, and more automobiles on O‘ahu contributed to rapid urbanization in Kailua-Kāne‘ohe (Durand Jr. 1959:244-245). Many landowners decided to develop their land for suburban housing and terminated leases with farm leaseholders.

In 1959 Hawai‘i was admitted to the Union making it the 50th state resulting in a construction boom and rapidly growing economy. Hawaiian Memorial Park opened in 1961 with a land area of 6 acres. It has gradually expanded to its current size, 80 acres. The Pikoiloa Subdivision lots, which are to the northwest of the project area were created by subdivision approvals executed in 1964. The Pikoiloa Tract Units 9 and 10 total 280 lots. Around the same time, Pohai Nani was opened in 1964 and is operated by the Evangelical Lutheran Good Samaritan Society, the largest non-profit operator of senior communities in the United States.

3.2 Previous Archaeological Research

A number of archaeological investigations have been conducted in Kāne‘ohe Ahupua‘a. This section provides a brief overview of the research and findings of previous archaeology in the general area surrounding the present project followed by a more detailed summary. Previous archaeological studies in the vicinity of the current project area are indicated on Figure 6 and are summarized in Table 1.

3.2.1 Previous Studies Adjacent to or Including Portions of the Project Area

3.2.1.1 McAllister

The earliest systematic archaeological coverage of Kāne‘ohe was by J.G. McAllister (1933) who recorded major sites throughout O‘ahu in the early 1930s. McAllister recorded a number of fishponds and other sites in the vicinity of the current project area (Figure 7). The following are brief descriptions of sites near the current project area (McAllister 1933 in Sterling and Summers 1978:210-221):

> Site 349. Waikalua Fishpond, adjacent to Waikalua, Kaneohe. The rebuilding of the pond has been completed. The wall was 1420 feet long of waterworn basalt 3 to 4 feet high but somewhat wider. The pond covers 11 acres.
>
> Site 350. Two ponds, Kailua side of Waikalua. The pond in use is said to be Keana with an area of 3.5 acres. According to Bell, the name of the other is Kalokohanahou. Its wall is broken. Both were built of waterworn basalt. The dirt-filled wall of Keana is wide enough for trees to grow on it.
>
> Site 351. Three adjacent ponds, located off the lands of Mikiola and Mahinui in Kaneohe. The two end ponds were probably built first, the middle pond being added later so as to take advantage of the walls of the other two. The pond on the east is known as Mahinui and that on the west as Mikiola. The name of the middle pond is Kaluoa, according to John Bell, but appears as Kapuu on a map in the Bishop Estate office. The wall of Mikiola is broken.
>
> Site 352. Ahukini Heiau, Keana, Kaneohe. A small structure, 70 by 127 feet, built on the top of an elevation 1200 feet from the sea…The only features remaining are the low walls, unusual because they are built of stones a few inches in size…most of the remains are scattered, for it is very easy for the cattle to disturb the small stones…When the drums at this *heiau* were beaten they could be heard over Kaneohe, but not just on the other side of the low ridge in Kailua.

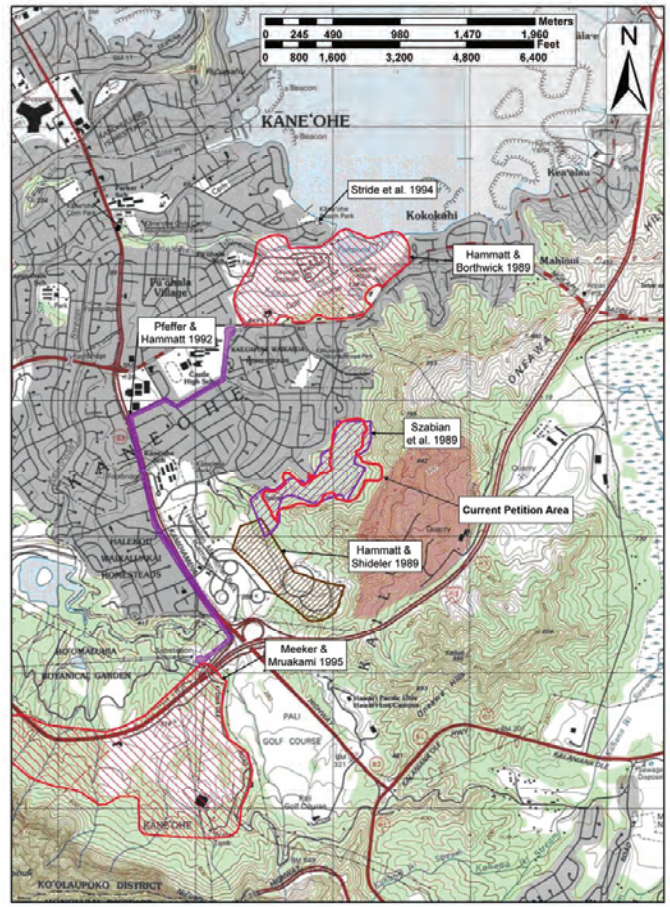

Figure 6. Portion of US Geological Survey Kāne‘ohe quad map showing locations of previous archaeological studies in the vicinity of the current petition area

Table 1. Previous Archaeological Studies in the Vicinity of Current Project Area

Reference	Type of Investigation	Location	Findings
McAllister 1933	Island-wide survey	Island wide	Identified 9 sites in the vicinity of the current project area, 3 of which were *heiau*
Sterling & Summers 1978	Island-wide survey	Island wide	Section concerning Kāne‘ohe includes legendary references to the naming of Kāne‘ohe and other sites and the descriptions of McAllister’s (1933) sites
Hammatt & Borthwick 1989	Archaeological Survey & Assessment	90-acre Bay View Golf Course Expansion	Documents Waikalua-loko and Waikalua fishponds
Hammatt & Shideler 1989	Archaeological Survey	Veterans Cemetery 90-acres	No significant finds
Szabian et al. 1989	Reconnaissance Survey	N & W facing slope of ridge separating Kailua and Kāne‘ohe	Describes 11 sites with 25 features, four pre-contact, seven post-contact & Kawa‘ewa‘e Heiau
Pfeffer and Hammatt 1992	Archaeological Assessment	Transmission Corridor mostly along Kamehameha Hwy.	No finds
Stride et al. 1994	Inventory Survey & Subsurface Testing	Waikalua Road (TMK 4-5-05: 1,2, 12-14) 3.3 acres at shoreline	No significant finds in eight backhoe trenches
Meeker & Murakami 1995	Archaeological Monitoring and Data Recovery Investigations	Ko‘olau Pali (TMK 4-5-42:1 and 6)	Seventeen sites investigated, of these, four were recommended for preservation. They include one set of dryland agricultural terraces, two open sites with lithic activity, and a single cluster of three stone mounds.

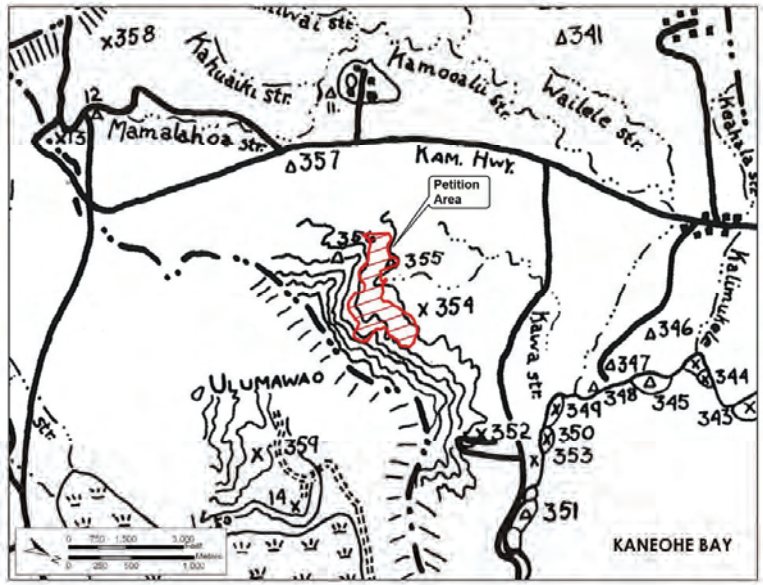

Figure 7. Portion of 1959 Bishop Museum map showing the locations of archaeological sites identified by McAllister (1933) in relation to the current petition area (adapted from Sterling and Summers 1978)

Site 353. A spring on the land known as Keana, called Kinikailua-Manokaneohe, as it is said that the people from both Kailua and Kaneohe died in great numbers from drinking its waters.

Site 354. Kawa‘ewa‘e Heiau, (see SIHP# 50-80-10-354 in Section 4.2)

Site 355. Small round hill, the name of which is not remembered, near the mountain side of Kawa‘ewa‘e Heiau. Said by John Bell to have been the location of a holua. This he saw destroyed when an attempt was made to plant pineapples in this section. Without doubt this is the site of the slide described by Bates in 1853.

Before reaching the mission station at Kaneohe, the road leads through a narrow but fertile ravine, tenanted by a few natives. In leaving the ravine, a low round hill, to the right of the path, is rather conspicuous from a long, narrow depression or channel on its side. It was an indication that one of the favorite games of the old Hawaiians had been played there. This game was called the holua, and was one of their favorite games of chance…

This same site was seen by Briggs in 1881:"Dewight pointed out to me a long narrow depression on some of the hills to be seen from our path, where old Hawaiians used to play one of their favorite games of chance".

Site 356. Puumakani Heiau, Kalapuhi, Waikalua, Kaneohe. This *heiau* was on the ridge facing the Nuuanu Pali, but the stones were removed and used for building a cattle corral farther down the slope. The heiau is said to have been built by Olopana

Site 357. Kamaikola across from the Japanese store at the first bridge beyond the end of Nuuanu Pali descent.

Many generations ago there lived at the foot of the Pali a Hawaiian of questionable habits. His name was Pakuanui and he lived on the land known as Kamaikola. Here he had his grass hut, the rock foundation of which was to be found only a few years ago. In one version of the story his wife used to b stationed at the head of the Pali to signal to her husband when but one or two travelers laden with goods descended the trail. Pakuanui waited in ambush, fell apon them with his spear, disposed of the bodies and appropriated the goods.

According to background research and historic maps, Site 355, the holua slide, was located in the southwestern portion of the project area. Site 354, Kawa‘ewa‘e Heiau borders the northern boundary and Site 356, Puumakani Heiau, was located near the southern boundary of the project area .

3.2.1.2 Szabian et al

From May 25 to June 3, 1989 Szabian et al. conducted an archaeological reconnaissance survey for the proposed Pikoiloa Cemetery. In addition to Kawa’ewa’a Heiau (SIHP -354), listed on the National Register of Historic Places since 1972, 11 sites were recorded with at least 25 associated features. Of these four were interpreted as pre-contact and seven as historic in nature. On the field map provided by Szabian et al. (1989:2) it appears that six of these sites are located within the current petition area (Figure 8). They include SIHP# -4680,- 4681, -4682, -4683, -4684, and 4686. Subsequent to the investigation conducted by Szabian et al. SIHP#’s -4681 and -4682 were determined to be outside the current petition area (Figure 10). In addition SIHP # 50-80-10-4682 was determined to be non-Cultural (see Section 4.1.4). All of the sites previously recorded by Szabian et al are summarized (Table 2).

3.2.2 Background Summary and Predictive Model

Kāne‘ohe Ahupua’a was intensively utilized during the pre-Contact period both as an agricultural and aquacultural center . Additionally, it was one of the primary population centers on O‘ahu (Devaney et al. 1976:6). Kawa‘ewa‘a Heiau, located in the vicinity of the project area, suggests the historical and archaeological importance of the area. Additionally, the oral tradition suggests that the area has had a long important history and was well known to many of the indigenous peoples.

Kāne‘ohe has long been viewed as a valuable *ahupua‘a* both in terms of agricultural and fishery productivity. In 1830 the chiefs of Hawai‘i, Maui, and O‘ahu, in a council meeting concerning the “late doings on Oahu”, referred to Kāne‘ohe as the “most valuable part” of the district of Ko‘olaupoko (Kamakau 1972:303). In the early 1900s, Kāne‘ohe Ranch came to dominate land holdings in the Kailua and Kāne‘ohe area. Included within this acreage is much ranch land, which had been bought, sold, let, and used as ranch land by numerous parties since the mid-1850s. Subsequently, the ranching and farming areas have been replaced by residential subdivisions.

Previous archaeological research has supported these indications with the documentation of Pre-contact ceremonial, habitational, and agricultural remains in the immediate vicinity of the project area (Szabian et al 1989). Additionally, historic background research has placed the Hawaiian Memorial Park Expansion project within an area employed for cattle ranching following indigenous Hawaiian settlement. Thus as a result of background research, expected finds during the archaeological inventory survey of the project area could include additional evidence of indigenous Hawaiian occupation and historic agriculture/ranching.

Table 2. Historic Properties identified in the Szabian et al. 1989 Archaeological Survey

SIHP # (50-80-10-)	# of Features	Formal Site Type	Probable Function	Estimated Age	Description
Historic Properties Located Within the Current Petition Area					
-4680	1	Terrace	Agricultural/Water control	Historic	Historic erosion control and water diversion terrace.
*** -4681**	5	Complex-Enclosures and Terracing	Agricultural/ Habitation	Pre-Contact	A habitation site consisting of several c-shaped structures, a terrace wall and a circular rock feature situated on a north-facing slope. This historic property is located outside of the petition area.
*** -4682**	0	Natural terracing, Platform	Natural	Non-Cultural	This is a series of natural "terraces" formed by lava rocks, which rolled down slope and were caught by exposed bedrock outcrops.
-4683	1	Pit feature	Charcoal kiln	Historic	Consists of a rectangular pit 3.6 m by 2.5 m and some natural terracing. The walls of the pit show evidence of burning, likely the remnants of a charcoal kiln or some similar processing area.
-4684	7	Complex-Enclosure, and Terracing	Habitation	Pre-Contact	Habitation site consisting of several c-shaped structures, a terrace wall, a circular rock feature and several house terraces.
-4686	1	Stone alignment	Boundary marker	Historic	This site consists of two features. Feature A is a rock alignment constructed of boulders running east/west parallel to a large stream cut. Feature B, previously described as a series of stone alignments, appears to have been badly disturbed due to landscaping and rubbish piling.

SIHP # (50-80-10-)	# of Features	Formal Site Type	Probable Function	Estimated Age	Description
Historic Properties Located in the Vicinity of the Current Petition Area					
4676	9	Complex of walls, stepped terracing	Agricultural and habitation	Pre-Contact	A site complex adjacent to KLEI radio tower along a tributary to the Kawa Stream.
4677	2	Wall remnant, earthen mound	Agricultural	Historic	Located adjacent to the Kawa Stream, it consists of a remnant stone wall and a large earthen mound.
4678	2	Wall remnant, earthen mound	Agricultural or habitation	Historic	Located approximately 70 m north of SIHP 4677. Consists of an alignment and a large earthen mound.
4679	1	Wall remnant	Boundary of habitation	Historic ?	Located at the base of the slope below KLEI radio tower and consisting of an L-shaped alignment of weathered basal stones.
4685	2+	Remnant walls, terracing	Habitation/ agricultural	Historic	Located on a ridge between two deep stream cuts consisting of a level terraced area with facing and an undetermined number of possible terrace facings downstream.

* Subsequent to the investigation conducted by Szabian et al. SIHP#'s -4681 and -4682 were determined to be outside the current petition area (Figure 10).

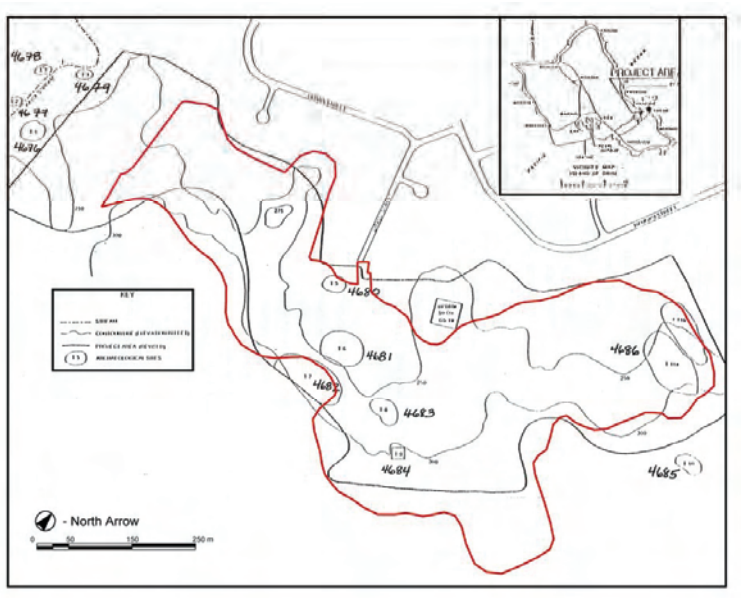

Figure 8. Map showing the current petition area (illustrated in red) in relation to that of Szabian et al (1989) (adapted from Szabian et al 1989:2).

Section 4 Results of Fieldwork

4.1 Survey Findings

The initial project area consisted of approximately 53 acres. Following the pedestrian inspection the boundaries of the Hawaiian Memorial Park Expansion project area were adjusted to include buffer zones for select archaeological resources identified along the periphery of the project area. As a result, an additional 13 acres was added to the project area to account for the lost acreage. The petition area defined for this report is approximately 56.6 acres. A total of 11 historic properties were recorded within or near the current petition area (Figure 9). Of these, one was previously recorded by McAllister (1933), SIHP # 50-80-10-354, and five were previously recorded by Szabian et al (1989), SIHP# s 50-80-10-4680, 50-80-10-4681, 50-80-10-4683, 50-80-10-4684, and 50-80-10-4686. The remaining five are new discoveries; these include SIHP #s 50-80-10-6929, 50-80-10-6930, 50-80-10-6931, 50-80-10-6932, and 50-80-10-6933. Four of the sites (SIHP-354, -4681, -6929 and -6931) are located outside of the current petition area but close enough for consideration. Also, a previously unrecorded feature associated with SIHP# 50-80-10-354 was recorded and a large grinding stone was discovered approximately 40 m (131 ft) south of SIHP # 50-80-10-4684. In addition SIHP # 50-80-10-4682, previously recorded by Szabian et al (1989) was determined to be non-Cultural and is not considered a historic property.

In most instances the historic properties previously recorded by Szabian et al (1989) were found in the general area as shown on their field map with the exception of SIHP #s -4683 and -4684 (Figure 10). We were unable to locate anything resembling the site descriptions in the indicated areas. CSH did however identify sites similar to the descriptions elsewhere within the project area. SIHP# 50-80-10-4683 was relocated approximately 80 m north of the location indicated on the Szabian et al (1989) map. Two sites were located resembling the description of SIHP# 50-80-10-4684, in this case the site closest to the original location plotted by Szabian et al (1989) was given this designation. The other, designated SIHP # 50-80-10-6930 also contains attributes similar to the site description recorded by Szabian et al (1989).

The individual historic properties are detailed in the following sections. The historic properties within the current petition area are presented first followed by the historic properties located outside of the petition area that are close enough for consideration. The previously identified historic properties include the original descriptions along with additional observations made by CSH.

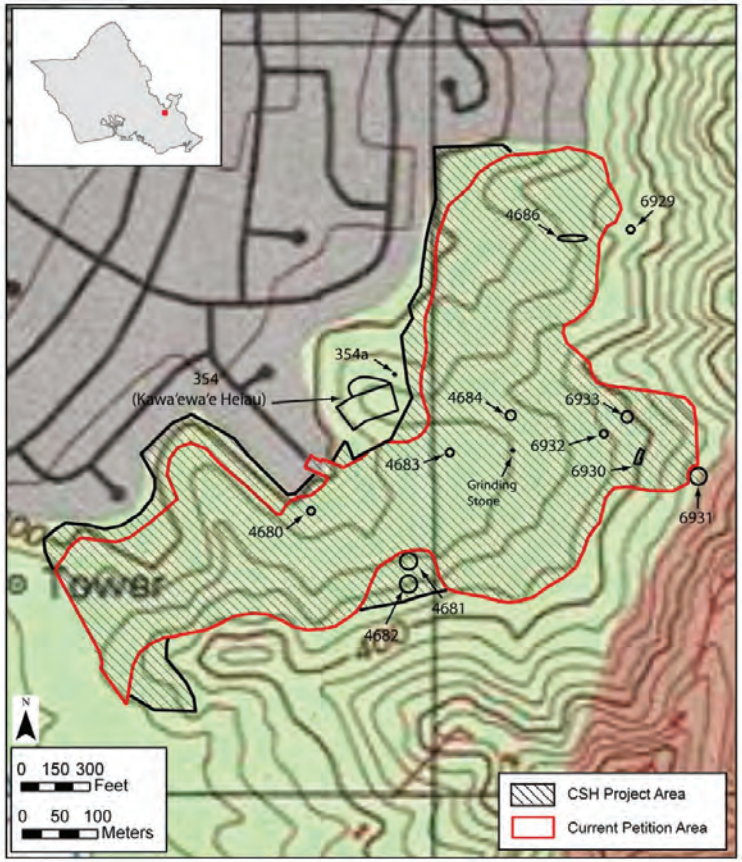

Figure 9. Portion of a USGS map showing all sites within the previous and current project areas.

Table 3. Sites identified within or near the petition area.

SIHP/CSH# (50-80-10)	Formal Site Type	Number of Associated Features	Probable Function	Estimated Age	Description
Historic Properties Located Within the Current Petition Area					
-4680	Terrace	1	Agricultural/ Water control	Historic	Historic erosion control and water diversion terrace.
-4683	Pit feature	1	Charcoal kiln	Historic	Consists of a rectangular pit 3.6 m by 2.5 m and some natural terracing. The walls of the pit show evidence of burning, likely the remnants of a charcoal kiln or some similar processing area.
-4684	Complex-Enclosure, and Terracing	7	Habitation	Pre-contact	Habitation site consisting of several c-shaped structures, a terrace wall, a circular rock feature and several house terraces.
-4686	Stone alignment	1	Boundary marker	Historic	This site consists of two features. Feature A is a rock alignment constructed of boulders running east/west parallel to a large stream cut. Feature B, previously described as a series of stone alignments, appears to have been badly disturbed due to landscaping and rubbish pilling from the Pohai Nani Retirement Community

-6930	Stone enclosure	1	Ceremonial	Pre-contact	This is a rectangular shaped stone enclosure oriented north /south with an irregular notch on the east wall. The dimensions are approximately 25 m n/s by 15 meters e/w.
-6932	Stone storage feature	1	Storage	Historic	This is a storage area dug out beneath a basalt boulder and lined with smaller stones. It is adjacent to an indeterminate drainage.
-6933	Pit feature with associated Stone wall	2	Charcoal kiln	Historic	This is a large circular pit, approximately 4 m in diameter with burned walls, likely the remnants of a charcoal kiln or some similar processing area. It is cut into a natural rise in the topography and includes a faced, two to three course stone wall fronting it on the northeast side.
Historic Properties Located in the Vicinity of the Current Petition Area					
-354	Enclosure, Platforms, Terraces	2+	Ceremonial	Pre-Contact	Kawa‘ewa‘e Heiau, this is on top of a small knoll and consists of one large enclosure 120 by 253 feet with a small terrace on the north side that follows the contours of the land. The walls average about 5 feet in width and 4 to 7 feet in height according to the contours of the land. This historic property is located outside of the project area.
-4681	Complex-Enclosures and Terracing	5	Agricultural/ Habitation	Pre-Contact	A habitation site consisting of several c-shaped structures, a terrace wall and a circular rock feature situated on a north-facing slope. This historic property is located outside of the petition area.

-6929	Quarry	2	Raw material collection	Pre-contact	Located along an intermittent drainage, this site consists of two concentrations of lithic debitage amid an abundance of basalt cobbles. This historic property is located outside of the petition area.
-6931	Stone alignments	2+	Ceremonial	Pre-contact	This is a possible ceremonial area located on a natural knoll between two intermittent drainages with a series of stone alignments on the slope. This historic property is located outside of the petition area.
Previously Recorded Historic Properties Considered Non-Cultural					
-4682	Natural terracing, Platform	0	Natural	Non-cultural	This is a series of natural “terraces” formed by lava rocks, which rolled down slope and were caught by exposed bedrock outcrops.

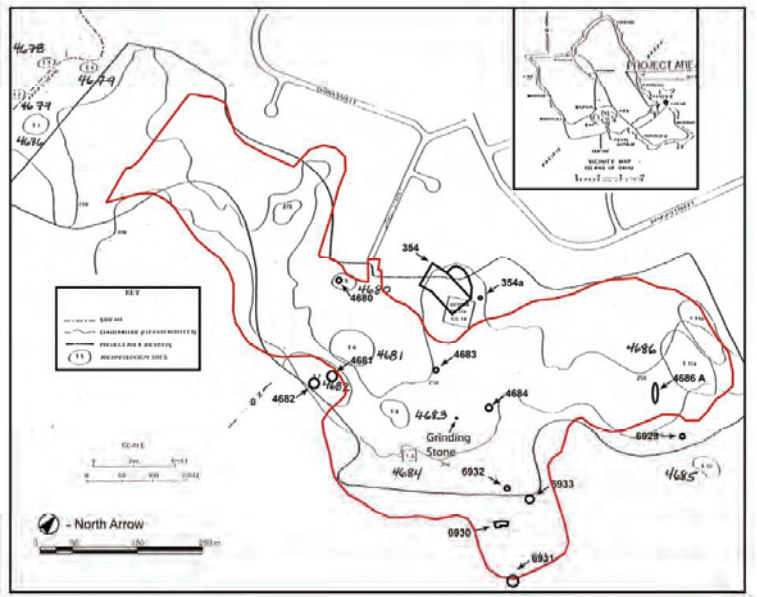

Figure 10. Map showing the current petition area (illustrated in red) and site locations in relation to the Szabian et al field map (adapted from Szabian et al 1989:2)

4.1.1 Historic Properties Located Within The Current Petition Area.

4.1.1.1 SIHP # 50-80-10-4680

FORMAL TYPE:	Terrace
FUNCTION:	Agriculture/water control
AGE:	Historic
# OF FEATURES:	1
DIMENSIONS:	5 meters north/south by 5 meters east/west
CONDITION:	Poor
UTM:	**GPS Point 1** **N**. 2366378 **E**. 625837
DESCRIPTION:	

Szabian et al (1989) described SIHP 50-80-10-4680 as:

> a rock concentration covered with Christmas berry approximately 5 m long and tumbling approximately 6 m down slope” (Szabian et al 1989: 11).

CSH has added the following descriptive attributes to SIHP 50-80-10-4680. It consists of a rock concentration forming a crude terraced structure (Figure 11 to Figure 13). The crude terrace retains a large amount of soil runoff that appears to have buried a portion of the site. The terrace forms the top of the hill and is adjacent to a water-cut ditch that drains into the larger drainage at the base of the hill

SIHP # -4680 is constructed of angular basalt cobbles stacked against a steeply sloping hill. The terrace wall is stacked 5 levels high (maximum height 125 cm) with 20 cm diameter cobbles. A crude alignment of boulders (55 cm diameter) extends east approximately 2 meters from the southeast corner. The southeast end is the best preserved with a poor facing exposed.

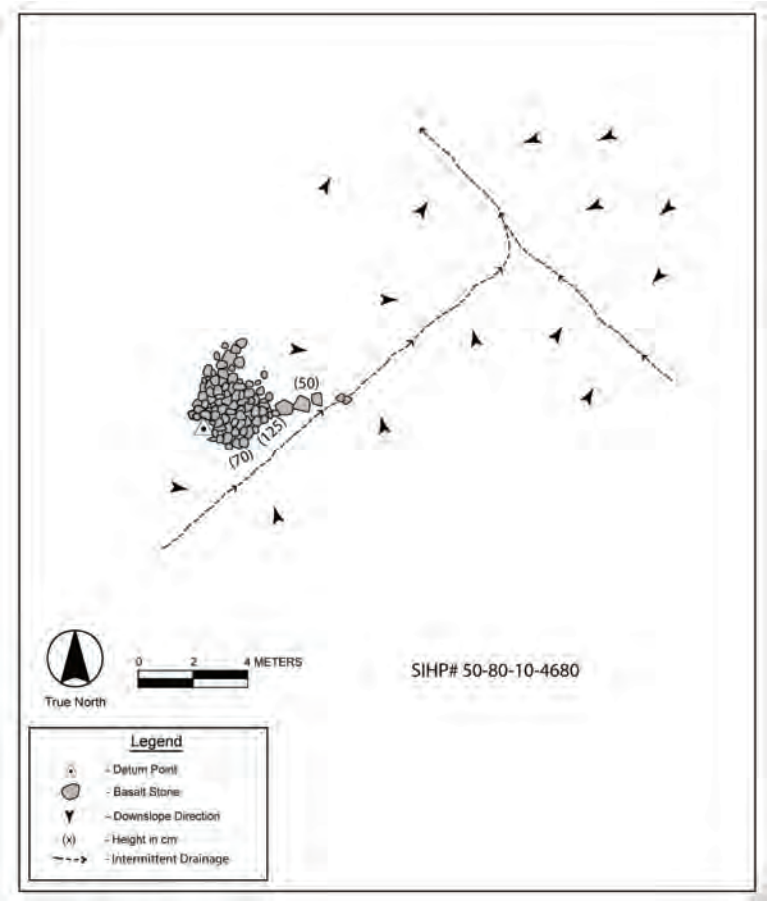

Figure 11. Plan view diagram of SIHP # 50-80-10-4680.

Figure 12. SIHP # 50-80-10-4680, overview of rock mound, view to the west.

Figure 13. SIHP # 50-80-10-4680, close-up of rock mound, view to west.

4.1.1.2 SIHP # 50-80-10-4683

FORMAL TYPE:	Pit feature
FUNCTION:	Charcoal kiln
AGE:	Historic
# OF FEATURES:	1
DIMENSIONS:	5 meters north/south by 5meters east/west
CONDITION:	Poor
UTM:	**GPS Point 1** **N**. 2366455.3 **E**. 626020.7
DESCRIPTION:	

SIHP# 50-80-10-4683 when first observed by Szabian et al (1989) was described as:

> Located on a fairly level area this site is comprised of two features: Feature A is an apparent excavation, rectangular in shape measuring 3.6 m by 2.5 m and approximately 0.7 m deep. Feature B is a series of terraces of undetermined extent (Szabian et al 1989:11)

The area shown on the Szabian field map was devoid of anything resembling the previous description. However during the subsequent survey work a rectangular excavation similar to the description of Feature A was observed approximately 80 m (262 ft) to the north (Figure 14 and Figure 15). The rectangular pit measuring 3.5 m by 2.5 m and 1.5 m deep, resembles a historic charcoal kiln. East of the rectangular pit is concentrated area of large stones and boulders similar to the description for Feature B (Figure 16). Random partial alignments among them may suggest man-made terracing but are most likely natural.

SIHP# 50-80-10-4683 is believed to be a historic site as charcoal production was a widespread industry in Windward O‘ahu during the later part of the 19th and early part of the 20th century. Remnant charcoal kilns have been extensively documented in a number of archaeological investigations conducted in Kāne‘ohe and He‘eia. For a thorough discussion of these types of features the reader is referred to Meeker (1995), Dockall (et al. 2003), and Allen (1987).

The following text from Meeker (1995:98-99) describes the construction and firing techniques of earth-covered pit kilns from developing countries and highlights the similarities between Feature A and documented non-industrial charcoal kilns:

> The earth-covered pit kiln is another traditional method of charcoal making still practiced in the developing countries. Booth (1983:50) describes it as the “equivalent of a mound but below ground level.” In size, it could range from an excavated hole of about 1 or 2 m^3 to a hillside pit measuring 4 m in diameter. Dug into the slope, the side and rear walls of the pit are formed by vertical cuts in the natural earth. Sometimes the walls are reinforced by a brick or stone lining. There

> may be an air vent or flue cut into the rear wall. Emrich (1985:24) further notes that “after loading, the pit is covered with a layer of leaves normally 20 cm thick and on top with a layer of soil of the same thickness.”

SIHP# 50-80-10-4683 is located in a relatively level area currently utilized by unauthorized paintball enthusiasts (Figure 17). Makeshift wooden barricades have been constructed; the area is littered with expended air cartridges and colorful splatter patterns on the surrounding vegetation.

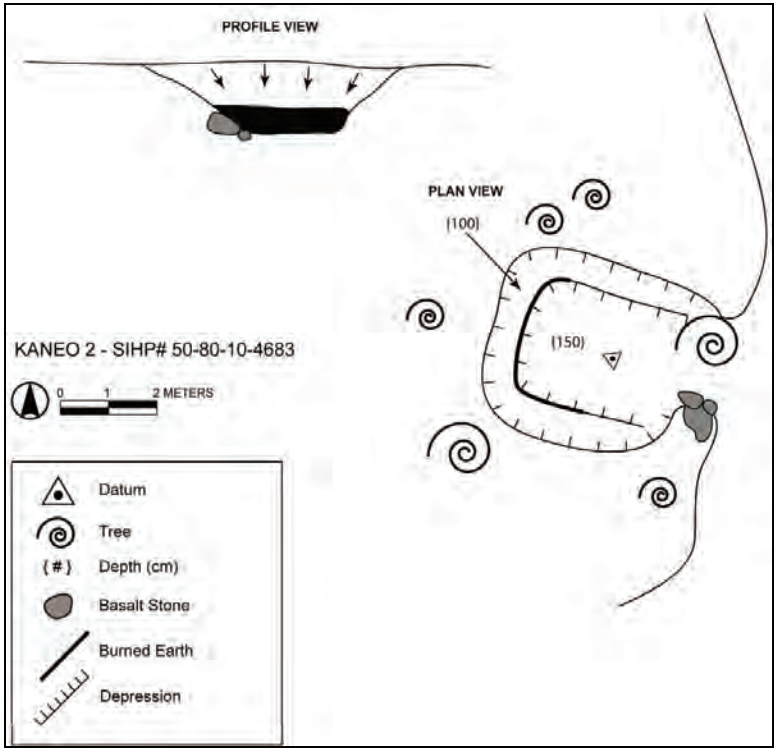

Figure 14. Plan view and profile of SIHP # 50-80-10-4683.

Figure 15. SIHP# 50-80-10-4683, rectangular excavation viewed from the east.

Figure 16. SIHP# 50-80-10-4683, natural terracing viewed from the east.

Figure 17. Picture showing SIHP# 50-80-10-4683 in relation to the unauthorized paintball area.

4.1.1.3 SIHP # 50-80-10-4684

FORMAL TYPE:	Complex- Enclosures & terracing	
FUNCTION:	Habitation	
AGE:	Pre-Contact	
# OF FEATURES:	7	
DIMENSIONS:	33 meters north/south by 56 meters east/west	
CONDITION:	Good	
UTM:	**GPS Point 1**	**N**. 2366505 **E**. 626104.3
	Grinding Stone	**N**. 2366454.4 **E**. 626104.7
DESCRIPTION:		

Szabian et al (1989) described this historic property as:

> Located on a small knoll between streambeds, this large multiple terraced structure is topped by a stacked freestanding wall on three sides, with the fourth wall incorporated into the slope. The overall size of the enclosure is approximately 25 by 18 m with walls averaging slightly over 1 m wide and 0.7 m high. The structure is comprised of stacked subangular weathered basalt cobbles and boulders. The facings of the north and west walls are intact, with the lower terrace steps collapsed. The level area within the enclosure appears to be soil filled and no surface features were evident. Possible terrace structures were encountered downslope approximately 20 m to the west.

As mentioned previously, the location depicted on the Szabian field map was devoid of anything resembling the previous description. However during the subsequent survey a site was observed approximately 150 m north that shared similar attributes to the available description.

SIHP# 50-80-10-4684 is a habitation site consisting of several c-shaped structures, a terrace wall, a circular rock feature and several house terraces, seven features in all (Figure 18). To the east, west and south of the complex is a badly disturbed area. The site is situated on a west-facing slope with vegetation consisting of dense canopy of large trees and an understory of laua‘e fern. An intermittent drainage borders the site to the east and south. Two 1x 1 m (3.3 x 3.3 ft.) test units were excavated in order to gather more information as to the function of this site. A detailed summary is available in the following section. Additionally, a large grinding stone was discovered approximately 40 m south of SIHP# 50-80-10-4684.

Feature A is an enclosure consisting of stacked basalt walls, the eastern corner is the highest standing approximately 45 cm above the ground surface. (Figure 19). The north wall measures 7 meters with the disturbed NW corner having little to no height; the west wall measures 4.2 meters, and is badly disturbed with no height. The east collapsed wall measures 7.5 meters by 40 cm high, and the southern wall measures 7 by 3.5 meters. The interior of the enclosure provides a

space of approximately 5 by 7 meters and is mostly soil with scattered rocks. A 1 by 1 meter test unit (TU1) was placed inside Feature A in the eastern corner.

Feature B is a stacked basalt cobble/boulder terrace wall located southwest of Feature A (Figure 20). It measures 19 meters long running at 262 degrees east of north and ranges in height from 0 to 80 cm.

Feature C is a stacked basalt cobble and boulder wall forming an “L” shaped terrace with the long segment measuring 20 meters oriented at 333 degrees and the shorter segment measuring 7 meters oriented at 252 degrees (Figure 21). This feature appears to be mostly collapsed, with the highest portion at 50 cm. It encloses 3 apparent c-shaped features and a possible hearth.

Feature D is a c-shaped feature consisting of basalt boulders and large cobbles (Figure 22). It measures 4 by 3.5 meters and opens to the southwest.

Feature E is a circular rock feature, possibly a hearth, measuring 2.3 meters in diameter and 30 cm in height (Figure 23). It is located near the 3 c-shaped habitation structures (Features D, F and G).

Feature F is a c-shaped feature consisting of basalt boulders and large cobbles. It measures 4 by 4 meters and opens to the southwest (Figure 24). Contiguous to the southwest is Feature C and about 4.5 meters to the northwest is Feature E. A 1 by 1 meter test unit (TU2) was placed in the middle of Feature F.

Feature G is a highly eroded c-shaped feature (damaged from unknown processes) consisting of basalt boulders and large cobbles (Figure 25). It is located about 6 meters NW of Feature F, about 3 meters north of Feature E. Feature G measures approximately 4 meters in diameter and a single course of cobbles/boulders is intermittently present along its circumference.

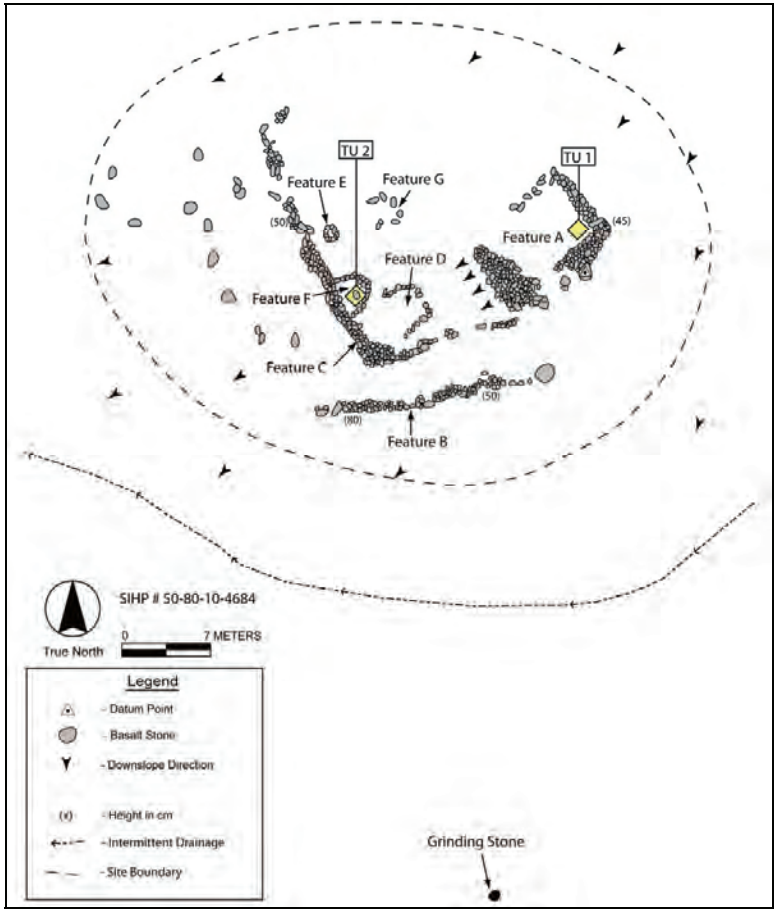

Figure 18. Plan view diagram of SIHP# 50-80-10-4684 showing the location of Test Units 1 &2 as well as a grinding stone discovered south of the site proper.

Figure 19. SIHP# 50-80-10-4684 Feature A, house structure, view to the northeast.

Figure 20. SIHP# 50-80-10-4684 Feature B, basalt cobble/ rock terrace wall, view to the north.

Figure 21. SIHP# 50-80-10-4684 Feature C, basalt boulder and cobble wall, view to the north.

Figure 22. SIHP# 50-80-10-4684 Feature D, c-shaped rock feature, view to the southwest.

Figure 23. SIHP# 50-80-10-4684 Feature E, circular rock feature, possible hearth, view to east.

Figure 24. SIHP# 50-80-10-4684 Feature F, c-shaped rock feature, view to the northeast.

Figure 25. SIHP# 50-80-10-4684 Feature G, c-shaped rock feature.

4.1.1.3.1 Test Excavations Findings

A total of two 1 x 1 m test units were excavated at SIHP# 50-80-10-4684. Test Unit #1, was excavated in the eastern portion of Feature A. Test Unit # 2 was located within Feature F, along the southeastern wall.

4.1.1.3.1.1 Test Unit 1

The test excavation was located in the eastern corner of the enclosure (Figure 26 to Figure 30). The test unit was excavated to a terminal depth of 35 cmbs (13.7 in). A total of three strata were observed, Stratum I was very dark brown, clay loam sediment composed of leaf litter and humus accumulated on and within the basalt stones, mixing with the clay soil below. Stratum II consisted of a dark reddish brown silty clay generally represented soils developed from material filtering down through Feature A’s construction. Stratum III was dark red silty clay consisting of saprolite developed from the decomposition of the underlying basalt bedrock. The test excavation terminated at sterile Stratum III sediments.

A total of four artifacts were recovered from the excavation, three basalt flakes and a small piece of brown bottle glass. Two of the basalt flakes were recovered from between 10 and 20 cmbs (4-8 in). The remaining flake and a single piece of brown bottle glass were recovered from 20 to 30 cmbs (8-11.8 in). All artifacts were recovered from Stratum II.

4.1.1.3.1.2 Test Unit 2

The test excavation was placed within Feature F, along the southeastern wall (Figure 31 to Figure 35). The test unit was excavated to a terminal depth of 40 cmbs (15.7 in). The stratigraphy was similar to Test Unit 1. Stratum I was very dark brown, clay loam with greater than fifty percent basalt stone inclusions. Stratum II consisted of a dark reddish brown silty clay and Stratum III was dark red silty clay. The test excavation terminated at sterile Stratum III sediments. No artifacts were recovered from this excavation.

Figure 26. Pre-excavation picture of Test Unit 1.

Figure 27. Post-excavation picture of Test Unit 1.

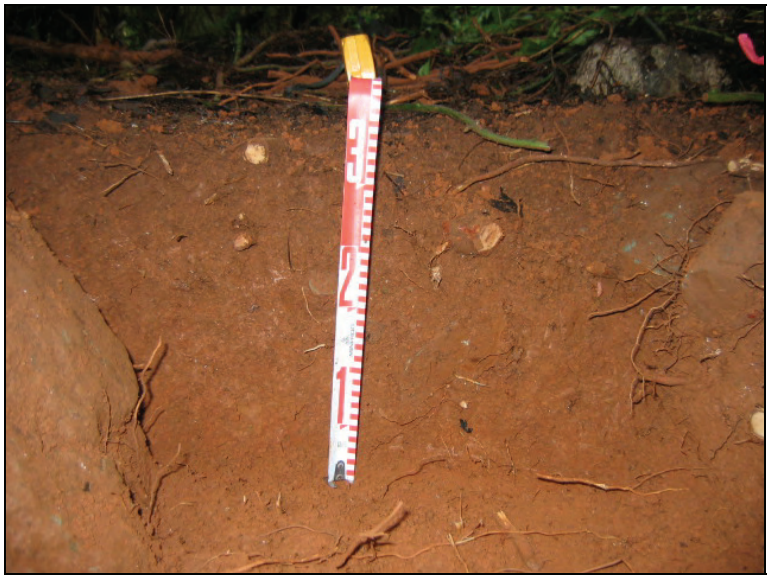

Figure 28. Picture of the northeast profile, Test Unit 1.

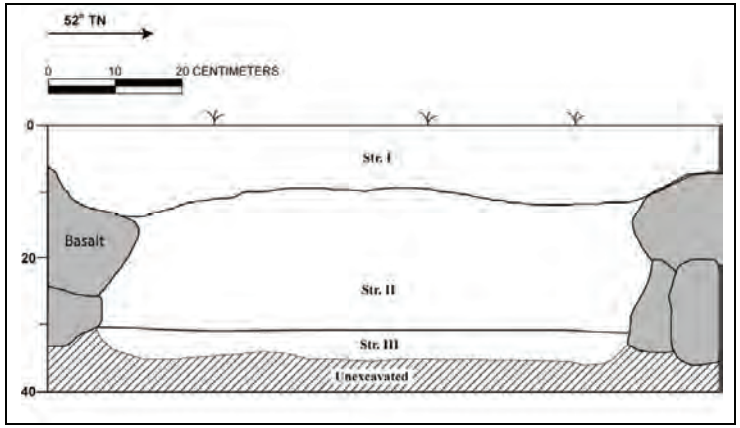

Figure 29. Drawing of the northeast profile, Test Unit 1.

Table 4. Soil description of Test Unit 1.

Stratum I: 0-14 cmbs	7.5 YR 2.5/3 very dark brown clay loam with a strong, fine, blocky structure. Firm moist consistency, slightly plastic with no cementation. Terrestrial origin with an abrupt boundary and smooth topography.
Stratum II: 9-30 cmbs	2.5 YR 3/6 dark red silty clay with a strong, fine, blocky structure. Very firm moist consistency, slightly plastic with no cementation and terrestrial origin.
Stratum III: 30-35 cmbs	2.5 YR 3/6-4/6 dark red silty clay with a very fine and medium subangular blocky structure. Hard dry consistency, plastic and a gradual wavy boundary.

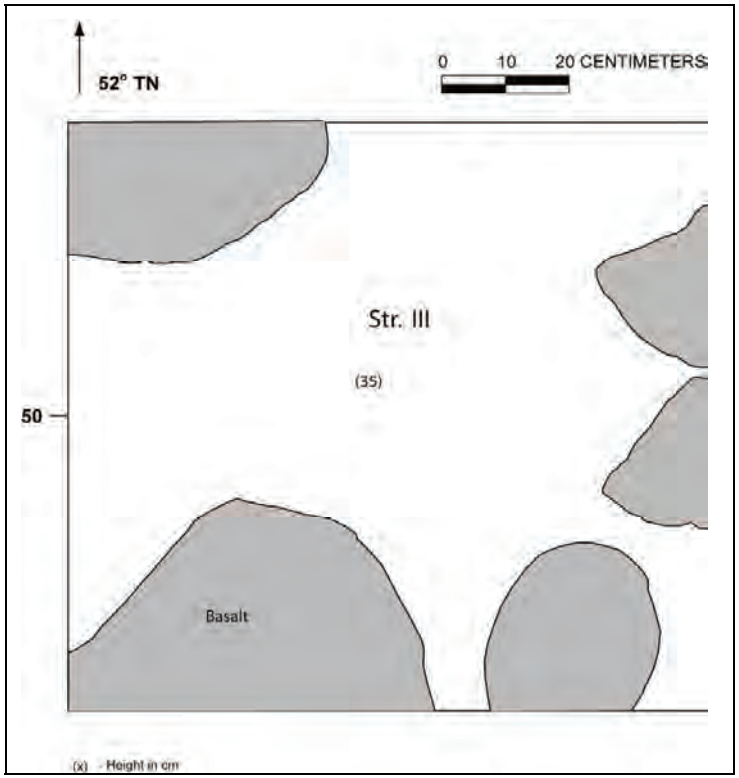

Figure 30. Post excavation plan view of Test Unit 1.

Figure 31. Pre-excavation picture of Test Unit 2.

Figure 32. Post-excavation picture of Test Unit 2

Figure 33. Picture of the southeast profile, Test Unit 2.

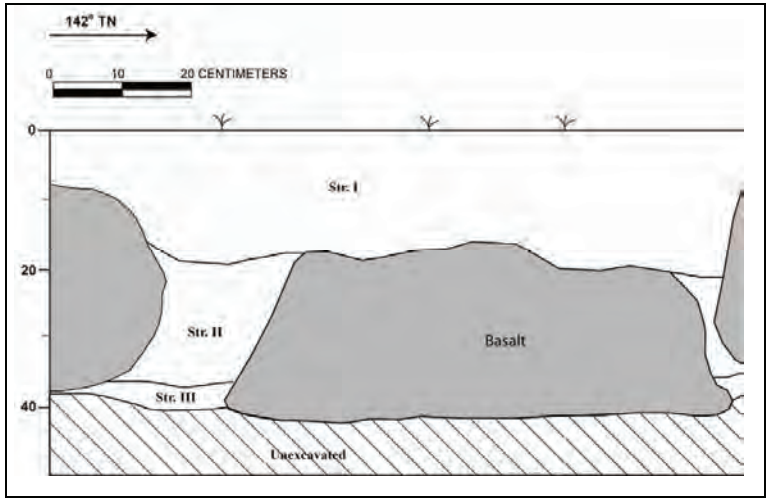

Figure 34. Drawing of the southeast profile, Test Unit 2.

Table 5. Soil description of Test Unit 2.

Stratum I: 0-20 cmbs	7.5 YR 2.5/3 very dark brown clay loam with a strong, fine, blocky structure. Firm moist consistency, slightly plastic with no cementation. Terrestrial origin with an abrupt boundary and smooth topography.
Stratum II: 14-37 cmbs	2.5 YR 3/6 dark red silty clay with a strong, fine, blocky structure. Very firm moist consistency, slightly plastic with no cementation and terrestrial origin.
Stratum III: 35-40 cmbs	2.5 YR 3/6-4/6 dark red silty clay with a very fine and medium subangular blocky structure. Hard dry consistency, plastic and a gradual wavy boundary.

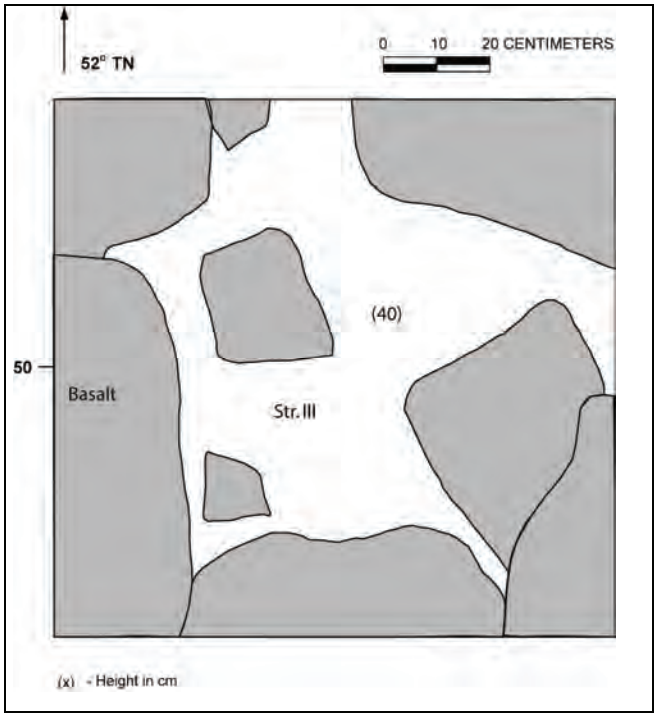

Figure 35. Post-excavation plan view of Test Unit 2

4.1.1.3.2 Grinding Stone

An isolated artifact was discovered approximately 40 m south of Feature B, a large grinding stone (Figure 36 to Figure 38). The stone is 60 x 45 cm (24 x 18 in) with an oval 48 x 33 cm (19 x 13 in) depression approximately 2 cm deep ground into it. No other artifacts or features were observed in the immediate vicinity. It is located in an area with abundant basalt stone and natural terracing.

Figure 36. Picture of the grinding stone oriented northeast.

Figure 37. Picture of the grinding stone oriented northwest.

Figure 38. Picture showing the grinding stone oriented north.

4.1.1.4 SIHP # 50-80-10-4686

FORMAL TYPE:	Stone Alignment
FUNCTION:	Boundary Marker
AGE:	Historic
# OF FEATURES:	2
DIMENSIONS:	50 meters east/west by approx. 1 meter north/south
CONDITION:	Fair
UTM:	**GPS Point 1** **N**. 2366741 **E**. 626185.3
DESCRIPTION:	

SIHP# 50-80-10-4686 consists of two features (Figure 39). The resource was previously identified by Szabian et al (1989) who provide the following description:

> Feature A is located adjacent to a large stream and dominated by a very large mango tree. This feature contains many alignments and an approximately 50.0 m long collapsed wall of angular basalt. There is a modern chicken coop to the north (Szabian et al 1989:13).
>
> Feature B, located adjacent to the Pohai Nani Care Center has a series of alignments and an abandoned modern chicken coop. There are large mango trees in the area and a great deal of discarded historic rubbish (Szabian et al 1989:13).

SIHP# 50-80-10-4686 Feature A is constructed of boulders (approximately 60 cm in diameter) running east/west parallel to a large stream cut (Figure 40). There are several natural alignments running across the slope, which consist of boulders ranging from 60-200 cm in diameter.

SIHP# 50-80-10-4686 Feature B appears to have been badly disturbed due to landscaping and rubbish piling (Figure 41 and Figure 42). The modern chicken coop and large mango trees described by Szabian et al (1989:13) were located. The site probably represents historic to modern use of the area by nearby residents.

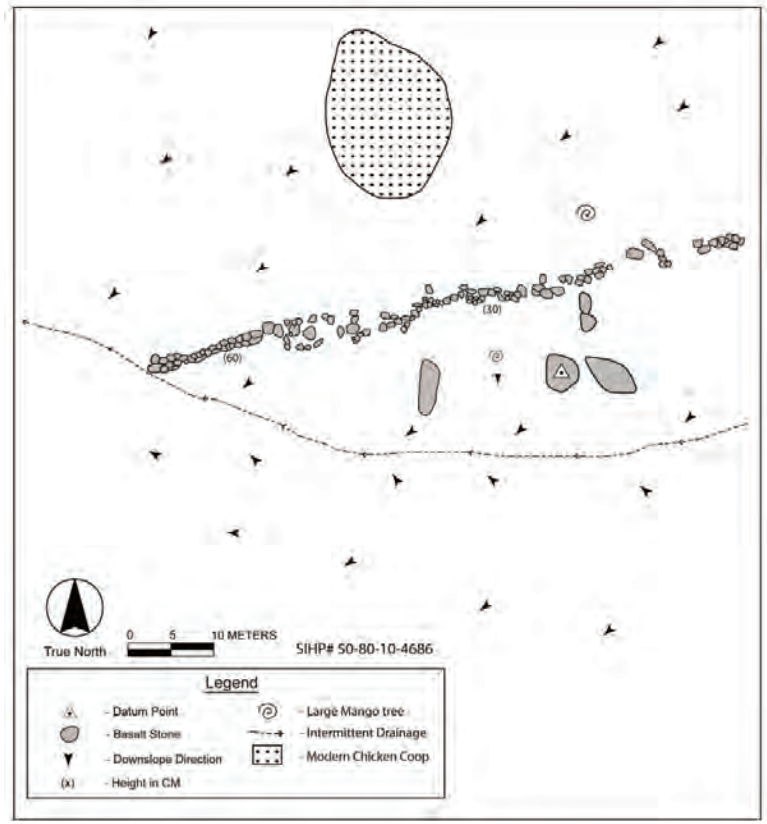

Figure 39. Plan view diagram of SIHP # 50-80-10-4686 Feature A, rock alignment.

Figure 40. SIHP# 50-80-10-4686 Feature A, boulder alignment, view to the southwest

Figure 41. SIHP# 50-80-10-4686 Feature B, disturbed area, view to the south.

Figure 42. SIHP# 50-80-10-4686 Feature B, rubbish area, view to the northwest.

4.1.1.5 SIHP # 50-80-10-6930

FORMAL TYPE:	Stone Enclosure
FUNCTION:	Ceremonial
AGE:	Pre-Contact
# OF FEATURES:	1
DIMENSIONS:	Approximately 22 m north /south and 14 m east/west.
CONDITION:	Good
UTM:	**GPS Point 1** **N**. 2366457.2 **E**. 626281.3
	GPS Point 2 **N**. 2366447.3 **E**. 626275.7
	GPS Point 3 **N**. 2366440.1 **E**. 626275.2
	GPS Point 4 **N**. 2366440.1 **E**. 626266.9
	GPS Point 5 **N**. 2366461.7 **E**. 626275.7

DESCRIPTION:

SIHP# 50-80-10-6930 is a rectangular shaped enclosure with an irregular notch on the east side of the structure that gives it an L shaped appearance (Figure 43). The structure is constructed on the east aspect of a slope with an intermittent drainage immediately to the south and another approximately 20 m (66 ft) to the north. Although trees and erosion have caused some collapse (Figure 44), the integrity of the structure is considered good (Figure 45). West of the notch, inside of the structure there are remnants of a possible paved surface (Figure 46). Several stone tools were observed in the general site vicinity (Figure 47). The effort expended on the construction seems excessive for a habitation and is more consistent with that of a ceremonial structure.

SIHP# 50-80-10-6930 is constructed of stacked basalt cobble/boulders four to five courses high. The enclosure measures approximately 14 m E/W by 22 m N/S with a total area of 256 m², on the outside. The north, south, and west walls are stacked freestanding walls. The eastern wall is built into the slope. The height of the outside walls ranges from approximately 30 cm in the NE corner to 1.54 m in the SW corner. The inside of the structure measures approximately 10.5 m E/W and 15.5 m N/S with a total area of 149 m². The wall height on the inside of the enclosure ranges from 72 cm at the north wall to 96 cm in the SE corner.

There is a commanding view to the north and west of the valley below SIHP# 50-80-10-6930, now dominated by alien/introduced vegetation such as Christmas berry (*Schinus terebinthifolius)*, *he‘e* - octopus tree (*Schefflera actinophylla)*, Java plum (*Syzygium cumini*) and lemon and strawberry guava (*Psidium guajava, Psidium cattleianum*). In the absence of the dense vegetation Kawa‘ewa‘a Heiau would be visible as it is only 320 m (1050 ft) west and over 50 m (164 ft) lower in elevation.

Based on the dimensions and features SIHP# 50-80-10-6930 is more characteristic of a ceremonial structure than a habitation. The interpreted function of this structure can only be inferred. (See summary, Section 5, for detailed discussion).

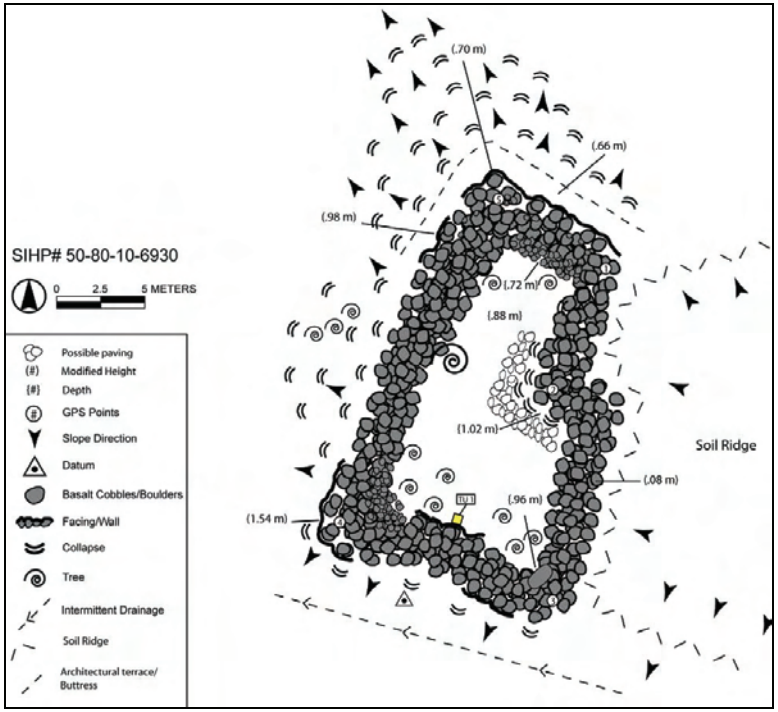

Figure 43.Plan view of SIHP# 50-80-10-6930.

Figure 44. The northwest corner of SIHP# 50-80-10-6930.

Figure 45. A portion of the west wall of SIHP# 50-80-10-6930.

Figure 46. The area west of the notch along the east wall.

Figure 47. An example of the stone tools observed in the general site vicinity.

4.1.1.5.1 Test Excavation Findings

A single exploratory 30 x 30 cm (12 x 12 in) test unit was excavated inside the enclosure against the southern wall to determine its vertical boundary and to obtain a soil profile.

4.1.1.5.1.1 Test Unit 1

Test Unit 1 was excavated to a depth of 37 cmbgs (14.5 in). A total of three strata were observed, Stratum I was dark brown, clay loam sediment composed of leaf litter and humus. Stratum II consisted of a strong brown silty clay and Stratum III was yellow red clay (Figure 48 and Figure 49).The wall of the enclosure continues at least one course, 20 cm (7.9 in) below the ground surface. No artifacts or cultural features were observed during this excavation.

Figure 48. A picture of the south wall of Test Unit 1, SIHP# 50-80-10-6930.

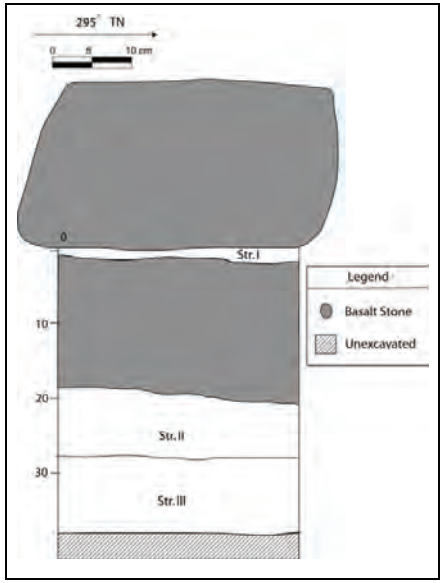

Figure 49. A profile drawing of the south wall of Test Unit 1, SIHP# 50-80-10-6930.

Table 6. Soil description of Test Unit 1.

Stratum I: 0-9 cmbs	7.5 YR 3/2 dark brown clay loam with a moderate, medium, blocky structure. Firm moist consistency, slightly plastic with no cementation. Terrestrial origin with an abrupt boundary and smooth topography.
Stratum II: 9-27 cmbs	7.5 YR 4/6 strong brown clay loam with a moderate, fine, blocky structure. Firm moist consistency, slightly plastic with no cementation and terrestrial origin with an abrupt boundary and smooth topography.
Stratum III: 27-37 cmbs	5 YR 4/6 yellow red clay with a moderate, medium, blocky structure. Hard dry consistency, plastic with no cementation. Terrestrial origin with an abrupt boundary and smooth topography.

4.1.1.6 SIHP # 50-80-10-6932

FORMAL TYPE:	Stone storage feature
FUNCTION:	Storage
AGE:	Historic
# OF FEATURES:	1
DIMENSIONS:	Approximately 4 m north /south and 4 m east/west.
CONDITION:	Good
UTM:	**GPS Point 1** **N**. 2366481.6 **E**. 6262229.2
DESCRIPTION:	

SIHP# 50-80-10-6932 is a possible storage area beneath a boulder (Figure 50 and Figure 51) 5 m southeast of an intermittent drainage. The floor inside is lined with small basalt cobbles and the rear of the inside is blocked off by medium sized basalt cobbles. This site is approximately 33 m southwest of SIHP# 50-80-1-6933, a post-contact charcoal kiln.

A single historic bottle was observed on the east side of the storage feature. The manufacturers mark, A B G M Co., indicates that it was a product of the Adolphus Bush Glass Manufacturing Co circa 1886 to 1928. The beer bottle was produced in Belleville, Illinois between 1886 and 1907 or St. Louis Missouri between 1904 and 1928 (Toulouse 1971:26).

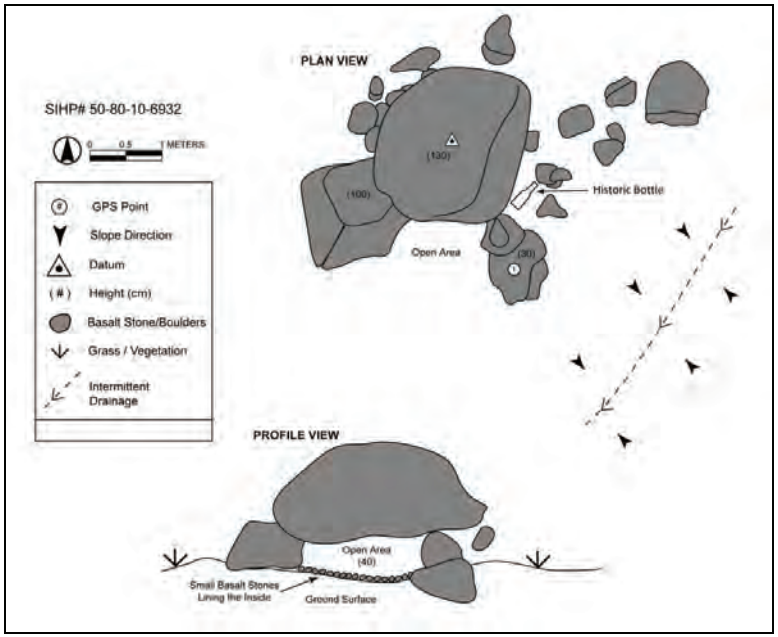

Figure 50. Plan view and profile of SIHP# 50-80-10-6932.

Figure 51. SIHP# 50-80-10-6932 viewed from the south.

4.1.1.7 SIHP # 50-80-10-6933

FORMAL TYPE:	Pit feature with associated stonewall
FUNCTION:	Activity area
AGE:	Historic(uncertain)
# OF FEATURES:	2
DIMENSIONS:	Approximately 8 m north /south and 10 m east/west.
CONDITION:	Fair
UTM:	**GPS Point 1** **N**. 2366507.1 **E**. 626254.1
	GPS Point 2 **N**. 2366503.8 **E**. 626256.3
DESCRIPTION:	

SIHP# 50-80-10-6933 is a large circular pit, approximately 4 m in diameter with burned walls. It is cut into a natural rise in the topography and includes a faced, two to three course stone wall on the northeast side (to). Currently 1.5 m in depth, the maximum depth is unknown at this time as it has been subject to slumping and erosion. Similar to SIHP 4683 this appears to be another historic charcoal kiln.

The following text from Meeker (1995:98-99) describes the construction and firing techniques of earth-covered pit kilns from developing countries and highlights the similarities between SIHP# 50-80-10-6933 and documented non-industrial charcoal kilns:

> The earth-covered pit kiln is another traditional method of charcoal making still practiced in the developing countries. Booth (1983:50) describes it as the “equivalent of a mound but below ground level.” In size, it could range from an excavated hole of about 1 or 2 m^3 to a hillside pit measuring 4 m in diameter. Dug into the slope, the side and rear walls of the pit are formed by vertical cuts in the natural earth. Sometimes the walls are reinforced by a brick or stone lining. There may be an air vent or flue cut into the rear wall. Emrich (1985:24) further notes that “after loading, the pit is covered with a layer of leaves normally 20 cm thick and on top with a layer of soil of the same thickness.”

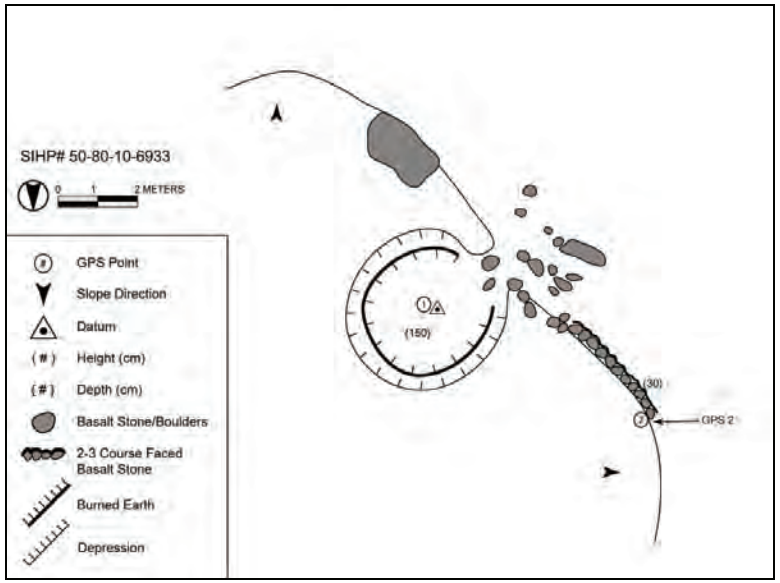

Figure 52. Plan view of SIHP# 50-80-10-6933

Figure 53. SIHP# 50-80-10-6933 faced stone alignment viewed from the east.

Figure 54. SIHP# 50-80-10-6933 pit feature viewed from the east.

4.1.2 Historic Properties Located in the Vicinity of the Current Petition Area.

4.1.2.1 SIHP # 50-80-10-354 (Kawa‘ewa‘e Heiau)

FORMAL TYPE:	Enclosure, platforms, terrace.	
FUNCTION:	Ceremonial	
AGE:	Pre-Contact	
# OF FEATURES:	2+	
DIMENSIONS:	36.5 m N/S by 77 m E/W	
CONDITION:	Good	
UTM:	**SE Corner**	**N**. 2366511.9 **E**. 625951.9
	NE Corner	**N**. 2366547.5 **E**. 625942.1
	S Corner	**N**. 2366485.4 **E**. 625892.4
	W Corner	**N**. 2366516 **E**. 625869.5
	Feature A	**N**. 2366559.3 **E**. 625949.4

DESCRIPTION:

SIHP 50-80-10-354, Kawa‘ewa‘a Heiau (Figure 55), is located approximately 30 m (100 ft) west of the current project area on the Kaneohe side of the ridge that divides Kaneohe and Kailua (Oneawa Hills). It has been on the National Register of Historic Places (NHRP) since 1972. Kawa‘ewa‘a Heiau is a *luakini* type heiau, commissioned by the king and associated with human and animal sacrifice (Malo 1898:159). J. G. McAllister (1933) recorded this site during his survey of the major sites of O‘ahu in the 1930’s noting:

> This is one of the five heiau said by John Bell to have been erected by Olopana. Ahukini, Pahukini, Holomakani, and Puumakani are the other four. It is on top of a small knoll and consists of one large enclosure 120 by 253 feet (35.5 x 77 m) with a small terrace on the north side which follows the contours of the land. As the structure was used as a cattle pen for many years any traces of heiau features have been obliterated, and it is not known where the opening to the heiau was situated. The walls are massive, averaging about 5 feet in width and from 4 to 7 feet in height according to the contours of the land. The inside corners of the wall are rounded; the outside corners appear more angular.
>
> Thrum notes that this heiau was “Built by Olopana about the opening of the 12th century”. It was mentioned as one of the heiaus constructed by the menehunes. Lonoaohi is said to have officiated as high priest.

> This is the heiau to which Olopana had Kamapuaa brought for sacrifice. Through treachery Kamapuaa is said to have killed Olopana and escaped (McAllister 1933:179-180).

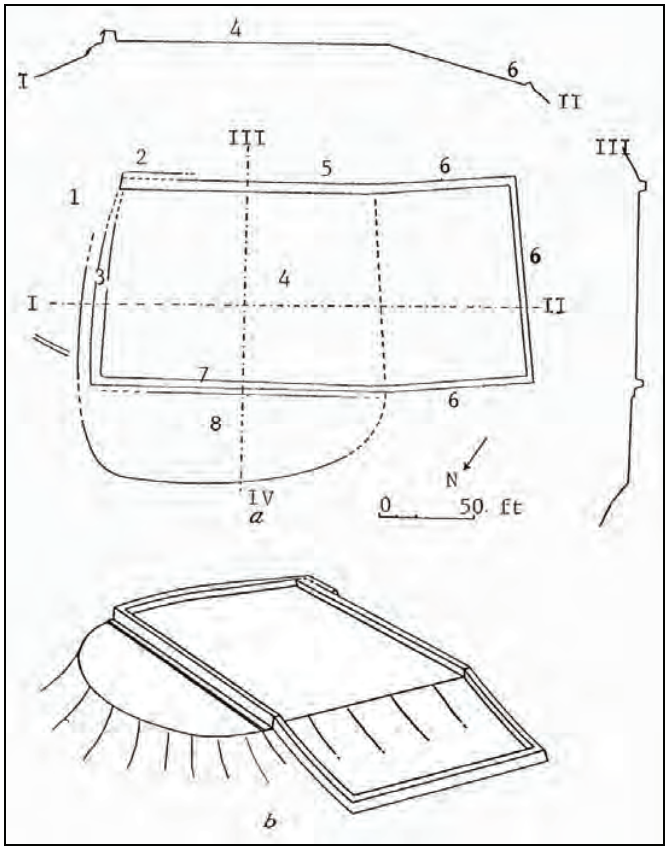

Figure 55. Kawa‘ewa‘e Heiau (adapted from McCallister 1933:180)

A local informant, Mr. Charlie Ogata, member of the Queen Emma Hawaiian Civic Club, mentioned a stone structure outside of the *heiau* at the base of the northern corner (Figure 56). The structure has been designated Feature A. This is rectangular, stacked stone structure that measures approximately 3 m north/south and 6 m east/west (Figure 57). There are three separate sections within the structure. The largest, designated section 1 (Figure 58), is oval in shape and makes up the eastern side measuring approximately 4 m by 2.5 m. Section 2 (Figure 59), more round than oval, is approximately 1.5 m by 2.5 m and makes up the western portion of the feature. Section 3 is a smaller C shaped portion along the southern boundary of Section 1 measuring approximately 1 m by 0.4 m. The function of this structure is indeterminate.

Another concern of Mr. Ogata was the presence of *lua* (burial pits) in the vicinity of Kawa‘ewa‘a Heiau as it is a *luakini* type heiau, commissioned by the king and associated with human and animal sacrifice (Malo 1898:159). The complete testimony of Mr. Ogata is available in the Cultural Impact Assessment (Gollin et al 2008) that accompanies this report.

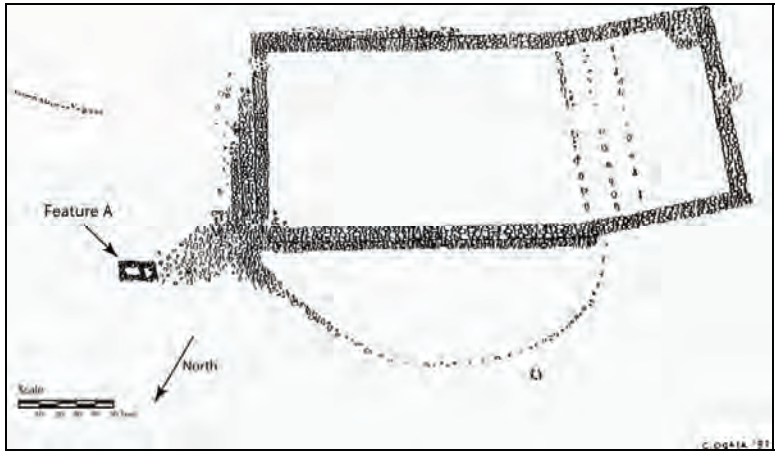

Figure 56 A sketch of Kawa‘ewa‘e Heiau showing the location of Feature A. (provided by Mr. Charlie Ogata)

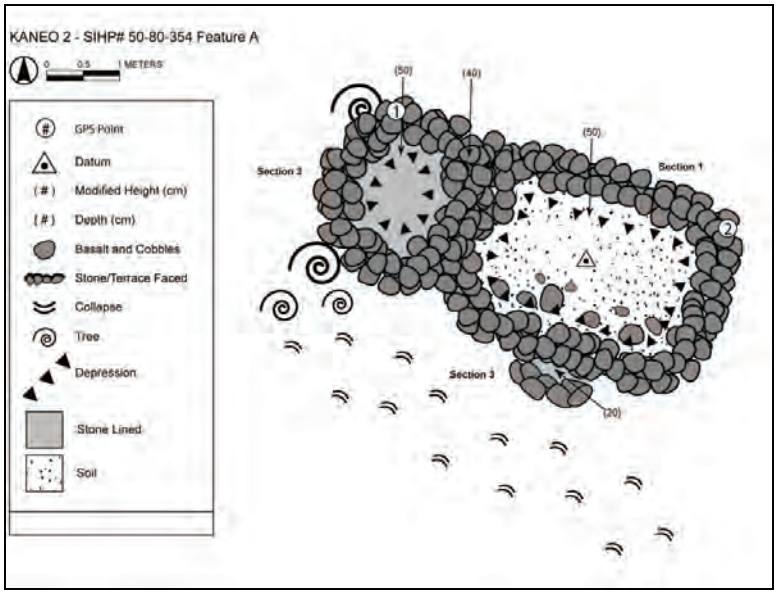

Figure 57. Plan view of SIHP# 50-80-10-354 Feature A.

Figure 58. SIHP# 50-80-10-354 Feature A viewed from the east, showing Section 1.

Figure 59. SIHP# 50-80 10-354 Feature A showing Section 2, from the east.

4.1.2.2 SIHP # 50-80-10-4681

FORMAL TYPE:	Complex – Enclosures & Terracing
FUNCTION:	Habitation/agricultural
AGE:	Pre-Contact
# OF FEATURES:	5
DIMENSIONS:	43 meters north/south by 45 meters east/west
CONDITION:	Fair
UTM:	**GPS Point 1** **N**. 236309 **E**. 625966.3
DESCRIPTION:	

Szabian et al (1989) provide the following description of SIHP# 50-80-10-4681:

> Located in the Lipalu Street drainage area this site is comprised of at least 3 features: Feature A is a depression 3.0 m in diameter and 0.5 m deep. Feature B is a level terraced area approximately 6.0 by 5.0 m with large boulders forming the facing. Feature C is a series of possible terraces upslope of Feature B of indeterminable extent (Szabian, et al 1989: 11).

SIHP# 50-80-10-4681 is located approximately 15m (50 ft) southwest of the current petition area. It is a probable pre-Contact habitation site consisting of several c-shaped structures, a terrace wall and a circular rock feature, five features in all. (Figure 60). The site is situated on a north-facing slope with vegetation consisting of dense canopy, Ti leaf and *laua‘e* fern. Although sufficient data was observed to qualify SIHP# 50-80-10-4681 as a site, the vegetation, primarily *hau*, in the area was too dense to definitively establish the site boundaries.

Feature A is a probable c-shaped habitation structure consisting primarily of stacked basalt cobbles (Figure 61). Feature A has experienced some collapse and at one point may have represented two separate rooms sharing a common wall. Feature A measures 7 meters E/W by 5 meters N/S; the south wall is 1 meter wide, the west wall is 35 cm and the east wall is 60 cm.

Feature B is comprised of a ring of 5 large cobbles with a slight opening in the SE end (Figure 62). The ring of stones and soil in the middle of the feature suggests a possible hearth function. Feature B measures 1.5 meters in diameter. Down slope are three to four possible terraced walls located NE of feature A (i.e. Features C and D).

Feature C is a terrace wall consisting of basalt cobbles which measure approximately 35 cm in diameter. The terrace wall is 12.3 m E/W by 1.1 m wide (Figure 63). Some constructed portions have collapsed and the height varies from 30-70 cm.

Feature D is a terrace wall constructed of basalt boulders which measure approximately 50 cm in diameter. The terrace wall is 2-4 courses high but collapsed in several places (Figure 64). The terrace appears to be semi-circular. Feature D is located just down slope from Feature C.

Feature E is a c-shaped feature located about 16 m west of feature C (Figure 65 and Figure 66). Feature E measures approximately 5 m N/S and 3 m E/W with a maximum wall height of approximately 50 cm.

No artifacts or midden were observed at SIHP# 50-80-10-4681, however the possible hearth (Feature B) and the C-shaped structure (Feature E) suggest a temporary habitation with associated agriculture.

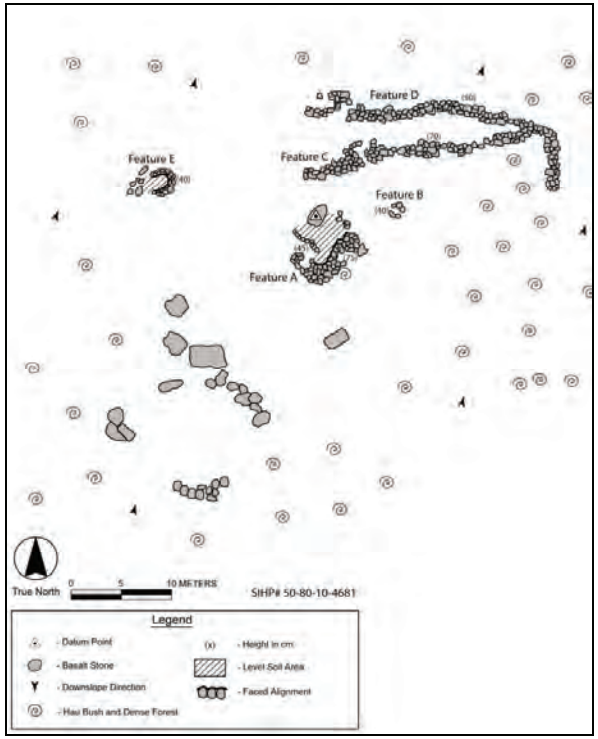

Figure 60. Plan view diagram of SIHP# 50-80-10-4681 enclosures and terracing.

Figure 61. SIHP # 50-80-10-4681 Feature A, overview of c-shaped habitation feature, view to the south.

Figure 62. SIHP # 50-80-10-4681 Feature B, circular rock feature, view to the south.

Figure 63. SIHP # 50-80-10-4681 Feature C, a basalt cobble terrace wall, view to the south.

Figure 64. SIHP # 50-80-10-4681 Feature D, terrace wall, view to the west.

Figure 65. SIHP # 50-80-10-4681 Feature E, overview of c-shaped rock feature, view to the southeast.

Figure 66. SIHP # 50-80-10-4681 Feature E, close-up of wall, view to the southeast.

4.1.2.3 SIHP # 50-80-10-6929

FORMAL TYPE:	Quarry
FUNCTION:	Raw material collection
AGE:	Pre-Contact
# OF FEATURES:	2
DIMENSIONS:	25 m northeast/southwest and 20 m northwest/southeast
CONDITION:	Poor
UTM:	**GPS Point 1** **N**. 2366752 **E**. 626260
DESCRIPTION:	

SIHP# 50-80-10-6929 consists of two concentrations of lithic debitage along an intermittent drainage (Figure 67 and Figure 68) approximately 150 meters (492 ft) southeast of the Pohai Nani Good Samaritan Retirement Community. There is an abundance of basalt cobbles and boulders in this area and many large pieces of debitage (Figure 69) scattered throughout indicative of a raw material procurement area (quarry). A natural dike extends away from the concentrations to the southeast.

The integrity of the site has been impacted by unauthorized artifact collection. There was a significant decrease in artifact density between the time of discovery and documentation, a matter of months, resulting in a dramatic decrease in the research potential of this site.

This site is located approximately 20 m (66 ft) east of the project area at the base of an eastern trending down slope. Although the integrity has been compromised this area should be considered in the event of any land alteration on the slope near the site. Additional areas of raw material procurement were observed to the southeast of SIHP# 50-80-10-6929 but extended too far outside of the current project area for further investigation.

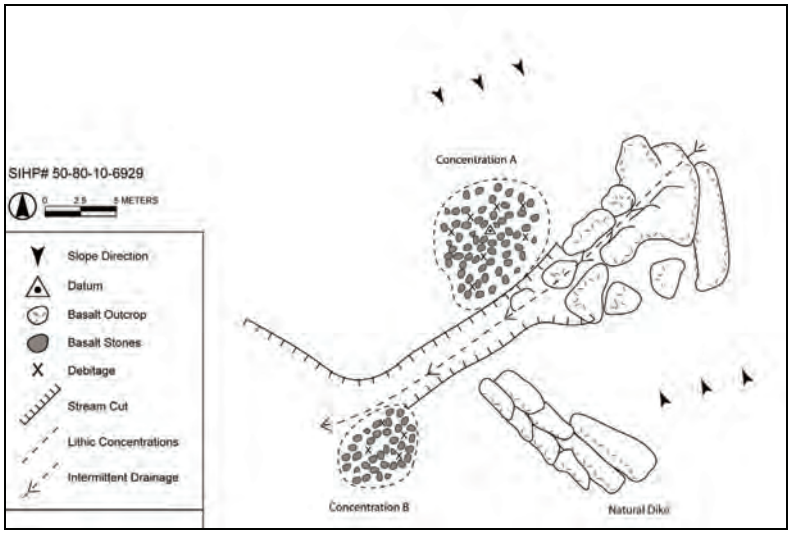

Figure 67. Plan view of SIHP# 50-80-10-6929.

Figure 68. View of Concentration B facing east.

Figure 69. Example of the artifacts observed in the area.

4.1.2.4 SIHP # 50-80-10-6931

FORMAL TYPE:	Stone alignment
FUNCTION:	Ceremonial
AGE:	Pre-Contact
# OF FEATURES:	3+
DIMENSIONS:	55 meters north/south and 40 meters east/west.
CONDITION:	Poor
UTM:	**GPS Point 1** **N**. 2366415.1 **E**. 626356
	GPS Point 2 **N**. 2366433.1 **E**. 626351
DESCRIPTION:	

SIHP# 50-80-10-6931 is located approximately 15m (50 ft) south of the current petition area. This is a possible pre-Contact ceremonial area located on a natural knoll between two intermittent drainages (Figure 70). The site consists of four features (A-D). Features A-C are a series of stone alignments/terraces on the southern slope of the landform. Feature D is a possible ceremonial area atop the landform. Feature A, located at the base of the slope is a single course stone alignment oriented E/W approximately 6 m (20 ft) in length (Figure 71). Feature B based on its location may be a collapsed terrace/alignment the result of natural circumstances. Feature C (Figure 72) is a one to two course stone alignment oriented E/W and approximately 3 m (10 ft) in length. Feature D is a cleared/leveled area atop the landform (Figure 73). There is a basalt boulder at the western boundary of the clearing with *kukui* nut fragments at its base.

SIHP# 50-80-10-6931 is approximately 75 m (246 ft) east of SIHP# 50-80-10-6930 and 25 m (82 ft) upslope. The intermittent drainages that border -6931 to the north and south also border -6930. Clear of the dense, introduced vegetation there would be a commanding view of -6930 and Kawa‘ewa‘a Heiau from Feature D.

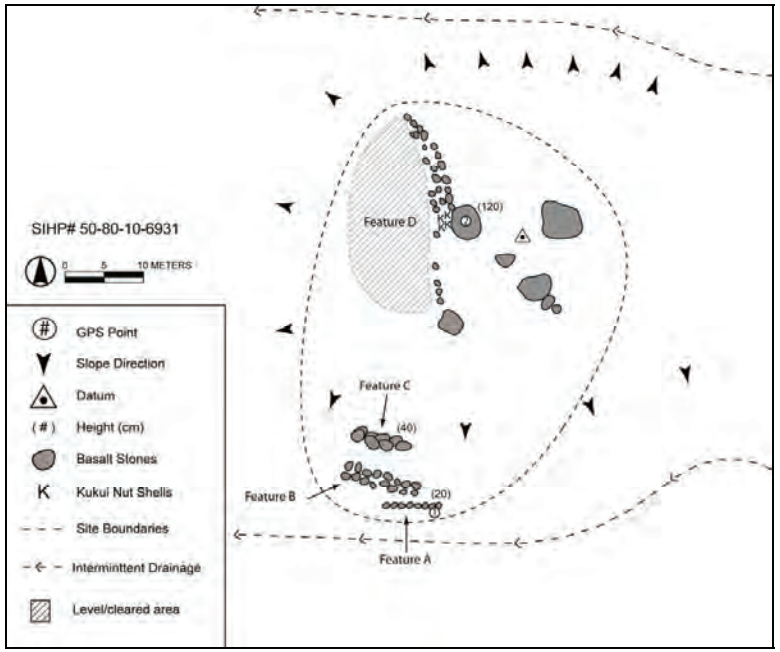

Figure 70. Plan view of SIHP# 50-80-10-6931.

Figure 71. SIHP# 50-80-10-6931, Feature A viewed facing west.

Figure 72. SIHP# 50-80-10-6931, Feature C facing north.

Figure 73. SIHP# 50-80-10-6931, Feature D viewed facing east.

4.1.3 Site 355 (The Holua Slide)

A substantial effort was made to relocate Site 355, the holua slide during the initial survey with little success. Additionally, Hallett H. Hammatt, PhD. visited the project area on July 21, 2007 specifically looking for any remnants or indications of the holua slide stating:

> We walked all the way up to the top most rise where the slide was previously reported. We were spread apart 1 to 20 feet and saw no indication on the land of a former slide such as rock alignments or depressions in the ground. The soil is red clay laterite which is clearly very slippery when wet. The configuration of the hill with alternating steep and more gradual gradients and an evenly shaped contour seems like the ideal symmetrical configuration for a holua. We walked again to the very base of the slope to the ironwood grove following the crest of the slope and again saw no alignments or depressions or ridges in the slope which would indicate the presence of a Holua. I suspect the hill could be used for that purpose in ancient times with the minimum of modification which may explain the absence of any sign of the former slide. I doubt if this slope was used for pineapple cultivation given its steepness but it may have been cleared or modified as part of the plantation activities.

According to Sterling and Sterling (1978:219) J. G. McAllister was also unable to relocate the holua slide in 1933. Adding that John Bell had seen the holua slide destroyed when an attempt was made to plant pineapples in this section.

4.1.4 Previously Recorded Historic Properties Considered Non-Cultural

4.1.4.1 SIHP # 50-80-10-4682

FORMAL TYPE:	Natural
FUNCTION:	Non Cultural
AGE:	
# OF FEATURES:	0
DIMENSIONS:	
CONDITION:	
UTM:	**GPS Point 1** **N**. 2366281 **E**. 626965
DESCRIPTION:	

Szabian et al (1989) provide the following description:

> This site contains two features: Feature A is a possible platform structure formed of large weathered basalt boulders; Feature B is a possible series of terraces of undetermined extent, this area is covered in dense laua‘e fern (Szabian et al 1989:11).

Based on observations made by CSH, SIHP # 50-80-10-4682 is not a cultural site, but a series of natural “terraces” formed by lava rocks, which rolled down slope and were caught by exposed bedrock outcrops (Figure 74 and Figure 75). SIHP # 50-80-10-4682 is located just *mauka* of a thick hau jungle at the base of a steep slope covered with ferns. None of the three natural “terraces” retain a significant amount of soil.

Figure 74. SHIP # 50-80-10-4682 Natural terracing, view to the southeast.

Figure 75. SHIP # 50-80-10-4682 Natural terracing, view to the southwest.

Section 5 Summary and Interpretation

In compliance with and to fulfill applicable Hawai‘i state historic preservation laws, CSH completed an archaeological inventory survey investigation for the proposed Hawaiian Memorial Park expansion. Minimally, the land alteration would include surface grubbing and grading excavations associated with the installation of sub-surface utilities, housing construction and landscaping. The petition area measures approximately 56.6 acres.

In consultation with the Hawai‘i State Historic Preservation Division (SHPD), the inventory survey investigation was designed to fulfill State requirements for an archaeological inventory survey per HAR Chapter 13-13-276 and Chapter 13-13-284.

Kāne‘ohe Ahupua’a was intensively utilized during the pre-Contact period both as an agricultural and aquacultural center. Additionally, it was one of the primary population centers on O‘ahu (Devaney et al. 1976:6). Kawa‘ewa‘a Heiau, located in the vicinity of the project area, suggests the historical and archaeological importance of the area. In the early 1900s, Kāne‘ohe Ranch came to dominate land holdings in the Kailua and Kāne‘ohe area. Included within this acreage were large tracts of ranch land, which had been bought, sold, let, and used as pasture by numerous parties since the mid-1850s. Subsequently, most of the ranching and farming areas have been replaced by residential subdivisions. Previous archaeological research has been consistent with the documentation of Pre-contact and historic ceremonial, habitational, and agricultural remains in the immediate vicinity of the project area (Szabian et al 1989). Expected finds during the archaeological inventory survey of the project area included additional evidence of indigenous Hawaiian occupation and historic agriculture/ranching.

As part of the inventory survey effort CSH conducted systematic inspection of the project area and limited test unit excavations. A total of 11 archaeological sites were observed within or near the current petition area. Six of these were previously recorded, they include SIHP #s 50-80-10-354, 50-80-10-4680, 50-80-10-4681, 50-80-10-4683, 50-80-10-4684 and 50-80-10-4686. The remaining five are new discoveries, SIHP #s 50-80-10-6929, 50-80-10-6930, 50-80-10-6931, 50-80-10-6932, and 50-80-10-6933.

Seven of the historic properties are within the petition area; these include SIHP #s 50-80-10-4680, -4683, -4684, -4686, -6930, -6932, and -6933. Of these, two are considered pre-contact and five are considered historic (Table 7). Four of the sites (SIHP-354 , -4681,-6929 and -6931) are located just outside of the current project area but close enough for consideration.

One of the concerns of knowledgeable community members was the presence of *lua*, or burial pits, associated with Kawa‘ewa‘a Heiau. This was considered throughout the duration of the survey. Although no *lua* were observed there is still a potential for subsurface cultural resources. The historic properties within the petition area will be discussed initially followed by those in those near the petition area.

5.1 Historic Properties Located Within the Current Petition Area

SIHP 50-80-10-4680 is a historic agricultural/water control feature consisting of a rock concentration forming a crude terraced structure. The crude terrace retains a large amount of soil

runoff that appears to have buried a portion of the site. The terrace forms the top of the hill and is adjacent to a water-cut ditch that drains into the larger drainage at the base of the hill

SIHP# 50-80-10-4683 is a historic charcoal kiln. It consists of a rectangular pit measuring 3.5 m (11.5 ft) by 2.5 m (8 ft) with charred walls. Charcoal production was a widespread industry in Windward O‘ahu during the later part of the nineteenth and early part of the twentieth century.

SIHP# 50-80-10-4684 is a pre-Contact habitation site consisting of several c-shaped structures, a terrace wall, a circular rock feature and several house terraces, seven features total. To the east, west and south of the main feature complex is a badly disturbed area with possible terraces. The site is situated on a west-facing slope with vegetation consisting of dense canopy, large trees and laua‘e fern. An intermittent drainage borders the site to the east and south. SIHP# 50-80-10-4684 is approximately 150 m (492 ft) east of Kawa‘ewa‘a Heiau. Additionally, a large grinding stone was discovered approximately 40 m south of SIHP# 50-80-10-4684.

SIHP# 50-80-10-4686 when previously identified by Szabian et al (1989) consisted of two historic features. Feature A is constructed of boulders (approximately 60 cm in diameter) running east/west parallel to a large stream cut. Feature B, a series of alignments, appears to have been badly disturbed due to landscaping and rubbish pilling. The modern chicken coop and large mango trees described by Szabian et al (1989:13) were located; however, a great deal of disturbance has taken place in the area.

SIHP# 50-80-10-6930 is a pre-Contact, rectangular shaped enclosure with an irregular notch on the east side of the structure that gives it an almost L shaped appearance. Measuring approximately 22m north/south and 14 m east/west, it is constructed on the east aspect of a slope with an intermittent drainage immediately to the south and another approximately 20 m (66 ft) to the north. Although trees and erosion have caused some collapse, the integrity of the structure is considered good. West of the notch, inside of the structure there are remnants of a paved surface. Several stone tools were observed in the general site vicinity. The effort expended on the construction seems excessive for a habitation and is more consistent with that of a ceremonial structure. There is a commanding view to the north and west of the valley below SIHP# 50-80-10-6930, now dominated by alien/introduced vegetation such as Christmas berry (*Schinus terebinthifolius*), *he‘e* - octopus tree (*Schefflera actinophylla*), Java plum (*Syzygium cumini*) and lemon and strawberry guava (*Psidium guajava, Psidium cattleianum*). In the absence of the dense vegetation Kawa‘ewa‘a Heiau would be visible as it is only 320 m (1050 ft) west and over 50 m (164 ft) lower in elevation.

SIHP# 50-80-10-6932 is a possible storage area beneath a boulder approximately five m southeast of an intermittent drainage. Measuring approximately 4 m north/south and 4 m east /west, the floor inside is lined with small basalt cobbles. This site is approximately 33 m (108 ft) southwest of SIHP# 50-80-1-6933, a post-contact charcoal kiln, and potentially associated with it. A single historic bottle was observed on the east side of the storage feature. The manufacturers mark, A B G M Co., indicates that it was a product of the Adolphus Bush Glass Manufacturing Co circa 1886 to 1928. The beer bottle was produced in Belleville, Illinois between 1886 and 1907 or St. Louis Missouri between 1904 and 1928 (Toulouse 1971:26).

SIHP# 50-80-10-6933 is a large circular pit, approximately 4 m (13 ft) in diameter with burned walls. It is cut into a natural rise in the topography and includes a faced, two to three

course stone wall on the northeast side. The pit is currently 1.5 m (5 ft) in depth, the maximum depth is unknown as it has been subject to slumping and erosion. Similar to SIHP# 50-80-10-4683 this appears to be another historic charcoal kiln.

5.2 Historic Properties Located Near the Current Petition Area

SIHP 50-80-10-354, Kawa‘ewa‘e Heiau , is located approximately 30 m (100 ft) west, outside of the current petition area on the Kaneohe side of the ridge that divides Kaneohe and Kailua (Oneawa Hills). It has been on the National Register of Historic Places (NHRP) since 1972. Kawa‘ewa‘a Heiau is a *luakini* type *heiau*. This type is commissioned by the king and associated with human and animal sacrifice (Malo 1990:159). Kawa‘ewa‘a Heiau is located atop a small knoll and consists of a large enclosure 120 by 253 feet (35.5 x 77 m) with a small terrace on the north side which follows the contours of the land. It is said to have been one of the five *heiau* erected by Olopana in the beginning of the twelfth century and the location of his subsequent demise (McAllister 1933:179-180). Kawa‘ewa‘a Heiau is presently maintained by several concerned groups.

SIHP# 50-80-10-4681 is located approximately 15m (50 ft) southwest of the current petition area. It is a probable pre-Contact habitation site consisting of several c-shaped structures, a terrace wall and a circular rock feature, five features total. The site is situated on a north-facing slope with vegetation consisting of dense canopy, Ti leaf and laua‘e fern. Although sufficient data was observed to qualify SIHP# 50-80-10-4681 as a site, the vegetation, primarily *hau*, in the area was too dense to definitively establish the site boundaries.

SIHP# 50-80-10-6929 is a pre-Contact site consisting of two concentrations of lithic debitage along an intermittent drainage approximately 20 m (66 ft) east of the petition area. There is an abundance of basalt cobbles and boulders in this area and many large pieces of debitage scattered throughout indicative of a raw material procurement area (quarry). A natural dike extends away from the concentrations to the southeast. Although this site is outside of the current project area it should be considered in the event of any land alteration on the slope near the site.

SIHP# 50-80-10-6931 is located approximately 15m (50 ft) south of the current petition area. This is a possible pre-Contact ceremonial area located on a natural knoll between two intermittent drainages. The site consists of four features (A-D). Features A-C are a series of stone alignments/terraces on the southern slope of the landform. Feature D is a possible ceremonial area atop the landform. There is a basalt boulder at the western boundary of Feature D with *kukui* nut fragments at its base. In addition SIHP# 50-80-10-6930 is approximately 75 m (246 ft) east of the enclosure at SIHP# 50-80-10-6930 and 25 m (82 ft) upslope. The intermittent drainages that border -6931 to the north and south also border -6930. Clear of the dense introduced vegetation there would be a commanding view of -6930 and Kawa‘ewa‘a Heiau.

5.3 Discussion

Data collected during this investigation is consistent with expectations based on the background research. Additionally, it has provided further insight to the importance and utilization of this area in pre-Contact and historic times. For instance, the effort expended on the

construction of SIHP# 50-80-10-6930 seems excessive for a habitation and is more consistent with that of a pre-Contact ceremonial structure, possibly a *heiau.*

The general consensus regarding heiau (e.g. Bennett1930, Kolb 1991, and Stokes and Dye 1991) is that they are “extraordinarily diverse” (Kolb 1991:108) and “found in a bewildering variety of forms, sizes, and locations throughout the islands” (Kirch 1985:257).

The 1930 dissertation of W.C. Bennett remains “the most comprehensive survey of *heiau* to date” (Kolb 1991:108) Bennett among others, have attempted to provide diagnostic attributes from which *heiau* could be identified and classified. These include size, uprights, depressions, altar, paving, tiers/terraces, coral, historical reference, location, and function.

Size refers to the surface area (i.e. m.^{2}) of the structure. Initially, W. C. Bennett designated two size classifications for *heiau*, small and large. The dividing line between them was arbitrarily set at 50 feet “though this figure is not absolutely fixed” (Bennett 1930:4). Over the years this has been refined to include three general size ranges, small being less than 200 m.^{2}, “mid-sized” (Kirch 1985:261) ranging from 200 to 400 m.^{2} and large being greater than 400 m.^{2}. Based on these specifications SIHP# 50-80-10-6930, (256 m.^{2}), fits into the mid-size range. In general, mid-size structures and larger have been interpreted as religious structures (Hammatt et al 1997:181).

Attributes including altars and paving, generally refer to internal features of the structures (Hammatt et al 1997:176-177). Altar in this case is employed to describe a slightly elevated or raised stone foundation within the structure. W.C. Bennett designated altars as one of the heiau features focusing primarily on ethnographic evidence related to “*lele*” which he described a “a sort of scaffolding supported by posts on which offerings were laid and left to moulder away” (Bennett 1930:39).

According to David Malo (1903):

> In front of the lele was a pavement of pebbles (or framework) on which offerings were deposited until they were offered up, when they were laid on the lele (Malo 1990:213-214).

The term paving is employed referring to well constructed surface layer(s) of a specific structure. Although a common structural component, paving is suggestive of a “greater construction effort” (Hammatt et al 1997:185). There is possible paving on the inside of SIHP# 50-80-10-6930. It is located along the notch in the east wall amid some collapse. Beyond clearing the vegetation nothing else was disturbed at the site. As there has been a substantial amount of collapse there may be additional, less obvious, associated features inside the enclosure.

Location refers to our perception of prominent placement of specific structures in terms of view planes from and to the particular structures (Hammatt et al 1997:189). The importance of heiau location has been well documented (Bennett 1930:341; Buck 1964:516; Stokes and Dye 1991:21; and Kolb 1991:80-83)

When considering location (Kolb 1991):

> …local topography of a temple was intimately tied to the concept of religious "sanctity". Large heiau were generally situated upon prominent locations such as hill tops, bluffs, or knolls. This higher ground affirms the divine and inaccessible nature of high-ranking ali‘i, while affording an excellent view of the surrounding countryside and coast. Smaller heiau, on the other hand were usually placed within villages, upon mountain slopes, in upland valleys, along the coast, or in any other location that would best serve the people (Bennett 1931:35). Shimizu's (1980) analysis of heiau topography found that heiau on O‘ahu were consistently located on the physiographic divisions between the fertile plains and upland areas rather than on land used for agriculture or residence.
>
> The incorporation of the local topography makes any cursory analysis of heiau form suspect in two ways (Hommon 1987:24-5). First, the placement of heiau architectural elements tends to be influenced more by the contour of the landscape than by the abstract plan imposed upon the site by the architect. This suggests that the location of a heiau played a much more important role in its design than previously thought, and may partially explain the large amount of variability present in heiau form. Each promontory varies in its size, shape, and orientation of natural rock outcrops….
>
> Second, some platforms and terraces that appear to be solid architectural elements are actually masonry veneers, and thus are deceptive as to the amount of labor used in their construction. (Kolb 1991:82-83).

There is a commanding view to the north and west of the valley below SIHP# 50-80-10-6930, now dominated by alien/introduced species such as Christmas berry (*Schinus terebinthifolius)*, *he‘e* - octopus tree (*Schefflera actinophylla)*, Java plum (*Syzygium cumini*) and lemon and strawberry guava (*Psidium guajava, Psidium cattleianum*). In the absence of the dense vegetation Kawa‘ewa‘a Heiau would surely be visible as it is only 320 m (1050 ft) west and over 50 m (164 ft) lower in elevation. There is little to see from the enclosure looking east besides the hill side. It was not clear at the time of the investigation if the notch in the east wall was intentional or a result of the natural topography as it appears to be cut into the hillside.

Based on the dimensions and features SIHP# 50-80-10-6930 the possibility that it is a *heiau* should be considered. The interpreted function of this structure can only be inferred. It has been suggested that *heiau* located inland amid agricultural fields are related to what P.V. Kirch refers to as "a large group of mid-sized temples that included many functional subtypes(such as *m pale, waihau ipu o Lono, Hale o Lono, unu o Lono,* and *heiau Ho‘o lu‘ai)* all directed to the gods of fertility (especially Lono)"(Kirch 1985:261-261).

The presence of two charcoal kilns, SIHP# 50-80-10 4683 and -6933 are indicative of charcoal production that was a widespread industry in Windward O‘ahu during the later part of the 19th and early part of the 20th century. The majority of the historic properties that remain are located in the rockiest most inaccessible areas suggesting prior land alteration (i.e. pineapple and ranching) in the area.

The current project area has been has been utilized from as early as the twelfth century up until the middle of the twentieth century for a variety of purposes. Kāne‘ohe Ahupua'a was an active area during the pre-Contact period capable of supporting a large population with its abundant natural resources. In post-contact years, Kāne‘ohe was employed for the cultivation of rice, sugar and pineapple, and eventually cattle ranching and dairy farming. Subsequently, the ranching and farming areas were replaced by residential subdivisions. The continuous occupation and utilization of the area is also demonstrated in the archaeological record with the presence of pre-Contact and historic resources.

Section 6 Significance Assessments

Each historic property identified by the current study was evaluated for significance according to the criteria established for the Hawai‘i Register of Historic Places (Table 7). The historic properties within the petition area are addressed initially followed by the historic properties near the petition area. The five criteria are:

A Associated with events that have made an important contribution to the broad patterns of our history;

B Associated with the lives of persons important in our past;

C Embodies the distinctive characteristics of a type, period, or method of construction, represents the work of a master, or possesses high artistic value;

D Have yielded, or is likely to yield information important for research on prehistory or history;

E Have an important value to the native Hawaiian people or to another ethnic group of the state due to associations with cultural practices once carried out, or still carried out, at the property, or due to associations with traditional beliefs, events or oral history accounts – these associations being important to the group’s history and cultural identity.

6.1 Historic Properties Located Within the Current Petition Area

SIHP 50-80-10-4680 is a historic agricultural/water control structure consisting of a rock concentration forming a crude terraced structure. This structure may yield information important for research about the historic utilization of this area. SIHP # 50-80-10-4680 has been evaluated as significant under Criterion D of the Hawai‘i Register of Historic Places.

SIHP# s 50-80-10-4683 and -6933 are historic charcoal kilns. These structures may yield information important for research about the historic utilization of this area. SIHP# s 50-80-10-4683 and -6933 have been evaluated as significant under Criterion D of the Hawai‘i Register of Historic Places.

SIHP# 50-80-10-4684 is a pre-Contact habitation site consisting of several c-shaped structures, a terrace wall, a circular rock feature and several house terraces, seven features total. This historic property has the potential to yield additional information concerning pre-Contact habitations in the *ahupua‘a* of Kāne‘ohe. SIHP # 50-80-10-4684 is evaluated as significant under Criterion D of the Hawai‘i Register of Historic Places.

SIHP# 50-80-10-4686 is a boundary marker constructed of boulders oriented east/west parallel to a large stream cut. This structure has the potential to yield information important for research on historic boundaries in this area. SIHP# s 50-80-10-4686 has been evaluated as significant under Criterion D of the Hawai‘i Register of Historic Places.

SIHP# 50-80-10-6930 is a pre-Contact, rectangular shaped enclosure with an irregular notch on the east side of the structure that gives it an almost L shaped appearance. The effort expended on the construction seems excessive for a habitation and is more consistent with that of a

ceremonial structure. This historic property has the potential to yield additional information concerning pre-Contact ceremonial structures in the *ahupua‘a* of Kāne‘ohe. Additionally, this structure may have an important value to the native Hawaiian people or to another ethnic group of the state due to associations with cultural practices once carried out, or still carried out, at the property. SIHP # 50-80-10-6930 has been evaluated as significant under both Criterion D and E of the Hawai‘i Register of Historic Places.

SIHP# 50-80-10-6932 is a possible storage area beneath a boulder approximately 5 m southeast of an intermittent drainage. Presence of this structure may yield information important for research in determining historic activities within this area. SIHP# s 50-80-10-6932 has been evaluated as significant under Criterion D of the Hawai‘i Register of Historic Places.

6.2 Historic Properties Located Near the Current Petition Area

SIHP 50-80-10-354, Kawa‘ewa‘e Heiau , is located approximately 30 m (100 ft) west, outside of the current project area on the Kaneohe side of the ridge that divides Kaneohe and Kailua (Oneawa Hills). It has been on the National Register of Historic Places (NHRP) since 1972.

SIHP# 50-80-10-4681 is located approximately 15m (50 ft) southwest of the current petition area. It is a probable pre-Contact habitation site consisting of several c-shaped structures, a terrace wall and a circular rock feature, five features total. Although sufficient data was observed to qualify SIHP# 50-80-10-4681 as a site, the vegetation, primarily *hau*, in the area was too dense to definitively establish the site boundaries. This historic property has the potential to yield additional information concerning pre-Contact habitations in the *ahupua‘a* of Kāne‘ohe. SIHP # 50-80-10-4681 has been evaluated as significant under Criterion D of the Hawai‘i Register of Historic Places.

SIHP# 50-80-10-6929 is a pre-Contact site consisting of two concentrations of lithic debitage along an intermittent drainage approximately 20 m (66 ft) east of the petition area. This historic property has the potential to yield additional information concerning pre-Contact resource procurement and stone tool manufacturing in the *ahupua‘a* of Kāne‘ohe. SIHP # 50-80-10-6929 has been evaluated as significant under Criterion D of the Hawai‘i Register of Historic Places.

SIHP# 50-80-10-6931 is located approximately 15m (50 ft) south of the current petition area. This is a possible pre-Contact ceremonial area located on a natural knoll between two intermittent drainages. This historic property has the potential to yield additional information concerning pre-Contact ceremonial areas in the *ahupua‘a* of Kāne‘ohe. Additionally, this historic property may have an important value to the native Hawaiian people or to another ethnic group of the state due to associations with cultural practices once carried out, or still carried out, at the property. SIHP # 50-80-10-6931 has been evaluated as significant under both Criterion D and E of the Hawai‘i Register of Historic Places.

Table 7. Significance assessments for sites located within the project area.

SIHP# (50-80-10)	Formal Site Type	Features	Probable Function	Age	Criteria	Mitigation Recommendation
Historic Properties Located Within the Current Petition Area						
-4680	Terrace	1	Agricultural/water control	Historic	D	No further work
-4683	Pit feature	1	Charcoal Kiln	Historic	D	No further work
-4684	Complex-enclosures and terracing	7	Habitation	Pre-Contact	D	Preservation, in the form of avoidance
-4686	Stone alignment	1	Boundary marker	Historic	D	No further work
-6930	Stone enclosure	1	Ceremonial	Pre-Contact	D, E	Preservation, in the form of avoidance
-6932	Stone storage feature	1	Storage	Historic	D	No further work
-6933	Pit feature with associated stonewall	2	Charcoal kiln	Historic	D	No further work

Historic Properties Located in the Vicinity of the Current Petition Area						
-354	Enclosure, Platforms, Terraces	2+	Ceremonial	Pre-Contact	A, B, C, D, E	Preservation, in the form of avoidance
-4681	Complex-Enclosures and terracing	5	Habitation/ **A**gricultural	Pre-Contact	D	Preservation, in the form of avoidance
-6929	Quarry	2	Raw Material Collection	Pre-Contact	D	Preservation, in the form of avoidance
-6931	Stone Alignment	2+	Ceremonial	Pre-Contact	D,E	Preservation, in the form of avoidance

Section 7 Project Effect and Mitigation Recommendations

The following project effect discussion and cultural resource management recommendations are intended to facilitate project planning and support the project's required historic preservation consultation. This discussion is based on the results of this archaeological inventory survey investigation and CSH's communication with agents for the project proponents regarding the project's potential impacts to the historic properties described in the Results of Fieldwork section.

7.1 Project Effect

Cultural Surveys Hawai‘i, Inc. (CSH) conducted an archaeological inventory survey of approximately 66-acres of State Conservation land owned by Hawaiian Memorial Life Plan LTD. The initial project area consisted of approximately 53 acres. Following the pedestrian inspection of the project area, the boundaries of the Hawaiian Memorial Park Expansion project area were adjusted to include buffer zones for select archaeological resources identified along the periphery of the project area. As a result, an additional 13 acres was added to the project area to account for the lost acreage. The petition area defined for this report is approximately 56.6 acres

The proposed development associated with the Hawaiian Memorial Park Expansion project includes building roads, mausoleums and some single-family lots on an approximately 4-acre part of the property on land adjacent to the Pohai Nani Retirement Home. Minimally, the land alteration would include surface grubbing and grading excavations associated with the installation of sub-surface utilities, housing construction and landscaping.

7.2 Mitigation Recommendations

To reduce the proposed project's potential adverse effect on significant historic properties, the following mitigation measures are recommended. These recommendations are also summarized in (Table 7). The mitigation measures should be completed prior to any land disturbing activities within the Hawaiian Memorial Park Expansion petition area. No further work is recommended for SIHP # s 50-80-10-4680, -4683, -4686, -6932, and -6933. Preservation, in the form of avoidance is recommended for SIHP # s 50-80-10-4681, -4684, -6929, -6930, and 6931. The historic properties within the petition area are addressed initially followed by the historic properties near the petition area.

7.2.1 Historic Properties Located Within the Current Petition Area

SIHP# s 50-80-10-4680, 4686 and -6932 have been thoroughly documented with written descriptions, photographs, scale drawings, and recorded with GPS survey equipment. No further work is recommended for these as sufficient information regarding location, function, age, and construction methods of these historic properties has been generated by the current inventory survey investigation to mitigate any adverse effect caused by proposed development activities.

SIHP# s 50-80-10-4683 and -6933 are historic charcoal kilns that have been documented with written descriptions, photographs, scale drawings, and accurately located with GPS survey equipment. No further work is recommended for these historic properties as sufficient

information regarding the location, function, age, and construction methods of these historic properties has been generated by the current inventory survey and other investigations (Meeker 1995, Dockall et al. 2003, and Allen 1987), to mitigate any adverse effect caused by proposed development activities.

SIHP# 50-80-10-4684, a pre-Contact habitation site consisting of several c-shaped structures, a terrace wall, a circular rock feature and several house terraces, was documented with written descriptions, photographs, scale drawings, and accurately located with GPS survey equipment. Limited subsurface testing was also conducted within the Features A and F. Preservation, in the form of avoidance and protection, is recommended for the SIHP # 50-80-10-4684. Additionally, a large grinding stone was discovered approximately 40 m south of SIHP# 50-80-10-4684. In the absence of any other cultural material and considering that it is a good example of its type, moving it within the preservation boundary for SIHP# 50-80-10-4684 is recommended.

SIHP# 50-80-10-6930, a pre-Contact enclosure/ceremonial structure was documented with written descriptions, photographs, scale drawings, and recorded with GPS survey equipment. Limited subsurface testing was also conducted within the enclosure. Preservation, in the form of avoidance and protection, is recommended for the SIHP # 50-80-10-6930.

7.2.2 Historic Properties Located Near the Current Petition Area

SIHP 50-80-10-354, Kawa‘ewa‘a Heia, is located approximately 30 m (100 ft) west, outside of the current petition area on the Kaneohe side of the ridge that divides Kaneohe and Kailua (Oneawa Hills). It has been on the National Register of Historic Places (NHRP) since 1972 and is maintained by several concerned groups. The client has established a 100 ft. buffer around this historic property and continues to work with concerned "caretaker" groups.

SIHP# 50-80-10-4681 is located approximately 15m (50 ft) southwest of the current petition area. It is a probable pre-Contact habitation site consisting of several c-shaped structures, a terrace wall and a circular rock feature, five features total. The historic property was documented with written descriptions, photographs, scale drawings, and GPS survey equipment. Although sufficient data was observed to qualify SIHP# 50-80-10-4681 as a site, the vegetation, primarily *hau*, in the area was too dense to definitively establish the site boundaries. Preservation, in the form of avoidance and protection, is recommended for SIHP # 50-80-10-4681 with the understanding that the site boundaries be firmly established prior to interim protection measures.

SIHP# 50-80-10-6929 is a pre-Contact quarry site consisting of two concentrations of lithic debitage along an intermittent drainage approximately 20 m (66 ft) east of the petition area. A natural dike extends away from the concentrations to the southeast. Preservation, in the form of avoidance and protection, is recommended for SIHP # 50-80-10-6929

SIHP# 50-80-10-6931, is located approximately 15m (50 ft) south of the current petition area. This is a possible pre-Contact ceremonial area was documented with written descriptions, photographs, scale drawings, and recorded with GPS survey equipment. Preservation, in the form of avoidance and protection, is recommended for SIHP # 50-80-10-6931.

An archaeological monitoring program is recommended to address the potential of project related excavations impacting subsurface cultural material. Should SHPD require archaeological

monitoring for the Hawaiian Memorial Park Expansion Project, an archaeological monitoring plan, written to fulfill the requirements of Hawai‘i Administrative Rules Chapter 13-279, will need to be reviewed and approved by SHPD prior to any land disturbing activities within the project area.

Additionally, it is recommended that a cultural resource preservation plan be prepared for the proposed Hawaiian Memorial Park Expansion project, in accordance with Hawai‘i Administrative Rules (HAR) 13-277-3, to address buffer zones and protective measures for all historic properties recommended for preservation within and near the petition area. This preservation plan should detail the short and long term preservation measures that will safeguard the historic property during project construction and subsequent use of the petition area.

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H. Air Quality Impact Assessment

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September 15, 2008

Mr. Scott Ezer
Helber Hastert & Fee, Planners
733 Bishop Street, Suite 2590
Honolulu, HI 96813

Subject: Hawaiian Memorial Park Expansion Project
Air Quality Impact Assessment

Dear Mr. Ezer:

In response to your request, we have examined the potential air quality impacts related to the proposed Hawaiian Memorial Park Expansion Project located at Kaneohe, Oahu. The results of this examination along with background information related to this issue and recommended mitigation measures are summarized below.

Project Description

Clark & Green Associates is proposing to expand the Hawaiian Memorial Park on the island of Oahu at Kaneohe. The project includes approximately 57 acres of land adjacent to the Hawaii State Veterans Cemetery, which next to the existing 72-acre Hawaiian Memorial Park. Three project alternatives (A, B and C) are being considered. Alternatives A and B include a small residential component, whereas Alternative C includes the memorial park expansion only. It is expected that the proposed cemetery expansion area would be open for burials by the year 2011.

Ambient Air Quality Standards

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 air quality standards are comparable to the national standards except those for nitrogen dioxide and carbon monoxide which are more stringent than the national standards.

Regional and Local Climatology

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 Kaneohe area is very much affected by its windward and near coastal situation and by nearby mountains. Winds are predominantly trade winds from the east or northeast and provide good ventilation much of the time. Wind speeds typically vary between about 10 and 25 miles per hour. Temperatures in the Kaneohe area are generally very consistent and moderate with an average daily temperature range of about 68°F to 79°F. Average annual rainfall in the area amounts to about 45 inches or more.

Existing Air Quality Conditions

Air quality in the vicinity of the project presently is mostly affected by emissions from natural, industrial, agricultural and/or vehicular sources with the latter probably being the dominant factor. The little air quality monitoring data available for the area from the Department of Health suggest that air quality standards are currently being met, although carbon monoxide measurements from Honolulu suggest that concentrations could exceed the state standards on occasion near high-volume traffic congested areas. The present air quality of the Kaneohe area is believed to be good.

Air Quality Impacts of Project

Short-term direct and indirect impacts on air quality could potentially occur during 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 soil excavation and vehicle movement; and (2) exhaust emissions from on-site construction equipment. Indirectly, there also could be short-term air quality impacts from the disruption of traffic on nearby roadways, from 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 from construction activities are difficult to estimate accurately because of their elusive nature

of emission and because the potential for dust 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 U.S. EPA 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 from project construction would likely be somewhere near this level. In any case, State of Hawaii Air Pollution Control Regulations prohibit visible emissions of fugitive dust from construction activities at the project property line. Thus, an effective dust control plan for the project construction phase should be prepared.

Adequate fugitive dust control can usually be accomplished by the establishment of a frequent watering program to keep bare-dirt surfaces in active construction areas from becoming significant sources of dust. On days without rainfall, construction areas should be watered at least twice during the workday to help keep dust to a minimum. Control regulations further stipulate that open-bodied trucks be covered at all times when in motion if they are transporting materials likely to give rise to airborne dust. Haul trucks tracking dirt onto paved streets from unpaved areas are oftentimes a significant source of dust in construction areas. Some means to alleviate this problem, such as tire washing or road cleaning, may be appropriate. Dust monitoring could be considered as a means to quantitatively evaluate 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.

Indirectly, slow-moving construction vehicles 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. 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.

After the period of construction, long-term impacts on air quality from motor vehicle exhausts can potentially occur at or near any project that attracts large volumes of motor vehicle traffic. Carbon monoxide emissions are usually the primary issue, and public areas near traffic-congested intersections are the main concern. Project Alternative B, which includes the largest number of residential units, is shown in the traffic study to generate the most traffic for the three project development alternatives being considered. The project traffic study examined several roadway intersections in the project vicinity along Kaneohe Bay Drive, Kamehameha Highway, Mokulele Drive and Namoku Street. Traffic associated with the proposed project will likely use these roads and intersections to gain access to the project. The project traffic study indicates that with project Alternative B at full build-out that the project would contribute at most 18 vehicles per hour during the peak hours at the intersection of Lipalu Street and Namoku Street. Other intersections in the area would experience lower increases in traffic volumes. Future (year 2011) traffic level-of-service conditions with or without the project at signalized intersections in the project area are estimated in the project traffic study to operate at acceptable levels. The estimated traffic level-of-service at some unsignalized intersections, such as at Kamehameha Highway and HMP Driveway and at Kaneohe Bay Drive and Namoku Street, indicate congested conditions on some approaches (with or without the project).

Based on extensive experience in assessing traffic-related air quality impacts, traffic volume increases of less than about 5 percent or less than about 100 vehicles per hour and traffic approach volumes of less than about 1,000 vehicles per hour do not cause any significant impacts on air quality if adequate traffic level-of-service is provided. While the estimated traffic level-of-service on some approaches at some intersections in the project area is less than adequate, considering the small project-related traffic volumes that are expected, traffic from the proposed project should have no significant long-term impacts on maximum air pollution levels in the project area. Although a detailed air quality modeling study could be performed to quantitatively predict project impacts, such an analysis is probably unwarranted.

In summary, any long-term impacts on air quality from traffic related to this project will likely be negligible. Short-term impacts from fugitive dust during project construction may occur. Because of this, an effective dust control plan should be prepared and implemented.

Please call me if you have any questions concerning the information presented herein or if you wish to discuss this matter further.

Very truly yours,

Barry D. Neal

Barry D. Neal
Certified Consulting
Meteorologist

I. Noise Review

(D.L. Adams Associates, Ltd.)

D. L. ADAMS ASSOCIATES, LTD.
Consultants in Acoustics and Performing Arts Technologies

August 19, 2008

Mr. Scott Ezer
Helber Hastert & Fee, Planners
733 Bishop Street, Suite 2590
Honolulu, HI 96813

RE: Hawaiian Memorial Park Expansion EIS Noise Review (DLAA #08-38)

Dear Mr. Ezer:

As requested, this letter summarizes our acoustical and noise control comments relating to the Environmental Impact Statement report submitted for the Hawaiian Memorial Park Expansion project. Please note we have not completed any computational analyses or noise modeling for the project. We also have not completed any noise measurements or visits to the project site. Rather, our work contained herein is based on our general observations of the project documents and professional experience in the areas of acoustics and noise control. We understand that this letter may be used as supplemental information for the Environmental Impact Statement.

The project consists of an expansion of the existing Hawaiian Memorial Park Cemetery, and a development of 20 single-family residential lots. The project area includes a 56.6 acre portion of the 164.4 acre land parcel, and is adjacent to a quiet neighborhood in Kaneohe, Hawaii.

State Noise Regulation

The Hawaii Administrative Rules, Title 11, Chapter 46 states maximum allowable noise limits due to stationary mechanical noise (measured at the property line or nearest listener location). The maximum noise limit for a single family home residential area is 55 dBA during the daytime hours (7AM – 10PM) and 45 dBA during the nighttime hours (10PM – 7AM).

Construction Noise

Development of project areas will involve excavation, grading, and other typical construction activities during construction. The various construction phases of the project may generate significant amounts of noise. The actual noise levels produced during construction will be a function of the methods employed during each stage of the construction process. In cases where construction noise exceeds, or is expected to exceed the State's "maximum permissible" property line noise levels, a permit must be obtained from the State DOH to allow the operation of vehicles, cranes, construction equipment, power tools, etc., which emit noise levels in excess of the "maximum permissible" levels.

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In order for the State DOH to issue a construction noise permit, the Contractor must submit a noise permit application to the DOH, which describes the construction activities for the project. The Contractor should use reasonable and standard practices to mitigate noise, such as using mufflers on diesel and gasoline engines, using properly tuned and balanced machines, etc. However, the State DOH may require additional noise mitigation, such as temporary noise barriers, or time of day usage limits for certain kinds of construction activities.

The DOH noise permit does not limit the noise *level* generated at the construction site, but rather the *times* at which noisy construction can take place. Therefore, noise mitigation for construction activities should be addressed using project management, such that the time restrictions within the DOH permit are followed.

Project Generated Stationary Mechanical Noise

The proposed 20-lot residential subdivision may incorporate stationary mechanical equipment that is typical for residential buildings, such as air handling equipment, condensing units, etc. Noise from this mechanical equipment and other stationary equipment must meet the State DOH noise rules, which stipulate maximum permissible noise limits at the property line. Mitigation of mechanical noise to meet the State DOH noise rules should be incorporated into the project design.

Project Generated Traffic Noise

A traffic noise analysis was not completed by D. L. Adams Associates, Ltd. Based on the Traffic Impact Analysis Study (April 2008) prepared by Perazim Consulting LLC, the peak hour traffic counts shows only minor changes. The traffic noise along the primary roads of Kaneohe Bay Drive and Kamehameha Highway are likely to have a very minimal effect (most likely much less than a 1 dB increase in noise level due to the project). Similarly, noise along other secondary roads, such as Namoku Street, Mokulele Drive, and other nearby roads is not expected to significantly increase due to the project. Lipalu Street shows some increase in the peak hour traffic; however, the total traffic counts and vehicle speeds are not expected to cause a significant noise impact.

Please let me know if you have any questions.

Sincerely,

Digitally signed by Todd Beiler
Date: 2008.08.19 13:38:57 -10'00'

Todd Beiler, P.E.
Vice President

J. Cultural Impact Assessment

(Cultural Surveys Hawai‘i, Inc.)

Cultural Impact Assessment for the Hawaiian Memorial Park Expansion Area, Kāneʻohe Ahupuaʻa, Koʻolaupoko District, Oʻahu Island

TMK: [1] 4-5-033:001

Prepared for

Helber, Hastert & Fee Planners

Prepared by

Hallett H. Hammatt, Ph.D.

Cultural Surveys Hawaiʻi, Inc.

Kailua, Hawaiʻi

(Job Code: KANEO 3)

April 2008

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Management Summary

Reference	Cultural Impact Assessment for the Kāneʻohe Hawaiian Memorial Park Expansion Area Project, Kāneʻohe Ahupuaʻa, Koʻolaupoko District, Island of Oʻahu
Date	April 2008
Project Number (s)	Cultural Surveys Hawaiʻi Inc. (CSH) Job Code: KANEO 3
Agencies	State of Hawaiʻi Department of Health / Office of Environmental Quality Control (DOH / OEQC)
Project Location	The CSH project area is bordered on its *mauka* extent by the Hawaiian Memorial Park, and extends *makai* to the Pohai Nani Retirement Community, from the south and east by Kapaʻa Ridge, and the northwest by a housing development and Namoku Street. This petition area is depicted on USGS 7.5 minute topographic quadrangle Kaneohe, HI (1998).
Land Ownership	Hawaiian Memorial Life Plan Ltd.
Project Description	Proposed development within the petition area is described as new burial areas, automobile circulation and a residential subdivision. Minimally, the land alteration would include surface grubbing and grading, excavations associated with the installation of sub-surface utilities, housing construction and landscaping. According to information provided by Helber, Hastert & Fee Planners: Hawaiian Memorial Park, opened in 1961 with a current extent of 80 acres, will run out of usable space in the next few years. The cemetery owners are now planning for its future expansion, on land they own, to the east of the existing cemetery. This parcel of land is about 164 acres in size, but the expansion will only use approximately 56 acres of this area. Part of the proposed expansion (about 4 acres) is being proposed for residential purposes, on land adjacent to the Pohai Nani Retirement Home. The owners of the cemetery are planning to develop about 20 single-family lots on this portion of the property. The build-out of the expansion would not begin for several years, and could last over 20 years or so, the expansion may include 4 mausoleums, each about 3,500 square feet in size, and one-story in height. Approximately 15 acres of the 56-acre Project Area will be graded and revegetated with native species, and there will be a vegetated buffer between the cemetery and existing

	homes. Otherwise, the land will be cleared and planted similar to the existing cemetery grounds.
Project Acreage	The CSH project area consisted of approximately 66 acres. The petition area, located within the project area is approximately 56.6 acres
Area of Potential Effect (APE) and Survey Acreage	For the purposes of this cultural impact assessment, the APE is defined by the the entire CSH project area, approximately 66 acres. While this investigation focused on the project APE, the study area included the entire *ahupua‘a* of Kāne‘ohe.
Document Purpose	The project requires compliance with the State of Hawai‘i environmental review process [Hawai‘i Revised Statutes (HRS) Chapter 343], which requires consideration of a proposed project's effect on cultural practices. At the request of Helber, Hastert & Fee Planners, CSH undertook this cultural impact assessment. Through document research and cultural consultation efforts this document provides information pertinent to the assessment of the proposed project's impacts to cultural practices (per the OEQC's Guidelines for Assessing Cultural Impacts). The document is intended to support the project's environmental review and may also serve to support the project's historic preservation review under HRS Chapter 6E-42 and Hawai‘i Administrative Rules (HAR) Chapter 13-284.
Consultation Effort	Hawaiian organizations, agencies and community members were contacted in order to identify potentially knowledgeable individuals with cultural expertise and/or knowledge of the project area and the vicinity. The organizations consulted included the State Historic Preservation Division (SHPD), the Office of Hawaiian Affairs (OHA), the O‘ahu Island Burial Council (OIBC), and organizations that *m lama* (take care of, protect) the Kawa‘ewa‘e Heiau (e.g., Sierra Club, Queen Emma Hawaiian Civic Club, Moanalua Gardens Foundation, Ko‘olaupoko Hawaiian Civic Club, Windward Lions Club).
Cultural Impact Results	Thirty-two people were contacted for the purposes of this cultural impact assessment, 27 people responded, and 10 *k puna* and/or *kama‘ ina* were interviewed for more in-depth contributions to the cultural impact survey. The findings of this cultural impact assessment suggest that there are three major cultural concerns (and several ancillary ones) regarding the proposed HMP expansion project. 1. The preservation and protection of the Kawa‘ewa‘e Heiau *and* contiguous cultural properties. A number of participants emphasized that the Kawa‘ewa‘e Heiau is part of a "complex",

	and should not be viewed as a discrete site. 2. Gathering practices, particularly the on-going collection of *hula* and *lei* plants in the proposed project area, should be recognized and accommodated by HMP. 3. There is a possibility of burial sites, or *iwi k puna* (ancestral remains) in the project area.
Cultural Impact Recommendations	As with any development project, there are a variety of viewpoints and concerns voiced by the individuals who have participated in this assessment, ranging from those who believe that appropriate project design and planning can improve and enhance access to cultural and natural resources, to those who are concerned that the potential project impacts cannot be reasonably mitigated. The following mitigation measures are recommended by CSH to address the potential adverse impacts of the proposed action on Hawaiian cultural beliefs, practices and resources by the HMP expansion project: 1. Recognize that the Kawa‘ewa‘e Heiau is part of a complex of cultural sites, not a discrete site. It is recommended that plans and the design for the cemetery be integrated with the religious significance of the area surrounding Kawa‘ewa‘e Heiau and it be ensured that significant archaeological sites and cultural features of the landscape are buffered and protected from any roadways, bulldozing or other intrusive activity. Additionally, Kawa‘ewa‘e Heiau complex should be protected and seen in relationship to other sacred sites in the Ko‘olaupoko District. **The owner has stated the intent to preserve the significant archaeological sites, and to incorporate buffer zones (*k puka*) as recommended by CSH and as indicated in the proposed project plans.** **2.** The Kawa‘ewa‘e Heiau (SIHP # 50-80-10-354), currently on the National Register of Historic Places, has been evaluated as significant under both Criterion D and E of the Hawai‘i Register of Historic Places and should be registered with the State. **The owner has stated the intent to register SIHP #. 50-80-10-354 with the State of Hawai‘i.** **3.** All cultural properties and archaeological sites in and near the project area should be investigated, preserved and protected through the creation of *k puka* (protected areas and buffers) as appropriate. *K puka* should be designed in careful consideration of site boundaries and in relationship to contiguous sites. **The owner has stated the intent to preserve the significant archaeological sites, and to incorporate buffer zones (*k puka*) as recommended by CSH and as indicated in the proposed**

project plans.

4. **The owner has stated the intent to continue consultation with appropriate state agencies, such as OHA, throughout the planning and development process to ensure appropriate evaluation and protection of archaeological and cultural resources**. **This consultation is required by law and will be continued throughout the process.**
5. The owner is invited to have the project reviewed by OHA's Native Hawaiian Historic Preservation Council (NHHPC) if there is need for further consultation regarding handling of archaeological sites. **The owner has stated the intent to continue to consult with all appropriate groups such as the NHHPC concerning the handling of archaeological sites.**
6. Personnel involved in development activities in the project area should be informed of the possibility of inadvertent cultural finds, including human remains. Should cultural or burial sites be identified during ground disturbance, all work should immediately cease, and the appropriate agencies notified pursuant to applicable law. **The owner has stated the intent to provide a mandatory education program for any entity or personnel working within the project site to ensure that appropriate protective and notification action is undertaken should any inadvertent cultural or archaeological finds take place.**
7. Cultural monitoring should be conducted during all phases of development. **The owner has stated the intent to ensure that a cultural and archaeological monitor shall observe all grading and excavation activities to provide verification that cultural and archaeological finds have been protected.**
8. On-going cultural practices, such as the gathering of *hula* and *lei* plants, should be recognized and accommodated (subject to safety and liability issues). **As provided by law and subject to appropriate safety and liability indemnification, the owner has stated the intent to accommodate native Hawaiian gathering of *hula* and *lei* plants. To the degree feasible, these plant communities shall be enhanced and expanded within the buffer areas and permanent open space areas as appropriate.**
9. In particular, protect the areas where *laua‘e* (*Phymatosorus grossus*) is most concentrated. *Laua‘e* found in the project area is noteworthy for its physiological characteristics of thickness, color and fragrance, and is especially valuable to several *hula h lau* in Kāne‘ohe and neighboring windward communities. It is

recommended that the availability, abundance and quality of *laua‘e* ferns be protected through the creation of plant gathering *k puka*, including maintenance of an intact overstory. **The owner has stated the intent to protect overstory for all undisturbed areas and to enhance *laua‘e* fern plant communities to the degree feasible and practicable.**

10. Community members and groups responsible for the long-term care of the Kawa‘ewa‘e Heiau, as well as cultural practitioners who utilize the area for gathering and cultural education activities, should be further consulted regarding the above issues and other concerns throughout the planning, development and operation of the proposed HMP expansion. This consultation should include all interested community groups and individuals who have a stake in the project area through their involvement in long-term care of the Kawa‘ewa‘e Heiau, plant-gathering or other cultural issues. **The owner has requested of various members of community groups wishing to have access to and maintenance permission for the *heiau* and related areas to begin the process of forming an appropriate master organization and preparing a master plan for the long term management, enhancement, maintenance, visitation activities, and financial requirements for the *heiau* complex and related issues such as plant gathering and plant community enhancement and other important cultural activities. The owner has stated the desire to continue to work with the appropriate individuals and groups on this matter and to participate at some appropriate level in the development of this master plan document.**

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Section 1 Introduction

1.1 Project Background

At the request of Helber Hastert & Fee, Planners, Cultural Surveys Hawai‘i, Inc. (CSH) conducted a cultural impact assessment of the proposed Hawaiian Memorial Park (HMP) expansion project to support an Environmental Impact assessment being prepared for a Petition to amend the State Land Use boundaries of the project site from the State Conservation District to the State Urban District. Although the area of the proposed petition is only 56.6 acres, the cultural assessment and archaeological inventory project area studied by CSH is 66 acres (Figure 1). The extra acreage was added as a study element in order to properly encompass potential archaeological and cultural sites, after the intial site visits, a literature search, and site plan changes required a reconsideration of the extent of the project area. For the purposes of this assessment, the 56.6 acres that comprise the area for State land use redesignation will be reffered to as the “Petition Area.” The 66 acres that comprise the area physically investigated by CHS will be referred to as the “Project Area.”

The current project area is located adjacent to the existing HMP, Kāne‘ohe Ahupua’a, Ko‘olaupoko District, Island of O‘ahu (TMK: [1] 4-05-033:001) (Figure 2 and Figure 3). The *mauka* side of the project area is bordered by the HMP and extends *makai* to Pohai Nani Retirement Community. From the south and east it is bounded by Kapa‘a ridge, and to the northwest by a housing development and Namoku Street. The project area extends *mauka* to approximately 170 m (557 ft) elevation. For the purposes of this CIA study, inquiry focused on the project area in the context of the entire Kāne‘ohe Ahupua’a, including questions regarding the Kawa‘ewa‘e Heiau and other cultural properties and resources in and around the project area.

The project area consists of a privately owned, undeveloped area utilized mainly for unauthorized hiking and paintball activities. Proposed developments within the project area include new interment areas, a residential subdivision and associated roadways. Minimally, the land alteration would include, surface grubbing and grading excavations associated with the installation of sub-surface utilities, housing construction, and landscaping.

According to information provided by Helber Hastert & Fee, Planners:

> Hawaiian Memorial Park, opened in 1961 with a current extent of 80 acres, will run out of usable space in the next few years. The cemetery owners are now planning for its future expansion, on land they own, to the east of the existing cemetery. This parcel of land is about 164 acres in size, but the expansion will only use approximately 56 acres of this area. Part of the proposed expansion (about 4 acres) is being proposed for residential purposes, on land adjacent to the Pohai Nani Retirement Home. The owners of the cemetery are planning to develop about 20 single-family lots on this portion of the property. The build-out of the expansion would not begin for several years, and could last over 20 years or so, The expansion may include 4 mausoleums, each about 3,500 square feet in size, and one-story in height. Approximately 15 acres of the 56-acre Project Area will be graded and revegetated with native species, and there will be a vegetated

> buffer between the cemetery and existing homes. Otherwise, the land will be cleared and planted similar to the existing cemetery grounds.

1.1.1 Archaeological Inventory Survey

An archaeological inventory survey including a surface survey and subsurface testing was conducted for the project area. The results of the archaeological study are presented in a companion report titled, “Archaeological Inventory Survey for the HMP expansion, Kāne‘ohe Ahupua‘a, Ko‘olaupoko District, Island of O‘ahu TMK: [1] 4-05-033:001” (McCurdy and Hammatt 2008).

1.1.2 Summary of Archaeology Inventory Survey Findings

A total of 11 historic properties were observed within or near the petition area. Six of these were previously recorded, SIHP #s 50-80-10-354, 50-80-10-4680, 50-80-10-4681, 50-80-10-4683, 50-80-10-4684 and 50-80-10-4686. The remaining five are new discoveries, SIHP #s 50-80-10-6929, 50-80-10-6930, 50-80-10-6931, 50-80-10-6932, and 50-80-10-6933. Seven of the historic properties are located within the petition area. They include, SIHP #s -4680, -4683, -4684, -4686, -6930, -6932 and -6933. Four of the properties (SIHP #’s -354, -4681 -6929, and -6931) are located outside of the current petition area but close enough for consideration. Of these sites, six are considered pre-Contact and five historic. In addition SIHP # 50-80-10-4682, previously recorded by Szabian et al. (1989), located in the vicinity of the petition area was determined to be non-Cultural in nature and therefore is not considered a historic property.

The archaeological inventory survey for the HMP expansion project identified eleven historic properties within or near the survey area that will likely, or potentially, be affected by the proposed project. Seven historic properties identified within the petition area are recommended eligible to the Hawai‘i Register. Four historic properties identified in the vicinity of the petition area are recommended eligible to the Hawai‘i Register. For AIS complete findings and mitigation recommendations, please refer to McCurdy and Hammatt (2008).

1.2 Scope of Work

The scope for the cultural impact assessment includes:

1. Examination of historical documents, Land Commission Awards, and historic maps with the specific purpose of identifying traditional Hawaiian activities including gathering of plant, animal and other resources or agricultural pursuits as may be indicated in the historic record.
2. A review of the existing archaeological information pertaining to the sites on the property as they may allow us to reconstruct traditional land use activities and identify and describe the cultural resources, practices and beliefs associated with the parcel and identify present uses, if appropriate.
3. Interviews with persons knowledgeable about the historic and traditional practices in the project area and region.

4. Preparation of a report on items 1-3 summarizing the information gathered related to traditional practices and land use. The report will assess the impact of the proposed action on the cultural practices and features identified.

1.3 Environmental Setting

1.3.1 Natural Environment

The project area is located within the Windward O‘ahu district of Ko‘olaupoko, and is situated within the *ahupua‘a* (traditional land division) of Kāne‘ohe. Kāne‘ohe is a large *ahupua‘a* of approximately 11,000 acres, extending from the Windward base of the Ko‘olau Range to include most of the Mōkapu Peninsula and is bordered by the *ahupua‘a* of He‘eia to the west and Kailua to the east of Kāne‘ohe. Annual rainfall is high at approximately 1500 millimeters (50 inches) (Giambelluca et al. 1986). Soils in, and in proximity to, the proposed project area include Kāne‘ohe silty clay (KHOF), 30-65% slopes; Aleloa silty clay (AeE), 15-35 % slopes; and Aleloa silty clay (ALF), 40-70 % slopes; Helemano silty clay (HLMG), 30-90% slopes; Kāne‘ohe silty clay (KgC), 8-15% slopes (Foote et al. 1972). Kaneohe series soils are generally well-drained soils on terraces and alluvial fans on the windward side of Oahu. These soils developed in alluvium and colluvium derived from basic igneous rock. In a few places they developed in volcanic ash and in material weathered from cinders. The soils are gently sloping to very steep. Elevations range from 100 to 1,000 feet (Soil Survey of the State of Hawaii 2007). See Figure 4.

The project area also has a number of rivulets and the Kawa Stream is approximately 110 m west and south of the project area. Kawa Stream is a short (~4.1 km), perennial stream located mostly in the Pikoiloa Tract of southern Kāne‘ohe Town. The central branch of the stream arises within the National Veterans Cemetery and the stream eventually discharges into the south basin of Kāne‘ohe Bay. Kawa Stream has a drainage area of 4.0 km^2 (1.56 sq. mile) that includes the National Veterans Cemetery and most of HMP, nearly all of the residential developments east of Kamehameha Highway from the cemetery down to Kāne‘ohe Bay Drive and the Bay View Golf Course (http://www.pixi.com/~isd/KawaStr.html).

Vegetation within and in the immediate vicinity of the project area is dominated by alien, oftentimes invasive species such as albizia trees (*Falcataria moluccana*), Christmas berry (*Schinus terebinthifolius)*, *he‘e* - octopus tree (*Schefflera actinophylla)*, Java plum (*Syzygium cumini*) lemon and strawberry guava (*Psidium guajava, Psidium cattleianum*), ironwood (*Cauarina* spp.), Cook and/or Norfolk Island pine (*Auracaria* spp.), cinnamon trees (*Cinnamomum* sp.), African tulip tree (*Spathodea campanulata*), and cultivar fruit trees such as mango (*Mangifera indica*), to name a few. There are a few possible Polynesian introductions such as *kukui* (*Aleurites moluccana*), (true) *kamani* (*Calophyllum inophyllum*), *hau* (*Hibiscus tiliaceus*), *k* or *t i* (*Cordyline fruticosa*), *noni* (*Morinda citrifolia*), *‘ohe* (possibly *Bambusa vulgaris* and/or *Schizostachyum glaucifolium*), and *mai‘a* - banana (*Musa* spp., possibly *M. paradisiaca*). Understory plants include primarily non-native grasses such as *honohono* - basketgrass (*Oplismenus hirtellus*), ferns such as *laua‘e* or *maile*-scented fern (*Phymatosorus grossus*), bamboo orchid (*Arundina graminifolia*), and more. There are also a few native plants within the project area, primarily on the ridges, such as the indigenous fern *pala‘* (*Sphenomeris chinensis)*, *neke* fern (*Cyclosorus interruptus*), wood fern (*Dryopteris* sp.), the native fern

palapalai (*Microlepia setosa*), *hi‘a lehua* trees (*Metrosideros* spp.), and the shrub/bush *‘ lei* or Hawaiian rose (*Osteomeles anthyllidifolia*).

1.3.2 Built Environment

The project area consists of a privately owned, undeveloped area. Field survey work revealed that portions of the project area are being utilized for unauthorized hiking and paintball activities. The *mauka* side the project area is bordered by the HMP and extends *makai* to the Pohai Nani Retirement Community. From the south and east it is bounded by Kapa‘a ridge, and to the northwest by a housing development and Namoku Street.

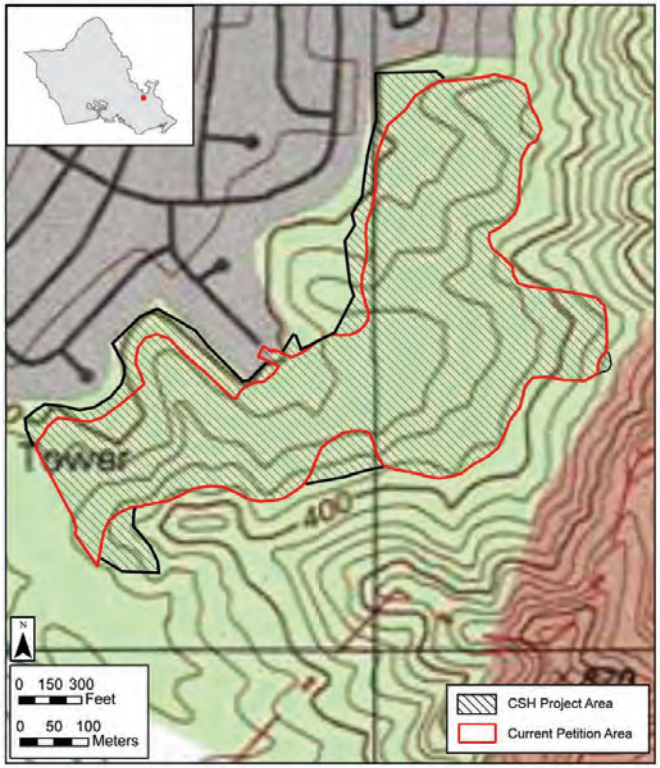


Figure 1. U.S. Geological Survey 7.5 Minute Series topographic map, Kāne‘ohe Quadrangle, showing project area location

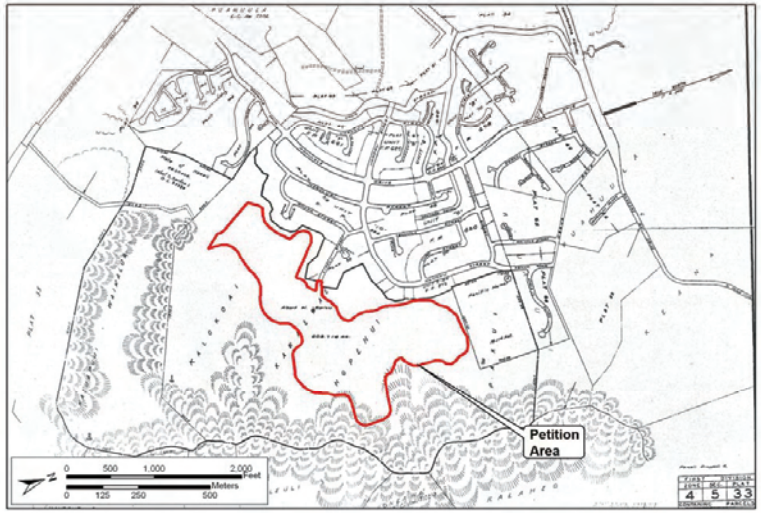


Figure 2. Tax Map Key (TMK: [1] 4-05-033:001) showing the current petition area

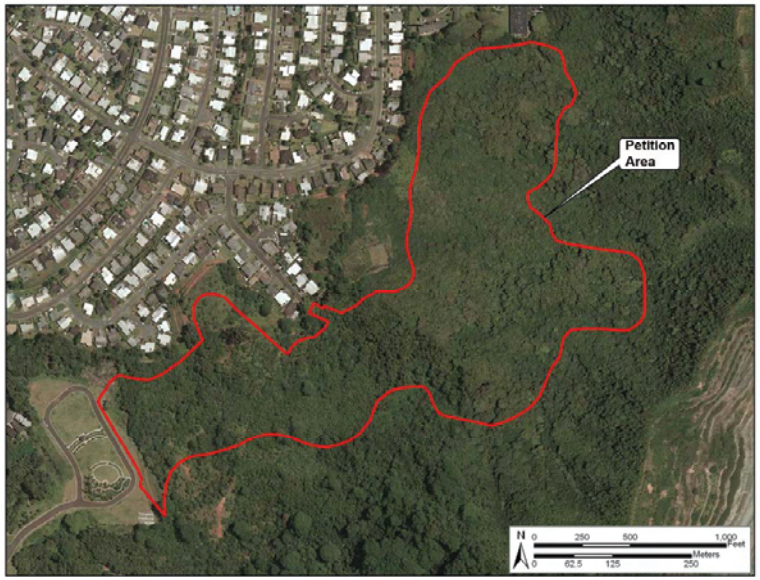


Figure 3. A 2005 aerial photograph showing the location of the current petition area (U.S. Geological Survey Orthoimagery 2005)

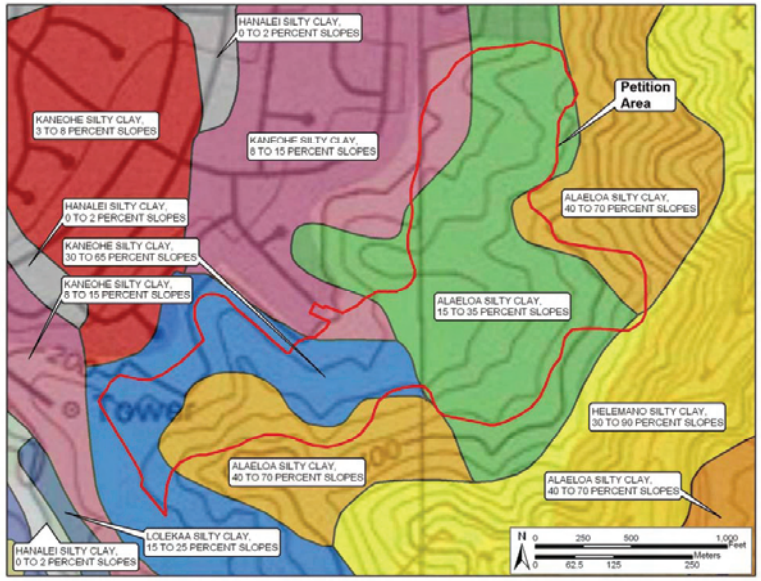


Figure 4. Overlay of Soil Survey of the State of Hawai‘i (Foote et al. 1972), indicating sediment types within the petition area (source: Soils Survey Geographic Database [SSUGRO] 2001, U.S. Department of Agriculture)

Section 2 Methods

Historical documents, maps and existing archaeological information pertaining to the sites in the vicinity of this project were researched at the CSH library. Information on Land Commission Awards was accessed through Waihona Aina Corporation's Māhele Data Base (www.waihona.com). The State Historic Preservation Division, Office of Hawaiian Affairs, O‘ahu Island Burial Council, and members of community organizations such as organizations responsible for cleaning and maintaining the Kawa‘ewa‘e Heiau, were contacted in order to identify potentially knowledgeable individuals with cultural expertise and/or knowledge of the project area and the surrounding vicinity. The names for potential community contacts were also provided by colleagues at CSH and from the lead author's familiarity with people who live in or around the project area. The cultural specialist conducting research on this assessment employed snowball and judgment sampling methods, an informed consent process and semi-structured interviews according to standard ethnographic methods (as suggested by Bernard 2005). Some of the prospective community contacts were not available to be interviewed as part of this project.. A discussion of the consultation process can be found in Section 4 on Community Consultations. Please refer to Table 4, Section 5 for a complete list of individuals and organizations contacted.

Section 3 Traditional and Historic Background

3.1 Mythological and Traditional Accounts

There are several myths and legends associated with Kāne‘ohe. A few stories provide the origin of the name of the *ahupua‘a* of Kāne‘ohe. The word "Kāne" in Kāne‘ohe has been interpreted variously as "husband", "man", or as a reference to the god Kāne, the god of creation, while *‘ohe* means "bamboo". One account attributes the name to a story about a woman who compared her husband's cruelty to the cutting edge of a bamboo knife (Pukui et al. 1974, Clark 2002). Kāne‘ohe may also be derived from *‘ohe*, which is said to be one of the *kinolau* (body forms) of the god Kāne (Abbott 1992:15). Another account is as follows:

> In Kaneohe proper, the people learned a new use for the Ohe…In olden times anyone who did not conform to the way of life lived so industriously by the shore people, was called E-epa, or non-conformist. The E‘epa were not actually "touched in the head", or lo-lo [crazy], but just different. They liked to wander off by themselves and dwell among the mysteries of the upland forests where they listened to the music of Nature, and often became poets or musicians.
>
> Those upland reaches, all unexplored territory and sacred to the Spirits or Akua of Nature, were referred to as the Wao [inland forest], or places of mystery. In order to keep children from wandering to the uplands, their elders told the little ones, "Do not go up there or the Bamboo Man may keep you. We would mourn your absence in loneliness. Remain at home and learn your useful duties."
>
> Hano-ihu…longed to explore. Pu‘ili…longed to accompany her playmate, Hano-ihu, when he wandered far. But, being more timid, she contented herself during the boy's absences and kept his secret of those upland trips he enjoyed.
>
> One sad day, Hano-ihu did not return. The people searched and could find no trace of the disobedient boy. Finally, the villagers decided the boy had died, and they told the other children that the Bamboo Man had taken the boy-wanderer.
>
> Pu‘ili…decided that he was not dead and she must search for him. Acting upon the thought, the little girl followed the direction often taken by the boy and was soon alone in the dark recesses of the forest lands of Wao, the Mysterious.
>
> She saw nothing to fear. Rather, she delighted in the beauty of the forests, the fragrance of the ferns and blossoms growing besides singing rills of sweet waters, and danced along happily to the whistling of the Wind Gods in the tree tops touching the blue sky far above.
>
> Soon she realized the whistling was not actually the Wind, for it had a bird-like note that repeated itself in a gentle rhythm. Also, she saw the bamboo moving in the breeze and heard how it rattled its branches. She found two lengths of a

> bamboo branch and, one in each hand, beat time on the two sticks while she followed the plaintive note calls.
>
> Before her…she saw her beloved playmate sitting on the bank. Beside him was a tall, thin man whose eyes watched the boy, while the child blew upon a bamboo length. The man's lean hands waved to the rhythm of the notes, and the girl went dancing toward the pair, keeping time with her pair of bamboo sticks.
>
> Hano-ihu and the tall man finished their melody, then praised the little Pu‘ili for joining them….She sat with them and learned that the man was Kane‘ohe, the Bamboo Man who, as a child, had followed the lure of Wao and had invented a bamboo flute. Kindly, the old man explained to the children how the art of creativity often is lost unless those inspired do follow the call. He told them, "Now we shall return to the village, for I have answered the call and you two little ones will be musicians like me. In honor of this occasion, I shall name the flute after you, my boy...we shall name the time-keeping sticks for her."
>
> Gaily, the three went down the forest trail of Wao the Inspiring. They were welcomed with feasting and joy. That is how we have the...Bamboo, instruments today. The Hano-ihu or Nose flute; and the Pu‘ili, or notched Bamboo sticks; and the hula named for these gifts of Kane‘ohe, the Bamboo Man. (Paki 1972:29-30)

The Kawa‘ewa‘e Heiau borders the west side of the project area (see McCurdy and Hammatt 2008). The word "kāwa‘ewa‘e" literally refers to a type of stone or coral used for polishing canoes, or in rubbing off pig bristles (Pukui and Elbert 1986). Windward O‘ahu is famous for legends of Kamapua‘a; the half man, half pig demigod renowned for making mischief and for his masterful escapes from retribution for his chicken and taro thievery. One story centers on Kamapua‘a and the Kawa‘ewa‘e Heiau. Thrum reports that Kawa‘ewa‘e Heiau was erected in the beginning of the 12th century by the high chief ‘Olopana (1906:48). Kawa‘ewa‘e Heiau was said to have been constructed by *menehune* (legendary race of small people who built structures by night) (Fornander 1878:23). ‘Olopana, depending on which story is being told, is said to have been the father or uncle of the notorious Kamapua‘a. In the version of the story presented by King David Kalākaua (1990), Kamapua‘a, embittered by ‘Olopana's rejection of this hog-child, retreats to the mountains where he attracts a band of like-minded thieves and commences to "harass the estates of Olopana", stealing ‘Olopana's pigs, fowls and fruits as well as taking pleasure in breaking his nets, cutting adrift his canoes and robbing his fish-ponds (Kalākaua 1990:143). Enraged by Kamapua‘a's pillage and acts of rebellion, ‘Olopana orders his capture. After several battles and failed attempts to catch Kamapua‘a, ‘Olopana's army succeeds in delivering Kamapua‘a to the high chief to the "great joy and relief of the people of Koolau" (p.145). Kalākaua relates the following:

> Olopana had erected a *heiau* at Kaneohe, Lonoaohi officiated as high priest, and thither he resolved to take his rebellious son or nephew, and offer him as a sacrifice to the gods. Hina [Kamapua‘a's mother] pleaded for the life of Kamapuaa, but Olopana could not be moved. Satisfied that he would listen to no appeals for mercy, she determined to save her son, even at the sacrifice of her

> husband, and to that end secured the assistance of the high priest, through whose treachery to Olopana the life of Kamapuaa was saved.
>
> On the day fixed for the sacrifice Kamapuaa…was taken to the *heiau*, followed by Olopana, who was anxious to witness the ghastly ceremonies, and with his own eyes see that his troublesome enemy was duly slain and his body laid upon the altar. In offering human sacrifices the victim was taken without the walls of the *heiau* and slain with clubs by the assistants of the high-priest. The body was then brought in and placed upon the altar in front of the entrance to the inner court, or sanctuary, when the left eye was removed by the officiating priest, and handed…to the chief who had ordered the sacrifice….
>
> Standing with three or four attendants, at the door of his tabued retreated…Olopana saw his victim preliminarily led to the place of sacrifice, and a few minutes after motioned for the ceremonies to begin. Kamapuaa was taken without the walls of the temple to be slain….Passing beyond the outer wall the party entered a small walled enclosure adjoining, and the executioner raised his club and brought it down upon the head of his victim. Kamapuaa smiled, but did not move. Twice, thrice with mighty sweep the club descended upon the head of Kamaupuaa, but scarcely bent the bristly hairs upon his crown.
>
> With a semblance of wonder the executioner, whose tender blows would have scarcely maimed a mouse, dropped his club and said:
>
> "Three times have I tried and failed to slay him! The gods refuse the sacrifice!"
>
> "It is so, it is so, it is so!" chimed his companions….
>
> Therefore, instead of slaying Kamapuaa, the assistants, as they had been secretly instructed to do by the high-priest, removed the cords from his limbs, smeared his hair, face and body with the fresh blood of a fowl, and on their shoulders bore him back and placed him upon the altar as if dead.
>
> The high-priest approached the apparently lifeless body, and bent for a moment over the face, as if to remove the left eye; then placing on a wooden tray the eye of a large hog, which had been procured for that purpose, he sent an assistant with it to Olopana, at the same time retiring within the inner court, and leaving by the side of Kamapuaa, and near his right hand, as if by accident, the sharp ivory *pahoa*, or dagger, with which he had, to all appearance, been operating.
>
> Giving but a single glance at the eye presented to him by the assistant of the high-priest, Olopana passed it to an attendant without the customary semblance of eating it, and approached the altar alone. Kamapuaa did not breathe. His face was streaked with blood, his eyelids were closed, and not a single muscle moved to indicate life.

> Olopana looked at the hated face for a moment, and then turned to leave the *heiau*….As he did so Kamapuaa clutched the dagger besides his hand, and, springing from the altar, drove the blade into the back of Olopana. Again and again he applied the weapon until the chief, with a groan of anguish, fell dead at the feet of his slayer. (Kalākaua 1990:145-146)

Kalākaua goes on to describe how Kamapua‘a is released from custody by the high-priest, and how as the people of the district had “suffered through his plundering visitations, and hundreds of lives had been sacrificed in his pursuit and final capture, the people rose almost in a body to hunt him down and destroy him” (p.147). Kamapua‘a and his cohorts eventually sail off O‘ahu for the windward islands in search of refuge.

3.2 Pre-Contact Period

In pre-Contact times, the *ahupua‘a* of Kāne‘ohe offered fresh water from *mauka* (upland) springs and a well-developed fishpond system, making it both an agricultural and aquacultural center, and one of the primary population centers on O‘ahu (Devaney et al. 1982:6). Handy and Handy (1972) described Kāne‘ohe as:

> ...an area of little hills with many small streams between them. In 1935 it was still one of the most active communities in planting commercial taro. A goodly proportion of its lowland *lo‘i*, tucked away in pockets flanked and often hidden by low hills or near the town itself, was then still planted in taro by Hawaiians who owned the land and by Orientals who leased land or were hired to cultivate it. (Handy and Handy 1972:455)

Pre-Contact land use would have consisted mainly of *kalo* (wetland taro) and *kula* (dryland) cultivation of *hala* - pandanus (used for making household furnishings such as mats), *wauke* – paper mulberry (used for making *tapa/kapa* cloth), bananas and sweet potatoes (Handy and Handy 1972:456). Kāne‘ohe Bay, with about two-dozen walled fishponds, was a bountiful source of fish (Devaney et al. 1982:6).

3.3 Early Historic Period to Mid 1800s

Kāne‘ohe has long been viewed as a valuable *ahupua‘a* both in terms of agricultural and fishery productivity. In 1830 the chiefs of Hawai‘i, Maui, and O‘ahu, in a council meeting concerning the “late doings on Oahu”, referred to Kāne‘ohe as the “most valuable part” of the district of Ko‘olaupoko (Kamakau 1992:303). Kāne‘ohe held a unique position in the history of *‘awa* cultivation. The relaxant drink prepared from rootstock of the *Piper methysticum* plant was regarded as immoral by missionaries who sought to restrict consumption of the “intoxicant” brew. In 1846 obliging lawmakers created licensing laws and set up a system of *‘awa* agents to plant and sell *‘awa* on the various islands. The argument for this system was that, although *‘awa* was considered morally hazardous, it had medicinal value. There were 2 *‘awa* agents assigned to O‘ahu: one was William Harbottle who was authorized to grow *‘awa* on 2 acres of land in Kāne‘ohe (Greer 1970:66-67).

Describing the early historical times of Hawaiian *ali‘i* (monarchy) in Kāne‘ohe, Devaney et al. (1982) state:

> …when Kahanahana ruled O‘ahu [circa 1773-1783], he sometimes lived in Kaneohe. After defeating Kahanahana circa 1783, Maui Chief Kahekili and most of his famous warriors lived in Koolaupoko at Kailua, Kaneohe, and Heeia (Fornander 1969:225; Kamakau 1961:138). When Kamahameha I apportioned the conquered O‘ahu lands in 1795 to his warrior chiefs and counselors (Ii 1959:69-70), he retained as his personal property the *ahupua‘a* of Kaneohe… Much of Kaneohe and all of Kahaluu and Kualoa were inherited as personal lands by Kamehameha’s sons Liholiho and Kauikeaouli, Kamehameha II and III (*Indices*…1920:27-28). (Devaney et al. 1982:5)

3.3.1 The Māhele (Land Divisions)

The Organic Acts of 1845 and 1846 initiated the process of the Māhele - the division of Hawaiian lands - that introduced private property into Hawaiian society. In 1848, the crown and the *ali‘i* (royalty) received their land titles. *Kuleana* awards to commoners for individual parcels within the *ahupua‘a* were subsequently granted in 1850. Kamehameha III, as mentioned above, had inherited Kāne‘ohe and retained the bulk of the *ahupua‘a* during the Māhele. After his death, his wife, Queen Kalama (Hakaleleponi), retained their portion of Kāne‘ohe (Barrère 1994, Kame‘eleihiwa 1992).

The crown lands were considered the private lands of the monarch, and many lands were sold or mortgaged during the reigns of Kamehameha III and IV to settle debts to foreigners. To end this practice, in 1865 the Crown lands were made inalienable, and their dispensation was regulated by a Board of Commissioners of Crown Lands, which effectively put them under the administrative control of foreign-born residents (Kame‘eleihiwa 1992:310).

Before the passage of the Act of January 3, 1865, which made Crown Lands inalienable, Kamehameha III and his successors did as they pleased with the Crown Lands, selling, leasing, and mortgaging them at will (Chinen 1958:27).

In 1850, the Privy Council passed resolutions that would affirm the rights of the commoners or native tenants. To apply for fee-simple title to their lands, native tenants were required to file their claim with the Land Commission within the specified time period of February 1846 and February 14, 1848. The *Kuleana* Act of 1850 confirmed and protected the rights of native tenants. Under this act, the claimant was required to have two witnesses who could testify they knew the claimant and the boundaries of the land, knew that the claimant had lived on the land for a minimum of two years, and knew that no one had challenged the claim. The land also had to be surveyed.

Not everyone who was eligible to apply for *kuleana* lands did so and, likewise, not all claims were awarded. Some claimants failed to follow through and come before the Land Commission, some did not produce two witnesses, and some did not get their land surveyed. For whatever reason, out of the potential 2,500,000 acres of Crown and Government lands “less than 30,000 acres of land were awarded to the native tenants” (Chinen 1958:31).

As a result of the *Kuleana* Act of 1850, a total of 242 land claims were made for Kāne‘ohe Ahupua‘a, but only a bit more than half of those were awarded (www.waihona.com). The average *kuleana* award was 2.38 acres (Kelly 1976:8). However, these claims were not only for commoners, as chiefs and/or *konohiki* (headmen) were also awarded lots. The bulk of Kāne‘ohe

Ahupua‘a eventually went to Queen Hakaleleponi Kalama (1817-1870), eleven *konohiki,* and 3 non-*konohiki* (privileged awardees who received large parcels of land) (Kelly 1976:7). The primary type of land claimed in Kāne‘ohe was taro land, identified in the claims, testimony, and awards as *lo‘i*, but there was also fishponds and *kula* (dryland crops) as well. The present project area straddles the *‘ili* (land section, usually a subdivision of an *ahupua‘a*) of Kalokoai and Pakui. Table 1 provides LCAs issued within Kalokoai and Pakui, as well as *‘ili* in proximity to the project area. Figures 5 to 7 present historic maps depicting *‘ili* and Māhele awards in and around the project area.

Table 1. LCAs Awarded in Kalokoai and Pakui and nearby ‘Ili of Kāne‘ohe

LCA #	*‘Ili*	Claimant	Land Use	Awarded
2444	Kalokoai	Keawekukahi	2 *lo‘i*; 1 house lot; 3 fish ponds	3 ‘ *pana*; 1.808 Acres
2806	Kalokoai	Kahilikoolani	2 *lo‘i*	1 ‘ *pana*; .839 Acres
1899	Pakui, Kaluapuhi, Puuiki	Opunui	12 *lo‘i*; 1 house lot; *loko*; *pali* (cliff, ridge), *kula* (dryland crops)	3 ‘ *pana*; 3.85 Acres
7171	Pakui, Waikalua	Kamakahi	6 *lo‘i*; 1 house lot; *muliwai* (river)	2 ‘ *pana*; 1.15 Acres

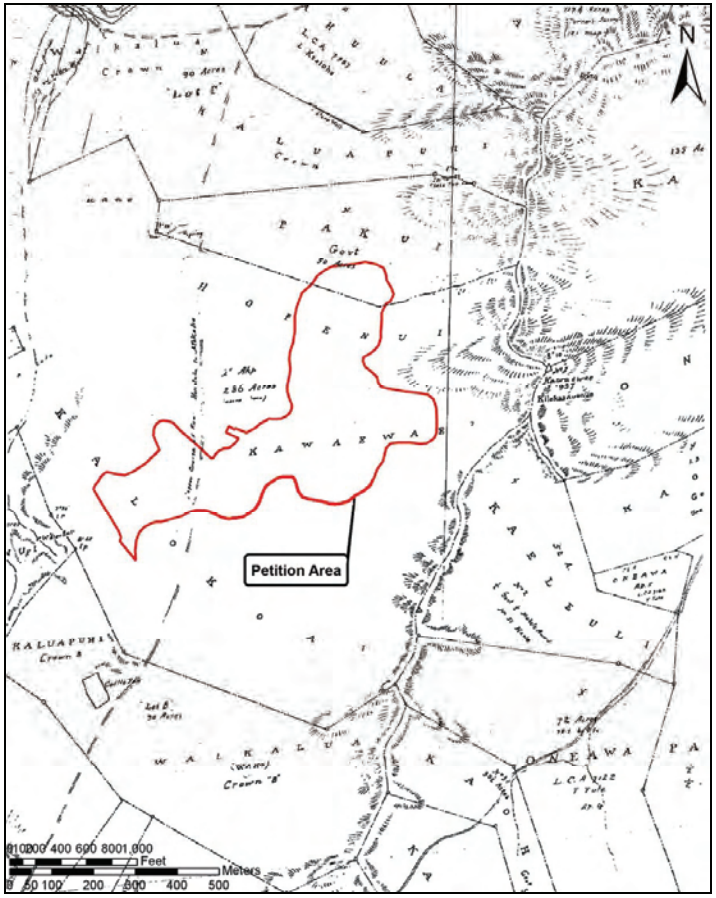


Figure 5. Portion of 1874 Lyons Map of Kāne‘ohe O‘ahu with West Kailua showing locations of LCAs in the vicinity of the petition area.

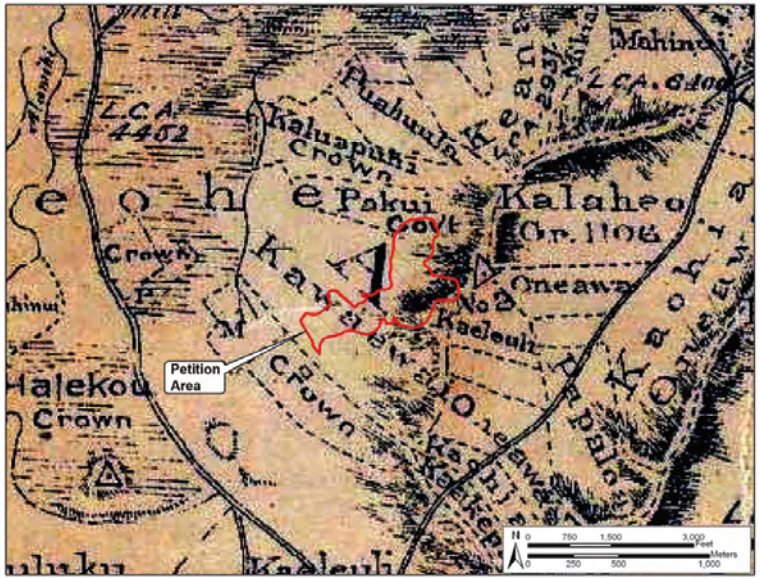


Figure 6. Portion of 1881 Hawaiian Government Survey map by C.L. Lyons showing locations of Crown and Government lands and LCAs in the vicinity of the project area

Figure 7. Portion of 1901 John Donn Map of Kailua and Kāne‘ohe subdivided into *‘ili*

3.3.2 1860s to 1920s: Sugar and Rice

In the 1860s, both commercial sugar cane and rice cultivation began in Kāne‘ohe. One of the earliest sugar plantations on O‘ahu was owned by Charles Coffin Harris, who came to Hawai‘i in 1850 with a plan to practice law. He established the Kaneohe Sugar Plantation Company (c. 1865) on 7,000 acres of Queen Kalama’s land (Dorrance and Morgan 2000:41). In 1871, C. C. Harris bought Queen Kalama’s Ko‘olaupoko properties from her heir, Charles Kanaina, as well as some land in Honolulu for $22,448. The sale included “…livestock, tool, fishponds, and fishing rights” (Bur. Of Conv. Book 34:53; in Devaney et al. 1976:29). C.C. Harris’s plantation shut down in 1891, when the sugar yield was not enough to support the operation (Dorrance and Morgan 2000:41). Judge C.C. Harris’s daughter and heir, Mrs. David Rice, incorporated the lands as Kaneohe Ranch and converted it to stock farming, to be eventually purchased by James B. Castle in 1907 (Montgomery 1971 in Dorrance and Morgan 2000:42). Harold K.L. Castle, the only child of James B. Castle, owned most of the *ahupua‘a* of Kāne‘ohe in the early 1900s (www.kaneoheranch.com), and in 1917 he purchased the land from Harris’s daughter (Henke 1929:62).

Rice cultivation was to eventually supersede taro and dominate the lowlands of Kāne‘ohe. The ancient taro *lo‘i* and *‘auwai* irrigation systems and additional new ditches were built to support rice cultivation. During the height of rice cultivation (c. 1880-1920), Chinese dominated the business. “To a great extent the rice business, growing and milling was controlled by Chinese *hui* (firms), which recruited laborers from China, handled investment capital from rich absentee landlords, and tallied profits” (Devaney et al. 1982:49). By the late 1880s, virtually the entire floodplain areas of Kāne‘ohe were under rice cultivation. In 1892-3, the Kaneohe Rice Mill was erected and put into production on property adjoining Waikalua Stream. There was a flume that brought water from the river to the rice mill. About twice a week a steamer came into Kāne‘ohe Bay to pick up and transport rice to market in Honolulu (Ching, personal communication, in Allen 1987:295).

By the 1920s, rice had gradually declined in importance due to a number of factors. Two of the primary reasons for this decline include the beginning of rice production in California as well as the “annexation of Hawaii by the United States in 1898 resulted in restrictions on the number of Chinese laborers arriving from the Far East” (Devaney et al. 1982:53). However, rice as well as some taro cultivation continued up to c. 1960.

3.3.3 Ranching

In the mid 19th century, ranching became a major enterprise. Cattle and sheep had been left on O‘ahu by the English Captain George Vancouver in 1793 (Henke 1929:8), and the former had multiplied into a large herd by the 1840s (Devaney et al. 1982:70). At its peak, Kaneohe Ranch extended from the ocean in Kailua to the Pali and included 12,000 acres and 2,000 head of cattle (Henke 1929:62). By the mid 1860s, the cattle were so numerous as to cause environmental degradation. Alien grasses and other species, such as pigeon peas, were introduced to the area as cattle fodder (Henke 1929:62). Much of the land modification in the upland and hilly portions of Kāne‘ohe may be the result of heavy cattle grazing over a long period of time:

> A view from the Pali looking toward Kaneohe in 1854 revealed that there were “hundreds of cattle…feeding on the rich pasture with which these plains were covered (Bates 1854:104). By the mid-1860s, we have an indication that livestock was altering the landscape. The undulating plains at the foot of Nuuanau Pali (Kekele lands) were described as “a rich land a while ago but now there are not many plants because animal are permitted there” (Sterling and Summers Ms.:207). (Devaney et al. 1982:70)

Figure 8. 1893 Photograph by J.J. Williams of *poi* pounding, taken near Kawa Stream in Kāne‘ohe south and west of the project area. Note grasses and degraded landscape. (Scott 1968)

3.3.4 1890s to Present: Pineapple and Dairy

The commercial cultivation of pineapple began in the 1890s and the first decade of the 1900s in Kāne‘ohe. From approximately 1910 to 1925, pineapple cultivation was a major industry in this area. In 1911, the company of Libby, McNeill and Libby built a pineapple cannery in He‘eia. At its peak, 2,500 acres were under pineapple cultivation on Windward O‘ahu (Harper 1972) stretching from Kāne‘ohe to Kahalu‘u. A large percentage of this acreage was in Kāne‘ohe located below the Pali where the golf course, Hawaii Loa College, and the Hawaiian Memorial Park are today (Kelly in Allen 1987:295-296). A *heiau*, Kaualauki Heiau in He‘eia, was mostly destroyed by pineapple field clearance during this time – a likely fate of many archaeological sites (Kelly in Allen 1987). In 1919, the Kaneohe Ranch Company and Heeia Agricultural Co., Ltd. leased 1,000 acres of land in He‘eia, Kāne‘ohe, and Kailua, formerly planted in sugar, to the Libby company for a term of 17 years. In 1917, Libby leased an additional 600 acres in He’eia (Libby, McNeill & Libby Ms:2, cited in Kawachi 1990). While the rice fields that covered old taro lands were mainly located near streams and near the coast, the pineapple fields were grown on the slopes of higher lands, usually on land subleased to individual Japanese farmers:

> Pineapples were planted by individual Chinese and Japanese farmers on moderately sloped hill land where rice and taro could not be grown . . . these areas included the dissected alluvial terraces and the lower slopes and spurs of the Ko‘olau range. (Miyagi 1963:115)

The change to the windward landscape in the first decades of the twentieth century as a result of pineapple cultivation is illustrated by the following passage:

> At last we reached the foot of the Pali. . . . Joe and I looked over the surrounding hills, but looked in vain for the great areas of guava through which but a few months ago we had fought and cut our way. As far as the eye could reach pineapple had taken the place of the forest of wild guava. The newest industry in Hawaii was beginning even to press upon the cane fields of this side of the island. (Alexander 1914:318, cited in Devaney et al. 1982:62)

The pineapple fields were abandoned when Moloka‘i and Lāna‘i pineapple cultivation began to boom, and Libby pulled out of the Ko‘olaupoko enterprise (Kelly 1976:47). The cannery closed in 1923 (Dorrance 1998:95). Most of the former pineapple land went to grass, and some of it was used to graze cattle. Several of the small farmers returned to rice cultivation. (Kelly 1975:47).

In 1918 the first military reservation was built on the Mōkapu Peninsula at Kāne‘ohe Bay; Fort Hase was commissioned and was known as the Kuwaahoe Military Reservation. Now known as the Marine Corps Base Hawaii (MCBH), the base helped lead to a boom in commercial and residential development in and around Kāne‘ohe.

By the end of World War II, ranching was no longer economically viable for the Kaneohe Ranch, and the ranch became primarily a landlord to other farmers (www.kaneoheranch.com). After World War II, residential developments changed the face of Kāne‘ohe Ahupua‘a. The opening of the Wilson Tunnel and the expansion of the Pali Highway in the 1950s and 60s creating an easier passage from Honolulu through the Ko‘olau mountains to windward

communities led the way to a development boom on the windward side of O‘ahu. High tax rates on real estate sales forced many old-time landowners to lease their land to residential developers rather than sell on a fee-simple basis. Kaneohe Ranch at one time leased their land to over 5,000 single family residential lots in Kailua and Kāne‘ohe. The vast majority of the leaseholds were sold to the lessees (www.kaneoheranch.com).

The dairy industry rose to prominence over beef cattle ranching in the post-war years. The shortage of available land due to urban expansion, the shortage of fee simple land, and the high price of land leases forced farmers in the dairy districts near Honolulu (e.g., Koko Head) to relocate to more remote areas of O‘ahu (Durand Jr. 1959:241). In the 1950s Kailua-Kāne‘ohe was an important dairy district of Windward O‘ahu. Dairy farming was dominated by white (Caucasians) particularly of Portuguese and Spanish ancestry, and secondarily Japanese, farmers (Durand Jr. 1959:235). “Among the names of island dairymen, illustrating the Portuguese-Spanish-Mainland importance…are…Brazil, Carlos, Campos, Costa, Ferreria, Foster, Freitas, Knowles, Medeiros, Moniz, Ornellas, Rapoza, Santos, Toledo, Vause and White” (Durand Jr. 1959:235). The Souza Brothers Dairy, which opened in the 1950s, was located near the project area. However, this period was relatively short-lived as the opening of the Pali route, exorbitant land prices in Honolulu, and more automobiles on O‘ahu contributed to rapid urbanization in Kailua-Kāne‘ohe (Durand Jr. 1959:244-245). Many landowners decided to develop their land for suburban housing and terminated leases with farm leaseholders. Figures 9 to 13 present historic maps of the project area and vicinity.

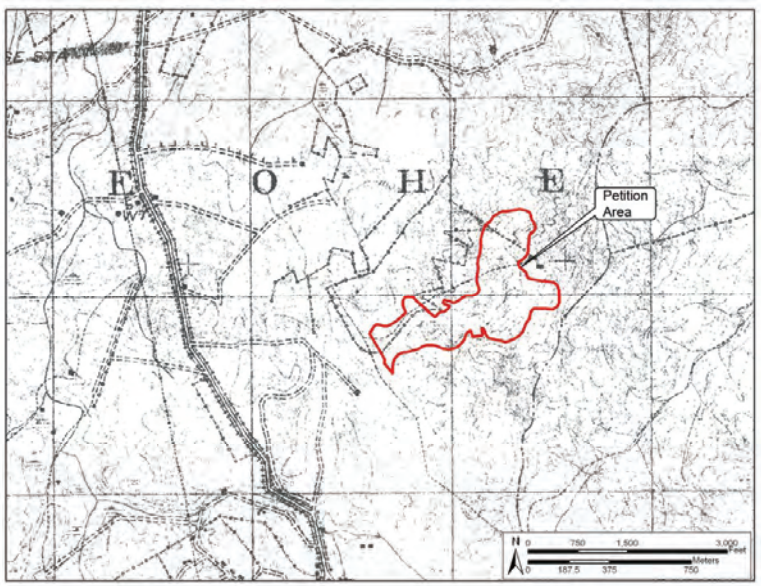


Figure 9. 1919 War Department Kāne‘ohe Quad map and project area

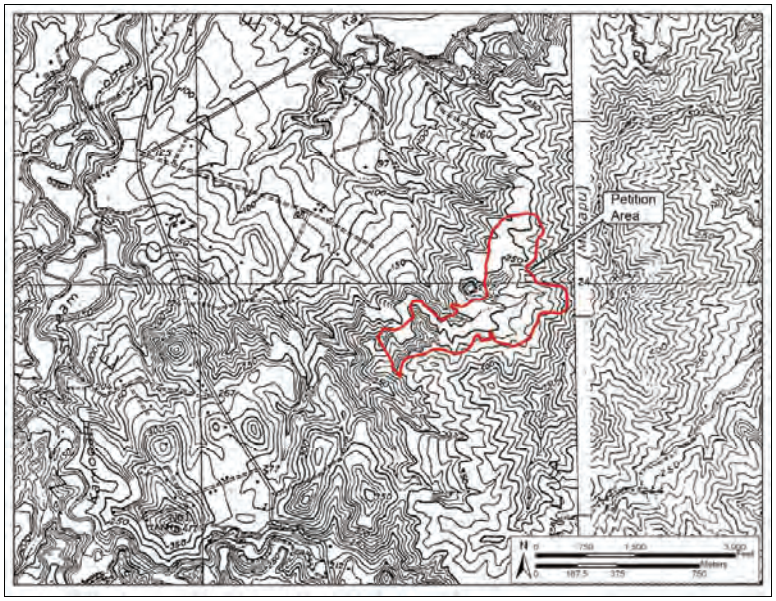


Figure 10. Portion of 1928 U. S. Geological Survey Kāne‘ohe and Mōkapu Quad map and project area

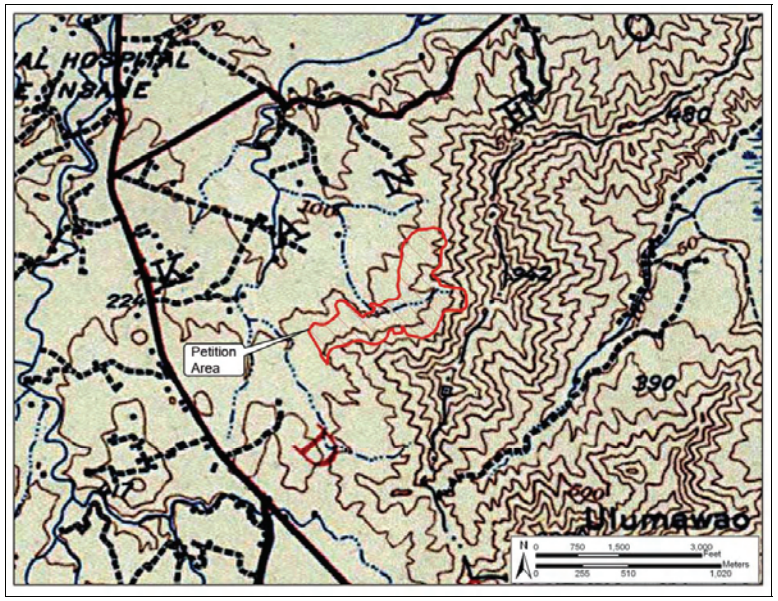


Figure 11. 1938 USGS topographical map of 1927-1930 survey of O‘ahu and project area

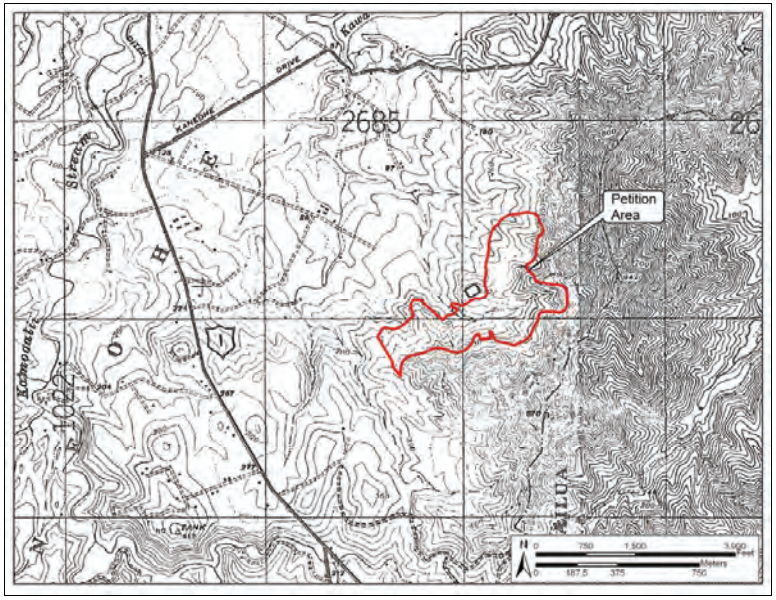


Figure 12. Portion of 1943 War Department Kāne‘ohe Quad map showing vicinity of project area

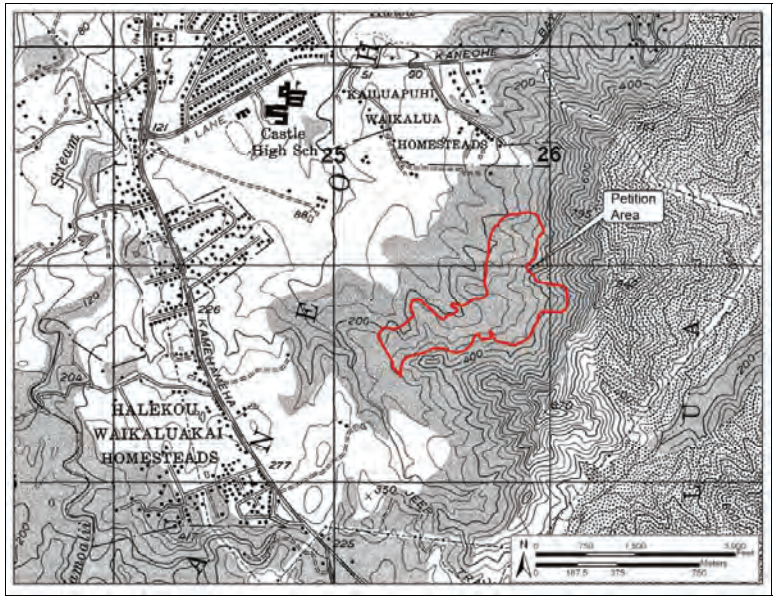


Figure 13. 1955 Army Map Service map and project area

Section 4 Previous Archaeological Research

A number of archaeological investigations have been conducted in Kāne‘ohe Ahupua‘a. This section provides a brief overview of the research and findings of previous archaeology in the general area surrounding the present project. For a more detailed summary see McCurdy and Hammatt 2008.

4.1 Previous Studies Adjacent to or Including Portions of the Project Corridor

4.1.1 McAllister

The earliest systematic archaeological coverage of Kāne‘ohe was by J.G. McAllister (1933) who recorded major sites throughout O‘ahu in the early 1930s. McAllister recorded a number of fishponds and other sites in the vicinity of the current project area (Figure 14). The following are brief descriptions of sites near the current project area (McAllister 1933 in Sterling and Summers 1978:210-221):

> Site 349. Waikalua Fishpond, adjacent to Waikalua, Kaneohe. The rebuilding of the pond has been completed. The wall was 1420 feet long of waterworn basalt 3 to 4 feet high but somewhat wider. The pond covers 11 acres.
>
> Site 350. Two ponds, Kailua side of Waikalua. The pond in use is said to be Keana with an area of 3.5 acres. According to Bell, the name of the other is Kalokohanahou. Its wall is broken. Both were built of waterworn basalt. The dirt-filled wall of Keana is wide enough for trees to grow on it.
>
> Site 351. Three adjacent ponds, located off the lands of Mikiola and Mahinui in Kaneohe. The two end ponds were probably built first, the middle pond being added later so as to take advantage of the walls of the other two. The pond on the east is known as Mahinui and that on the west as Mikiola. The name of the middle pond is Kaluoa, according to John Bell, but appears as Kapuu on a map in the Bishop Estate office. The wall of Mikiola is broken.
>
> Site 352. Ahukini heiau, Keana, Kaneohe. A small structure, 70 by 127 feet, built on the top of an elevation 1200 feet from the sea…The only features remaining are the low walls, unusual because they are built of stones a few inches in size…most of the remains are scattered, for it is very easy for the cattle to disturb the small stones…When the drums at this heiau were beaten they could be heard over Kaneohe, but not just on the other side of the low ridge in Kailua.
>
> Site 353. A spring on the land known as Keana, called Kinikailua-Manokaneohe, as it is said that the people from both Kailua and Kaneohe died in great numbers from drinking its waters.

Site 354. Kawa‘ewa‘e Heiau, this is one of the five heiaus said by John Bell to have been erected by Olopana. Ahukini, Pahukini, Holomakani, and Puumakani are the other four. It is on top of a small knoll and consists of one large enclosure 120 by 253 feet with a small terrace on the north side which follows the contours of the land. As the structure was used as a cattle pen for many years any traces of heiau features have been obliterated, and it is not known where the opening to the heiau was situated. The walls are massive, averaging about 5 feet in width and from 4 to 7 feet in height according to the contours of the land. The inside corners of the wall are rounded; the outside corners appear more angular.

Thrum notes that this heiau was “Built by Olopana about the opening of the 12th century”. It was mentioned as one of the heiaus constructed by the menehunes. Lonoaohi is said to have officiated as high priest.

This is the heiau to which Olopana had Kamapuaa brought for sacrifice. Through treachery Kamapuaa is said to have killed Olopana and escaped. [See and 16].

Site 355. Small round hill, the name of which is not remembered, near the mountain side of Kawa‘ewa‘e Heiau. Said by John Bell to have been the location of a holua. This he saw destroyed when an attempt was made to plant pineapples in this section. Without doubt this is the site of the slide described by Bates in 1853.

Before reaching the mission station at Kaneohe, the road leads through a narrow but fertile ravine, tenanted by a few natives. In leaving the ravine, a low round hill, to the right of the path, is rather conspicuous from a long, narrow depression or channel on its side. It was an indication that one of the favorite games of the old Hawaiians had been played there. This game was called the holua, and was one of their favorite games of chance…

This same site was seen by Briggs in 1881:”Dewight pointed out to me a long narrow depression on some of the hills to be seen from our path, where old Hawaiians used to play one of their favorite games of chance”.

Site 356. Puumakani Heiau, Kalapuhi, Waikalua, Kaneohe. This heiau was on the ridge facing the Nuuanu Pali, but the stones were removed and used for building a cattle corral farther down the slope. The heiau is said to have been built by Olopana.

Site 357. Kamaikola across from the Japanese store at the first bridge beyond the end of Nuuanu Pali descent.

Many generations ago there lived at the foot of the Pali a Hawaiian of questionable habits. His name was Pakuanui and he lived on the land known as Kamaikola. Here he had his grass hut, the rock foundation of which was to be found only a few years ago. In one version of the story his wife used to be

stationed at the head of the Pali to signal to her husband when but one or two travelers laden with goods descended the trail. Pakuanui waited in ambush, fell upon them with his spear, disposed of the bodies and appropriated the goods.

According to background research and historic maps, Site 355, the *h lua* slide, was located in the southwestern portion of the project area. Site 354, Kawa‘ewa‘e Heiau, borders the northern boundary and Site 356, Puumakani Heiau, was located near the southern boundary of the project area. Additional information about Kawa‘ewa‘e Heiau is available in McCurdy and Hammatt 2008: Appendix A.

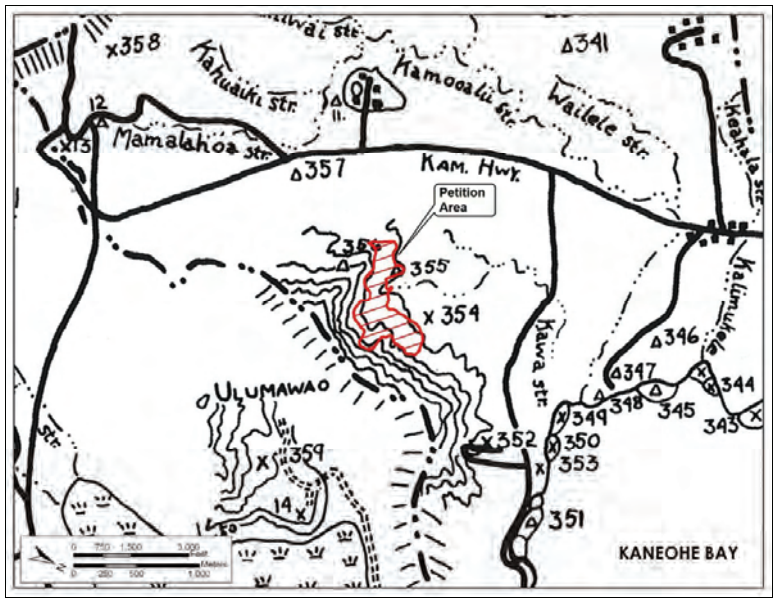


Figure 14. Portion of 1959 Bishop Museum map showing the locations of archaeological sites identified by McAllister (1933) in relation to the current petition area (adapted from Sterling and Summers 1978)

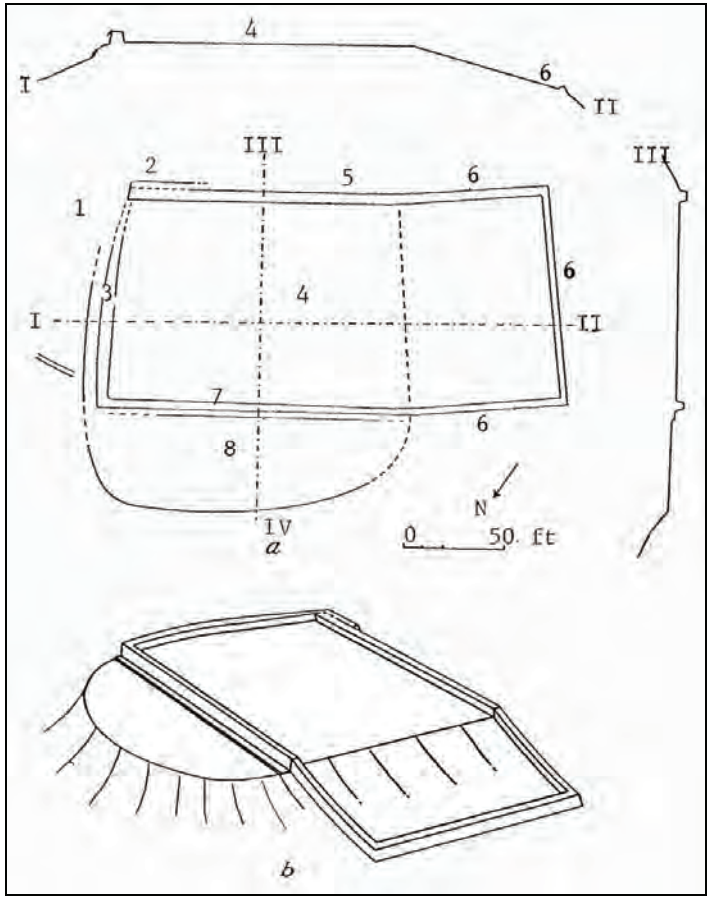


Figure 15. Kawa‘ewa‘e Heiau (adapted from McAllister 1933:180)

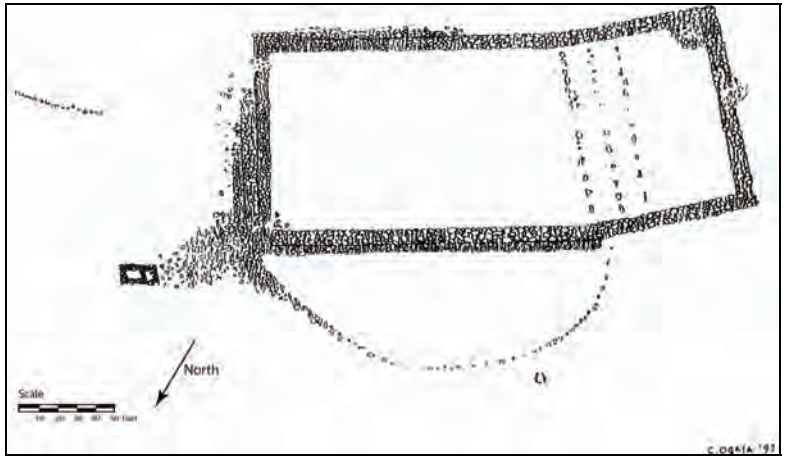


Figure 16. A sketch of Kawa‘ewa‘e Heiau provided by Mr. Charles Ogata (see Section 6)

4.1.1.1 Szabian et al.

From May 25 to June 3, 1989 Szabian et al. conducted an archaeological reconnaissance survey for the proposed Pikoiloa Cemetery. In addition to Kawa’ewa’a Heiau (SIHP # -354), listed on the National Register of Historic Places since 1972, 11 sites were recorded with at least 25 associated features. Of these four were interpreted as pre-Contact and seven as historic in nature. On the field map provided by Szabian et al. (1989:2) it appears that six of these sites are located within the current petition area (Figure 17). They include SIHP# -4680,-4681, -4682, -4683, -4684, and -4686. Subsequent to the investigation conducted by Szabian et al. SIHP#’s -4681 and -4682 were determined to be outside the current petition area (Figure 17). In addition SIHP # 50-80-10-4682 was determined to be non-Cultural (see McCurdy and Hammatt 2008). All of the sites previously recorded by Szabian et al. are summarized in Table 2.

Table 2. Historic Properties identified in Szabian et al. 1989 Archaeological Survey

SIHP # (50-80-10-)	# of Features	Formal Site Type	Probable Function	Estimated Age	Description
Historic Properties Located Within the Current Petition Area					
4680	1	Terrace	Agricultural/ Water control	Historic	Historic erosion control and water diversion terrace.
***4681**	5	Complex-Enclosures and Terracing	Agricultural/ Habitation	Pre-Contact	A habitation site consisting of several c-shaped structures, a terrace wall and a circular rock feature situated on a north-facing slope. This historic property is located outside of the petition area.
*** 4682**	0	Natural terracing, Platform	Natural	Non-Cultural	This is a series of natural “terraces” formed by lava rocks, which rolled down slope and were caught by exposed bedrock outcrops.
4683	1	Pit feature	Charcoal kiln	Historic	Consists of a rectangular pit 3.6 m by 2.5 m and some natural terracing. The walls of the pit show evidence of burning, likely the remnants of a charcoal kiln or some similar processing area.
4684	7	Complex-Enclosure, and Terracing	Habitation	Pre-Contact	Habitation site consisting of several c-shaped structures, a terrace wall, a circular rock feature and several house terraces.
4686	1	Stone alignment	Boundary marker	Historic	This site consists of two features. Feature A is a rock alignment constructed of boulders running east/west parallel to a large stream cut. Feature B, previously described as a series of stone alignments, appears to have been badly disturbed due to landscaping and rubbish piling.

SIHP # (50-80-10-)	# of Features	Formal Site Type	Probable Function	Estimated Age	Description
Historic Properties Located in the Vicinity of the Current Petition Area					
4676	9	Complex of walls, stepped terracing	Agricultural and habitation	Pre-Contact	A site complex adjacent to KLEI radio tower along a tributary to the Kawa Stream.
4677	2	Wall remnant, earthen mound	Agricultural	Historic	Located adjacent to the Kawa Stream, it consists of a remnant stone wall and a large earthen mound.
4678	2	Wall remnant, earthen mound	Agricultural or habitation	Historic	Located approximately 70 m north of SIHP 4677. Consists of an alignment and a large earthen mound.
4679	1	Wall remnant	Boundary of habitation	Historic ?	Located at the base of the slope below KLEI radio tower and consisting of an L-shaped alignment of weathered basal stones.
4685	2+	Remnant walls, terracing	Habitation/ agricultural	Historic	Located on a ridge between two deep stream cuts consisting of a level terraced area with facing and an undetermined number of possible terrace facings downstream.
* Subsequent to the investigation conducted by Szabian et al. SIHP#’s -4681 and -4682 were determined to be outside the current petition area					

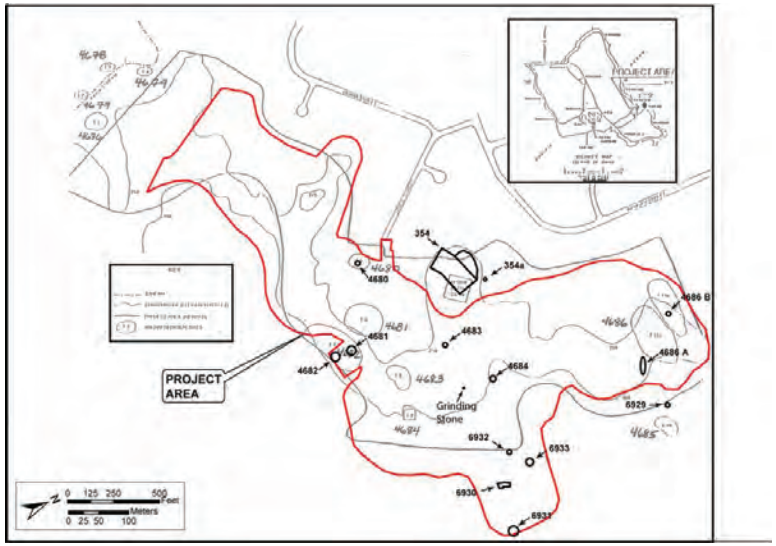
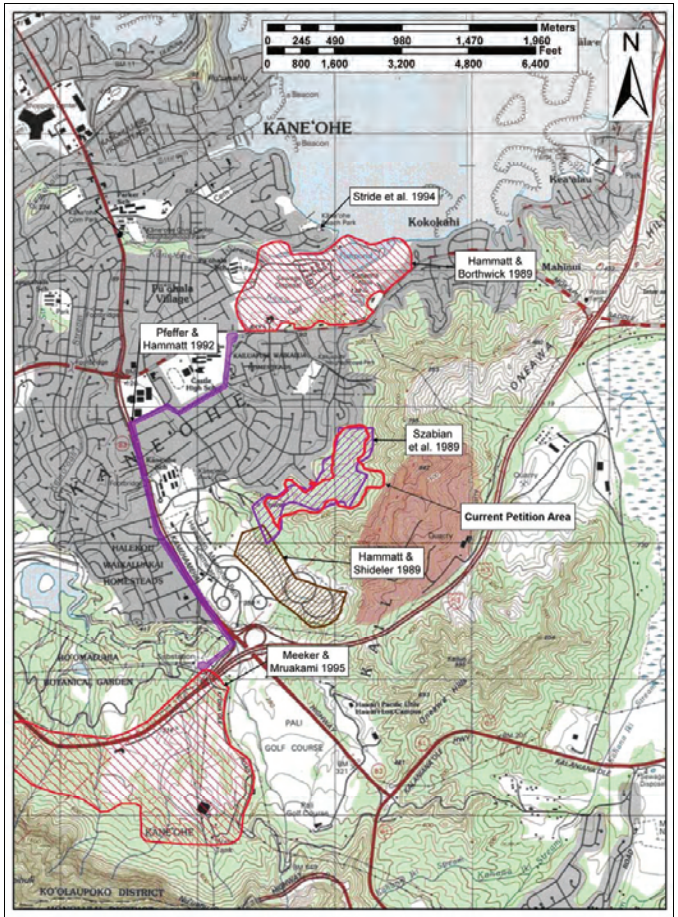


Figure 17. Map showing the current petition area and site locations in relation to the Szabian et al. field map (adapted from Szabian et al. 1989:2)

4.1.2 Summary of Previous Archaeological Studies

Previous archaeological studies in the vicinity of the current project area are indicated on Figure 18 and are summarized in Table 3.



1998 Kaneohe/Honolulu USGS 7.5' minute quadrange
UTM NAD 83 zone 4N

Figure 18. Portion of US Geological Survey Kāne‘ohe and Mōkapu quad map showing locations of previous archaeological studies in the vicinity of the current petition area

Table 3. Previous Archaeological Studies in the Vicinity of Current Project Area

Reference	Type of Investigation	Location	Findings
McAllister 1933	Island-wide survey	Island wide	Identified 9 sites in the vicinity of the current project area, 3 of which were heiau
Sterling & Summers 1978	Island-wide survey	Island wide	Section concerning Kāne‘ohe includes legendary references to the naming of Kāne‘ohe and other sites and the descriptions of McAllister’s (1933) sites
Hammatt & Borthwick 1989	Archaeological Survey & Assessment	90-acre Bay View Golf Course Expansion	Documents Waikalua-loko and Waikalua fishponds
Hammatt & Shideler 1989	Archaeological Survey	Veterans Cemetery 90-acres	No significant finds
Szabian et al. 1989	Reconnaissance Survey	N & W facing slope of ridge separating Kailua and Kāne‘ohe	Describes 11 sites with 25 features, four pre-Contact, seven post-contact & Kawa‘ewa‘e Heiau
Pfeffer and Hammatt 1992	Archaeological Assessment	Transmission Corridor mostly along Kamehameha Hwy.	No finds
Stride et al. 1994	Inventory Survey & Subsurface Testing	Waikalua Road (TMK 4-5-05: 1,2, 12-14) 3.3 acres at shoreline	No significant finds in eight backhoe trenches
Meeker & Murakami 1995	Archaeological Monitoring and Data Recovery Investigations	Ko‘olau Pali (TMK 4-5-42:1 and 6)	Seventeen sites investigated; of these, four were recommended for preservation. They include one set of dryland agricultural terraces, two open sites with lithic activity, and a single cluster of three stone mounds.

Section 5 Community Consultations

5.1 Community Consultation Effort

Throughout the course of this assessment, an effort was made to contact and consult with Hawaiian cultural organizations, government agencies, and individuals who might have knowledge of and/or concerns about traditional cultural practices specifically related to the project area. This effort was made by letter, e-mail, telephone and in person. The initial outreach effort was started in March, 2007. In the majority of cases, letters with a detailed description of the proposed action including project acreage and conceptual plan provided by Helber, Hastert & Fee, Planners along with a map and aerial photograph of the project area were mailed with the following text:

> At the request of Helber, Hastert & Fee, Planners, Cultural Surveys Hawai‘i Inc. (CSH) is conducting a Cultural Impact Assessment for an expansion of the Hawaiian Memorial Park in Kāne‘ohe Ahupua‘a, Ko‘olaupoko District, O‘ahu Island Tax Map Key ([1] 4-5-033: por. 001). See enclosed maps of the project.
>
> Hawaiian Memorial Park, opened in 1961 with a current extent of 80 acres, will run out of usable space in the next few years. The cemetery owners are now planning for its future expansion, on land they own, to the east of the existing cemetery. This parcel of land is about 164 acres in size, but the expansion will only use about 40 acres of this area, and is shown on the attached aerial photo as the “Proposed Expansion Area.” Part of the proposed expansion (about 4 acres) could be used for residential purposes, on land adjacent to the Pohai Nani Retirement Home. The owners of the cemetery are exploring the possibility of either having Pohai Nani take this land over for its possible expansion, or developing about 20 single-family lots. Neither of these options may work out, and the land may be used for the cemetery expansion instead. The build-out of the expansion would not begin for several years (possibly 5 or more), and could last over 20 years or so, The expansion may include 4 mausoleums, each about 3,600 square feet in size, and one-story in height. Otherwise, the land will be cleared and planted similar to the existing cemetery grounds. Drainage improvements and internal roadways are the two most important improvements for the project. Drainage is a particular concern, and the owners understand the need to consider stormwater impacts to downhill neighbors. Preliminary fieldwork has identified or re-located two archaeological sites within the expansion area, and two sites adjacent to the expansion area (including the Kawa‘ewa‘e Heiau). These are shown on the attached concept plan map, along with buffer zones around these sites.
>
> The purpose of this cultural study is to assess potential impacts to cultural practices as a result of future development in Kāne‘ohe. We are seeking your *k kua* and guidance regarding:

- **General history and present and past land use of the project area, including pineapple cultivation and dairy farming (Souza Dairy).**
- **Knowledge of cultural sites which may be impacted by future development of the project area - for example, historic sites, archaeological sites, and burials.**
- **Knowledge of traditional gathering practices in the project both past and ongoing.**
- **Cultural associations of the project area, such as legends and traditional uses.**
- **Referrals of *k puna* or elders and *kama‘ ina* who might be willing to share their cultural knowledge of the project area and the surrounding *ahupua‘a* lands.**
- **Any other cultural concerns the community might have related to Hawaiian cultural practices within or in the vicinity of the project area.**

In August, 2007 new letters and figures were sent to all community contacts explaining that the owner had decided to expand the initial project area from approximately 40 acres to 56 acres (see Section 1.1) and inviting further commentary from cultural assessment study participants. Figure 19 depicts the old and new projects areas. Figures 20 and 21 present the figures sent to community contacts in August.

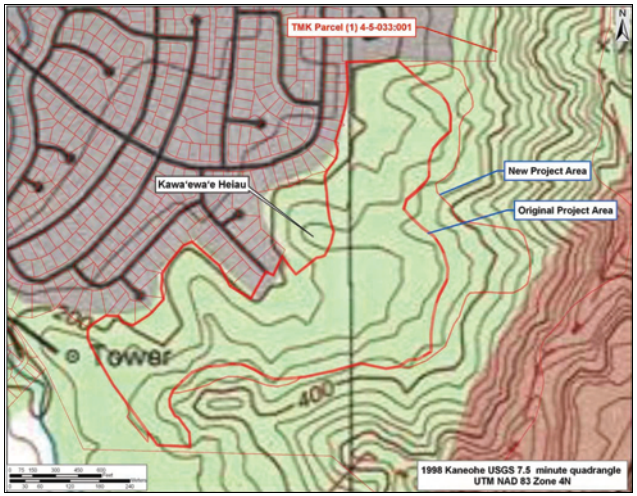


Figure 19. U.S. Geological Survey 7.5 Minute Series topographic map, Kāne‘ohe Quadrangle, showing original and revised project location

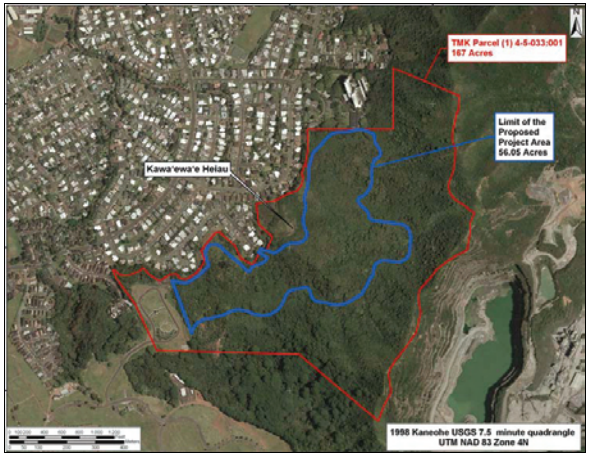


Figure 20. Aerial photograph sent to community contacts depicting revised project area

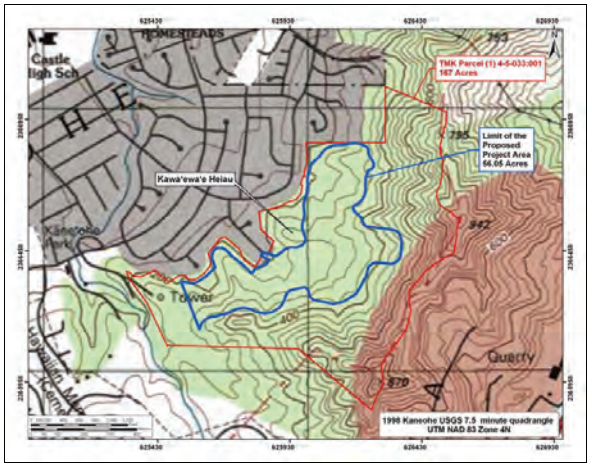


Figure 21. USGS map sent to community contacts depicting revised project area

Several (3-9) attempts were made to contact individuals, organizations, and agencies apposite to the cultural impact assessment for Kāne‘ohe. The results of the community consultation process are presented in the Table 4. A number of the organizations listed in the table are, or were, caretakers of the Kawa‘ewa‘e Heiau (namely, Sierra Club, Queen Emma Hawaiian Civic Club, Moanalua Gardens Foundation, Ko‘olaupoko Hawaiian Civic Club, Windward Lions Club). Excerpts from more extensive interviews and confidential statements specifically related to Kāne‘ohe and its environs are presented in Section 6 below.

Table 4. Results of Community Consultation

Name	Affiliation, Background	Comments
Ailā, William	Hui Mālama I Nā Kūpuna O Hawai‘i Nei, Wai‘anae Representative	In an email sent to CSH on November 26, 2007 in response to October 10, 2007 letter of invitation to comment on the proposed project, Mr. Ailā recommended: 1. As complete as possible archaeological inventory survey be conducted. 2. Any burials found should be preserved in place unless they are in the path of utility lines that cannot be rerouted. 3. No architectural plans be finalized until archaeological inventory [is] finalized, this [will] allow for redesign.
Brown, Steve	Hawaiian Trail and Mountain Club, Trails Committee Chair	In an email response sent to CSH on October 15, 2007 Mr. Brown wrote: “The Hawaiian Trail & Mountain Club does conduct a recreational hike in the area. It may be easiest to identify the route on your aerial view. We start in Friendship Garden, at Kokokahi Place, off of your aerial view to the north. We then follow roughly along the main ridgeline which eventually skirts the quarry, in approximately a southern direction. The final leg of the route descends from the main ridge in a northwest, or west-northwest direction, following a side ridge, and passing Kawaewae Heiau to terminate at the end of Lipalu Place. There are two such side ridge routes, either of which may be used on a particular hike. We have been hiking this route twice a

Name	Affiliation, Background	Comments
		year for the last ten years. In addition, there is one more organized group which conducts yearly hikes on this route, as well as many individuals who do it on their own. The route is unique, in that it affords panoramic views of the surrounding area, along with the opportunity to visit and appreciate the heiau. It is clear from the condition of the trail that usage of the route predates our usage by many years. It would be a shame to lose this valuable community resource to encroaching development.”
Burrows, Chuck	‘Ahahui Mālama I ka Lōkahi, President	See Charles Pe‘ape‘a Makawalu Burrows, Ed.D. (“Doc” Chuck Burrows) interview in Section 6. Dr. Burrows recommended CSH contact Earl “Buddy” Neller.
Camvel, Donna	Ko‘olaupoko Hawaiian Civic Club, 2nd Vice President	See Ko‘olaupoko Hawaiian Civic Club field interview summary in Section 6
Camvel, Wali	Ka ‘Ailehua, Operations Manager	See Ko‘olaupoko Hawaiian Civic Club field interview summary in Section 6
Chang, Linda	Hula practitioner, *kupuna* and *kama‘ ina* of Kāne‘ohe	See interview summary in Section 6
Chinen, Melanie	State Historic Preservation Division	CSH sent a letter to the SHPD on March 5, 2007.
Ching, Randy	Hawai‘i Chapter of the Sierra Club, O‘ahu Chair	Referred CSH to Jim and Cindy Waddington
Cypher, Mahealani	Ko‘olaupoko Hawaiian Civic Club, Past President and current Recording Secretary, Cultural Interpreter	See Ko‘olaupoko Hawaiian Civic Club field interview summary in Section 6 and letter in Appendix A
Dunn, Elizabeth	Hawai‘i Chapter of the Sierra Club, O‘ahu Volunteer Coordinator	Referred CSH to Randy Ching

Name	Affiliation, Background	Comments
	and Membership Chair	
Gon, Samuel ‘Ohukaniohi‘a, III	The Nature Conservancy of Hawai‘i, Senior Scientist and Cultural Advisor; Kahuna Kakalaleo (Chant Practitioner)	Dr. Samuel ‘Ohukaniohi‘a Gon, III was contacted via email on October 2, 2007. In an email response sent on October 5, 2007 Dr. Gon explained that he can provide no substantive site-specific comments on the proposed project.
Hewett, Alice	*Kupuna* and *kama‘ ina* of Kāne‘ohe	In a phone conversation on October 22, 2007 Ms. Hewett said that she would like to comment on the project (after reviewing the letter and figures) and will get back to CSH. She informed CSH that her son, Frank Hewett, is traveling in Japan and elsewhere over the next few months and may not be available for awhile. CSH left several follow-up phone messages for Aunty Alice.
Hewett, Frank Kawaikapuokalani	Kumu Hula	See above
Hiramatsu, Gary	Ko‘olaupoko Lions Club, President	CSH sent email inquiries inviting Mr. Hiramatsu’s comments on the project. CSH was unable to find a current phone number for Mr. Hiramatsu. See Motohiro below.
Lau, Elizabeth C.	Ko‘olaupoko Hawaiian Civic Club, Pelekikena (President)	See interview summary in Section 6
Leong, Marian	Moanalua Gardens Foundation, Director, Partners in Education Program	In a phone conversation with CSH on May 1, 2007 Ms. Leong stated that she has done little work at the Kawa‘ewa‘e Heiau and has no comments about the proposed project.
Mahi, Aaron	O‘ahu Island Burial Council, Ko‘olaupoko Representative	In a phone conversation with CSH on October 17, 2007, Mr. Mahi stated that he will reserve comments for now, and recommended CSH consult Kāne‘ohe *k puna*. He recommended contacting Elizabeth Lau and the Ko‘olaupoko Hawaiian Civic Club.
Mahoe, Chinky	Kumu Hula o	CSH sent email inquiries and followed up with phone messages inviting Mr. Mahoe’s

Name	Affiliation, Background	Comments
		comments and *mana‘o* on the project.
McQuivey, Jace	O‘ahu Island Burial Council, Chair	Referred CSH to Aaron Mahi
Merryman, Mahealani	Moanalua Gardens Foundation, Executive Director	Referred CSH to Charlie Ogata and Dr. Chuck Burrows
Motohiro, Daniel	Pali Lion’s Club, Secretary	In a phone conversation with CSH on November 21, 2007, Mr. Motohiro stated that the Ko‘olaupoko Lion’s Club used to be involved with the restoration of the Kawa‘ewa‘e Heiau. Mr. Motohiro attempted to contact the Ko‘olaupoko branch of the Lion’s Club without success, and explained that the club is inactive at this time. He had no comments about the proposed project.
Nāmu‘o, Clyde	Office of Hawaiian Affairs, Administrator	In a letter dated April 5, 2007, OHA requested the submission of a summary of the known historic properties in the vicinity of the Kawa‘ewa‘e Heiau in order to make a more substantive recommendation, and advised contacting Elizabeth Lau, President of the Ko‘olaupoko Hawaiian Civic Club regarding recommendations specific to the proposed project (see full text of OHA letter in Appendix A). See subsequent, September 27, 2007 OHA letter sent to CSH below this table (Figure 20).
Neller, Earl “Buddy”	Archaeologist	Mr. Neller was referred to CSH by Chuck Burrows. See comments sent by Mr. Neller to CSH on October 23, 2007 below table.
Ogata, Charlie	Queen Emma Hawaiian Civic Club, member and former *kia‘i* (caretaker) of the Kawa‘ewa‘e Heiau	See interview summary in Section 6
Steinwascher, Kimo	Kaneohe Ranch Mgmt. Ltd., Vice President, Leasing & Development	In an email sent to CSH on April 27, 2007 Mr. Steinwascher, responding to CSH request for archival information on Kāne‘ohe and any comments on the project area, wrote:

Name	Affiliation, Background	Comments
		“Nothing that I am aware of”.
Wada, Susan	Queen Lili‘uokalani Children’s Center, Ko‘olau Poko Unit, Director	CSH sent letter on March 5, 2007 and left messages on several occasions for Ms. Wada at the QLCC inviting her *mana‘o* and participation in the CIA.
Waddington, Jim	Hawai‘i Chapter of the Sierra Club, O‘ahu Sierra Club, O‘ahu Group Hike Leader	In an email response sent to CSH on June 23, 2007 Jim Waddington wrote: “Sierra Club has not done regular service trips to Kawaewae Heiau for a couple of years, so I haven't been to the site in quite some time. The attachments to your email, however, are disturbing... especially the map which shows a road almost adjacent to one corner of the heiau. The upkeep of the heiau has been adopted by the Queen Emma Hawaiian Civic Club (QEHCC)... Sierra Club just provided some manpower for them. Two individuals who should definitely be contacted regarding the proposal and who could address your questions more aptly than I would be Cassina Waterman, president of QEHCC, and Charlie Ogata, a member of QEHCC who spear-headed the heiau's restoration.” In a phone conversation on October 10, 2007, Mr. Waddington also recommended CSH contact the Hawaiian Trail and Mountain Club.
Waterman, Casina K.	Queen Emma Hawaiian Civic Club, Pelekikena (President)	See Ms. Waterman’s comments below this table. Ms. Waterman recommended CSH contact Charlie Ogata, Frank Kawaikapuokalani Hewett and Sam Gon.
Yoshimori, Grant	Hui O‘ Piko‘iloa	In a letter sent to CSH dated June 14, 2007, Mr. Yoshimori stated that: “I am aware of several cultural practices taking place on the Mahinui Mountainside, and would like to share these with you. • There are at least four Hawaiian hula

Name	Affiliation, Background	Comments
		halau which visit the area to gather plants to make the traditional Hawaiian hula leis. • I have seen people going hunting into the hillside, and personally know someone who has hunted for pigs in the area. • Many people use the area for hiking. It is a well known hiking trail. And it has been sited [*sic*] in the Honolulu Advertiser by Richard McMahon. • Schools tour the archaeological sites and use it for cultural education purposes. I have personally seen Kamehameha Schools and Hakipu‘u Learning Center visiting and learning about the area. • The area is also frequented by people who engage in combat exercises. As you can see, there are quite a few cultural uses of the land. I hope that Service Corporation International (dba Hawaiian Memorial Park) will endeavor to keep the land in its natural state so these cultural practices can continue.” See Appendix A for full text of letter.

PHONE (808) 594-1888 FAX (808) 594-185

STATE OF HAWAI'I
OFFICE OF HAWAIIAN AFFAIRS
711 KAPI'OLANI BOULEVARD, SUITE 500
HONOLULU, HAWAI'I 96813

September 27, 2007 HRD07_2939B

Lisa Gollin, Projects Manager
Cultural Surveys Hawai'i, Inc.
P.O. Box 1114
Kailua, Hawai'i 96734

Dear Ms. Gollin:

Re: Cultural Impact Assessment
Kane'ohe Ahupua'a, Ko'olaupoko District, Island of O'ahu
Tax Map Key: 4-5-033: por.001

The Office of Hawaiian Affairs (OHA) is in receipt of your August 13, 2007 letter initiating consultation ahead of a cultural impact assessment for a proposed expansion of the Hawaiian Memorial park.

OHA requests that a comprehensive archaeological inventory survey for the project area be conducted and submitted to the Department of Land and Natural Resources- Historic Preservation Division for review and approval. OHA should be allowed the opportunity to comment on the criteria assigned to any cultural or archaeological sites identified within the archaeological inventory survey pursuant to §13-284-6(c), Hawai'i Administrative Rules. Consideration should also be afforded to any individuals accessing the project area for constitutionally protected traditional and customary purposes.

As you know, Kawa'ewa'e Heiau is located on the subject tax map key parcel adjacent to the proposed expansion area. Certain accounts related to the epic tale of Kamapua'a identify Kawa'ewa'e Heiau as the location where Kamapua'a was taken for sacrifice following his capture by the forces of the high chief Olopana during a time when Lonoaohi was the high priest of the heiau. It was during this episode, that these same accounts detail the death of Olopana at Kawa'ewa'e Heiau.

OHA seeks assurances that if this project moves forward, should Native Hawaiian traditional, cultural, or burial sites be identified during ground disturbance, all work will immediately cease, and the appropriate agencies notified pursuant to applicable law.

Lisa Gollin, Projects Manager
Cultural Surveys Hawai'i, Inc.
September 27, 2007
Page 2

Thank you for initiating consultation at this early stage and we look forward to the opportunity for a comprehensive review of the completed cultural impact assessment. Should you have any questions, please contact Keola Lindsey, Lead Advocate-Culture at (808) 594-1904 or keolal@oha.org.

'O wau iho nō,

Clyde W. Nāmu‘o
Administrator

Figure 20. September 27, 2007 review letter from the Office of Hawaiian Affairs

5.1.1 Casina Waterman, Pelekikena (President), Queen Emma Hawaiian Civic Club

Queen Emma Hawaiian Civic Club (QEHCC) is one of the community groups that has been care-taking the Kawa‘ewa‘e Heiau. In a telephone interview conducted by CSH on August 28, 2007 Ms. Casina Waterman, Pelekikena (President) of the QEHCC, kindly shared her knowledge of the project area and cultural concerns:

> The QEHCC goes to *m lama* [caretake] the Kawa‘ewa‘e Heiau about 3 to 4 times a year. Charlie Ogata was our *kahu* [caretaker] but he is in his 90s now. There have been cultural practices up there and there are archaeological sites back there. Hula *h lau* [hula groups] go and collect plants in the area. The group never got to GPS by the *luakini* [large *heiau* where ruling chiefs prayed and human sacrifices were offered]. There were sacrifices there. There could be *iwi* [human remains, bones] in the area. If you look at the dimensions of the *heiau*, it is a pretty large *heiau luakini*. On the *‘ewa* side of the *heiau* there is a stone path and possibly a few homes [archaeological habitation sites]. Many years ago there was a family that used the *heiau* for a cattle pen (can't remember their name, maybe it was the Medieros family). There would be an impact if [the proposed project] comes close to the *heiau*. I am concerned that there are good buffer zones around the *heiau* and around the others sites. We need to *m lama* [all the sites]. A 100 foot buffer zone is not enough for the *heiau*. Would the buffer zone be 100 feet from [outside or inside] the walls of the *heiau* or from the center? One part of the *heiau* is higher. I think the north wall is 17 feet…16 feet on the Kailua side. One part is

> flat and goes down and then comes back up. At the boundary of one of the walls there is a terrace and houses [habitation sites] and not too far beyond that is where Charlie's property was. You can look up the dimensions of the *heiau…* The weather has changed over the years. There used to be more moisture. There is a native bird that is an endangered species that lives in the area. I'm not sure of name. Have you seen the old drawings of the Ko‘olau Bluff [project]? It was a [subdivision] with million dollar homes done in the late 1980s. The community stopped that because they were scared of run-off and other logistical [problems].

5.1.2 Earl "Buddy" Neller

Earl "Buddy" Neller was referred to CSH by Dr. Chuck Burrows (see interview in Section 5). Mr. Neller is an archaeologist currently living in Washington. He formerly worked for the State of Hawai‘i in the State Historic Preservation Office, the Office of Hawaiian Affairs, the National Park Service at Hawai‘i Volcanoes National Park and Kalaupapa National Historical Park. Mr. Neller also taught a non-credit course in *heiau* sites at the University of Hawai‘i in the College of Continuing Education. Mr. Neller offered the following comments regarding the Kawa‘ewa‘e Heiau and nearby sites in an email sent to CSH on October 23, 2007:

> Thanks for contacting me, and for asking me about sites in the area of Kawa‘ewa‘e Heiau. I have been to the area many times, generally related to my job as an archaeologist for the State of Hawaii.
>
> To my knowledge, the boundaries of Kawa‘ewa‘e Heiau are unknown. Generally, people think of the large stone wall forming a rectangular enclosure as the boundaries of the site, but it is known that there are visible stone features on the ground that extend beyond the enclosure, as described in Gilbert McAllister's report "Archaeology of Oahu" (1933), and as seen by myself and others during visits to the heiau. Understanding the boundaries of the heiau is important, because there may be features in your project area which could be relevant to the archaeological study and modern day use of the heiau.
>
> One of the problems with visiting Kawa‘ewa‘e Heiau is that there is no good access: no good parking area, no good trail.
>
> The current configuration of the heiau results partially from its use as a cattle enclosure, and partially from other activities during the historic period, such as the probable removal of rock for nearby construction. It is entirely possible that at some time in the past the heiau grounds were much larger than the rectangular enclosure (and appendages) that we easily see today. The extent of the heiau throughout its history is an archaeological question that has never been investigated.
>
> People talk about a heiau site as if the visible stone ruins were a heiau, rather than being the ruins of a heiau with much of the original structure gone. People talk about a heiau as if its boundaries are determined by the limits of the visible stone

pavings and rock alignments, as if landscape features such as springs, gardens and other landscape features such as akua represented by pohaku were not an integral part of the historic and cultural site. At the heiau site of Halulu, for instance, the pohaku known as Lohe is a part of the cultural tradition at the site, but it is located outside the boundaries of the enclosing walls and terraces, near the ko‘a in the valley below. Plants, such as ti, are an integral part of heiau traditions, but they are generally not mentioned in archaeological surveys. Don't overlook the importance of Hawaiian plants growing in the project area. Ti is often found at heiau sites, and in Hawaiian gardens of old, and the leaves are still used in many ways. At Kalaupapa I used the ti leaves in my garden when I made kulolo [Pudding made of baked or steamed taro and coconut cream]. I have never had the chance to eat the baked roots of ti plants, but I look forward to it.

Archaeology of Oahu lists a heiau that should be in this land parcel, although it may not be in the project area, Site 356, Pu‘u Makani Heiau. The stones were taken to build a cattle enclosure down slope from the heiau. The stone-walled corral is shown on an 1876 map of Kane‘ohe, reg. map no. 585, DAGS Survey Division Archives. This heiau was probably located on the small hill delineated by the 400-420 foot contours on the topographic map. The remains of this destroyed heiau should be located.

While looking for Pu‘u Makani Heiau many years ago, I found two sites on this parcel which should be noted. On the ridge above Kawa‘ewa‘e Heiau, along the boundary between Kailua and Kaneohe, I found the remains of a small, terraced heiau. The terraces were small, and there was not much stone to be seen. It seems possible that it was the site of Pu‘u Makani Heiau. I do not believe it is big enough to provide the stone that must have been used to make the cattle corral below, nor is the location the same as that indicated by McAllister in Archaeology of Oahu.

Also, on the ridge leading down from the ahupua‘a boundary (and above the small knoll where Pu‘u Makani Heiau was probably located) I crossed a steeply sloping dirt ramp (covered in dense vegetation) that seemed to be man made, and I thought it may have served as a holua in ancient times. One of the interesting things about holua in this area is that they are described as earthen troughs, rather than sloping stone platforms.

Section 6 Summaries of *Kama‘ ina* “Talk Story” Interviews

6.1 Talk Story Interviews

Kama‘ ina and *k puna* with knowledge of the Kāne‘ohe Ahupua‘a and the area within the vicinity of the proposed Hawaiian Memorial Park Expansion Area project participated in “talk-story” sessions for this assessment. The approach of CSH to cultural impact studies affords community contacts an opportunity to review transcriptions and/or interview notes and to make any corrections, deletions or additions to the substance of their testimony.

CSH employed snowball sampling, an informed consent process and semi-structured interviews (Bernard 2005) with 10 *k puna* and *kama‘ ina*. To assist in discussion of natural and cultural resources and any cultural practices specific to the project area, CSH initiated the “talk-story” sessions with questions from the five broad categories. The categories include: Gathering Practices, Marine and Freshwater Resources, Burials, Trails and Historic Properties. Presented below are brief backgrounds of participants’ “talk-story” sessions and their comments and concerns about the proposed project area.

6.1.1 Elizabeth Lau

Mrs. Elizabeth Lau, Pelekikena (President) of the Ko‘olaupoko Hawaiian Civic Club, was interviewed at her home in Kahalu‘u by CSH on May 18, 2007. Mrs. Lau, who is 88, kindly shared her early memories and knowledge of Kāne‘ohe and the project area:

Mrs. Lau described the project area vicinity in the pre-World War II years, “There used to be pineapple down from the Pali…where the golf course is now….Below where Pohai Nani [Retirement Home] is now there were dairies like Souza’s and Freitas’s Dairy….The Souza dairy would use the Kawa‘ewa‘e Heiau as a cattle pen”. Mrs. Lau recalled the collaboration between farming families; two of the dairy families in the area shared cows, “the Ruiz family owned the cow and the De Costa family milked the cow!” When she was a child, her father was a butcher. He would share meat and butter with the Portuguese families in exchange for Portuguese bread. There was also an egg farm. She and her brother worked there “candling eggs”, referring to the process of holding a strong light above or below the egg to observe the embryo and any cracks in the egg. Mrs. Lau mentioned that there also was a *heiau* near the egg farm, but was uncertain of the name or exact location. “Souza’s Dairy and others closed when the war came because they had to go to war.” Her family had a “piggery down on Waikalua Road. During the war the area was turned into an Italian prisoner of war camp and the prisoners would work in the laundry across the street”.

According to Mrs. Lau, the Pohai Nani Retirement Home was built on top of a *heiau*. She reported that when Pohai Nani was still new the elevator would mysteriously go up and down, and the doors in the apartments would open and shut on their own.

Mrs. Lau has no specific cultural concerns about the proposed cemetery expansion project. She commented that the memorial park is a “beautiful place for the [Kawa‘ewa‘e] *heiau*”, but expressed her concern about the possible subdivision proposed for land adjacent to the Pohai Nani Retirement Home, “Better a cemetery than housing. If you have housing, that would

damage the *heiau*. The cemetery [referring to the current Hawaiian Memorial Park] is beautiful. If the cemetery [is expanded] they [Hawaiian Memorial Park] would have to care for the *heiau*. This would be educational for our younger people [and provide] a place to exercise, and a pretty place to sit and eat lunch.” Mrs. Lau recommended that CSH contact Denise De Costa, who also goes by the name of Mahealani Cypher.

6.1.2 Ko‘olaupoko Hawaiian Civic Club (Donna and Wali Camvel, Mahealani Cypher)

On June 23, 2007, two principals of the Ko‘olaupoko Hawaiian Civic Club (KHCC) and one of Ka ‘Ailehua joined CSH on a visit to four of the eleven archaeological sites identified during the archaeological inventory survey by CSH in or immediately adjacent to the proposed project area. The club participants were Donna Camvel (2nd Vice President), and Mahealani Cypher (Recording Secretary/Immediate Past President) of KHCC. Ka ‘Ailehua was represented by Wali Camvel. Ka ‘Ailehua is a non-profit organization whose mission is to perpetuate Hawaiian culture and *m lama* nationally recognized historic sites including the Kawa‘ewa‘e Heiau. The sites visited were CSH 2, 5 and 11 (later changed to CSH 12, SIHP-6929 and currently *outside* of the petition area) as well as the Kawa‘ewa‘e Heiau: CSH 2 (SIHP-4681) features include rock terraces and a temporary shelter; CSH 5 (SIHP-4684) includes terraces and a habitation site; CSH 11/12 (SIHP-6929) includes a possible *p haku* (rock-shrine) and a small rock quarry where a number of flakes, pre-forms and hammer-stones were found. For updated CSH site numbers and corresponding SHIP numbers see the companion Archaeological Inventory Survey report (McCurdy and Hammatt 2008). The group kindly shared their impressions, interpretations and *mana‘o* about the sites with CSH:

The group first visited CSH 2 (SIHP-4681). The general consensus of Mahealani Cypher, Donna Camvel and Wali Camvel was that the terraces and other features of the landscape did not represent an agricultural complex, but has a distinct spiritual feel to it. The site must be viewed in relationship to the Kawa‘ewa‘e Heiau, as part of the *heiau* complex. Two large stones on a small rise above the shelter were noted, and it was suggested that they may be *p haku kia‘i* or, stone guardians (Figures 23 and 24). One rock appears to be in the shape of a dog’s head (see Figure 24), and Mahealani Cypher suggested that perhaps it was there to represent the Hawaiian god, Kāne. According to the group, together, the 2 *p haku kia‘i* appear to guard the area which may have been used by chiefs and their retinue for preparation, prayer and/or sacrifice.

The point was emphasized that all the sites near the Kawa‘ewa‘e Heiau must be viewed in relationship to the *heiau* as part of a complex. Mahealani Cypher offered that CSH 2 (SIHP-4681), or features nearby, may have been where the Hale o Papa or women’s *heiau*, and/or the Luakini, or men’s prayer complex, associated with the Kawa‘ewa‘e Heiau may have been located. Hale o Papa were temples where the female chiefs worshiped. The Hale o Papa was located next or adjacent to the Luakini for the purposes of conducting ritual ceremony. Luakini were used by the ruling chiefs for prayer, human sacrifices and to perform temple work.

The group did not have many comments about CSH 5 (SIHP-4684), though noted that a large rock between sites 2 and 5 may also be a *p haku*. Wali Camvel expressed *mana‘o* that perhaps this location could have been the house site for the *kahu* or caretaker of Kawa‘ewa‘e Heiau. He suggested the group follow the ridgeline for its proximity to the site. The group then followed the ridgeline extending from above CSH 5 (SIHP -4684) to Kawa‘ewa‘e Heiau. The group members

shared stories of the *heiau*, particularly ‘Olopana’s attempt to sacrifice Kamapua‘a and the hog-god’s brilliant escape through chicanery (see one version of the story in Section 3). Mahealani Cypher shared a version of the *mo‘olelo* she learned from a translation provided by historian Dr. Lilikala Kame‘eleihiwa in her book, “Kamapua‘a”. The point was made that there are several versions of the Kamapua‘a legend, as well as stories about the origin of the Kawa‘ewa‘e Heiau. The group also mentioned that there is a *h lua* (referring to the sled or sled course, used on mountain slopes) associated with the *heiau*, presumably on the ridges near the *heiau*. They were uncertain of the precise location of the *h lua* and wondered if CSH has found archaeological evidence of the slides.

The final site visited by the group was CSH 11/12 (SIHP-6929), immediately south of Pohai Nani Retirement Home where participants viewed the *p haku* and noted the arrangement of old *k* or *t* (*Cordyline fruticosa*) planted around the *p haku* (Figure 25) and explored the small rock quarry upstream. Mahealani Cypher remarked that the area around the *p haku* had a number of mango trees and shared her theory that *k puna* long ago may have planted mango trees to mark sacred sites for future generations. She bases her belief on the observation that many sacred areas she has visited around the Hawaiian Islands have had mango trees planted around the sites. Around the 1820s (the time of the introduction of the mango to Hawai‘i), pressure from Caucasian missionaries to Christianize Hawaiians, coupled with the overthrow of the *kapu* system by ruling chief Liholiho (Kamehameha II) in 1819, drove many Hawaiians to practice their native religion underground. She believes that clandestine practitioners of the indigenous religion, noticing the size and longevity of mango trees, decided to plant trees in sacred areas as indicators of religious sites for their descendants. Wali Camvel shared that that the walled structures located at this site could have included a *kuahu* (altar) and further added that the *ahu* might have been dedicated to the god Kāne.

Representatives from the Ko‘olaupoko Hawaiian Civic Club and Ka ‘Ailehua who visited the project area and vicinity made the following recommendations:

1. All the above sites — including the *p haku* between CSH 2 (SIHP-4681) and 5 — should be preserved and protected through the creation of *k puka*, referring to a calm or clear place, or oasis, in this case a protected area and buffer zone.
2. Identification and preservation of the *h lua* (sled course).
3. The group looks forward to working with the planners and owner to establish a collaborative agreement for the care of the Kawa‘ewa‘e Heiau and associated sites.

6.1.3 Mahealani Cypher’s Additional Comments

In a letter to CSH dated September 11, 2007 Mahealani Cypher contributed post-interview comments regarding the field trip (in addition to those offered by Donna and Wali Camvel via phone and email and incorporated into the above interview summary). Following are key points and excerpts from Ms. Cypher’s letter (see full text of letter in Appendix A):

> 1. Kawa‘ewa‘e Heiau [is] a religious site sacred to native Hawaiians… [T]he surrounding area would also have religious significance as part of the heiau complex. With a luakini heiau as prominent as Kawa‘ewa‘e, there is little doubt that there would have been associated sections of the property nearby that

complete the full operation of the heiau in keeping with its use and purpose. Its connection with Chief Olopana and Kamapua‘a, for example, would further support its having a complex of associated compartments – not just a hale for the kahuna – to include the hale o papa and other key elements.

2. Pohaku:…[M]y understanding is that stand-alone pohaku that had religious significance were usually known as “pohaku o Kane”, which we consider to be religious shrines and places of worship. At the site referred to as “CSH 5”… [the] stone by itself…is likely to have been a “pohaku o Kane”. I am not sure it would have marked the location of a caretaker’s hale or the home of the kahuna (priests), but that is possible. But Pohaku o Kane were generally just outside the door of many hale, serving as a family protector or shrine. In the case of the two pohaku seen at the area designated as “CSH 2”, I concur with Donna Camvel’s thinking that these serve as guardians and hence would be “pohaku ki‘ai”. The proximity of the two stones in a site which appears to have multi-level platforms, the size and shape of the two stones, indicated to me (and possibly to Donna Camvel) that this was a very important site. These pohaku ki‘ai may even have guarded the women of the hale o Papa, as the chiefess would have lived there and had the elevated status to warrant placement of such stones near her worship area.

3. Mo‘olelo about Olopana and Kamapua‘a: I believe the story I shared with you about Kamapua‘a overcoming Olopana at Kawa‘ewa‘e was learned from a translation provided by historian Dr. Lilikala Kame‘eleihiwa in her book, “Kamapua‘a”.

4. Holua slides: I recall I pointed out to you the two slopes, covered with trees and brush, just mauka of Kawa‘ewa‘e, where I believe the holua slides once were used by the chiefs for recreation. If the brush and trees were cleared and soft grasses re-planted on those slopes, they would adequately serve as fine holua slide areas. It is likely the nearby cemetery land once contained springs and ti leaf groves, and could have been the source of water needed to wet the slopes.

5. Location and Relationship to broader Kane‘ohe ahupua‘a and other heiau: Standing upon Kawa‘ewa‘e Heiau, it is clear that the heiau was constructed strategically to be in the sight-line with Kukuiokane Heiau, the largest and most important heiau in the Kane‘ohe region. Also clearly visible from Kawa‘ewa‘e are the peaks of Pu‘u Ma‘eli‘eli and ‘Ohulehule, and the island known as Moku o Lo‘e (Coconut Island). Also clear from this site are the peaks of Konahuanui and Keahiakahoe, all of which bring stronger mana to elevate the spiritual and religious strength or power of Kawa‘ewa‘e. Our mo‘olelo tells us that the great chief Olopana (and others) occupied or visited at Kawa‘ewa‘e for some time; hence, it would have been a place where the po‘e kahiko (people of ancient times) brought their pleas for kokua, for resolution of disputes, or other requests for help. A great chief’s presence indicates the complex had to be quite extensive to support his entourage, his retainers and those who served the chief. Food had to be gathered by the kahuna and others from the surrounding area, and these goods

had to be managed by the priests and their helpers at Kawa‘ewa‘e. It was a thriving mini-community of its own within the ‘ili of Kawa‘ewa‘e. Therefore, the location, prominence and connection with other major sites, and the historical record of Olopana’s presence, tell me that the heiau was not limited to the rock lined walls atop the ridge of Kawa‘ewa‘e, but had to contain an entire complex of associated structures and dwellings that housed and accommodated all who would be needed for a heiau of this prominence.

6. Mango trees: I still maintain that the mango trees were chosen by some kahuna to mark important religious sites. This occurred after the heiau were torn down or burned by the Priest Hewahewa following the breaking of the kapu system….It’s not just the planting of the trees that was interesting; but how the trees were planted, often in a circle around what may have been the piko, or center of mana in that heiau. I recall in the mid-1980s, I took a group of kupuna (elders) from Kane`ohe to see Kukuiokane Heiau. We stood in the fern-covered open center of a grove of large old mango trees that seemed to have been planted in this oval orientation, down the slope of Punalu`u mauka (some say it was ‘ili Kihapa‘i). After our pule (prayers) were said, the kupuna stood quietly, observant and calm. Later, they told me they felt the mana of the heiau was strongest here, in the piko, in the center of this circular grove of ancient mango trees. Although the mango is an alien species here on O`ahu, its appearance here a few short years after the heiau were destroyed would have been convenient and desirable to those kahuna wishing to mark their sacred sites with a tree that they were told would survive for a very long time.

7. Recommendation: It is my recommendation that the landowner consider integrating its plans with the religious significance of the area surrounding Kawa‘ewa‘e Heiau’s walled enclosure, ensuring that the more obvious and significant cultural properties are buffered and protected from any roadways, bulldozing or other intrusive activity. In all likelihood, there are burials in the area, probably pre-Contact, and this should be addressed through other research. Although the area in modern times was used for farming and urban activities, the radius in the currently undeveloped landscape adjacent to the walled section of Kawa‘ewa‘e is relatively undisturbed (except from dirt-bikers and others) and was probably kept that way for a good reason. I request to be further consulted, should you proceed with additional research for the current or expanded project area.

In a subsequent email sent to CSH on October 22, 2007, Ms. Cypher added:

In paragraph 4, with reference to the location of the holua slides, I am not too uncertain [sic] as to the location of the slopes they used. If you are in the center of the walled Kawa‘ewa‘e Heiau looking mauka, you can see the slopes very clearly, albeit covered with brush and trees. It is a logical location. Further research, if necessary, could confirm or reject my observation. I was trying to

look at this through the eyes of my ancestors, the kupuna who lived and worked in the area.

In paragraph 6, sub-section #1, I am a little concerned about whether paved roadways would be appropriate through the undeveloped area we visited, all of which may be part of the heiau complex. On the day of our field trip, it was explained to us that the landowner wishes to build roadways in this area for the cemetery expansion. I would like to emphasize that this may be problematic.

Figure 21. The *p haku kia‘i* (stone guardians) at the CSH 2 (SIHP-4681) site

Figure 22. One of the *p haku kia‘i* appears to be the shape of a dog’s head, representing the god Kāne, in the interpretation of KHCC interview participants

Figure 23. *P haku* and *t* plants

6.1.4 Charlie Ogata

Mr. Charlie Ogata is a member of the Queen Emma Hawaiian Civic Club and is considered the club’s longstanding *kia‘i* (caretaker) of the Kawa‘ewa‘e Heiau. At 82, Mr. Ogata no longer lives in the Pikoiloa neighborhood and has not had a chance to visit the *heiau* in a few years. Mr. Ogata was interviewed on September 13 and October 3, 2007 at the Kawa‘ewa‘e Heiau. He took CSH on a tour of sites in and around the *heiau*, recounting his son’s discovery of the *heiau* in the late 1970s, and generously sharing his scholarship on the Kawa‘ewa‘e Heiau and surrounding environs:

Mr. Ogata’s family moved to the Pikoiloa neighborhood in the late 1970s. His son, Kalani, and other kids from the neighborhood used to explore the mountainside behind the homes. His son reported finding a “pile of rocks” or rock wall in the understory. He took his father to the site, and later one of his teachers who expressed interest in seeing the site after Mr. Ogata’s son wrote an essay about the *heiau* for summer school. The teacher (Dr. Donald Kilolani Mitchell of Kamehameha Schools) having read about the Hawaiian sites of the area, ascertained the authenticity of the Kawa‘ewa‘e Heiau. Mr. Ogata recalls that this (re)discovery of the *heiau* was about 1978. “Do you remember in the 1970s there was a Hawaiian Renaissance? I became very interested in Hawaiian culture and language and started taking classes at the university.” Mr. Ogata became a devoted student of Hawaiian history and pre-history, and in particular, the Kawa‘ewa‘e Heiau. His model (Figure 24) and illustrations (Figure 25) depict his re-creation of how the *heiau* might have looked and functioned in ancient Hawaiian times.

“When my son found the *heiau* it was all grown over. I would come up here and cut the trees with my handsaw to clear the area. Eventually, I got help from others…with power tools.” Mr. Ogata spoke of the many years of volunteerism that went into the restoration of the *heiau*. The history of the *heiau* and the public effort to restore and protect the *heiau* is provided in a presentation Mr. Ogata made in 1986 to various organizations (Figure 26). Mr. Ogata learned that the Kawa‘ewa‘e Heiau was a *luakini*, a *heiau* of the largest class used for prayer and sacrificial offerings. According to his readings, the *heiau* was built by *menehune* (a legendary race of small people who worked at night, building temples, etc.) and rebuilt by Kahikiula for his brother Olopana who was the the *ali‘i nui* (high chief) of Ko‘olaupoko.

“‘Lua’ means ‘hole’ and ‘kini’ means ‘40,000’ or ‘many.’” He explained that the *lua*, holes or pits found inside and outside the *heiau*, were used to bury the bones of those sacrificed (Figures 27 and 28). “Human sacrifices were usually done outside of the *heiau*. [The priests] didn’t like blood in the *heiau* (blood was considered unclean) so they made the sacrifice on the big rocks outside of the *heiau*. You see that there are big rocks around the *heiau*? These were probably used to *hana make* (kill) the person or animal being sacrificed and then they were cleaned and placed on the *lele* platform in the *heiau*. The human sacrifices were usually law breakers…someone who had broken a *kapu*, or enemy warriors. But sometimes people would be tricked into breaking a *kapu*. They [the priests] would call people out after dark when a *kapu* was on and then catch them for sacrifice. Or sometimes, if they couldn’t find a human to sacrifice, they would use an *ulua* [certain species of crevalle, jack, or pompano fish] as a substitute probably because the name *ulua* also means ‘man’. Sometimes when they made a human sacrifice they would put a *maunu‘ia* [fish hook] in the person’s mouth.”

Walking up to the *heiau* Mr. Ogata noted that some *hula h lau* often come to the area to collect *hula* ferns. He pointed out a *koa* tree (*Acacia koa*) beside the trail he planted to commemorate his son’s wedding. He also planted a *kukui* (*Aleurites moluccana*) and a coconut tree at the north end of the *heiau*, near what is now the entrance. “I noticed that there was no opening in the rock walls for an entrance. Well there is an opening now but I found out that this was made [more recently] by ranchers who used the *heiau* as a cattle pen. I asked myself, ‘how did the ancients get into the *heiau*?’, and saw the pile of rocks [pointing to rocks on the northeast side of the *heiau*] I think was used as a ramp up to the wall of the *heiau*” (Figure 29). Entering from the north opening of the *heiau*, Mr. Ogata explained that there were three levels to a *lananu‘u mamao* (oracle tower): the *lana* or the lowest platform of the oracle tower where offerings were placed; the *nu‘u* or the second platform in the tower; and, the *mamao* or the highest platform of the *lananu‘u mamao*, where the high priest conducted services (Figures 32 to 32). He believes that the rocks that still carpet the upper, north end of the *heiau* are remnants of the rock platform and noted that the *ti* or *ki* (*Cordyline terminalis*) plants scattered in and around the *heiau* were there when Mr. Ogata and his son first visited the site. Walking over the west wall of the *heiau*, he pointed to a flat grassy area over the wall he believes may have been the site of the Hale o Papa, or the women’s *heiau* (Figures 33 and 34). Moving to the center of the *heiau*, Mr. Ogata pointed out the lines of rocks that formed four terraces across the width of the *heiau* (Figure 24). He wonders if one purpose the rock terraces may have served was as a stadium for watching sledding competitions on the ridge directly south of the *heiau*, “After all, a *heiau* is only sacred during certain times of the year”. Looking towards the ridge (Figure 35), he explained how Hawaiians created *h lua* (sled course) by making a rock track, covering it with grasses, and wetting it down for speed. At the lower (south) end of the *heiau*, Mr. Ogata pointed out the *lua* adding that he has found another 2 *lua* outside of the *heiau* and believes there are more. He concluded his discussion of the features inside the *heiau* with a brief telling of the *mo‘olelo* about Kamupua‘a’s chicken thievery and subsequent capture and escape from Olopana’s attempt to sacrifice him at the Kawa‘ewa‘e Heiau (see Section 3).

Mr. Ogata mentioned, and in some cases identified for CSH, a number of sites outside of the Kawa‘ewa‘e Heiau and stated his regret that a more detailed archaeological survey has yet to be done on the features immediately adjacent, or in proximity, to the *heiau.* In addition to finding at least one other *lua* for the disposal of sacrificial bones (located approximately 25 yards north and *mauka* of the *heiau*), he found: a stone alignment extending about 50 yards on the north side of the *heiau;* a site that may be a human burial also north of the *heiau*; and what he thinks may be stairs or a stone pathway leading up to the *heiau* on the north and west/*makai* side (Figures 36 and 37) and a rectangular rock enclosure (Figure 38). He wonders if the latter was a burial site or a *kuahu* (altar). Mr. Ogata stressed that these sites should be viewed in relationship to the Kawa‘ewa‘e Heiau. Also, the Kawa‘ewa‘e Heiau should be considered in relationship to the other four *heiau* built by or for ‘Olopana in the Ko‘olaupoko area. Mr. Ogata theorizes that there is meaning, perhaps astrological or astronomical, to the alignment of the *heiau* around Ko‘olaupoko and wondered aloud if anybody has explored the spatial relationships of these *heiau*?

Mr. Ogata spoke of the threat to the Kawa‘ewa‘e Heiau since the early 1800s when Kamehameha I died (1819), the American Protestant missionaries first started arriving in Hawai‘i (1820) and began Christianizing Hawaiians, and Kamehameha II (Liholiho) ascended

the throne (1819) and discontinued the *kapu* system. Referring to Kamehameha I’s wife, and the mother of Liholiho, Queen Ka‘ahumanu, Mr. Ogata explained “Ka‘ahumanu said destroy the *heiau*!” The Kawa‘ewa‘e Heiau was not destroyed, but was abandoned by Christianized Hawaiians who, in Mr. Ogata’s words, “became very superstitious and fearful of the ancient sites”. Mr. Ogata also mentioned the general disregard for Hawaiian cultural properties until the late 1970s when historic preservation laws were legislated in Hawai‘i (Figure 26). Even so, many sites were destroyed because they were not recognized as significant. “There was another *heiau* built by Olopana where the [HMP] cemetery is now. The *heiau* was taken apart to build the cemetery and some of the rocks from the *heiau* were possibly used to construct a waterfall.” Mr. Ogata continued, “I know [nowadays] they won’t touch the *heiau*. But I am worried about the other sites that may not be considered significant to the cemetery [HMP]. Are they going to destroy the *h lua* slide, the *ahu…*? Not too many people know about the *heiau* anymore…I’d like to see the archaeological sites excavated…and to [locate] and excavate all of the *lua.*”

Mr. Ogata commented that he hopes that the conservation land will not be developed “especially where they want to build the subdivision” and expressed cultural concerns regarding the Kawa‘ewa‘e Heiau and surrounding project area and offered the following recommendations:

1. An archaeology inventory survey of sites associated with the Kawa‘ewa‘e Heiau, particularly rock features immediately adjacent to or in proximity to the Kawa‘ewa‘e Heiau that may not have been covered in earlier works, should be conducted. The sites should be excavated (especially where *lua* are found) and preserved.
2. Other cultural properties in the project area, such as the *h lua* (sled course) on the ridge line immediately south of the Kawa‘ewa‘e Heiau, should be preserved.
3. On-going cultural practices, such as the gathering of *hula* and medicinal plants, should be recognized and accommodated.
4. Hawaiians and people of Kāne‘ohe gather and voice their opinions about the proposed project in a public hearing. Site should be verified to see if it is (still) on the state and/or federal register.

Figure 24. Charlie Ogata’s model of the Kawa‘ewa‘e Heiau viewed from the south (bottom of photograph) to the north (top)

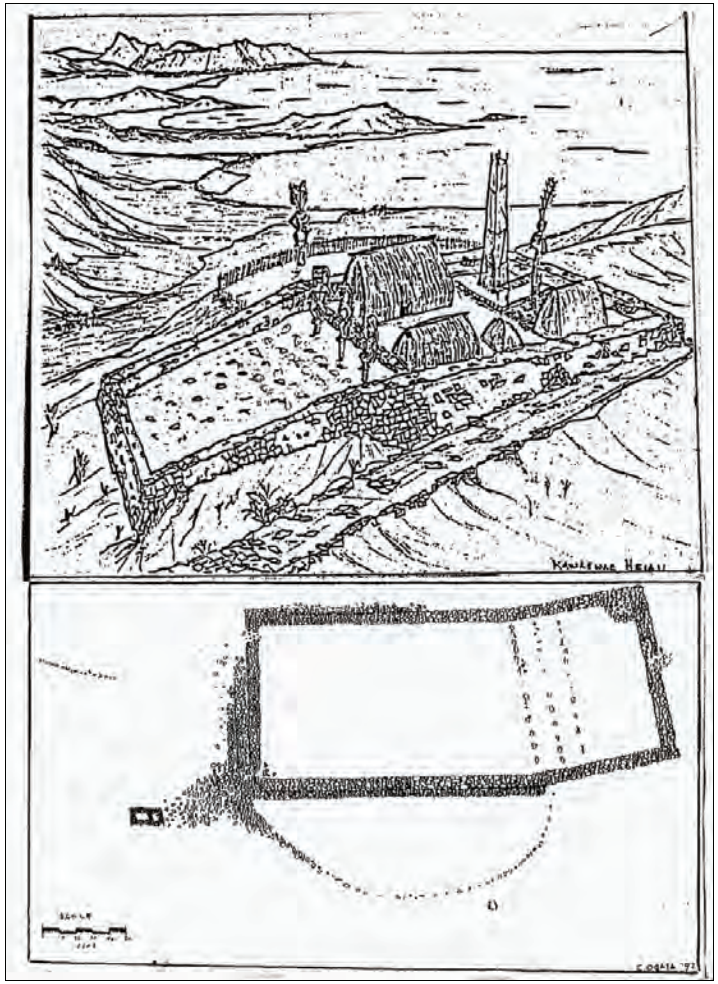


Figure 25. Two illustrations of the Kawa‘ewa‘e Heiau by Charlie Ogata

18 FEB 1986

TO WHOM IT MAY CONCERN:

Since the discovery of Hawai'i by Captain James Cook, other explorers, travelers, missionaries, and traders, took with them many of Hawai'i's valuable artifacts including feather cloaks, feathered and carved images and other irreplaceable objects of great historical value. Numerous objects of historical value were taken from burial sites and other historical sites by vandals and the curiousity seekers. Many historical sites, including heiau were and are being destroyed by developers even today.

In 1921 while Hawai'i was still a territory, a Historical Commission was set up by the Territorial Legislature, but its only accomplishment was to locate and identify several important sites. Although this was a good start, it did not stop the destruction of many historic sites. In 1951 the Legislature established a Historic Sites Comission which performed the same functions as its predecessors with some success in preserving certain sites.

In 1959, when Hawai'i became a state, the Constitution, in Article VIII, under Public Health and Welfare, Section 5, gave the state the power to 'conserve and develop places of historic or cultural interest'. Later the responsibility of the Historic Commission was placed under the Division of State Parks in the Department of Land and Natural Resources.

10 years ago, in 1976, the State Historic Preservation Office staff published an official document of historic preservation under the provisions of the National Historic Preservation Act of 1966, which was endorsed by governor George R. Ariyoshi. In this document is listed several preservation programs, recommendations, and planning, all of which are very ambitious and worthy of implementation. What has become of all these programs?

Today 1986, we still seem to be bogged down in bureaucratic muck when it comes to rendering any decision regarding the preservation of certain historic site/s, e.g. the Kawainui Marsh, certain salt water ponds in Kahala, the sites at the banana patch in Kaneohe, etc. Surely with all the scientists, historians, and archeologists available to the state, decisions regarding historical sites can be made in a more timely manner before they are compromised or destroyed.

The property in question today (Pikoiloa) contains a heiau of historic, religious, and traditional value. It is the Kawa'ewa'e Heiau, a registered Historic Site. According to Thrum, it was built in the 12th century by 'menehunes' and rebuilt by Kahikiula for his brother Olopana who was the Ali'i Nui of Koolaupoko. It is a Luakini type heiau, one of many others built in this general area. The kahuna nui was Lonoaahi. The heiau consists of an enclosure 120 by 260 feet and walls averaging 5 feet in width. Height anywhere from 3 feet to 7 feet. It is said that this was the heiau in which Kamapua'a the demigod was to have been sacrificed by Olopana, in the famous traditional stories of Kamapua'a. At the present time although the site is overgrown, and some portions destroyed by cattle ranching, it is in fairly good condition. It is hoped that the State will consider the possibility of preserving and restoring this site and include it in their general plan. As representative of the Queen Emma Hawaiian Civic Club, we offer our whole-hearted support toward this goal. Thank you.

Figure 26. 1986 testimony made by Charlie Ogata to restore and preserve the Kawa‘ewa‘e Heiau.

Figure 27. Mr. Ogata indicates where the *lua* for bones is located

Figure 28. A picture of the *lua* at the southeast corner of the Kawa‘ewa‘e Heiau

Figure 29. Rocks on the east and *mauka* side of the *heiau*, Mr. Ogata believes formed a ramp to the entrance

Figure 30. Charlie Ogata points to the north side the Kawa‘ewa‘e Heiau

Figure 31. A close-up of the *lananu‘u mamao* (oracle tower), *hale pahu* (drum house) (center), *hale umu* (oven house), the *hale mana* (spirit house) (center, top) and the *hale wai ea* (spirit water house).

Figure 32. A close-up of the *ki‘i akua* (temple images) and *lele* (sacrificial altar)

Figure 33. Mr. Ogata points out where he believes the Hale O Papa (women prayer complex) was located on the *komohana* (west) side of the *heiau*

Figure 34. A close-up of the Hale o Papa from Charlie Ogata’s model of the *heiau*

Figure 35. A view of the south wall and the ridge line immediately south of the *heiau* where the *h lua* (sled course) was located taken from the rock terraced area in the middle of the *heiau*

Figure 36. The north wall of the Kawa‘ewa‘e Heiau and possible steps leading to *makai* side trail

Figure 37. West wall of *heiau*, stairs leading downslope not visible in this photograph

Figure 38. The rectangular rock feature immediately downslope on the west and *makai* of the *heiau*. Mr. Ogata wonders if this was a guard shack for the *heiau*

6.1.5 Linda Chang

In an interview conducted by CSH on October 8, 2007, Mrs. Linda Chang, a *lei*-maker, *hula* practitioner and longtime resident of Kāne‘ohe, discussed her background and knowledge of the project area. Mrs. Chang recently moved with her husband to Hilo, Hawai‘i for the quiet and lush environment that is ideal for growing and gathering *lei* plants. Formerly, her family lived on Nāmoku Street, a few blocks away from the proposed HMP expansion project area, since 1978. She has danced *hula* for the last 15 years and has been associated with floral arrangements, *lei* making, and native plants for over 40 years. She has conducted *lei* making classes/workshops, and has made many of the adornments for the *hula h lau* she danced with for over 14 years, Hālau Hula ‘O Nāpunaheleonāpua. Mrs. Chang developed her *lei*-making skills through this experience and has been producing *lei*(s) and adornments professionally for the last 12 years. She has also participated as a judge for several years in the City of Honolulu's Lei Day Contest.

Mrs. Chang stressed the importance of the proposed project area for collection of the *hula* plant *laua‘e* (*Phymatosorus grossus*) because of its superior color, thickness and *maile*-like scent, and noted that the closest area where *laua‘e* of this quality can be found is on a trail at the top of the Pali, but that it is difficult to access. Mrs. Chang has also been involved in cultural education through her *hula h lau.* She noted that the *hula h lau* always takes responsibility for tending the areas from which plants are collected and commented, “The *h lau* realizes the importance of preserving the native flora for future generations to enjoy. How we have done this and continue to do this, is by taking the *haum na* [students] to sites where our *kumu* and *k kua* have gone to harvest the *laua‘e*, and the *palapalai* [native fern, *Microlepia setosa*] and we teach them how to look for the mature branches and how to pick the stems without damaging the plant. They are also cautioned to take only what they need and not to over-harvest, not to waste.”

Mrs. Chang emphasized that in Hawaiian culture, culture and environment are “intertwined”. She shared her *mana‘o* and cultural-conservation concerns about the proposed project area:

> The [proposed project area] is a place to find respite. How many parcels will be destroyed before the last greenbelt is all gone? Where will we be able to go to listen to the wind blow through the trees? Dollars speak louder than the grace and beauty of a place. We take children in the *h lau* to see the context of *hula* plants. Going to a park is not the same as taking them to the natural environment [in which *hula* plants are gathered]. The context of *hula* plants is very important.

Mrs. Chang recommended CSH contact Kumu Hula Frank Kawaikapuokalani Hewett and Aunty Alice Hewett.

6.1.6 Dr. Charles Pe‘ape‘a Makawalu Burrows

Dr. Charles Pe‘ape‘a Makawalu Burrows, familiarly known as “Doc” Chuck Burrows, is the President of ‘Ahahui Mālama i ka Lōkahi, a nonprofit organization devoted to developing, promoting and practicing a native Hawaiian conservation ethic. Dr. Burrows leads volunteer groups in the cultural and ecological restoration of Ulupō Heiau and Na Pohaku o Hauwahine in Kawai Nui Marsh of the Kailua Ahupua‘a. Ulupō Heiau is located in Kailua Ahupua‘a, approximately 2.2 miles east-south-east of the project area (Figure 39). Ulupō Heiau is said to

have been built by the first Polynesians arriving to the shores of the Kawai Nui lagoon 1500 years ago. In an interview conducted by CSH at the Ulupō Heiau on October 11, 2007, Dr. Burrows lead CSH on an extensive tour of the *heiau* pointing out cultural features of the landscape and sharing his knowledge of *heiau* in the Ko‘olaupoko district and his *mana‘o* on the proposed project area.

Dr. Burrows explained that the reason this site was chosen for a *heiau* was most likely the *punawai* or fresh water springs found at the base of the *heiau* and used by the early *k huna* (priests) for ritual purposes, drinking and irrigation of their *lo‘i kalo* (taro pond fields):

> There are very few *heiau* associated with *lo‘i kalo* and the growing of other ethnobotanical crops. Below the *heiau* complex and into the marsh, extending to Maunawili Valley, was grown with taro. The dryland slopes were cultivated with the growing of sweet potato, banana, breadfruit and sugarcane. One part of the marsh, about 450 acres, was constructed as an inland *loko i‘a* (fishpond), the largest of its kind in the Hawaiian Islands at that time.

Dr. Burrows pointed out ‘*auwai* (irrigation ditches) and other cultural sites that can be seen from the Ulupō Heiau such as the Pahukini Heiau, across the marsh on the slopes of Kapa‘a, and Holomakani Heiau -- two of five *heiau*, including Kawa`ewa`e Heiau, purported to have been built by the high chief ‘Olopana. The Pahukini Heiau once overlooked the site of an ancient Hawaiian adze quarry. Pahukini Heiau, also in Kailua Ahupua‘a, is approximately 1.02 miles east-south-east of the project area (Figure 39). Dr. Burrows described the Ulupō Heiau in pre-Contact times and now:

> When you think about Ulupō Heiau, it is more than what you see here…more than just the *heiau*. It’s a whole complex where present buildings, houses, churches, roadways have been constructed during the historic and modern periods. There was a *kahuna* and *konohiki* (*ahupua‘a* land manager) who lived in the *heiau* complex who took care of the *heiau* and managed the growing of food crops and other useful plants not only for the rituals that took place at the *heiau* but also for the community’s food subsistence. In the Ulupō Heiau state property of 28 acres are the last remnants of the ancient Hawaiian archaeological and historic sites still existing and serves as a cultural *k puka* [island, buffer zone] for future generations. A cultural *k puka* in Kailua serves as seeds for new growth that perpetuates the Hawaiian and historic cultures but also for the restoration of its biological ecosystems. It provides the seeds for renewal, culturally and ecologically and is at once our past, present and future.

Regarding the Kawa‘ewa‘e Heiau and the proposed HMP expansion project, Dr. Burrows is particularly concerned about the archaeological sites in the project area, possibly associated with the *heiau*. “Sewer lines [and other aspects of the development], especially where the subdivision is planned, could impact the sites.” He suggested that CSH also try and contact “Buddy” Earl Neller, and offered the following recommendations:

1. The project should be reviewed by the Office of Hawaiian Affairs’ Native Hawaiian Historic Preservation Council (NHHPC) which serves to advise the

OHA trustees on matters pertaining to Hawaiian archaeological sites and also the OHA Administrator (see Clyde Nāmu‘o, OHA in Table 4). Dr. Burrows sits on the NHHPC and noted that the Council would be interested in seeing a survey of all the archaeological sites in and around the project area “right up to the ridge line”.

2. In designing a plan for protecting the sites, the owner should consult and work directly with the Queen Emma Hawaiian Civic Club and the Ko‘olaupoko Hawaiian Civic Club.

3. There should be cultural monitoring during all phases of the planned development.

Figure 39. Ulupō Heiau in relation to Kawa‘ewa‘e Heiau and other neighboring *heiau*

6.2 Additional Statements

Because a few of the community contacts approached for this cultural impact study actively oppose the proposed cemetery expansion, and/or are concerned about trespassing issues related to gathering plants on Hawaiian Memorial Park owned land, the following Kāne‘ohe cultural practitioners have agreed to contribute their comments to the study on the condition that their names are withheld.

6.2.1 Cultural Practitioner and Educator

On September 18, 2007 CSH interviewed a cultural practitioner and educator who has been actively involved in the Ko‘olaupoko Hawaiian Civic Club, in helping to clean (weed) the Kawa‘ewa‘e Heiau, and in gathering plants in the area for a number of years. The study participant shared the following information about the project area:

S/he is from a neighboring *ahupua‘a* to Kāne‘ohe, and has been visiting and utilizing the project area since s/he was a child. “All those properties used to be pasture land. We used to run in those mountains [when we were kids]... There used to be a dairy... I think it was ‘Santos Dairy’. I’ve been hearing ‘Souza Dairy’, but it wasn’t Souza that was somewhere else. We used to see the *heiau* when we were young, but when you’re young you don’t think about it. We didn’t really know what it is…. A lot of historical sites we can’t get to because they are on private land, we can’t touch it with a ten foot pole…” The study participant painted a picture of the landscape that is quite different than it is today, “If you look at pictures from the 1920s and 30s there were no trees. You have to visualize [in and around the *heiau*] from point A to B with no trees.” S/he noted that another large *heiau* s/he is familiar with (located in Wailua), like the Kawa‘ewa‘e Heiau, was used for sacrifices. S/he observed that in some parts of the *heiau* in Wailua, the surface rocks appeared to be hollow. S/he reached down below the surface and found that the rocks underneath were white, like coal, “The place was like a massive furnace”. S/he described indications of ancient Hawaiian habitation near the *heiau*: “a kahuna lived there and there is noni, mango and there was a *lo‘i*…. I haven’t really explored the back of the valley, but I know that people hunt back there and play paint ball”.

The interviewee has been involved in cultural work in the area for the last ten years. “We go to the *heiau* on the weekends to clean…to weed whack. We go when we need plants…*laua‘e* to make leis and for table decorations…when we need volume. It is easy to pick there. The plants are easy to get and they are clean. They’re growing in the shade, under the canopy.” S/he went on to explain that the variety that grows in the area is more fragrant and that, “when they don’t have seeds [spores] they don’t have a fragrance,” (referring to the more ornamental *laua‘e* commonly grown in peoples’ yards) “Pick the mature *laua‘e*. You can feel the stem. When the stem is brown, snap it right off…. Look at the leaves… you can tell the fragrant *laua‘e*.” The study participant reported that s/he takes *hula h lau* to the area to teach them what and how to pick ferns. S/he also mentioned that “kids from Kamehameha Schools” visit the Kawa‘ewa‘e Heiau. “Now it’s almost rainy season. We have to go fertilize the *laua‘e* patches. It’s not just about take take take. We give back too.”

The study participant expressed the following concerns regarding the proposed Hawaiian Memorial Park expansion project:

> Leave it alone. It’s conservation land. We’re trying to clean-up Kāne‘ohe Bay. There is already an invasive *limu* [seaweed, algae] problem. I am concerned about all the run-off from the cemetery – fertilizers, pesticides… it kills the fish.

6.2.2 Kāne‘ohe Kama‘āina and Hula Practitioner

On October 8, 2007 CSH interviewed a longtime resident of the Pikoiloa neighborhood. S/he has been dancing hula since s/he was a small child and is currently a member of the Hālau Hula ‘O Nāpunaheleonāpua. The study participant shared information about the project area.

S/he has been dancing hula since the age of 5 or 6 and has been a member of a number of hula hālau. S/he is aware that *hula h lau* gather hula plants in the project area. “We collect *laua‘e* there because it is the darkest, greenest, thickest and most fragrant…the best for making head, wrist [and other] lei. I think this is because of the lush trees…the thickness of the trees and the breeze. The shade, dampness and coolness makes the *laua‘e* more fragrant…. This is an important place for hula adornments. The only other place to collect *laua‘e* of this quality is up on the Pali, but that is not easily accessible.” The interviewee explained that the best way to pick laua‘e is to take only the leaves and leave the roots. “When our *kumu* picks he also tends the *laua‘e*.”

The interviewee drew a connection between *hula*, the land and natural and cultural conservation: “Hawaiian culture and the land are one. Everything has a spirit. When we go to pick something, we always ask permission first and then give an offering after. I was brought up in a *hula* culture and that means respect for the land. The land goes with our names, our genealogy… Access to pick *hula* plants [if the cemetery expands] is not enough. [The proposed project] will violate our ancestors land.” S/he further expressed his/her cultural, conservation and additional concerns regarding the proposed cemetery expansion project:

1. Protect the areas where *laua‘e* is concentrated. *Laua‘e* found in the project area is noteworthy for its physiological characteristics of thickness, color and fragrance, and especially valuable to *hula h lau* for making adornments. It is abundant *mauka* of the Kawaewa‘e Heiau and in the gulleys below the *heiau* that can be easily accessed from Lipalu Street.

2. Generally, “Don’t touch conservation land. Preserve the flora and fauna…. Green space is increasingly rare on this island.”

3. Sites such as the Kawa‘ewa‘e Heiau and associated sites in the project area should be protected and seen in relationship to other sacred sites in the Ko‘olaupoko area such as Mōkapu that were “training grounds for warriors.” The area is used for cultural education. For example, his/her daughter’s girlscout troop will be studying the Kawa‘ewa‘e Heiau to earn a Hawaiiana patch.

4. There is community concern that the cemetery will bring more traffic and crime, and generally disrupt the quiet of the neighborhood. “[Now] the neighborhood is safe and protected. Any stranger comes up here and everybody knows it.” S/he is concerned that people could use the cemetery to access homes. “We have already seen people come down from the [HMP] graveyard at night. We saw flashlights coming down the hill…they went into someone’s backyard. Maybe they were just kids, but still it is easy to get into a person’s backyard from the graveyard.”

5. The community is concerned about drainage issues. There was a mud slide and flood in the 1980s that ran through peoples’ homes and killed one person.

6.2.3 Kāne‘ohe Kama‘āina and Kumu Hula

In a phone conversation on October 17, 2007, CSH spoke with a Kāne‘ohe *hula* instructor regarding the proposed Hawaiian Memorial Park expansion project. His/her *hula* group gathers plants for *hula* adornments in the project area. The interviewee shared the following comments regarding the proposed project:

> We feel that it is important for Hawaiian cultural practices that this area is preserved. We collect *laua‘e* [in and near the project area]. *Laua‘e* is picked in honor of Laka, the god of *hula*. This area is important for *laua‘e*: 1) although you can find *laua‘e* throughout the island, this is one of the few places you can find it in abundance. If you need *lei*(s) for 25 people, you can go to this one place [rather than having to go to more than one site to pick enough] and 2) the quality of the *laua‘e* ferns are better – the ferns are mature, darker green in color, firm, and have no bumps [spores], preferred for *hula lei* and other adornments.

Section 7 Cultural Landscape of the Project Area

Discussions of specific aspects of traditional Hawaiian culture as they may relate to the project area are presented below. This section examines resources and practices identified within the project area in the broader context of the encompassing Kāne‘ohe Ahupua‘a landscape. As emphasized by a number of the participants in this cultural impact assessment, the entire project area must be seen in light of its association with the Kawa‘ewa‘e Heiau *and* in relation to neighboring *heiau* in the Ko‘olaupoko district. Dr. Chuck Burrows described *heiau* as part of a "complex" of sites serving habitation, agricultural, ceremonial and ritual purposes. Findings of the archaeological inventory survey for the Hawaiian Memorial Park expansion project enumerate several pre-Contact sites that suggest association with Kawa‘ewa‘e Heiau as well as, possibly, a ceremonial/*heiau* structure (SIHP# 50-80-10-6930) (McCurdy and Hammatt 2008). Excerpts from talk story sessions are incorporated throughout this section where applicable.

7.1 Hawaiian Habitation and Agriculture

In pre-Contact times, the *ahupua‘a* of Kāne‘ohe offered fresh water from *mauka* (upland) springs and a well-developed fishpond system, making it both an agricultural and aquacultural center, and one of the primary population centers on O‘ahu (Devaney et al. 1982:6). Handy and Handy (1972) described Kāne‘ohe as:

> ...an area of little hills with many small streams between them. In 1935 it was still one of the most active communities in planting commercial taro. A goodly proportion of its lowland *lo‘i*, tucked away in pockets flanked and often hidden by low hills or near the town itself, was then still planted in taro by Hawaiians who owned the land and by Orientals who leased land or were hired to cultivate it. (Handy and Handy 1972:455)

Pre-Contact land use would have consisted mainly of *kalo* (wetland taro) and *kula* (dryland) cultivation of *hala* - pandanus (used for making household furnishings such as mats), *wauke* – paper mulberry (used for making *tapa/kapa* cloth), bananas and sweet potatoes (Handy and Handy 1972:456).

Cultural and ecological conservationist Dr. Burrows discussed the significance of water in relationship to the Ulupō Heiau. He explained that the reason the sight was chosen for a *heiau* was most likely due to the *p n wai* or fresh water springs found at the base of the *heiau* and used by the early *k huna* (priests) for ritual purposes, drinking and irrigation of their *lo‘i kalo* (taro pond fields). One of the contributors to this cultural assessment (see Section 6.2.1) described what s/he believes are indications of ancient Hawaiian habitation near the Kawa‘ewa‘e Heiau, "a kahuna lived there and there is *noni*, mango and there was a *lo‘i*…"

Archaeologist Earl "Buddy" Neller, adjuring archaeologists to pay closer attention to vegetation associated with historic and cultural sites, commented in an email:

> Plants, such as ti, are an integral part of heiau traditions, but they are generally not mentioned in archaeological surveys. Don't overlook the importance of Hawaiian

> plants growing in the project area. Ti is often found at heiau sites, and in Hawaiian gardens of old, and the leaves are still used in many ways.

Charlie Ogata, *kia‘i* (caretaker) of the Kawa‘ewa‘e Heiau, pointed out the *t* or *k i* (*Cordyline terminalis*) plants scattered in and around the *heiau*. He mentioned that the plants were there when Mr. Ogata and his son first visited the site in the 1970s.

It is worth noting that *t /k* , a Polynesian introduced cultivar, in addition to its use for food and the (post-contact) distilled liquer *‘okolehao*, was of ceremonial and ritual importance:

> *Ti* received heavy ceremonial use… and was frequently planted around *heiau*. Priests wore leaves about their necks as an indication of high rank or divine power, and it was among the plants customary on the altar of the *h lau hula*, representing Laka, the goddess of hula. (Abbott 1992:115)

7.2 Gathering of Plant Resources

In ancient Hawai‘i, upland forest regions provided various woods needed for canoes, tools and more, as well as cordage, food and herbs (Abbott 1992). Several of the plants within the project area have past and present ethnobotanical uses for native Hawaiians (e.g., as medicinal, building, weaving, *hula* and *lei* plants). Many of these plants are (possible) Polynesian introductions such as *kukui* (*Aleurites moluccana*), (true) *kamani* (*Calophyllum inophyllum*), *hau* (*Hibiscus tiliaceus*), *k* or *t* (*Cordyline fruticosa*), *noni* (*Morinda citrifolia*), *‘ohe* (possibly *Bambusa vulgaris* and/or *Schizostachyum glaucifolium*), and *mai‘a* - banana (*Musa* spp., possibly *M. paradisiaca*). Some of these Hawaiian canoe plants (plants brought by the early Polynesians in their canoes) are indicators of former Hawaiian habitation. For example, *kamani* was often planted around *heiau* (temples), and considered a sacred tree in parts of Polynesia; the same is true of *k /t* ; both *k /t* and *mai‘a* were planted around taro *lo‘i* (pondfields); and, the latter, *mai‘a*, was planted around dwellings (http://www.canoeplants.com).

There are also a small number of native plants in, and in the immediate vicinity of, the proposed project area such as the indigenous fern *pala‘* (*Sphenomeris chinensis)*, *neke* fern (*Cyclosorus interruptus*), wood fern (*Dryopteris* sp.), *possibly* the native fern *palapalai* (*Microlepia strigosa*), ‘ *hia lehua* trees (*Metrosideros* spp.), and the shrub/bush *lei* (*Osteomeles anthyllidifolia*), many of which have ethnobotanical applications. Most significantly, *palapalai* and *pala‘* are culturally valued native *hula* and *lei* fern. Although *M. strigosa* and *S. chinensis* are not listed as endangered or threatened, a study conducted by researchers at the University of Hawai‘i Department of Botany found that cultural practitioners were concerned that the availability of these species is declining dramatically (Ticktin et al. 2006).

Contributors to this cultural assessment rarely mentioned past or ongoing plant gathering with the singular exception of frequent reference to the continued collection and value of *lei/hula* plants gathered in the area, particularly *laua‘e* or *maile*-scented fern (*Phymatosorus grossus*). Mr. Ogata indicated that people collect *hula* and medicinal plants in the area. Though there are a number of plants that can be used as *lei* and *hula* plants in the project area, the focus of most study participants' comments and concern was on the naturalized non-native fern, *laua‘e*. Hula practitioners such as Linda Chang and other study participants (see Sections 6.2.1-3), detailed the care, collection and use of *laua‘e*. As one contributor explained, "*Laua‘e* found in the project

area is noteworthy for its physiological characteristics of thickness, color and fragrance, and especially valuable to *hula h lau* for making adornments." Plant gatherers also mentioned that the proposed project area is the only easily accessible area in Kāne‘ohe where *laua‘e* can be found in enough abundance to gather for *hula h lau.* One gatherer explained:

> We collect *laua‘e* there because it is the darkest, greenest, thickest and most fragrant…the best for making head, wrist [and other] lei. I think this is because of the lush trees…the thickness of the trees and the breeze. The shade, dampness and coolness makes the *laua‘e* more fragrant…. This is an important place for hula adornments. The only other place to collect *laua‘e* of this quality is up on the Pali, but that is not easily accessible.

P. grossus is a very common alien fern found as a ground cover plant from coastal to shaded moist low-elevation forests and windswept ridges. It is also a popular ornamental yard plant. It is ubiquitous in the Hawaiian Islands, particularly in environments disturbed by humans, either directly or indirectly by their agents (e.g., grazing animals, bulldozers). For the purposes of this cultural impact assessment it is critical to understand the cultural and botanical reasons the *laua‘e* in the proposed project area is especially valued. Community consultants have repeatedly emphasized the qualities of color, thickness, fragrance and lack of sori as most desirable for *hula* adornments. They have also discussed the context in which *hula* plants are gathered.

Laua‘e patches found in the project area are understory plants, and differ considerably from plants encountered in open sunny areas. Plants in sunny areas tend to be, in the words of the Maya Le Grand (botanist conducting the floral inventory for the project EIS) more chlorotic, referring to yellowing of green plant tissues due to decreased chlorophyll often due to nutrient deficiencies, infection or toxicity (Maya Le Grand, personal communication 2008). Full sun will cause fronds to be lighter green, less culturally desirable than darker fronds (CTAHR, 2002:100). There is evidence that *laua‘e* tends to bear a much higher proportion of spore-bearing fronds in sunny habitats. The sori (cluster of sporangia – the spore-bearing structure of ferns) are less aesthetically pleasing to *hula* practitioners, and of greater significance, cause skin irritation and itching and are therefore avoided by gatherers.

The crushed leaves of *P. grossus* have a faint, but distinctive smell reminiscent of another popular *hula* plant *maile* (*Alyxia oliviformis*). Coumarins, the chemical component that gives *laua‘e* its characteristic smell, are ubiquitous in plants including ferns in the Polypodiaceae family (of which *P. grossus* is a member) (Harborne et al. 1999), lavender, licorice, cherries and sweet clover, etc. (http://www.phytochemicals.info/phytochemicals/coumarin.php). While un- or mildly scented when fresh and green, as coumarin-containing plants dry and age they develop a sweet fragrance often compared to vanilla or new-mown hay. This helps explain why *hula* plant gatherers and *lei*-makers, who experience the plant fresh and as it dries, have a greater awareness, knowledge and preference for the more fragrant *laua‘e* found in certain habitats.

Puanani Anderson-Fung, an ethnobotanist at the University of Hawai‘i, specializes in the study of all plants known to the Hawaiian community as *laua‘e.* An initial objective of her research was to determine the identity of the *laua‘e* mentioned in hawaiian chants and lore prior to 1900, since the plant identified today as *laua‘e* (a fern known scientifically as both *Phymatosorus grossus* and *Microsorum scolopendria* is thought to have been introduced to the

islands around 1900 (Wilson 2005: 43). Her work provides evidence that the original *laua‘e*, which is deeply and emotionally connected to Hawaiian culture, is a native species found no where else in the world outside of Hawai‘i. She refers to the native species (*Microsorum spectrum*) as *laua‘e maoli (“true laua‘e”*) in order to distinguish it from the non-native *laua‘e* that is abundant and easily accessible to all residents of Hawai‘i. Through her extensive research regarding both the original native and the post-Contact *laua‘e*, Ms. Anderson-Fung has acquired a thorough understanding of the physical features and habitats of both species.

Based on extensive field observations and ethnographic interviews Ms. Anderson-Fung concludes that *P. grossus* fronds are darker, thicker, more fragrant and with fewer sori in shady areas with high rainfall. She notes that the orographic rainfall that falls at the base of the Ko‘olau Range provides ideal moisture conditions for achieving abundant, luxuriant and healthy stands of the most coveted forms *laua‘e*. Ms. Anderson-Fung suggested that one mitigation measure that could be taken to protect the quality of *laua‘e* in the project area would be to maintain a tree canopy surrounding stands set aside for gatherers as shade from an intact overstory is essential to maintaining a *laua‘e* understory that is both fragrant and robust. She added that, ideally, the overstory should be replanted with native and Polynesian introductions, such as *kukui* (*Aleurites moluccana*).

Ms. Anderson-Fung, who serves on the advisory board of ‘Ahahui Mālama I Ka Lōkahi, a Native Hawaiian conservation organization which exists to give voice to both Hawaiian cultural values and the conservation science aspects of Hawaiian environmental and resource management issues, acknowledges the scientific-physiologic and biogeographic reasons for *laua‘e* selection preferences in the proposed project area. She also emphasizes the need to recognize the cultural significance of gathering the plant *in situ* and its reference to the, now rare, endemic Hawaiian plant *M. spectrum.* In an email sent to CSH and followup phone call on February 21, 2008, Ms. Anderson-Fung explained:

> The non-native fern identified today as *Laua‘e* has become a vital part of Hawaiian culture. I use the term "vital" in the literal sense, to indicate that *Laua‘e* is truly a source of support of the life of the culture. In the days before European contact, our ancestors related to plants in a deeply personal and emotional way and they used the plants in their vicinity on a daily basis. The French botanist Gaudichaud, who visited Hawai`i in 1819 observed that Hawaiians wore lei on a daily basis and availed themselves of all the fragrant plants, flowers and fruits in their local environment (see Anderson-Fung and Maly 2002). Unfortunately those plants and places are gone now. *Laua‘e* has become a *l ‘au h nai* , a term that I use to indicate that the plant has been "adopted" into Hawaiian culture and serves to "feed," or provide sustenance, to the host culture. My research has shown that all of the emotional and cultural importance of the fragrant and beloved native *Laua‘e maoli (Microsorum spectrum)* has, over the years, been conferred upon the non-native *laua`e.* This change occurred gradually and imperceptibly, and it may be said that the newcomer holds virtually all of the significance of its native predecessor. Furthermore, since the native *Laua‘e maoli* populations have become rare and sparse due to human activities and the introduction of non-native understory plants, using the non-native *Laua‘e*

also removes collecting pressure from the now uncommon endemic *Laua‘e maoli* fern.

As a vessel of Hawaiian cultural belief and values, collecting the *Laua‘e* that grows in today’s almost wholly alien environment provides native Hawaiians the ability to practice the uniquely Hawaiian protocols that engage us with the physical environment in a deeply respectful, emotional, and spiritual way that is at the very core of our culture and is a great part of what makes us Hawaiians. This is why I think it is very important that Hawaiians be allowed to gather in the old Hawaiian ways in an intact forest -- even if the vegetation of this forest is predominantly non-native. When we offer our entry chants and our gathering chants and offer our thanks to the non-human beings that live in the forest, we practice what it is to be Hawaiian. This can not be accomplished by picking ferns in a back yard or in an urban commercial setting. In summary, the *Laua‘e* of this forest is not the *Laua‘e* of the time of our ancestors, but, practially speaking, it is the only *Laua‘e* we have left. It is a vessel for carrying our deeply emotional, profoundly spiritual Hawaiian ties to the land into a modern context.

Figures 40 and 41 present views of forest understory *laua‘e* in the proposed project area.

Figure 40. *Laua‘e* or *maile*-scented fern (*Phymatosorus grossus*), found in abundance in the project area, is noted for its superior glossy texture, thickness, color and fragrance

Figure 41. Understory *laua‘e* located *mauka* of the Kawa‘ewa‘e Heiau

7.3 Marine and Freshwater Resources

In pre-Contact times, the *ahupua‘a* of Kāne‘ohe offered fresh water from *mauka* (upland) springs and a well-developed fishpond system, making it both an agricultural and aquacultural center, and one of the primary population centers on O‘ahu (Devaney et al. 1982:6). Kāne‘ohe Bay, with about two-dozen walled fishponds, was a bountiful source of fish (Devaney et al. 1982:6). McAllister recorded a number of fishponds in the vicinity of the current project area (Figure 14). Beyond Dr. Burrows reference to the *loko i‘a* (fishpond) in relationship to Ulupō Heiau, cultural consultations for this study did not discuss freshwater resources in or around the proposed project area.

7.4 Cultural Properties

For a complete consideration of the archaeological sites in and near the project area see the AIS report by McCurdy and Hammatt 2008. The proposed project area is noteworthy for several sites and features, many of which may be associated with the Kawa‘ewa‘e Heiau. McAllister described the *heiau* as follows:

> Site 354. Kawa‘ewa‘e Heiau, this is one of the five heiaus said to by John Bell to have been erected by Olopana. Ahukini, Pahukini, Holomakani, and Puumakani are the other four. It is on top of a small knoll and consists of one large enclosure 120 by 253 feet with a small terrace on the north side which follows the contours of the land. As the structure was used as a cattle pen for many years any traces of heiau features have been obliterated, and it is not known where the opening to the heiau was situated. The walls are massive, averaging about 5 feet in width and from 4 to 7 feet in height according to the contours of the land. The inside corners of the wall are rounded; the outside corners appear more angular.
>
> Thrum notes that this heiau was “Built by Olopana about the opening of the 12th century”. It was mentioned as one of the heiaus constructed by the menehunes. Lonoaohi is said to have officiated as high priest.
>
> This is the heiau to which Olopana had Kamapuaa brought for sacrifice. Through treachery Kamapuaa is said to have killed Olopana and escaped. (McAllister 1933 in Sterling and Summers 1978:218).

The Kawa‘ewa‘e Heiau was of primary interest to many of the community contacts interviewed for this assessment. Charles Ogata shared his many years of scholarship on the Kawa‘ewa‘e Heiau, detailing his understanding of the features both inside and around the *luakini heiau* (Figures 24 to 38) and stressed that Kawa‘ewa‘e Heiau should be viewed in relationship to the other four *heiau* built for ‘Olopana in the Ko‘olaupoko area. Mr. Ogata theorizes that there is meaning, perhaps astrological or astronomical, to the alignment of the *heiau* and suggested exploring the spatial relationships of these *heiau*. In a follow up letter regarding the project, Mahealani Cypher (Culturer Interpreter) also discussed the importance of viewing the Kawa‘ewa‘e Heiau as part of a complex of cultural features of the landscape and in association with other *heiau*:

> Standing upon Kawa‘ewa‘e Heiau, it is clear that the heiau was constructed strategically to be in the sight-line with Kukuiokane Heiau, the largest and most important heiau in the Kane‘ohe region. Also clearly visible from Kawa‘ewa‘e are the peaks of Pu‘u Ma‘eli‘eli and ‘Ohulehule, and the island known as Moku o Lo‘e (Coconut Island). Also clear from this site are the peaks of Konahuanui and Keahiakahoe, all of which bring stronger mana to elevate the spiritual and religious strength or power of Kawa‘ewa‘e. Our mo‘olelo tells us that the great chief Olopana (and others) occupied or visited at Kawa‘ewa‘e for some time; hence, it would have been a place where the po‘e kahiko (people of ancient times) brought their pleas for kokua, for resolution of disputes, or other requests for help. A great chief's presence indicates the complex had to be quite extensive to support his entourage, his retainers and those who served the chief. Food had to be gathered by the kahuna and others from the surrounding area, and these goods had to be managed by the priests and their helpers at Kawa‘ewa‘e. It was a thriving mini-community of its own within the ‘ili of Kawa‘ewa‘e. Therefore, the location, prominence and connection with other major sites, and the historical record of Olopana's presence, tell me that the heiau was not limited to the rock lined walls atop the ridge of Kawa‘ewa‘e, but had to contain an entire complex of associated structures and dwellings that housed and accommodated all who would be needed for a heiau of this prominence.

Earl Neller, Casina Waterman (President, Queen Emma Hawaiian Civic Club), the principals and members of the Ko‘olaupoko Hawaiian Civic Club (Elizabeth Lau, Mahealani Cypher, Donna and Wali Camvel) all spoke extensively of their understanding of the *heiau* and associated features, and expressed their concerns and recommendations regarding protection of the Kawa‘ewa‘e Heiau and surrounding sites (see Section 8).

A few of the cultural consultants for this study also commented on the *h lua* or slide described by McAllister as Site 353 (McAllister 1933 in Sterling and Summers 1978:219). According to background research and historic maps, Site 355 was located in the southwestern portion of the project area. Mr. Ogata explained how Hawaiians created the sled course by making a rock track, covering it with grasses, and wetting it down for speed. He believes that the *h lua* may have been on the ridge immediately south of the *heiau*, and that during certain seasons spectators would watch *h lua* competition from the terraced midsection inside the *heiau.* During the group field interview of Mahealani Cypher, and Donna and Wali Camvel, all three expressed an interest in locating the *h lua*. Ms. Cypher later wrote in a letter regarding the project:

> I recall I pointed out to you the two slopes, covered with trees and brush, just mauka of Kawa‘ewa‘e, where I believe the holua slides once were used by the chiefs for recreation. If the brush and trees were cleared and soft grasses re-planted on those slopes, they would adequately serve as fine holua slide areas. It is likely the nearby cemetery land once contained springs and ti leaf groves, and could have been the source of water needed to wet the slopes.

Mr. Neller shared his understanding of the location and type of *h lua*:

> Also, on the ridge leading down from the ahupua‘a boundary (and above the small knoll where Pu‘u Makani Heiau was probably located) I crossed a steeply sloping dirt ramp (covered in dense vegetation) that seemed to be man made, and I thought it may have served as a holua in ancient times. One of the interesting things about holua in this area is that they are described as earthen troughs, rather than sloping stone platforms.

7.5 Burials

No human burials have been documented within the present project area (McCurdy and Hammatt 2008). Study contributors did not *specifically* mention knowledge of *iwi k puna* (ancestral remains) in the project area. However, Mr. Ogata explained that the *lua* or pits found inside and outside the *luakini* (lit, 'many holes') *heiau*, were used to bury the bones of those sacrificed. He is aware of at least one other *lua* for the disposal of sacrificial bones and suspects there could be more worthy of further investigation. Mr. Ogata refered to a stone alignment north of the *heiau* he believes may be a human burial site. In a site visit with CSH on October 3, 2007 Mr. Ogata was unable to locate the *lua*. It has been many years since he has visited the area and vegetation has overtaken the sites we visited hoping to locate *lua* and the possible human burial site. Further, Casina Waterman, William Ailā (Hui Mālama I Nā Kūpuna O Hawai‘i Nei), Mahealani Cypher and the Office of Hawaiian Affairs all expressed their concern that there could be *iwi k puna* in the area. Ms. Cypher commented that, "In all likelihood, there are burials in the area, probably pre-Contact, and this should be addressed through other research".

7.6 Trails

Trails once served to connect the various settlements throughout O‘ahu. The most popular was the coastal route which circled O‘ahu. There were many trails traversing the mountain ranges (‘Ī‘ī 1959). John Papa ‘Ī‘ī (1959) documented early post-contact trails on the leeward side of O‘ahu Island. There is scant information on the network of *alaunui*, or pathways that once undoubtedly connected Kāne‘ohe to outlying communities. During the October 3, 2007 field visit to the Kawa‘ewa‘e Heiau, Mr. Ogata pointed out a trail (still used by hikers) he believes may have been used to connect ‘Olopana's *heiau.*

Oneawa is a popular hiking trail still utilized today. The trail begins at the Friendship Garden on Kokokahi Street, off Kāne‘ohe Bay Drive. It follows the ridge formed by the Oneawa Hills, than descends to the end of Lipalu Street just below the Kawa‘ewa‘e Heiau. Oneawa is the name of an *‘ili* east of the project area (Figures 6 and 7). Steve Brown of the Hawai‘i Trail and Mountain Club shared that the club has been "hiking this route twice a year for the last ten years….The route is unique, in that it affords panoramic views of the surrounding area, along with the opportunity to visit and appreciate the heiau. It is clear from the condition of the trail that usage of the route predates our usage by many years." He also mentioned that there are other groups that may be utilizing the area for hiking.

7.7 *Wahi Pana* (Storied Places)

Kāne‘ohe is rich in *mo‘olelo* (legends) concerning legendary references to the naming of Kāne‘ohe Ahupua‘a and other sites (Clark 2002, Paki 1972; Pukui et al. 1974; Sterling and Summers 1978). Of particular relevance to this cultural assessment are stories of the Kawa‘ewa‘e Heiau. Thrum (1906:48) reported that Kawa‘ewa‘e Heiau was erected in the beginning of the 12th century by the high chief ‘Olopana and constructed by *menehune* (legendary race of small people who built structures by night) (Fornander 1878:23). There are many versions of the story of Kamapua‘a (the notorious pig-god) and his capture and escape from sacrifice at the Kawa‘ewa‘e Heiau as told in books (e.g., Kalākaua 1990; Kame‘eleihiwa 1996) and by contributors to this cultural assessment (Charlie Ogata, Mahealani Cypher).

There are many cultural features of the landscape that are apart of, as Dr. Burrows called it, a *heiau* complex. During the June 23, 2007 field outing with Donna and Wali Camvel, and Mahealani Cypher, the group pointed out two large stones on a small rise above a temporary shelter. It was suggested that they may be *p haku kia‘i* or, stone guardians (Figures 21 and 22). One rock appears to be in the shape of a dog’s head (Figure 22), and Mahealani Cypher suggested that perhaps it was there to represent the Hawaiian god, Kāne. According to the group, together, the 2 *p haku kia‘i* appear to guard the area which may have been used by chiefs and their retinue for preparation, prayer and/or sacrifice. Ms. Cypher provided further explanation in her September 11, 2007 letter:

> My understanding is that stand-alone pohaku that had religious significance were usually known as “pohaku o Kane”, which we consider to be religious shrines and places of worship. At the site referred to as “CSH 5”… [the] stone by itself…is likely to have been a “pohaku o Kane”. I am not sure it would have marked the location of a caretaker’s hale or the home of the kahuna (priests), but that is possible. But Pohaku o Kane were generally just outside the door of many hale, serving as a family protector or shrine. In the case of the two pohaku seen at the area designated as “CSH 2”, I concur with Donna Camvel’s thinking that these serve as guardians and hence would be “pohaku ki‘ai”. The proximity of the two stones in a site which appears to have multi-level platforms, the size and shape of the two stones, indicated to me (and possibly to Donna Camvel) that this was a very important site. These pohaku ki‘ai may even have guarded the women of the hale o Papa, as the chiefess would have lived there and had the elevated status to warrant placement of such stones near her worship area.

Ms. Cypher also put forth the theory that *k puna* long ago may have planted mango trees to mark sacred sites for future generations. She bases her belief on the observation that many sacred areas she has visited around the Hawaiian Islands have had mango trees planted, often in a circle, around what may have been the *piko*, or center of *mana* (supernatural or divine power) of the *heiau*.

Section 8 Summary and Recommendations

At the request of Helber Hastert & Fee, Planners, Cultural Surveys Hawai‘i, Inc. (CSH) conducted a cultural impact assessment of the proposed Hawaiian Memorial Park (HMP) expansion project to support an Environmental Impact assessment being prepared for a Petition to amend the State Land Use boundaries of the project site from the State Conservation District to the State Urban District. Although the area of the proposed petition is only 56.6 acres, the cultural assessment and archaeological inventory project area studied by CSH is 66 acres (see Figure 1). The extra acreage was added as a study element in order to properly encompass potential archaeological and cultural sites, after the intial site visits, a literature search, and site plan changes required a reconsideration of the extent of the project area. For the purposes of this assessment, the 56.6 acres that comprise the area for State land use redesignation will be reffered to as the “Petition Area.” The 66 acres that comprise the area physically investigated by CHS will be referred to as the “Project Area.”

The owners are planning to expand the HMP on land they own, to the east of the existing HMP cemetery. In addition to building roads, mausoleums and other structures in the cemetery expansion area, the owners are planning to develop about 20 single-family lots on an approximately 4-acre part of the property on land adjacent to the Pohai Nani Retirement Home.

Background research indicated the importance of Kāne‘ohe Ahupua‘a and the proposed project area during the pre-Contact period. Kāne‘ohe Ahupua‘a and the project area vicinity were prime areas containing extensive natural and cultural resources including taro *lo‘i*, streams, and fishponds. The Kawa‘ewa‘e Heiau, which borders the northern boundary of the project area, was a center of religious activity with several associated habitation, agricultural, ceremonial and other sites extending throughout the project area (McCurdy and Hammatt 2008). In post-contact years, Kāne‘ohe has been widely used for the cultivation of rice, sugar and pineapple, and eventually beef cattle ranching and dairy farming. The post-World War II years, with the expansion of the Pali Highway connecting Honolulu to windward communities, coupled with economic factors, brought a development boom to Kāne‘ohe. Ranching and farming areas were replaced by residential subdivisions.

An effort was made to contact and consult with Hawaiian cultural organizations, government agencies, and individuals who might have knowledge of and/or concerns about the project area. Thirty-two people were contacted for the purposes of this cultural impact assessment, 27 people responded, and 10 *k puna* and/or *kama‘ ina* were interviewed for more in-depth contributions to the cultural survey. Because a few of the community contacts approached for this cultural impact study actively oppose the proposed cemetery expansion, and/or are concerned about trespassing issues related to gathering plants, hunting, hiking and other cultural or recreational activities on HMP owned land, 3 of the cultural practitioners who contributed their comments to this study preferred to have their names withheld.

The findings of this cultural impact assessment suggest that there are two *primary* cultural concerns (and several ancillary ones) regarding the proposed HMP expansion project. The first is the preservation and protection of the Kawa‘ewa‘e Heiau and contiguous cultural properties. The second is gathering practices, particularly the on-going collection of *hula* and *lei* plants in the proposed project area. Community contacts interviewed for this assessment were divided

about whether the proposed cemetery expansion would aid or hinder the effort to *m lama* (care take, tend) Kawa‘ewa‘e Heiau and associated archaeological sites, and whether the proposed expansion would negatively impact the gathering of *hula* plants and other cultural and educational activities (e.g., hunting, school and *hula* groups visit the area to learn about Kawa‘ewa‘e Heiau and gathering practices).

Several interviewees and community contacts explicitly stated their complete opposition to the proposed HMP expansion project citing mainly cultural and conservation reasons (see, for example, Steve Brown, Linda Chang, Charlie Ogata, Grant Yoshimori, Casina Waterman, and the 3 unnamed interviewees). One interviewee explained that in Hawaiian perspective, culture and the environment are inextricably linked:

> Hawaiian culture and the land are one. Everything has a spirit. When we go to pick something, we always ask permission first and then give an offering after. I was brought up in a *hula* culture and that means respect for the land. The land goes with our names, our genealogy… Access to pick *hula* plants [if the cemetery expands] is not enough. [The proposed project] will violate our ancestors land.

Mrs. Chang lamented the loss of green spaces on the island of O‘ahu and also drew a link to cultural practice:

> The [proposed project area] is a place to find respite. How many parcels will be destroyed before the last greenbelt is all gone? Where will we be able to go to listen to the wind blow through the trees? Dollars speak louder than the grace and beauty of a place. We take children in the *h lau* to see the context of *hula* plants. Going to a park is not the same as taking them to the natural environment [in which *hula* plants are gathered]. The context of *hula* plants is very important.

Mrs. Elizabeth Lau, Pelekikena (President) of the Ko‘olaupoko Hawaiian Civic Club (KHCC), Mahealani Cypher, and Donna and Wali Camvel view the proposed HMP expansion as an opportunity to better preserve the Kawa‘ewa‘e Heiau and contiguous archaeological sites through the careful creation of *k puka*, or a protected area and buffer zone. Mrs. Lau commented that the HMP is “a beautiful place for the [Kawa‘ewa‘e] *heiau*….The cemetery is beautiful. If the cemetery [is expanded] they [Hawaiian Memorial Park] would have to care for the *heiau*. This would be educational for our younger people [and provide] a place to exercise, and a pretty place to sit and eat lunch.” The KHCC is currently the most active group care-taking the Kawa‘ewa‘e Heiau. They offered their assistance and *mana‘o* (thoughts, ideas, theories) and expressed their interest in establishing a collaborative agreement with the planners and owner regarding the protection and preservation of the Kawa‘ewa‘e Heiau and associated sites.

Boundaries and buffer zones (*k puka*) for the Kawa‘ewa‘e Heiau and associated sites were key topics of discussion. For example, study contributors Charlie Ogata, Earl Neller, Dr. Chuck Burrows and Casina Waterman questioned the boundaries of the *heiau* in regard to a proposed buffer zone. Ms. Waterman wondered if a buffer of “100 feet” from the walls of the heiau would adequately cover the sites just outside the walls of the heiau, including “a terrace and houses”. Mr. Ogata took CSH on a walking tour of the sites adjacent to the *heiau.* Mr. Neller wrote, “Understanding the boundaries of the heiau is important, because there may be features in your project area which could be relevant to the archaeological study and modern day use of the

heiau…. The extent of the heiau throughout its history is an archaeological question that has never been investigated.”

A few participants spoke about the proposed infrastructure and access to the Kawa‘ewa‘e Heiau. Jim Waddington (Hawai‘i Chapter of the Sierra Club) wrote in an email, “The attachments to your email…are disturbing... especially the map which shows a road almost adjacent to one corner of the heiau.” Earl Neller, sent an email stating, “One of the problems with visiting Kawa‘ewa‘e Heiau is that there is no good access: no good parking area, no good trail.” Regarding proposed roadways Mahealani Cypher wrote, “I am a little concerned about whether paved roadways would be appropriate through the undeveloped area we visited, all of which may be part of the heiau complex. On the day of our field trip, it was explained to us that the landowner wishes to build roadways in this area for the cemetery expansion. I would like to emphasize that this may be problematic.”

Some participants discussed the possibility of **burial sites**, or *iwi k puna* (ancestral remains) in the project area. Mr. Ogata explained that the *lua* or pits found inside and outside the *luakini* (lit, ‘many holes’) *heiau*, were used to bury the bones of those sacrificed. He also reported to have seen in the past what he believes is a burial site in the vicinity of the Kawa‘ewa‘e Heiau. Casina Waterman, William Ailā, Mahealani Cypher and the Office of Hawaiian Affairs all expressed their concern that there could be *iwi k puna* within the project area.

Hula and other cultural practitioners stressed the continued significance of **collection of *lei/hula* plants** gathered in the area. Though there are a number of plants that can be used as *lei* and *hula* plants in the project area (see Section 7: Gathering of Plant Resources) the focus of most study participants’ comments and concern was on *laua‘e* or *maile*-scented fern (*Phymatosorus grossus*). Hula practitioners such as Linda Chang, and 3 unnamed study participants, detailed the care, collection and use of *laua‘e*. As one contributor explained, “*Laua‘e* found in the project area is noteworthy for its physiological characteristics of thickness, color and fragrance, and especially valuable to *hula h lau* for making adornments.” These interviewees also emphasized that common ornamental *laua‘e* found in yards, in fact ubiquitous on O‘ahu, differ significantly from the type of *laua‘e* most desired by cultural practitioners. According to these cultural specialists, *laua‘e* found in the project area is unique, and cannot easily be found in Kāne‘ohe in such abundance outside of the proposed project area (with the exception of a remote patch off of the Pali Highway). As one participant commented, “…although you can find *laua‘e* throughout the island, this is one of the few places you can find it in abundance. If you need *lei*(s) for 25 people, you can go to this one place.”

Again, there was a divergence of opinion regarding continued accessibility to *hula/lei* plants. Acknowledging that there are trespassing and liability issues at stake, some participants saw the HMP expansion project as a threat to continued access and fear destruction of plant resources and the “context” of gathering *hula* plants, while others view this as an opportunity to protect *laua‘e* (and other plant resources) and establish a formal protocol for accessing plants. The September 27, 2007 letter from the Office of Hawaiian Affairs recommended: “Consideration be afforded to any groups or individuals accessing the project area for constitutionally protected traditional and customary purposes.”

Among study participants for this cultural assessment there was consensus that the proposed residential subdivision planned adjacent to the Pohai Nani Retirement Home would endanger the

integrity of the Kawa‘ewa‘e Heiau and associated sites. For example, Dr. Chuck Burrows commented, “Sewer lines [and other aspects of the development], especially where the subdivision is planned, could impact the sites.” Mrs. Lau, though a strong proponent of the proposed HMP expansion, expressed her concern about the possible subdivision, “Better a cemetery than housing. If you have housing, that would damage the *heiau*.” There is also shared sentiment that conservation land should not be developed. In the words of one participant, “Don’t touch conservation land. Preserve the flora and fauna…. Green space is increasingly rare on this island.”

The companion archaeological inventory survey reports that eleven **archaeological sites** were recorded within or near the current project area (McCurdy and Hammatt 2008). This confirms the observations and assumptions of cultural consultants for this assessment that the Kawa‘ewa‘e Heiau is a *complex* with potentially several associated cultural properties to be identified (e.g., *h lua* sled course, Hale o Papa), investigated and protected for current and future generations. The point was repeatedly made that the Kawa‘ewa‘e Heiau and environs are frequently visited by school and other community groups (e.g., Kamehameha Schools and Hakipu‘u Learning Center, KHCC) and is vital to cultural education.

Beyond cultural concerns, there are other issues some of the community contacts raised in regard to the proposed development. Some community contacts are concerned that the cemetery will bring more traffic and crime, and generally disrupt the quiet of the neighborhood. One participant remarked, “[Now] the neighborhood is safe and protected. Any stranger comes up here and everybody knows it.” Flooding in the Pikoiloa neighborhood is another issue raised by a few of the community contacts: “The community is concerned about drainage issues. There was a mud slide and flood in the 1980s that ran through peoples’ homes and killed one person.”

As with any development project, there are a variety of viewpoints and concerns voiced by the individuals who have participated in this assessment, ranging from those who believe that appropriate project design and planning can improve and enhance access to cultural and natural resources, to those who are concerned that the potential project impacts cannot be reasonably mitigated. Over the course of conducting this assessment, CSH received numerous phone calls, emails and letters expressing opposition to the proposed HMP expansion. For the purposes of this cultural impact assessment, only communiqués directly related to cultural concerns are included in the report recommendations. The following mitigation measures are recommended by CSH to address the potential adverse impacts of the proposed action on Hawaiian cultural beliefs, practices and resources by the HMP expansion project:

1. Recognize that the Kawa‘ewa‘e Heiau is part of a complex of cultural sites, not a discrete site. It is recommended that plans and the design for the cemetery be integrated with the religious significance of the area surrounding Kawa‘ewa‘e Heiau and it be ensured that significant archaeological sites and cultural features of the landscape are buffered and protected from any roadways, bulldozing or other intrusive activity. Additionally, Kawa‘ewa‘e Heiau complex should be protected and seen in relationship to other sacred sites in the Ko‘olaupoko District. **The owner has stated the intent to preserve the significant archaeological sites, and to incorporate buffer zones (*k puka*) as recommended by CSH and as indicated in the proposed project plans.**

2. The Kawa‘ewa‘e Heiau (SIHP # 50-80-10-354), currently on the National Register of Historic Places, has been evaluated as significant under both Criterion D and E of the Hawai‘i Register of Historic Places and should be registered with the State. **The owner has stated the intent to register SIHP #. 50-80-10-354 with the State of Hawai‘i.**
3. All cultural properties and archaeological sites in and near the project area should be investigated, preserved and protected through the creation of *k puka* (protected areas and buffers) as appropriate. *K puka* should be designed in careful consideration of site boundaries and in relationship to contiguous sites. **The owner has stated the intent to preserve the significant archaeological sites, and to incorporate buffer zones (*k puka*) as recommended by CSH and as indicated in the proposed project plans.**
4. **The owner has stated the intent to continue consultation with appropriate state agencies, such as OHA, throughout the planning and development process to ensure appropriate evaluation and protection of archaeological and cultural resources. This consultation is required by law and will be continued throughout the process.**
5. The owner is invited to have the project reviewed by OHA’s Native Hawaiian Historic Preservation Council (NHHPC) if there is need for further consultation regarding handling of archaeological sites. **The owner has stated the intent to continue to consult with all appropriate groups such as the NHHPC concerning the handling of archaeological sites.**
6. Personnel involved in development activities in the project area should be informed of the possibility of inadvertent cultural finds, including human remains. Should cultural or burial sites be identified during ground disturbance, all work should immediately cease, and the appropriate agencies notified pursuant to applicable law. **The owner has stated the intent to provide a mandatory education program for any entity or personnel working within the project site to ensure that appropriate protective and notification action is undertaken should any inadvertent cultural or archaeological finds take place.**
7. Cultural monitoring should be conducted during all phases of development. **The owner has stated the intent to ensure that a cultural and archaeological monitor shall observe all grading and excavation activities to provide verification that cultural and archaeological finds have been protected.**
8. On-going cultural practices, such as the gathering of *hula* and *lei* plants, should be recognized and accommodated (subject to safety and liability issues). **As provided by law and subject to appropriate safety and liability indemnification, the owner has stated the intent to accommodate native Hawaiian gathering of *hula* and *lei* plants. To the degree feasible, these plant communities shall be enhanced and expanded within the buffer areas and permanent open space areas as appropriate.**
9. In particular, protect the areas where *laua‘e* (*Phymatosorus grossus*) is most concentrated. *Laua‘e* found in the project area is noteworthy for its physiological

characteristics of thickness, color and fragrance, and is especially valuable to several *hula h lau* in Kāne‘ohe and neighboring windward communities. It is recommended that the availability, abundance and quality of *laua‘e* ferns be protected through the creation of plant gathering *k puka*, including maintenance of an intact overstory. **The owner has stated the intent to protect overstory for all undisturbed areas and to enhance *laua‘e* fern plant communities to the degree feasible and practicable.**

10. Community members and groups responsible for the long-term care of the Kawa‘ewa‘e Heiau, as well as cultural practitioners who utilize the area for gathering and cultural education activities, should be further consulted regarding the above issues and other concerns throughout the planning, development and operation of the proposed HMP expansion. This consultation should include all interested community groups and individuals who have a stake in the project area through their involvement in long-term care of the Kawa‘ewa‘e Heiau, plant-gathering or other cultural issues. The owner has requested of various members of community groups wishing to have access to and maintenance permission for the *heiau* and related areas to begin the process of forming an appropriate master organization and preparing a master plan for the long term management, enhancement, maintenance, visitation activities, and financial requirements for the *heiau* complex and related issues such as plant gathering and plant community enhancement and other important cultural activities. **The owner has stated the desire to continue to work with the appropriate individuals and groups on this matter and to participate at some appropriate level in the development of this master plan document.**

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Appendix A: Community Consultation Letters

PHONE (808) 594-1888 FAX (808) 594-1865

STATE OF HAWAI'I
OFFICE OF HAWAIIAN AFFAIRS
711 KAPI'OLANI BOULEVARD, SUITE 500
HONOLULU, HAWAI'I 96813

HRD06/2939

April 5, 2007

Lisa Gollin
Cultural Surveys Hawaii, Inc.
P.O. Box 1114
Kailua, HI 96734

RE: Cultural Impact Assessment Consultation for the Proposed Expansion of Hawaiian Memorial Park, Kāne'ohe, O'ahu, TMK (1) 4-5-003: por. 1.

Dear Lisa Gollin,

The Office of Hawaiian Affairs (OHA) is in receipt of your March 5, 2007 submission and offers the following comments:

Please submit a summary (type and function assessments, significance evaluations, plan view maps, etc.) of the known historic properties within the vicinity of Kawa'ewa'e Heiau as adjunct to the above-listed consultation request. The above-listed correspondence does not contain the type of information that would allow our staff to make substantive recommendations at this time. The ambiguity regarding the size and scale of the proposed action also makes it difficult for our staff to make meaningful recommendations.

You may wish to contact Elizabeth Lau of the Ko'olaupoko Hawaiian Civic Club as she may have information or recommendations specific to the proposed action. Thank you for your correspondence.

OHA asks that, in accordance with Section 6E-46.6, Hawaii Revised Statutes and Chapter 13-300, Hawaii Administrative Rules, if the project moves forward, and if any significant cultural deposits or human skeletal remains are encountered, work shall stop in the immediate vicinity and the State Historic Preservation Division (SHPD/DLNR) shall be contacted.

Thank you for the opportunity to comment. If you have further questions or concerns, please contact Jesse Yorck, Native Rights Policy Advocate, at (808) 594-0239 or jessey@oha.org.

Aloha,

Clyde W. Nāmu'o
Administrator

A.1 Initial April 5, 2007 review letter from the Office of Hawaiian Affairs

June 14, 2007

Ms. Lisa Gollin
Cultural Surveys Hawaii, Inc.
P.O Box 1114
Kailua, HI 96734

Dear Ms. Gollin:

I'm responding to your May 2007 flyer entitled "Requesting Your Mana'o and Kokua on a Cultural Survey". I am aware of several cultural practices taking place on the Mahinui Mountainside, and would like to share these with you.

- There are at least four Hawaiian hula halau which visit the area to gather plants to make their traditional Hawaiian hula leis.
- I have seen people going hunting into the hillside, and personally know someone who has hunted for pigs in the area.
- Many people use the area for hiking. It is a well known hiking trail. And it has been sited in the Honolulu Advertiser by Richard McMahon.
- Schools tour the archeological sites and use it for cultural education purposes. I have personally seen Kamehameha Schools and Hakipu'u Learning Center children visiting and learning about the area.
- The area is also frequented by people who engage in combat exercises.

As you can see, there are quite a few cultural uses of the land. I hope that Service Corporation International (dba Hawaiian Memorial Park) will endeavor to keep the land in its natural state so these cultural practices can continue.

Sincerely,

Grant Yoshimori
45-464 Lipalu St.
Kaneohe, HI 96744

cc: B.Harris
J.McCreedy
L.Ching
R.Kim

A.2 June 14, 2007 letter from Grant Yoshimori, Hui O ‘Piko‘iloa

M A H E A L A N I C Y P H E R
P. O. Box 4749
Kane`ohe, HI 96744
malamapono@aol.com

September 11, 2007

Ms. Lisa Gollin, Projects Manager
Cultural Impact Assessments
Cultural Surveys Hawai`I, Inc.
Post Office Box 1114
Kailua, HI 96734

Re: Comments Regarding Your Notes Concerning our Site Visit
to TMK (1) 4-5-033:001, Hawaiian Memorial Park Expansion

Dear Ms. Gollin:

Mahalo for this opportunity to comment on your field notes of our recent site visit to the property on which Hawaiian Memorial Park is contemplating making improvements. My comments are as follows:

1. Overall: You are correct in noting that all of us who visited the area agree that it has connection with Kawa`ewa`e Heiau, a religious site sacred to native Hawaiians. As such, the surrounding area would also have religious significance as part of the heiau complex. With a luakini heiau as prominent as Kawa`ewa`e, there is little doubt that there would have been associated sections of the property nearby that complete the full operation of the heiau in keeping with its use and purpose. Its connection with Chief Olopana and Kamapua`a, for example, would further support its having a complex of associated

compartments – not just a hale for the kahuna – to include the hale o papa and other key elements. (see item #5)

2. Pohaku: you refer to certain stones as “pohaku”, although my understanding is that stand-alone pohaku that had religious significance were usually known as “pohaku o Kane”, which we consider to be religious shrines and places of worship. At the site referred to as “CSH 5”, you mention a stone by itself as a “pohaku” when it is likely to have been a “pohaku o Kane”. I am not sure it would have marked the location of a caretaker’s hale or the home of the kahuna (priests), but that is possible. But Pohaku o Kane were generally just outside the door of many hale, serving as a family protector or shrine. In the case of the two pohaku seen at the area designated as “CSH 2”, I concur with Donna Camvel’s thinking that these serve as guardians and hence would be “pohaku ki`ai”. The proximity of the two stones in a site which appears to have multi-level platforms, the size and shape of the two stones, indicated to me (and possibly to Donna Camvel) that this was a very important site. These pohaku ki`ai may even have guarded the women of the hale o Papa, as the chiefess would have lived there and had the elevated status to warrant placement of such stones near her worship area.

3. Mo`olelo about Olopana and Kamapua`a: I believe the story I shared with you about Kamapua`a overcoming Olopana at Kawa`ewa`e was learned from a translation provided by historian Dr. Lilikala Kame`eleihiwa in her book, “Kamapua`a”.

4. Holua slides: I recall I pointed out to you the two slopes, covered with trees and brush, just mauka of Kawa`ewae, where I believe the holua slides once were used by the chiefs for recreation. If the brush and trees were cleared and soft grasses re-planted on those slopes, they would adequately serve as fine holua slide areas. It is likely the nearby cemetery land once contained springs and ti leaf groves, and could have been the source of water needed to wet the slopes.

5. Location and Relationship to broader Kane`ohe ahupua`a and other heiau: Standing upon Kawa`ewa`e Heiau, it is clear that the heiau was constructed strategically to be in the sight-line with Kukuiokane Heiau, the largest and most important heiau in the Kane`ohe region. Also clearly visible from Kawa`ewa`e are the peaks of Pu`u Ma`eli`eli and `Ohulehule, and the island known as Moku

o Lo`e (Coconut Island). Also clear from this site are the peaks of Konahuanui and Keahiakahoe, all of which bring stronger mana to elevate the spirititual and religious strength or power of Kawa`ewa`e. Our mo`olelo tells us that the great chief Olopana (and others) occupied or visited at Kawa`ewa`e for some time; hence, it would have been a place where the po`e kahiko (people of ancient times) brought their pleas for kokua, for resolution of disputes, or other requests for help. A great chief’s presence indicates the complex had to be quite extensive to support his entourage, his retainers and those who served the chief. Food had to be gathered by the kahuna and others from the surrounding area, and these goods had to be managed by the priests and their helpers at Kawa`ewa`e. It was a thriving mini-community of its own within the `ili of Kawa`ewa`e. Therefore, the location, prominence and connection with other major sites, and the historical record of Olopana’s presence, tell me that the heiau was not limited to the rock lined walls atop the ridge of Kawa`ewa`e, but had to contain an entire complex of associated structures and dwellings that housed and accommodated all who would be needed for a heiau of this prominence.

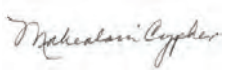
6. Mango trees: I still maintain that the mango trees were chosen by some kahuna to mark important religious sites. This occurred after the heiau were torn down or burned by the Priest Hewahewa following the breaking of the kapu system. Your recollection of what I told you – my “mango tree theory” – is a very good rendering – mahalo. It’s not just the planting of the trees that was interesting; but how the trees were planted, often in a circle around what may have been the piko, or center of mana in that heiau. I recall in the mid-1980s, I took a group of kupuna (elders) from Kane`ohe to see Kukuiokane Heiau. We stood in the fern-covered open center of a grove of large old mango trees that seemed to have been planted in this oval orientation, down the slope of Punalu`u mauka (some say it was `ili Kihapa`i). After our pule (prayers) were said, the kupuna stood quietly, observant and calm. Later, they told me they felt the mana of the heiau was strongest here, in the piko, in the center of this circular grove of ancient mango trees. Although the mango is an alien species here on O`ahu, its appearance here a few short years after the heiau were destroyed would have been convenient and desirable to those kahuna wishing to mark their sacred sites with a tree that they were told would survive for a very long time.

7. Recommendation: It is my recommendation that the landowner consider integrating its plans with the religious significance of the area surrounding

Kawa`ewa`e Heiau's walled enclosure, ensuring that the more obvious and significant cultural properties are buffered and protected from any roadways, bulldozing or other intrusive activity. In all likelihood, there are burials in the area, probably pre-contact, and this should be addressed through other research. Although the area in modern times was used for farming and urban activities, the radius in the currently undeveloped landscape adjacent to the walled section of Kawa`ewa`e is relatively undisturbed (except from dirt-bikers and others) and was probably kept that way for a good reason. I request to be further consulted, should you proceed with additional research for the current or expanded project area.

Again, thank you for this opportunity to offer comment.

Malamapono,



MAHEALANI CYPHER

Cultural Interpreter

A.3 September 11, 2007 letter from Mahealani Cypher

K. Traffic Impact Study

(Perazim Consulting, LLC)

LINDA LINGLE
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IN REPLY REFER TO:

HWY-PS
2.9209

September 18, 2008

Mr. Jay Morford
Hawaiian Memorial Life Plan, Ltd.
130 Maunakea Street
Honolulu, Hawaii 96813

Dear Mr. Morford:

Subject: Hawaiian Memorial Park Cemetery Expansion

The proposed expansion—grave sites and residential—is not anticipated to have a significant impact on our State highway facilities. However, we request that the Hawaiian Memorial Park provide a traffic signal warrant study for our Highways Traffic Branch. The particulars for the study have already begun between our Traffic Branch and the Hawaiian Memorial Park consultants.

If there are any questions regarding this letter, please contact Ken Tatsuguchi, Head Planning Engineer, Highways Division, at 587-1830. Please reference file review number 08-229 in all contacts and correspondence.

Very truly yours,

BRENNON T. MORIOKA, Ph.D., P.E.
Director of Transportation

TRAFFIC IMPACT ANALYSIS STUDY

HAWAIIAN MEMORIAL PARK EXPANSION

KANEOHE, OAHU, HAWAII

APRIL 2008

Prepared For:
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TRAFFIC IMPACT ANALYSIS STUDY

HAWAIIAN MEMORIAL PARK EXPANSION

KANEOHE, OAHU, HAWAII

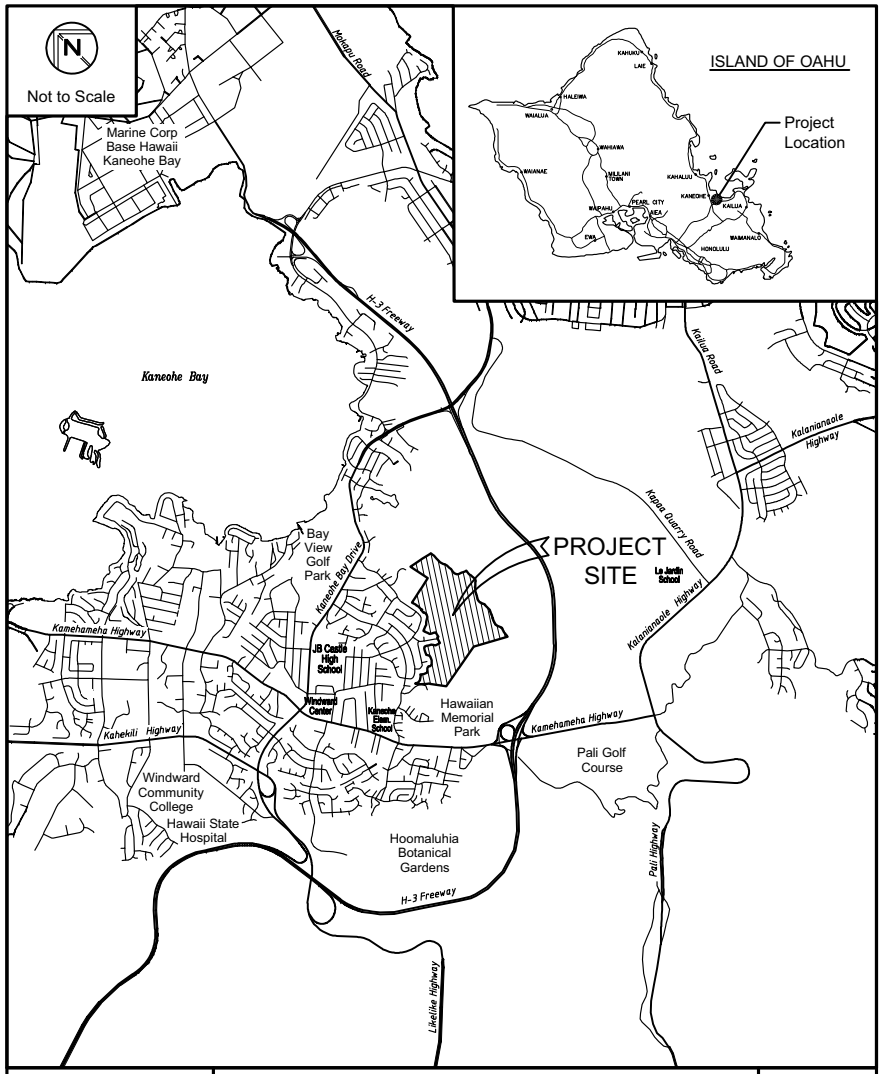
I. INTRODUCTION

This report summarizes the analysis and findings of a traffic study for three alternatives for the proposed expansion of Hawaiian Memorial Park (HMP), located in Kaneohe on the island of Oahu. This traffic study describes the potential traffic impacts of the proposed land use alternatives and identifies mitigation measures, as appropriate.

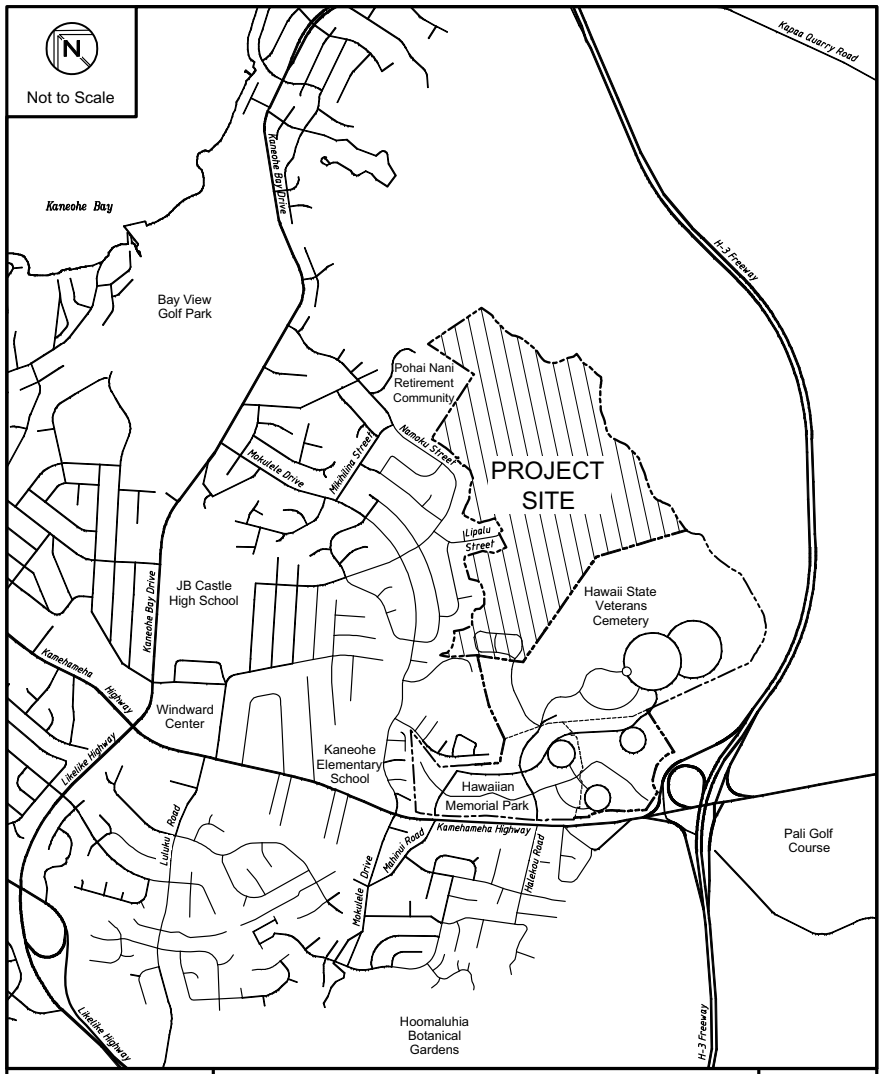
II. PROJECT DESCRIPTION

A vicinity map for the Hawaiian Memorial Park is displayed in Figure 1 and a location map is given in Figure 2. The existing Hawaiian Memorial Park contains 72.00 acres and is located at TMK 4-5-34:013 and TMK 4-5-35:008. The neighboring Hawaii State Veterans Cemetery of 122.50 acres is designated as TMK: 4-5-33:002. The Hawaiian Memorial Park and Hawaii State Veterans Cemetery currently share the same driveway connections at the Kamehameha Highway intersection with Halekou Road and at the Kamehameha Highway intersection with Mahinui Road. The primary memorial park driveway is located across Halekou Road and secondary driveway is aligned directly across Mahinui Road

The proposed Hawaiian Memorial Park expansion area of 56.6 acres is situated within TMK 4-5-33:001. Three alternative land use scenarios, referred to as Alternative A, Alternative B, and Alternative C are analyzed in this traffic study.



PERAZIM CONSULTING, LLC	Hawaiian Memorial Park Expansion Vicinity Map	FIGURE 1

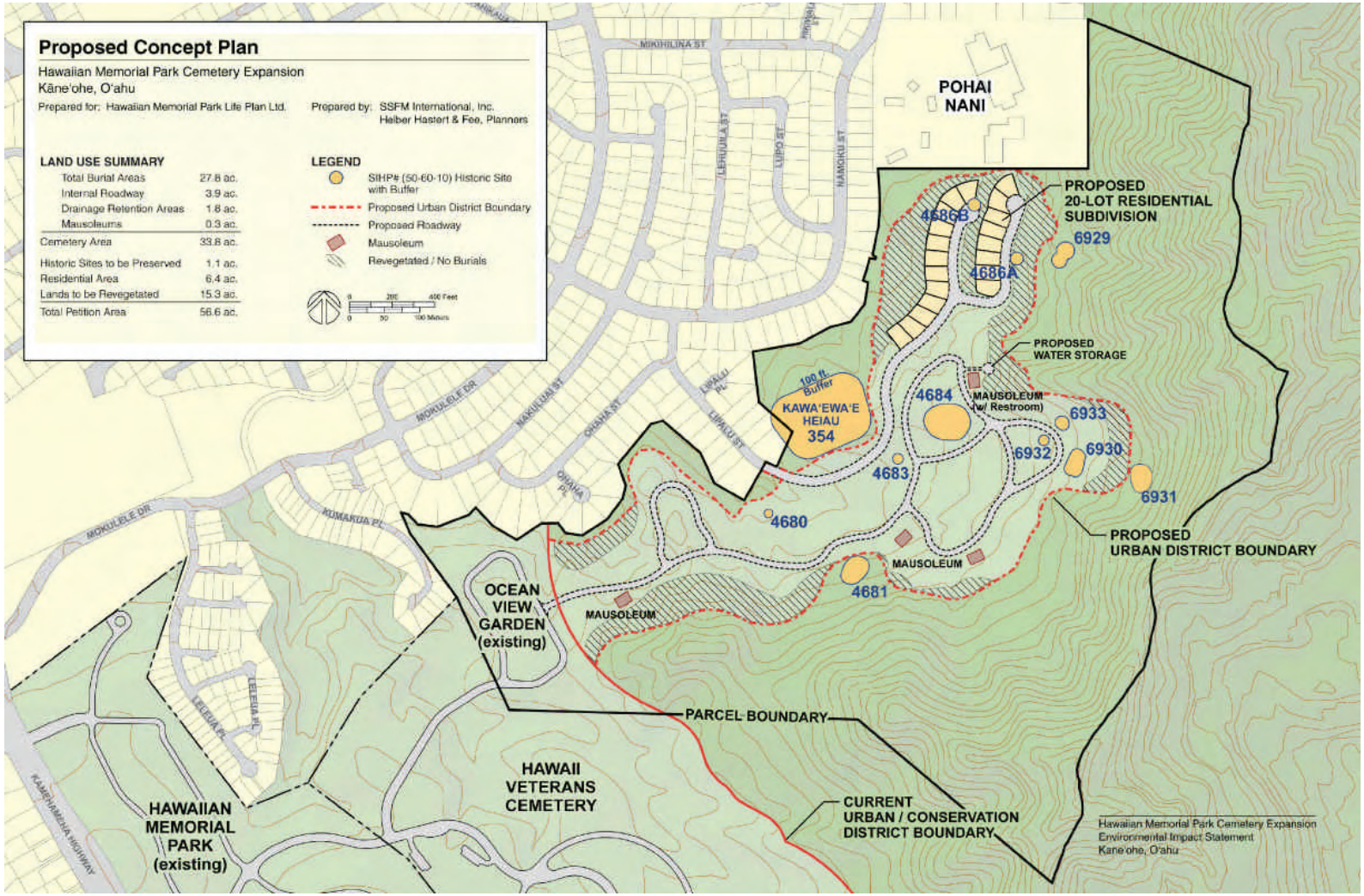


PERAZIM CONSULTING, LLC	Hawaiian Memorial Park Expansion Location Map	FIGURE 2

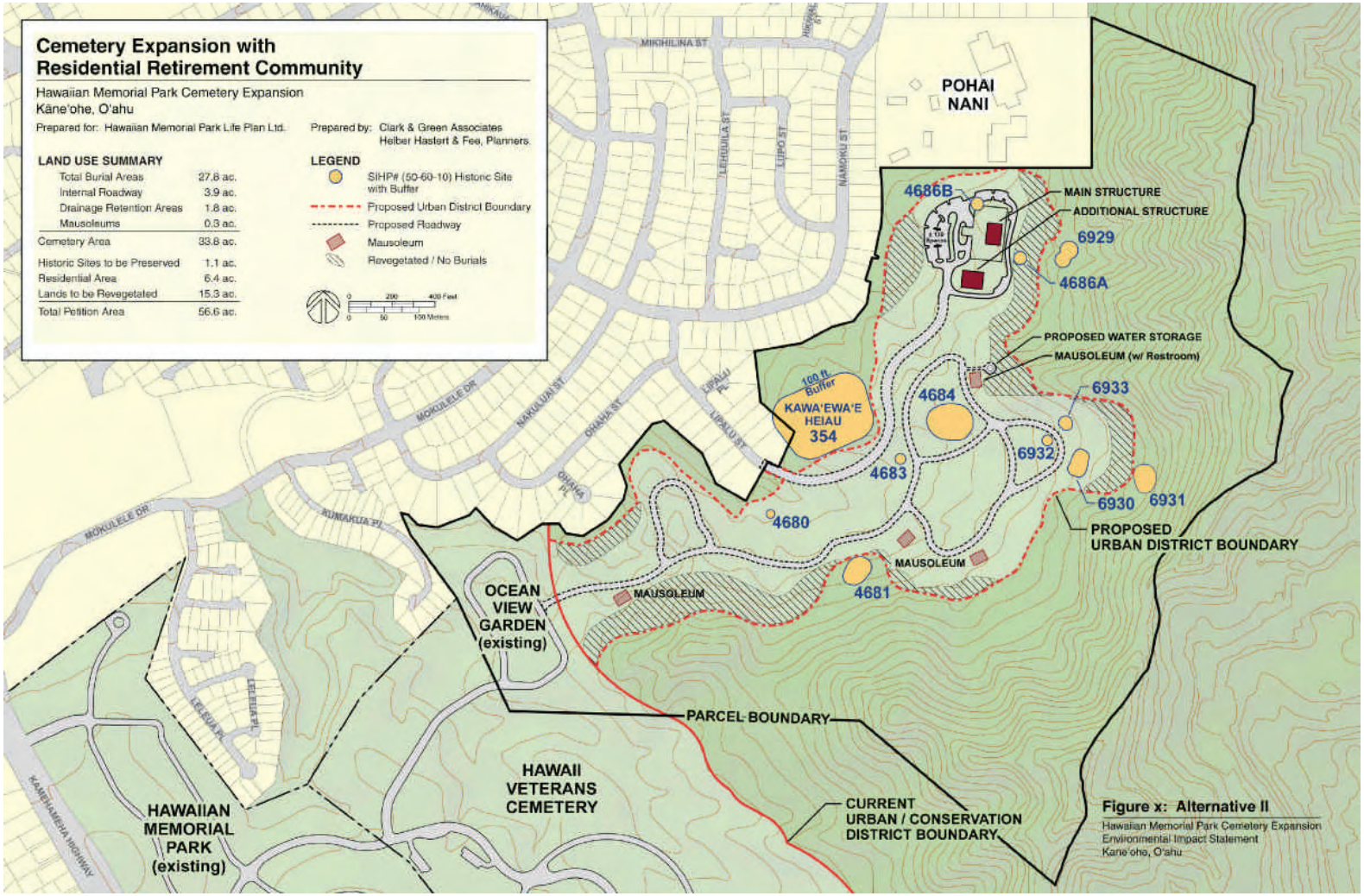
For Alternative A, the Hawaiian Memorial Park will be expanded and a residential subdivision of 20 single-family units is proposed. The residential subdivision would have access onto Lipalu Street while the memorial park expansion would utilize the two existing driveways at the Kamehameha Highway intersection with Halekou Road and at the Kamehameha Highway intersection with Mahinui Road. The Alternative A layout is depicted in Figure 3.

With Alternative B, the Hawaiian Memorial Park will be expanded and a residential retirement community would be constructed containing approximately 125 senior apartment units. Access for the new senior apartment units would be via Lipalu Street. The expanded area of the Hawaiian Memorial Park would served by the two existing Kamehameha Highway intersections at Halekou Road and at Mahinui Road. The site map for Alternative B is shown in Figure 4.

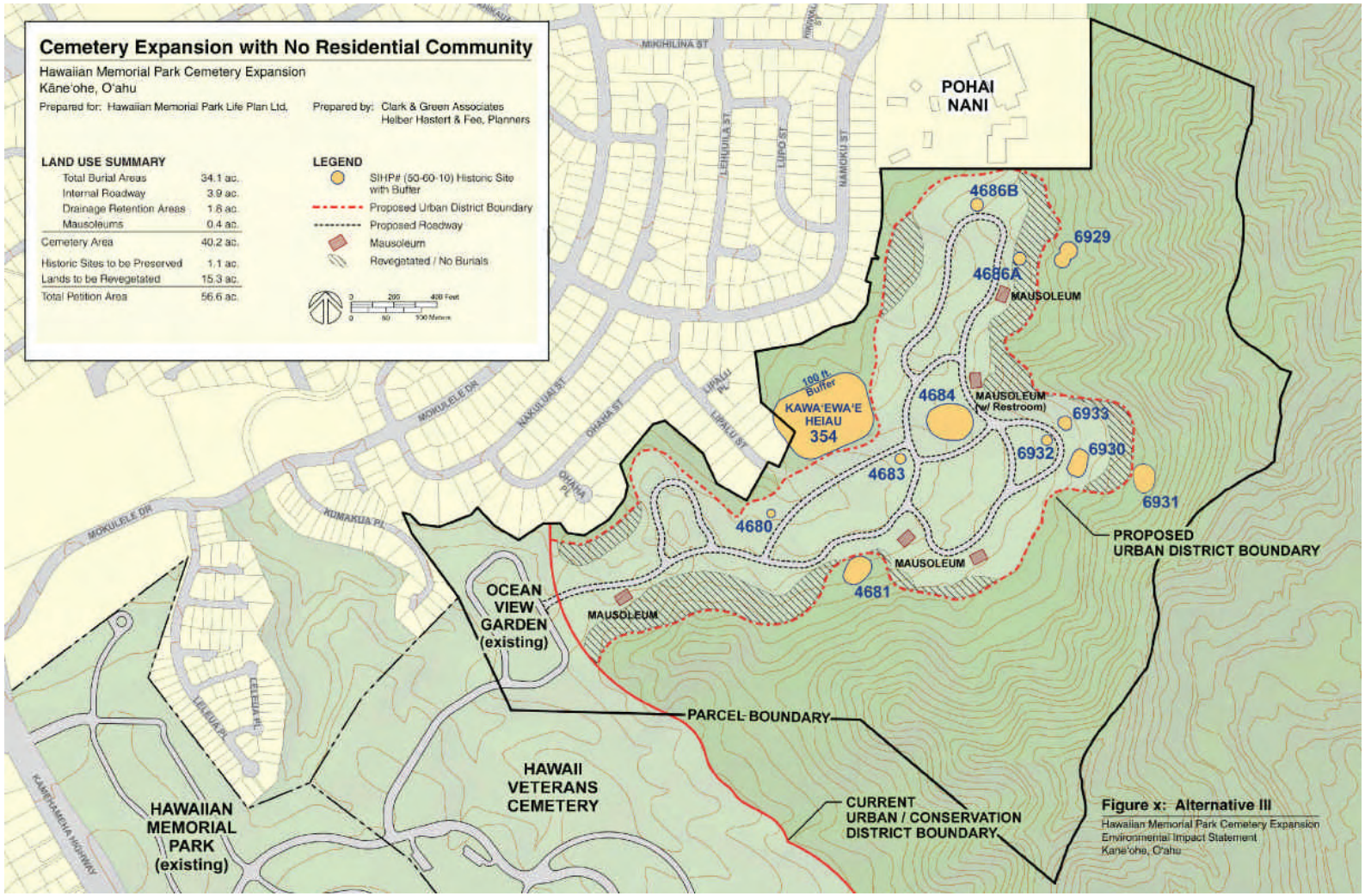
For Alternative C, the Hawaiian Memorial Park cemetery would be expanded. There would be no residential component. Access to the expanded cemetery area would be through the primary driveway at the Kamehameha Highway intersection with Halekou Road and the secondary driveway the Kamehameha Highway intersection at Mahinui Road. The site plan for Alternative C is given in Figure 5.



PERAZIM CONSULTING, LLC	ALTERNATIVE A SITE PLAN HAWAIIAN MEMORIAL PARK EXPANSION AND RESIDENTIAL SUBDIVISION	FIGURE 3



PERAZIM CONSULTING, LLC	ALTERNATIVE B SITE PLAN HAWAIIAN MEMORIAL PARK EXPANSION WITH RESIDENTIAL RETIREMENT COMMUNITY	FIGURE 4



PERAZIM CONSULTING, LLC	ALTERNATIVE C SITE PLAN HAWAIIAN MEMORIAL PARK EXPANSION WITH NO RESIDENTIAL COMMUNITY	FIGURE 5

III. STUDY METHODOLOGY

Various types of traffic information, including roadway laneage and traffic volume data, are collected to establish existing traffic conditions. Future traffic forecasts without the proposed alternatives are developed to identify future baseline conditions. Project traffic volumes are estimated and the future traffic assignments with Alternative A, Alterative B and Alternative C are analyzed. The analytical comparison of future traffic conditions with and without Alternatives A, B and C determines the project-related traffic impacts. Traffic mitigation measures are identified as needed.

IV. EXISTING TRAFFIC CONDITIONS

The analysis of existing traffic conditions establishes the current traffic operating conditions for the traffic study. Existing data, such as roadway geometrics, traffic volume data, current traffic signal phasing and timing, intersection laneage and signage are collected for this analysis.

The existing Hawaiian Memorial Park site shares two driveways with the neighboring Hawaii State Veterans Cemetery. The site is bordered by existing residential subdivisions to the northwest, Kamehameha Highway to the southwest, H-3 Freeway to the south and hilly terrain on the eastern side of the property.

A. Existing Roadway System

Kamehameha Highway is a State highway that links the Kaneohe area with the communities along the northeast coast of Oahu and into Central Oahu, Pearl City and Honolulu. In vicinity of the project, Kamehameha Highway is a divided four-lane highway with 12-foot travel lanes and left turn lanes within the median area at selected intersections.

Kaneohe Bay Drive links Kaneohe town and Kailua town. Kaneohe Bay Drive begins as a four-lane divided highway with 12-foot travel lanes at its connection to Likelike Highway and transitions to a two-lane undivided highway with 12-foot travel lanes between Castle High School and Nohea Place.

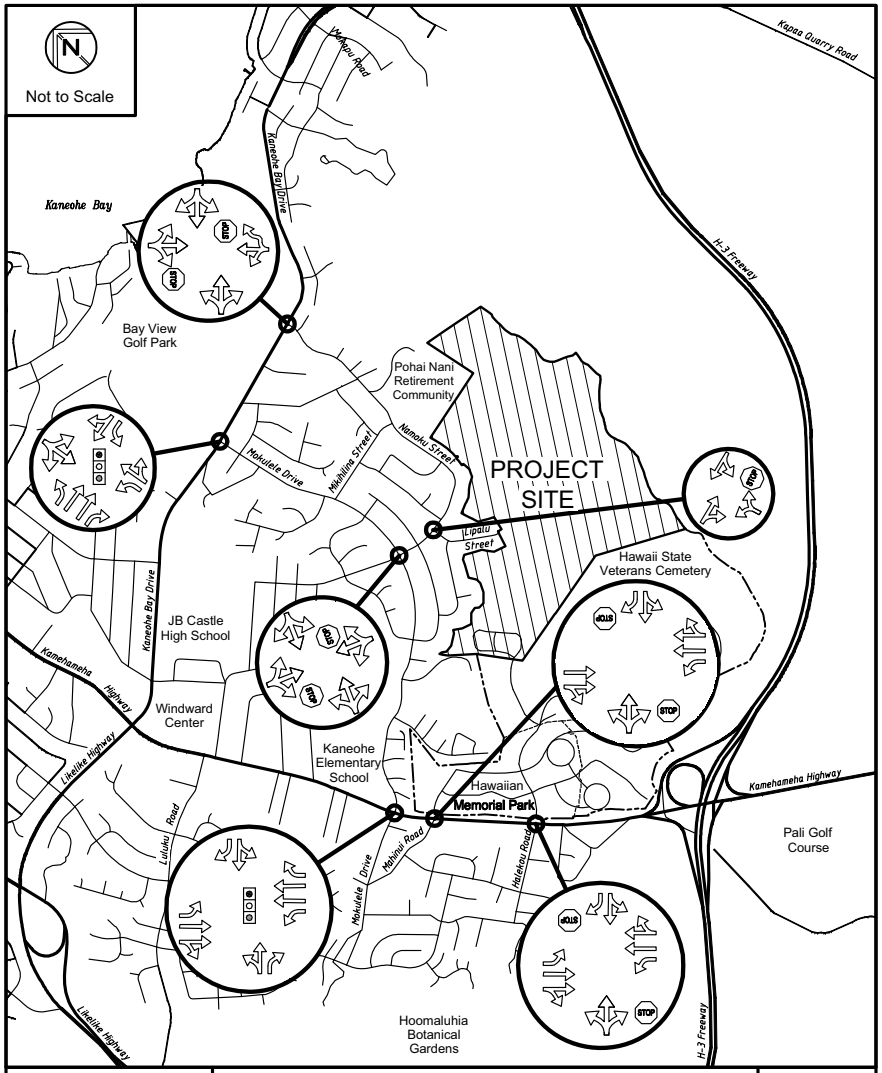
Halekou Road and Mahinui Road are two-lane collector roads for the residential subdivisions on the west side of Kamehameha Highway. Mokulele Drive, Namoku Street are collector roads while Mihikilina Street and Lipalu Street are two-lane local roadways within the residential subdivisions on the east side of Kamehameha Highway. Mokulele Driveway terminates at Kamehameha Highway and at Kaneohe Bay Drive in signalized intersections. Parking is allowed along these residential streets, but most motorists park away from the intersections which permits right turn movements to travel around other motorists waiting to execute left turn or through movements at the intersections.

For this study, seven study intersections were selected for analysis to identify the potential traffic impacts for Alternative A and Alternative B. The intersection laneage configurations are identified in Figure 6.

- Kamehameha Highway and Halekou Road
  (Alternatives A, B and C cemetery expansion primary access)
- Kamehameha Highway and Mahinui Road
  (Alternative A, B and C cemetery expansion secondary access)
- Kamehameha Highway and Mokulele Street
- Kaneohe Bay Drive and Mokulele Street
- Kaneohe Bay Drive and Namoku Street
- Mokulele Street and Namoku Street
- Namoku Street and Lipalu Street
  (Alternative A residential subdivision access and
  Alternative B residential retirement community access)

B. Traffic Counts

Manual turning movement count data and field observations were collected at the ten study intersections. The traffic counts were conducted on April 11-12 and 18-19, 2007. Weather conditions varied from sunny to cloudy and rainy, which are typical for Windward Oahu.



PERAZIM CONSULTING, LLC	Hawaiian Memorial Park Expansion Existing Intersection Configurations	FIGURE 6

The manual traffic count data is contained in Appendix A. The existing morning and afternoon peak hour traffic volumes are presented in Figure 7.

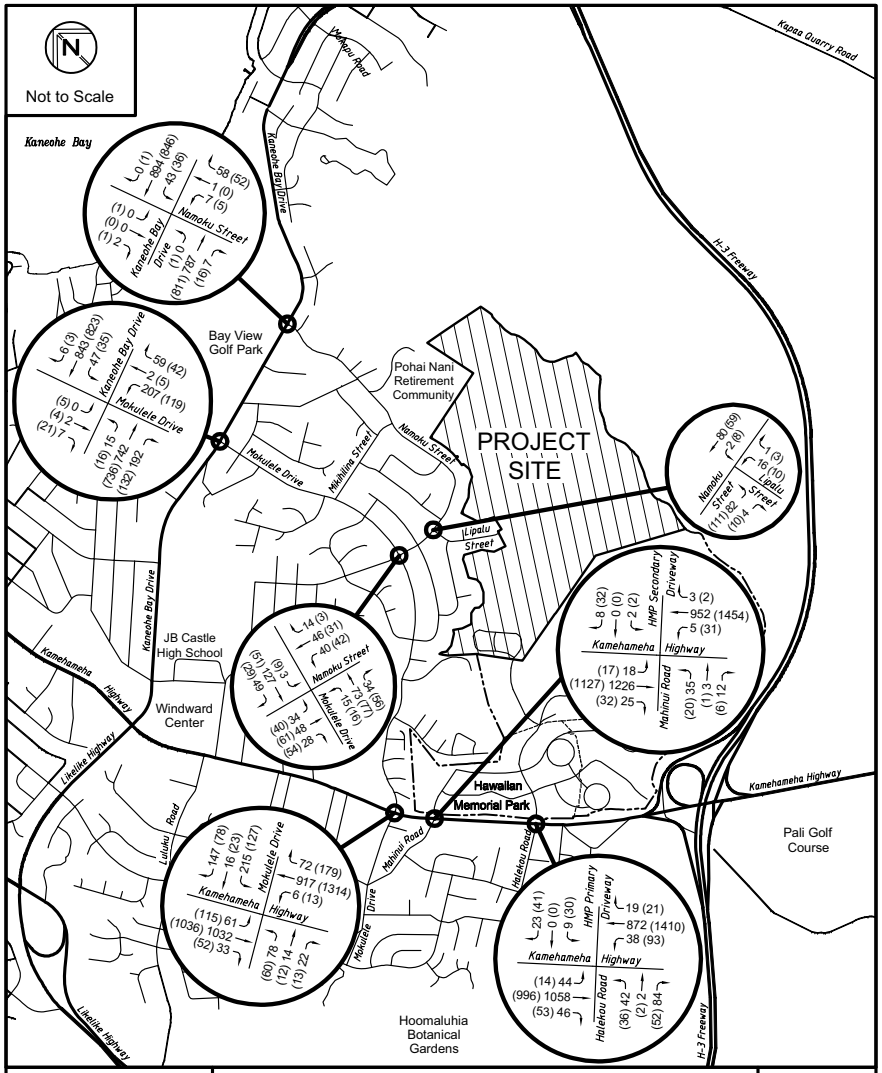
C. Analysis Results

This report utilizes the Highway Capacity Manual (HCM) 2000 analytical methodology for unsignalized intersections and signalized intersections. The analysis results provide Level of Service conditions, which are rated from A to F (best to worst), and capacity conditions. Level of Service represents a qualitative measure of traffic operating conditions and considers speed, travel time, freedom to maneuver, types of traffic controls and interruptions as well as driver comfort and convenience. Level of service definitions for unsignalized intersections and signalized intersections are summarized in Appendix B.

The analysis results of the five unsignalized study intersections are summarized in Table 1. The morning peak hour conditions at the unsignalized intersection of Kamehameha Highway, Halekou Road and the HMP primary driveway are at Level of Service D or better. However, the primary cemetery driveway experiences Level of Service F conditions during the afternoon peak hour.

For the unsignalized intersection of Kamehameha Highway, Mahinui Road and HMP secondary driveway, the Mahinui Road approach experiences Level of Service E conditions during the morning and afternoon peak hours. The left turn and through movements at the cemetery secondary driveways experience Level of Service E conditions during the afternoon peak hour.

The unsignalized intersection of Kaneohe Bay Drive and Namoku Street has Level of Service F conditions at the northbound left turn and through movements during the morning and afternoon peak hours. The southbound approach operates with Level of Service E conditions during the afternoon peak hour; this approach provides access for the Bay View Estates subdivision currently under construction.



PERAZIM CONSULTING, LLC

Hawaiian Memorial Park Expansion

Existing Traffic Volumes

FIGURE 7

Table 1

EXISTING TRAFFIC CONDITIONS
UNSIGNALIZED INTERSECTION ANALYSIS RESULTS

	AM Peak Hour Delay (seconds)	AM Peak Hour LOS	PM Peak Hour Delay (seconds)	PM Peak Hour LOS
Kamehameha Highway, Halekou Road and HMP Primary Driveway				
Kamehameha Highway				
Northbound Left Turn	11.1	B	11.4	B
Southbound Left Turn	10.0	B	12.9	B
Halekou Road				
Eastbound Approach	30.7	D	34.8	D
HMP Primary Driveway				
Westbound Approach	16.7	C	44.6	E
Westbound Left Turn/Through Movement	29.7	D	84.1	F
Westbound Right Turn	11.6	C	15.7	C
Kamehameha Highway, Mahinui Road and HMP Secondary Driveway				
Kamehameha Highway				
Northbound Left Turn	11.6	B	11.3	B
Southbound Left Turn	10.2	B	13.1	B
Mahinui Road				
Eastbound Approach	36.8	E	36.0	E
HMP Secondary Driveway				
Westbound Approach	14.5	B	17.4	C
Westbound Left Turn/Through Movement	25.6	B	44.6	E
Westbound Right Turn	11.8	B	15.7	C
Kaneohe Bay Drive and Namoku Street				
Kaneohe Bay Drive				
Eastbound Left Turn	9.7	A	9.6	A
Westbound Left Turn	9.6	A	9.7	A
Namoku Street				
Northbound Approach	22.7	C	20.4	C
Northbound Left Turn/Through Movement	72.9	F	66.0	F
Northbound Right Turn	15.7	C	16.0	C
Southbound Approach	15.6	C	44.6	E
Mokulele Drive and Namoku Street				
Mokulele Drive				
Northbound Left Turn	7.6	A	7.4	A
Southbound Left Turn	7.4	A	7.5	A
Namoku Street				
Eastbound Approach	11.6	B	11.1	B
Westbound Approach	11.9	B	11.6	B
Namoku Street and Lipalu Street				
Namoku Street				
Northbound Left Turn	7.4	A	7.4	A
Lipalu Street				
Eastbound Approach	9.4	A	9.4	A

The unsignalized intersection of Mokulele Drive and Namoku Street operates with short or little delays at Level of Service A and B during the morning and afternoon peak hours.

For the unsignalized intersection of Namoku Street and Lipalu Street, there is little or no delay with Level of Service A conditions during the morning and afternoon peak hours.

The analysis results for the two signalized study intersections are presented in Table 2. For the signalized intersection of Kamehameha Highway and Mokulele Drive, the Mokulele Drive westbound left turn and through movement is at Level of Service E during the morning and afternoon peak hours. Overall, the intersection operates at Level of Service C during both peak hours

The turning movements at the intersection of Kaneohe Bay Drive and Mokulele Drive are at Level of Service D or better the morning and afternoon peak hours. Overall, this intersection is at Level of Service C.

D. Operational Observations

The wide median along Kamehameha Highway allows motorists to cross the highway in a two-step process by first crossing one direction of traffic, then utilizing the median area as a waiting area to cross or merge with traffic in the other direction. At the unsignalized intersection of Kamehameha Highway, Halekou Road and HMP primary driveway, some motorists waited for two to three minutes for each step of their crossing or merging with Kamehameha Highway traffic. Thus, motorists on the Halekou Road or HMP primary driveway approaches experienced delays at Level of Service F, longer than indicated by the analysis results. Sometimes waiting vehicles in the median area caused delays for other movements that also utilize the median area. For instance, the northbound or southbound left turn motorists on Kamehameha Highway may not be able execute their movement until the other vehicles waiting to cross the highway have completed their movement. Also, Kamehameha Highway motorists commonly drive at 40-45 miles per hour which is higher than the posted

Table 2

EXISTING TRAFFIC CONDITIONS
SIGNALIZED INTERSECTION ANALYSIS RESULTS

	AM Peak Hour			PM Peak Hour		
Intersection	v/c	Delay (seconds)	LOS	v/c	Delay (seconds)	LOS
Kamehameha Highway and Mokulele Drive						
Northbound Approach	--	19.3	B	--	21.6	C
Left Turn	0.06	44.6	D	0.12	53.1	D
Through Movement	0.60	19.6	B	0.75	22.3	C
Right Turn	0.10	14.3	B	0.22	14.0	B
Southbound Approach	--	14.9	B	--	14.9	B
Left Turn	0.24	37.1	D	0.57	52.8	D
Through Movement	0.58	13.7	B	0.52	10.9	B
Eastbound Approach	--	34.5	C	--	46.9	D
Left Turn/Through Movement	0.53	35.7	D	0.49	47.8	D
Right Turn	0.06	29.4	C	0.05	42.1	D
Westbound Approach	--	48.8	D	--	56.3	E
Left Turn/Through Movement	0.85	58.9	E	0.75	62.3	E
Right Turn	0.42	32.9	C	0.32	44.7	D
Overall Intersection	0.62	22.4	C	0.72	22.2	C
Kaneohe Bay Drive and Mokulele Drive						
Northbound Approach	--	44.9	D	--	36.7	D
Left Turn	0.77	48.5	D	0.50	37.7	D
Through/Right Turn	0.20	32.9	C	0.17	34.2	C
Southbound Approach	0.03	31.4	C	0.11	33.6	C
Eastbound Approach	--	16.0	B	--	25.6	C
Left Turn	0.31	50.8	D	0.17	45.4	D
Through Movement	0.74	16.9	B	0.84	27.5	C
Right Turn	0.22	9.3	A	0.17	12.8	B
Westbound Shared Approach	--	18.5	B	--	19.1	B
Left Turn	0.41	46.7	D	0.22	42.0	D
Through Movement/Right Turn	0.79	16.9	B	0.79	18.2	B
Overall Intersection	0.77	20.7	C	0.69	23.8	C

speed limit of 35 miles per hour. The close proximity to the H-3 Freeway Halekou Interchange may contribute to higher speeds as ramp traffic merges or diverges with Kamehameha Highway traffic.

There are similar long delays at the Kamehameha Highway intersection with Mahinui Road and HMP secondary driveway. Northbound or southbound left turns or some of the motorists exiting Halekou Road or the HMP secondary driveway experience long delays with Level of Service F conditions.

During the afternoon peak period, the northbound queuing from the signalized intersection of Kamehameha Highway and Mokulele Drive extended past the secondary driveway for the Hawaiian Memorial Park. Thus, most motorists that desired to execute a left turn movements used the internal cemetery road and exited at the primary driveway. Despite the long queues, the traffic on each leg cleared the Kamehameha Highway and Mokulele Drive intersection during their green phase of the traffic signal cycle.

Field observations of the operations at the intersections of Kamehameha Highway with Mokulele Drive, Kaneohe Bay Drive with Mokulele Drive, Kaneohe Bay Drive with Namoku Street, Mokulele Street with Namoku Street, and Namoku Street with Lipalu Street generally concur with the analysis results.

E. Traffic Signal Peak Hour Warrants

There are two unsignalized intersections which have existing Level of Service F conditions for left turns or through movements: Kamehameha Highway Intersection with Halekou Road/HMP primary driveway and the Kaneohe Bay Drive intersection with Namoku Street. The existing traffic volumes at these two intersections were assessed by the technical criteria for the Manual of Uniform Traffic Control Devices (MUTCD) traffic signal peak hour warrants. There is a modified peak hour warrant (70% factor) which can be used where the local community population is less than 10,000 or where speeds on the major street are above 40 miles per hour. The peak hour warrant assessment is summarized in Table 3. The morning traffic volumes at the Kamehameha Highway

Intersection with Halekou Road/HMP primary driveway meet the regular peak hour warrant; however, both morning and afternoon peak hour traffic volumes meet the technical criteria for the modified peak hour warrant. The traffic volumes at Kaneohe Bay Drive intersection with Namoku Street do not satisfy the peak hour warrant criteria.

Table 3
Existing Traffic Conditions
Peak Hour Warrant Assessment

	Regular Peak Hour Warrant		Modified Peak Hour Warrant*	
	AM	PM	AM	PM
Kamehameha Highway, Halekou Road and HMP primary driveway	Yes	No	Yes	Yes
Kaneohe Bay Drive and Namoku Street	No	No	--	--

Note: * Speeds above 40 miles per hour on the major street.

E. Mitigation Measures

The intersection of Kamehameha Highway, Halekou Road and the HMP primary driveway was further analyzed as a signalized intersection; the analysis results are given in Table 4. While some left turn movements or approaches would be at Level of Service D, the intersection would operate with overall Level of Service B conditions during the morning and afternoon peak hours. The installation of traffic signals at the Kamehameha Highway, Halekou Road and the HMP primary driveway intersection would be adequate for mitigation improvements for this intersection. The enforcement of existing Kamehameha Highway posted speed limits by police would also be helpful for Halekou Road and HMP traffic.

No mitigation measures are proposed for the Kaneohe Bay Drive intersection with Namoku Street as traffic volumes do not satisfy the peak hour warrants.

Table 4

EXISTING TRAFFIC CONDITIONS
SIGNALIZED INTERSECTION ANALYSIS RESULTS WITH MITIGATION

Intersection	AM Peak Hour v/c	AM Peak Hour Delay (seconds)	AM Peak Hour LOS	PM Peak Hour v/c	PM Peak Hour Delay (seconds)	PM Peak Hour LOS
Kamehameha Highway and Mokulele Drive						
Northbound Approach	--	19.6	B	--	14.3	B
Left Turn	0.35	47.1	D	0.32	37.8	D
Through Movement/Right Turn	0.52	18.4	B	0.65	12.8	B
Southbound Approach	--	14.0	B	--	17.2	B
Left Turn	0.15	36.4	D	0.13	45.1	D
Through Movement	0.54	13.1	B	0.57	16.8	B
Eastbound Approach	0.34	32.0	C	0.31	35.5	D
Westbound Approach	--	29.3	C	--	33.8	C
Left Turn/Through Movement	0.02	29.1	C	0.12	33.8	C
Right Turn	0.06	29.4	C	0.13	33.9	C
Overall Intersection	0.47	17.6	B	0.54	16.7	B

V. FUTURE TRAFFIC CONDITIONS WITHOUT THE PROJECT

Future baseline traffic assignments without the project were developed for Year 2011 when the proposed cemetery expansion area within the Hawaiian Memorial Park cemetery is scheduled to be opened for burials.

Research of historical traffic volume data, traffic generated by nearby projects and regional traffic forecasts was conducted to develop future Year 2011 traffic assignment without the proposed project. For the regional traffic growth, historical traffic volumes collected by the State of Hawaii Department of Transportation were reviewed. The historical traffic data indicates that Kamehameha Highway traffic volumes in the vicinity of the proposed project have been been increasing at approximately 1.4 percent per year. However, regional traffic volumes on Kaneohe Bay Drive in vicinity of the two study intersections have been declining by about 0.7 percent per year. The decrease in Kaneohe Bay Drive traffic volumes may be attributable to the deployment of Kaneohe Marine Corps troops to Iraq and Afghanistan.

For this study, a growth factor of 1.4 percent per year was applied to Kamehameha Highway to account for future increase in regional highway volumes. For Kaneohe Bay Drive, a growth factor of 0.7 percent per year was utilized with the assumption that some of the declining traffic would return in the future conditions without the project.

Nearby projects include project 27 single family residential units for the Bay View Estates project and two single family residential units on Namoku Street. Sales and construction for Bay View Estates were ongoing at the time of the traffic counts. The north leg at the intersection of Kaneohe Bay Drive and Namoku Street serves as access for this new subdivision. Two new single family homes are presently under construction on Namoku Street. The new homes have will have access onto Namoku Street and are situated about two blocks from the intersection of Kaneohe Bay Drive and Namoku Street. The single famity trip rates are identified in Table 5. The new trips for the nearby projects are shown in Table 6.

Table 5

RESIDENTIAL TRIP RATES

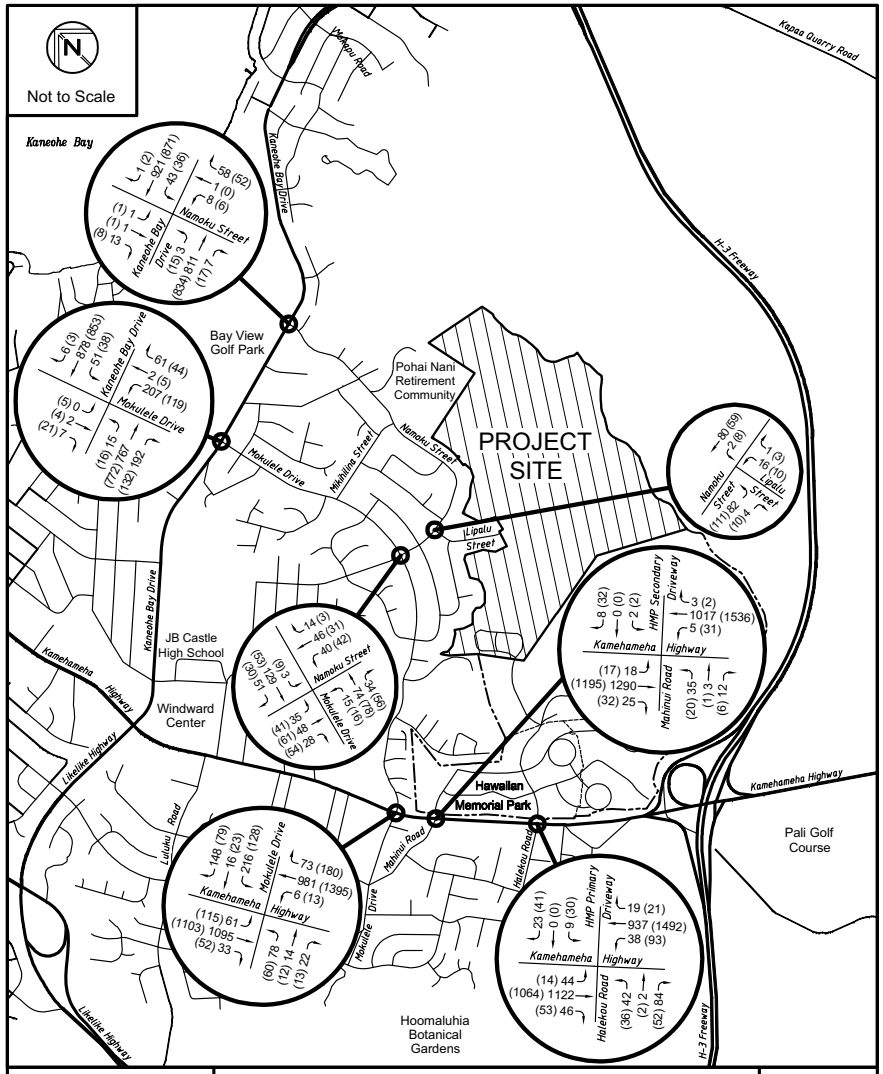
Land Use	Parameter	AM Peak Hour Enter	AM Peak Hour Exit	PM Peak Hour Enter	PM Peak Hour Exit
Residential Single Family	Dwelling Units	0.19	0.56	0.65	0.36

Table 6

TRIPS FOR NEARBY PROJECTS

	AM Peak Hour Enter	AM Peak Hour Exit	PM Peak Hour Enter	PM Peak Hour Exit
Bay View Estates				
27 single family dwelling units	5	15	17	10
Namoku Street				
2 single family dwelling units	0	1	1	1
Total	5	16	18	11

The future Year 2011 traffic assignment without the project is provided in Figure 8. Construction traffic from the Bay View Estates subdivision and two single family units on Namoku Street were deducted where field observations during the manual traffic counts identified construction traffic volumes.



PERAZIM CONSULTING, LLC

Hawaiian Memorial Park Expansion

Future Traffic Assignment Without Project

FIGURE 8

A. Analysis Results

The future traffic conditions without the project would result in slightly longer delays at the several of the study intersections. The unsignalized analysis results are provided in Table 7 while the signalized intersection analysis results are shown in Table 8.

For the Kamehameha Highway, Halekou Road and HMP primary driveway unsignalized intersection, the Halekou Road approach would drop from Level of Service D to Level of Service E during the morning and afternoon peak hours. The westbound left turn and through movements at HMP primary driveway would continue to experience Level of Service F conditions.

At the Kaneohe Bay Drive unsignalized intersection with Namoku Street, the northbound left turn/through movement would continue to operate with long delays with Level of Service F conditions.

E. Traffic Signal Peak Hour Warrants

The technical criteria for the Manual of Uniform Traffic Control Devices (MUTCD) traffic signal peak hour warrant assess the need for signalization of an intersection. Altthough the posted speed limit on Kamehameha Highway is 35 miles per hour, the modified peak hour warrant (70% factor) can be utilized as motorists commonly drive at speeds between 40 and 45 miles per hour. The peak hour warrant assessment is summarized in Table 9.

The traffic volumes at Kamehameha Highway Intersection with Halekou Road/ HMP primary driveway meet the regular peak hour warrant for the morning peak hour; this intersection also satisfies the technical criteria for the modified peak hour warrant during both morning and afternoon peak hours.

The traffic volumes at Kaneohe Bay Drive intersection with Namoku Street do not satisfy the peak hour warrant criteria.

Table 7

FUTURE TRAFFIC CONDITIONS WITHOUT PROJECT
UNSIGNALIZED INTERSECTION ANALYSIS RESULTS

	AM Peak Hour		PM Peak Hour	
	Delay (seconds)	LOS	Delay (seconds)	LOS
Kamehameha Highway, Halekou Road and HMP Primary Driveway				
Kamehameha Highway				
Northbound Left Turn	11.5	B	11.8	B
Southbound Left Turn	10.4	B	13.5	B
Halekou Road				
Eastbound Approach	35.5	E	40.0	E
HMP Primary Driveway				
Westbound Approach	17.7	C	53.1	F
Westbound Left Turn/Through Movement	32.3	D	103.1	F
Westbound Right Turn	12.0	B	16.5	C
Kamehameha Highway, Mahinui Road and HMP Secondary Driveway				
Kamehameha Highway				
Northbound Left Turn	12.0	B	11.8	B
Southbound Left Turn	10.5	B	13.8	B
Mahinui Road				
Eastbound Approach	41.2	E	39.9	E
HMP Secondary Driveway				
Westbound Approach	15.2	C	18.3	C
Westbound Left Turn/Through Movement	27.5	D	49.4	E
Westbound Right Turn	12.1	B	16.4	C
Kaneohe Bay Drive and Namoku Street				
Kaneohe Bay Drive				
Eastbound Left Turn	9.9	A	9.7	A
Westbound Left Turn	9.7	A	9.8	A
Namoku Street				
Northbound Approach	25.9	D	23.2	C
Northbound Left Turn/Through Movement	88.6	F	81.5	F
Northbound Right Turn	16.1	C	16.4	C
Southbound Approach	25.2	D	27.9	D
Mokulele Drive and Namoku Street				
Mokulele Drive				
Northbound Left Turn	7.6	A	7.4	A
Southbound Left Turn	7.4	A	7.5	A
Namoku Street				
Eastbound Approach	11.6	B	11.1	B
Westbound Approach	11.9	B	11.6	B
Namoku Street and Lipalu Street				
Namoku Street				
Northbound Left Turn	7.4	A	7.4	A
Lipalu Street				
Eastbound Approach	9.4	A	9.4	A

Table 8

FUTURE TRAFFIC CONDITIONS WITHOUT PROJECT
SIGNALIZED INTERSECTION ANALYSIS RESULTS

Intersection	AM Peak Hour v/c	AM Peak Hour Delay (seconds)	AM Peak Hour LOS	PM Peak Hour v/c	PM Peak Hour Delay (seconds)	PM Peak Hour LOS
Kamehameha Highway and Mokulele Drive						
Northbound Approach	--	20.1	C	--	23.1	C
Left Turn	0.06	44.6	D	0.12	53.1	D
Through Movement	0.64	20.3	C	0.79	24.0	C
Right Turn	0.10	14.3	B	0.23	14.0	B
Southbound Approach	--	15.4	B	--	15.1	B
Left Turn	0.24	37.1	D	0.57	52.8	D
Through Movement	0.61	14.2	B	0.55	11.3	B
Eastbound Approach	--	34.6	C	--	47.0	D
Left Turn/Through Movement	0.53	35.8	D	0.50	47.9	D
Right Turn	0.06	29.4	C	0.05	42.1	D
Westbound Approach	--	49.2	D	--	56.6	E
Left Turn/Through Movement	0.85	59.6	E	0.76	62.8	E
Right Turn	0.42	32.9	C	0.33	44.8	D
Overall Intersection	0.64	22.7	C	0.75	22.9	C
Kaneohe Bay Drive and Mokulele Drive						
Northbound Approach	--	45.5	D	--	36.7	D
Left Turn	0.77	49.4	D	0.50	37.7	D
Through/Right Turn	0.21	32.9	C	0.18	34.2	C
Southbound Approach	0.03	31.4	C	0.11	33.6	C
Eastbound Approach	--	16.8	B	--	29.9	C
Left Turn	0.31	50.9	D	0.17	45.4	D
Through Movement	0.76	18.0	B	0.89	32.5	C
Right Turn	0.22	9.3	A	0.17	12.8	B
Westbound Shared Approach	--	20.4	C	--	20.9	C
Left Turn	0.45	47.2	D	0.23	42.1	D
Through Movement/Right Turn	0.83	18.8	B	0.82	20.0	B
Overall Intersection	0.79	21.9	C	0.71	26.5	C

Table 9

Existing Traffic Conditions Without Project

Peak Hour Warrant Assessment

	Regular Peak Hour Warrant AM	Regular Peak Hour Warrant PM	Modified Peak Hour Warrant* AM	Modified Peak Hour Warrant* PM
Kamehameha Highway, Halekou Road and HMP primary driveway	Yes	No	Yes	Yes
Kaneohe Bay Drive and Namoku Street	No	No	--	--

Note: * Speeds above 40 miles per hour on the major street.

C. Mitigation Measures

For the intersection of Kamehameha Highway, Halekou Road and the HMP primary driveway, the installation of traffic signals would alleviate delays and the individual turning movements would be at Levels of Service D or better. The overall intersection would operate with Level of Service B conditions during the morning and afternoon peak hour. The analysis results are given in Table 10.

The enforcement of the posted speed limit of 35 miles per hour on Kamehameha Highway would slow highway traffic and create larger gap times for left turning and through movements on the Halekou Road and HMP primary driveway. Also, the lowering of the existing Kamehameha Highway posted speed limit of 45 miles per hour on the south side of the Halekou Interchange should be considered.

No traffic improvements are proposed for the intersection of Kaneohe Bay Drive and Namoku Street as this intersection does not meet the peak hour warrants criteria. Also, the northbound left turn/through movements are low and some of these motorists could utilize the signalized Kaneohe Bay Drive/Mokulele Drive intersection to turn left onto Kaneohe Bay Drive.

Table 10

FUTURE TRAFFIC CONDITIONS WITHOUT PROJECT
SIGNALIZED INTERSECTION ANALYSIS RESULTS WITH MITIGATION

Intersection	AM Peak Hour v/c	AM Peak Hour Delay (seconds)	AM Peak Hour LOS	PM Peak Hour v/c	PM Peak Hour Delay (seconds)	PM Peak Hour LOS
Kamehameha Highway and Mokulele Drive						
Northbound Approach	--	20.0	C	--	15.0	B
Left Turn	0.35	47.1	D	0.32	37.8	D
Through Movement/Right Turn	0.56	19.0	B	0.69	13.5	B
Southbound Approach	--	14.4	B	--	17.8	B
Left Turn	0.15	36.4	D	0.13	45.1	D
Through Movement	0.57	13.6	B	0.61	17.5	B
Eastbound Approach	0.34	32.0	C	0.31	35.5	D
Westbound Approach	--	29.3	C	--	33.8	C
Left Turn/Through Movement	0.02	29.1	C	0.12	33.8	C
Right Turn	0.06	29.4	C	0.13	33.9	C
Overall Intersection	0.49	17.9	B	0.57	17.2	B

VI. PROJECT TRAFFIC

For the proposed Hawaiian Memorial Park expansion, there are three proposed land use alternatives. Alternative A includes the cemetery expansion and a single family residential subdivision. Alternative B would provide senior apartments with the cemetery expansion. Alternative C cemetery expansion has no residential component. The project traffic forecasts for these three alternatives are developed through a three-step procedure of trip generation, trip distribution and traffic assignment.

A. Trip Generation

In trip generation, the estimates of project traffic volumes are typically quantified through the trip rates compiled in the informational report entitled, Trip Generation, Seventh Edition, by the Institute of Transportation Engineers (ITE). The project land uses are listed in Table 11 for each of the three alternatives.

Table 11
HAWAIIAN MEMORIAL PARK EXPANSION LAND USES

Alternative A
- 30 acres cemetery expansion
- 20 single family dwelling units

Alternative B
- 30 acres cemetery expansion
- 125 senior apartment dwelling units

Alternative C
- 34 acres cemetery expansion
- No residential uses

Although cemeteries typically have long usage periods of 40 to 50 years, overall visitor traffic generally remain stable over time because the frequency of visits by family or friends to a deceased's grave site or columbarium niche decline over

the years as family members grow older or move away. As new areas of a cemetery are opened for new burials or columbarium buildings, then visitor traffic shifts to the newer areas of the cemetery and visitor traffic slowly declines in the older areas of the cemetery. The existing HMP cemetery is at approximately 80 percent utilization which includes advance reservations for burial/niche sites. The HMP cemetery originally opened in Year 1961 with 8 acres and has expanded to 72 acres. The Hawaii State Veterans Cemetery, which opened in Year 1991 and contains 122.5 acres, is at about 10 percent utilization and does not take advance reservations.

The cemetery burial/niche occupancy rate depends upon the actual interment market demand. The overall size of a cemetery in terms of acreage serves as a better parameter to estimate visitor traffic because the utilization rate changes as the cemetery decides to open new acreage for internment usage. Thus, the total acreage in the expanded cemetery area for each alternative serves as the parameter to estimate new cemetery visitor trips for future year 2011. In actuality, the cemetery would open new acreage incrementally, based on market demand. The use of full burial acreage in this traffic study provides a conservative estimate of cemetery traffic when the new expansion area is opened.

Current HMP cemetery operations limit burial and inurnment ceremonies to mid-day time periods, typically from 9:00 a.m. to 3:00 p.m. Funerals are also restricted to similar mid-day time periods. Some funeral services are scheduled during the evenings, starting at 6:00 p.m. Thus, the cemetery activities that would draw the largest crowds are intentionally scheduled during the non-peak mid-day or evening time periods when there are lower traffic volumes and less congestion on Kamehameha Highway.

For this study, traffic volume data were collected at the two HMP driveways on Kamehameha Highway and at the Pohai Nani driveway on Namoku Street at the same time the April 2007 manual traffic counts to compare existing cemetery and retirement community traffic volumes with trips estimated with ITE rates. For the HMP, it was found that morning peak hour trips to and from the cemetery are

about four times than estimated through ITE rates. The cemetery afternoon trip rates derived from the manual traffic counts were about the same as the ITE cemetery rates. The Pohai Nani morning trip rates estimated from the manual traffic counts were about 17 percent higher than ITE trip rates, but the afternoon derived trip rates similar to ITE afternoon trip rates. The comparison of ITE and derived trip rates from the manual traffic counts is contained in Appendix C.

The significantly higher morning trip rates derived from the HMP driveway traffic counts were attributed to local residents, especially senior adults, who also use the HMP cemetery as a recreational/exercise facility. Field observations during the manual traffic counts indicate that several people walked through the cemetery roads for exercise by themselves or with dogs, especially during the morning peak periods. Some of the cemetery visitors brought their own gardening tools to tend to grave sites. The rolling terrain within HMP cemetery offers scenic views of the Koolau Mountains, Kaneohe town and Kaneohe Bay which encourages some residents to visit the cemetery for restful breaks during lunch period or at other times during the work day. In addition, some of the higher morning trips are attributable to the neighboring Hawaii State Veterans Cemetery, a public facility, which shares driveways with the HMP cemetery.

The morning trip rates derived from traffic counts for HMP as well as the derived morning and afternoon trip rates for Pohai Nani were applied in lieu of the ITE morning trip for cemetery and senior apartment land uses; the afternoon ITE trip rates for the cemetery were retained since they provided similar estimates as the trip rates derived from the manual traffic counts. The trip rates utilized for this traffic study are listed in Table 12. The estimates for project traffic volumes are Alternative A, Alternative B and Alternative C are presented in Table 13.

Table 12

PROJECT TRIP RATES

Land Use	Parameter	AM Peak Hour Enter	AM Peak Hour Exit	PM Peak Hour Enter	PM Peak Hour Exit
Cemetery*	Acreage	0.46	0.22	0.28	0.56
Residential Single Family	Dwelling Units	0.19	0.56	0.65	0.36
Residential Senior Apartments*	Dwelling Units	0.15	0.06	0.11	0.18

Note: * indicates morning trip rates derived from manual traffic counts.

Table 13

PROJECT TRIPS

	AM Peak Hour Enter	AM Peak Hour Exit	PM Peak Hour Enter	PM Peak Hour Exit
Alternative A				
30 acres cemetery expansion	14	7	8	17
20 single family dwelling units	4	11	13	7
Total	18	18	21	14
Alternative B				
30 acres cemetery expansion	14	7	8	17
125 senior apartment dwelling units	19	7	13	23
Total	33	14	21	40
Alternative C				
34 acres cemetery expansion only	16	7	10	19

B. Trip Distribution

In trip distribution, the general direction of trips traveling to and from the project site is identified. Information about existing and future travel patterns, population and employment on Oahu and the manual traffic count data at the study intersections were utilized to determine the direction of travel for external trips entering and exiting the project site. The trip distribution is provided in Table 14.

For the cemetery, the distribution of population on Oahu was used to estimate the direction of travel. Most of the population on Oahu lives on the Leeward side of the island. Yet, it is also recognized that many Windward residents would prefer Hawaiian Memorial Park because of its close proximity to their homes.

For the residential subdivision, the distribution of employment on Oahu serves as an indication for direction of travel. Most of the jobs are located in Leeward Oahu and a lower proportion of jobs are situated in Windward Oahu.

The morning trips for the retirement community would be expected to be mostly employee traffic and the direction of travel is based on Oahu population. In the afternoon, the retirement community traffic is likely to contain a mixture of employee traffic as well as retirees returning from medical appointments, shopping trips or other recreational activities located in the Kaneohe area. Thus, it is expected that a higher proportion of the afternoon retirement community trips would remain on the Windward side of Oahu.

Table 14

Project Trip Distribution

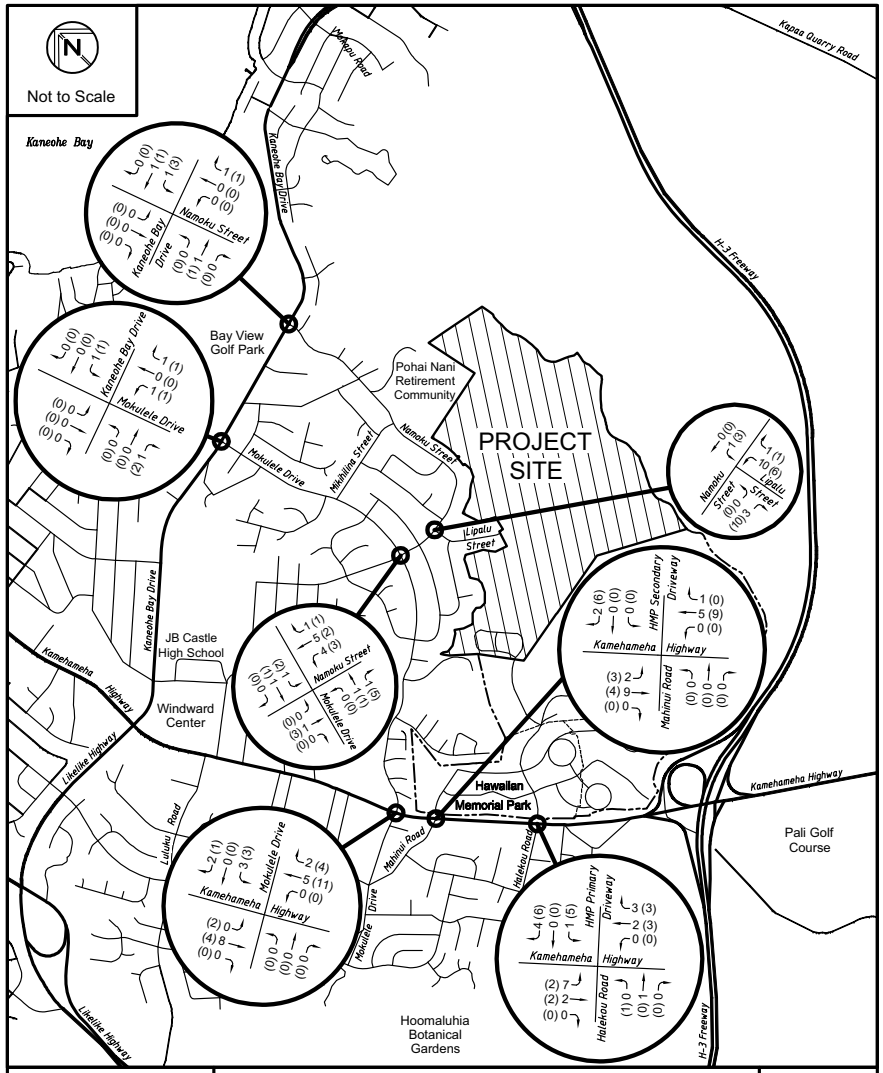
	Cemetery and Residential Subdivision	Retirement Community	
	AM and PM	AM	PM
Honolulu/Leeward Oahu-West	70%	70%	40%
Kaneohe/Mokapu/Kailua-East	10%	10%	20%
Kaneohe -North	10%	10%	30%
Kailua-Soutth	10%	10%	10%
Total	100%	100%	100%

C. Traffic Assignment

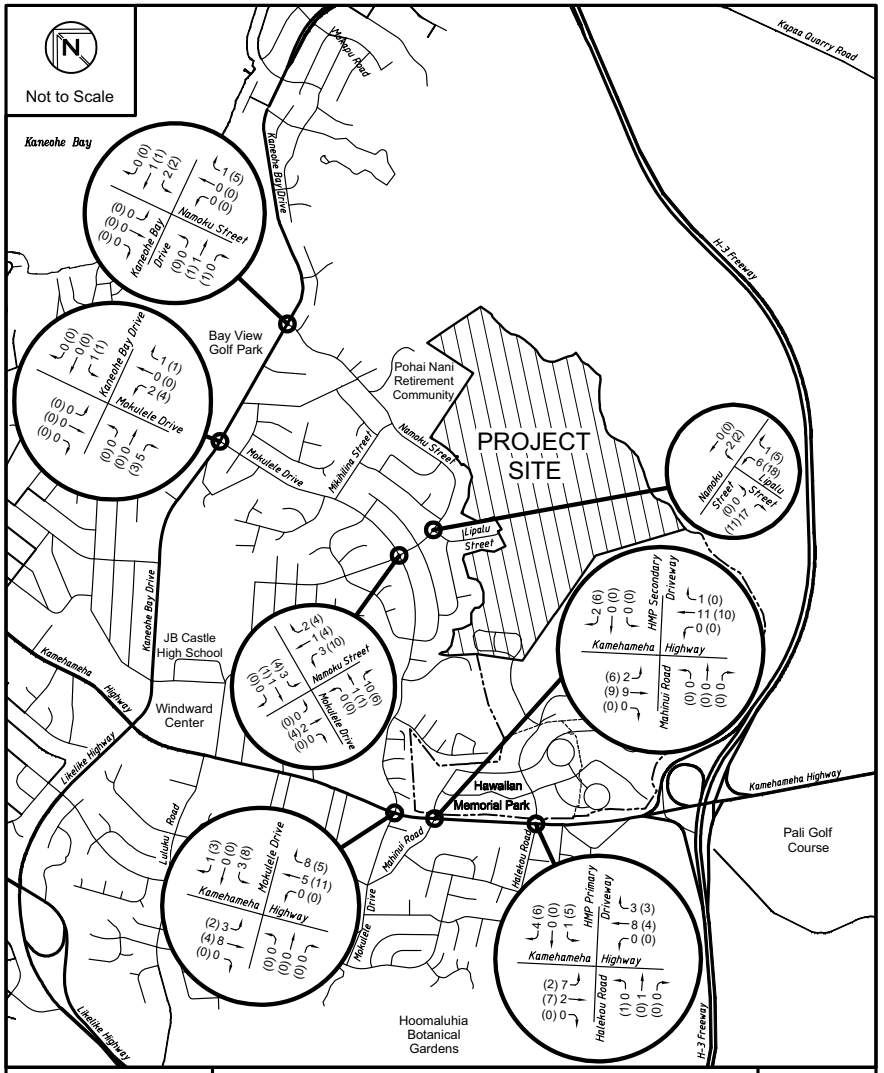
Traffic assignment defines the specific roadways that would be utilized by the project traffic as well as the proportion of project traffic volumes on each of these roadways. The trips related to the cemetery expansion component of Alternatives A, B and C must utilize HMP primary or secondary driveways at the Kamehameha Highway/Halekou Road intersection and Kamehameha Highway/Mahinui Road intersection to reach the expansion site. Vehicular access for Alternative A residential subdivision trips and the Alternative B retirement community trips will be via Lipalu Street.

Some of the parents living in the Alternative A residential subdivision are likely to drop off or pick up their children at schools on their way to and from work. Kaneohe Elementary School has a driveway on Kamehameha Highway and a rear loading area accessed via Akimala Street. Alternative A residents can travel to Akimala Street via Namoku Street and Koa Kahiko Street. King Intermediate School is located on Kamehameha Highway in the Heeia area. Castle High School is situated on Kaneohe Bay Drive and it also has a rear driveway on Namoku Street.

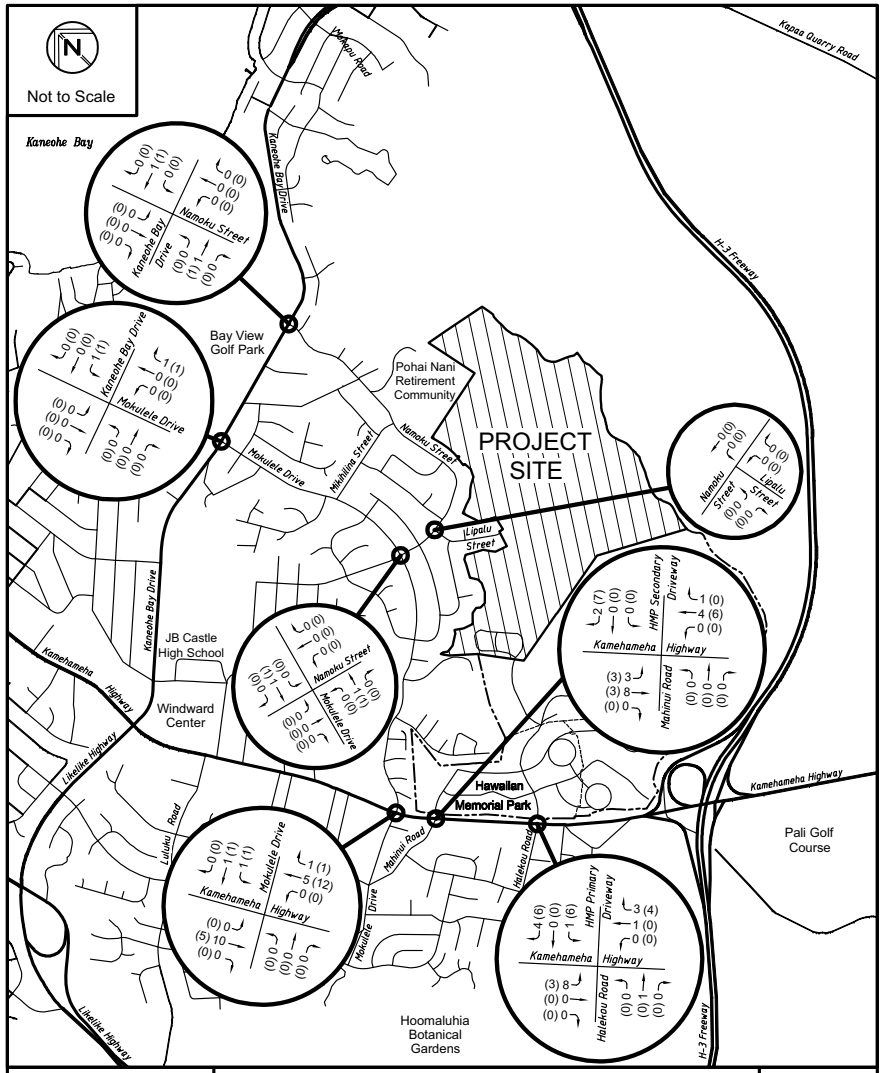
Residents traveling to work on the Leeward side of Oahu could travel via Pali Highway, Likelike Highway and the H-3 Freeway. Kaneohe residents can access the H-3 Freeway at its Halekou Interchange with Kamehameha Highway and at its Kaneohe Interchange with Likelike Highway. Trips to/from Kailua can utilize, Kaneohe Bay Drive and Pali Highway/Kalanianaole Highway. Most of the retirement community trips within in Kaneohe town would use Kamehameha Highway to reach medical offices, shopping centers or other recreational destinations.



PERAZIM CONSULTING, LLC	Alternative A Project Traffic Hawaiian Memorial Park Expansion With Residential Subdivision	FIGURE 9



PERAZIM CONSULTING, LLC	Alternative B Project Traffic Hawaiian Memorial Park Expansion With Retirement Community	FIGURE 10



PERAZIM CONSULTING, LLC	Alternative C Project Traffic Hawaiian Memorial Park Expansion With No Residential Community	FIGURE 11

VII. FUTURE TRAFFIC CONDITIONS WITH THE PROJECT

The future Year 2011 traffic forecasts with the project are developed by adding the future traffic assignment and the net project trips. The future traffic assignment with Alternative A, Alternative B and Alternative C traffic volumes are displayed in Figures 12, 13 and 14, respectively.

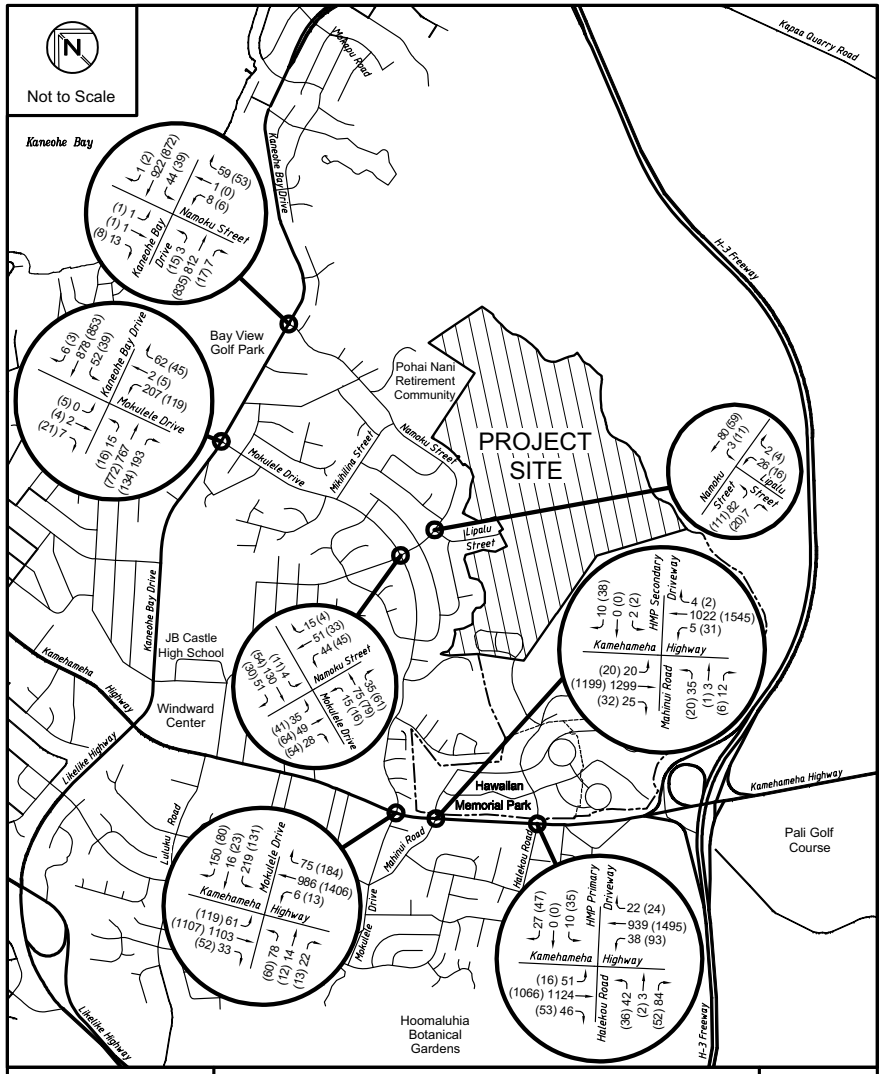
A. Analysis Results

The study intersection analysis results for future conditions with Alternative A are provided in Tables 15 and 16, Alternative B in Table 17 and 18 and Alternative C in Table 19 and 20.

The unsignalized intersection analysis results are virtually the same for Alternatives A, B and C. The Level of Service conditions for the three alternatives are also the same as the future traffic conditions without the project.

For the unsignalized intersection of Kaneohe Bay Drive and Namoku Street, the northbound left turn/through movement continues with Level of Service F conditions.

The signalized intersection analysis results for Alternative A, Alternative B and Alternative C remain the same as future traffic conditions without the project

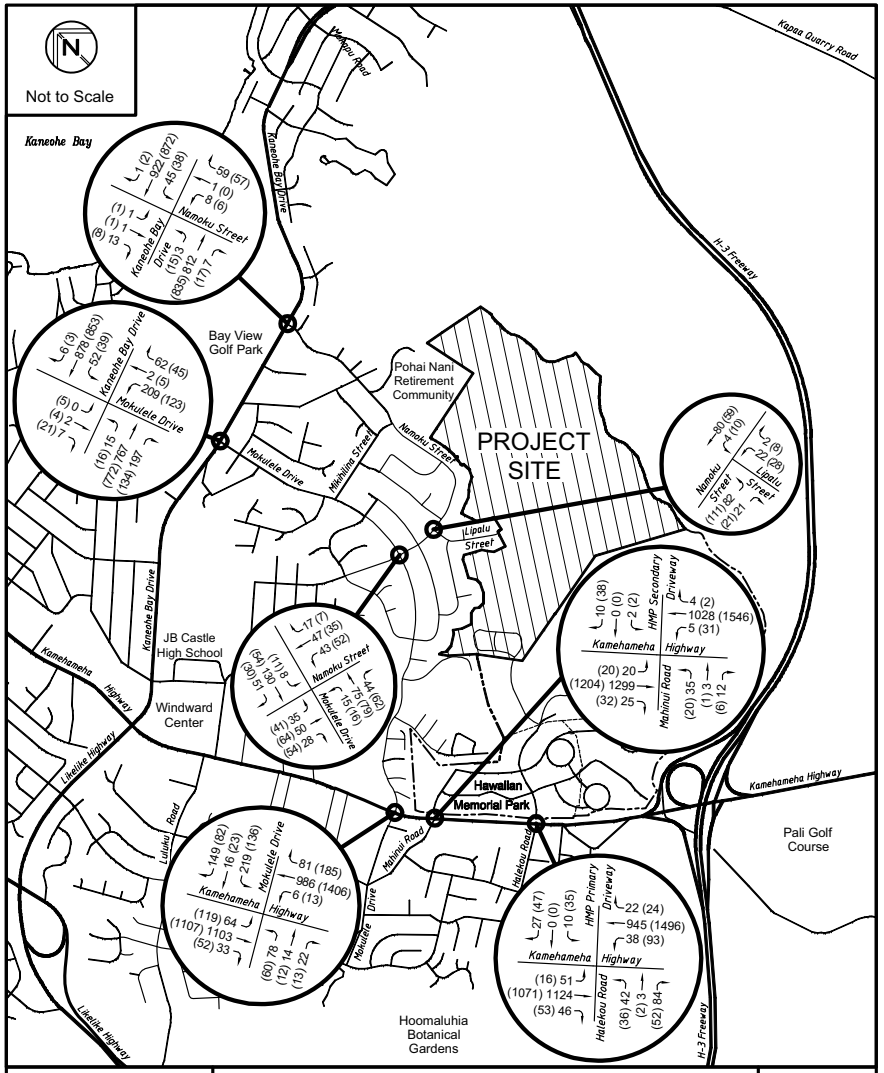


PERAZIM CONSULTING, LLC

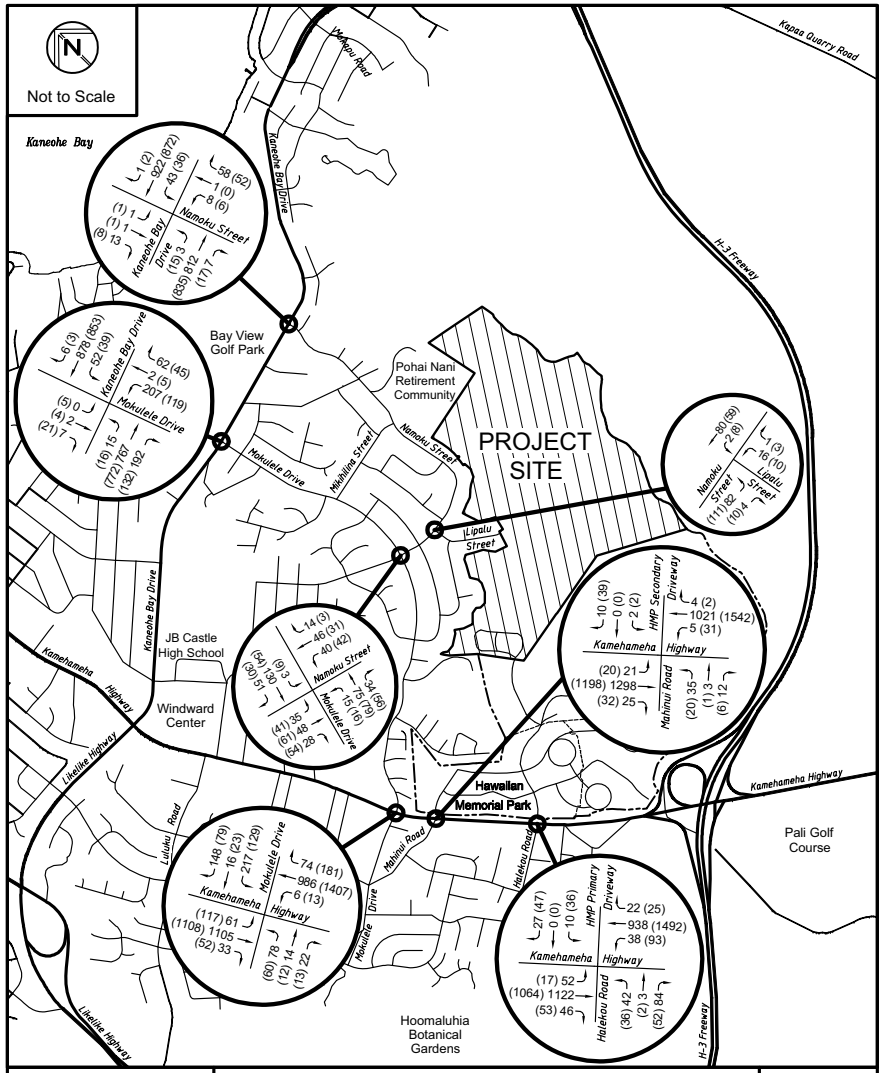
Future Traffic Assignment With Alternative A

Hawaiian Memorial Park Expansion With Residential Subdivision

FIGURE 12



PERAZIM CONSULTING, LLC	Future Traffic Assignment With Alternative B Hawaiian Memorial Park Expansion With Retirement Community	FIGURE 13



PERAZIM CONSULTING, LLC	Future Traffic Assignment With Alternative C Hawaiian Memorial Park Expansion With No Residential Community	FIGURE 14

Table 15

FUTURE TRAFFIC CONDITIONS WITH ALTERNATIVE A
HAWAIIAN MEMORIAL PARK EXPANSION WITH RESIDENTIAL SUBDIVISION

UNSIGNALIZED INTERSECTION ANALYSIS RESULTS

	AM Peak Hour		PM Peak Hour	
	Delay (seconds)	LOS	Delay (seconds)	LOS
Kamehameha Highway, Halekou Road and HMP Primary Driveway				
Kamehameha Highway				
Northbound Left Turn	11.5	B	11.8	B
Southbound Left Turn	10.4	B	13.6	B
Halekou Road				
Eastbound Approach	37.7	E	41.4	E
HMP Primary Driveway				
Westbound Approach	17.8	C	59.6	F
Westbound Left Turn/Through Movement	33.3	D	117.2	F
Westbound Right Turn	12.1	B	16.8	C
Kamehameha Highway, Mahinui Road and HMP Secondary Driveway				
Kamehameha Highway				
Northbound Left Turn	12.0	B	11.8	B
Southbound Left Turn	10.5	B	13.9	B
Mahinui Road				
Eastbound Approach	42.4	E	41.0	E
HMP Secondary Driveway				
Westbound Approach	14.8	C	18.4	C
Westbound Left Turn/Through Movement	27.8	D	50.0	E
Westbound Right Turn	12.2	B	16.7	C
Kaneohe Bay Drive and Namoku Street				
Kaneohe Bay Drive				
Eastbound Left Turn	9.9	A	9.8	A
Westbound Left Turn	9.7	A	9.8	A
Namoku Street				
Northbound Approach	25.8	D	23.3	C
Northbound Left Turn/Through Movement	88.6	F	83.2	F
Northbound Right Turn	16.2	C	16.5	C
Southbound Approach	25.2	D	28.2	D
Mokulele Drive and Namoku Street				
Mokulele Drive				
Northbound Left Turn	7.6	A	7.4	A
Southbound Left Turn	7.4	A	7.5	A
Namoku Street				
Eastbound Approach	11.7	B	11.3	B
Westbound Approach	12.1	B	11.8	B
Namoku Street and Lipalu Street				
Namoku Street				
Northbound Left Turn	7.4	A	7.5	A
Lipalu Street				
Eastbound Approach	9.5	A	9.6	A

Table 16

FUTURE TRAFFIC CONDITIONS WITH ALTERNATIVE A
HAWAIIAN MEMORIAL PARK EXPANSION WITH RESIDENTIAL SUBDIVISION

SIGNALIZED INTERSECTION ANALYSIS RESULTS

	AM Peak Hour			PM Peak Hour		
Intersection	v/c	Delay (seconds)	LOS	v/c	Delay (seconds)	LOS
Kamehameha Highway and Mokulele Drive						
Northbound Approach	--	20.1	C	--	23.3	C
Left Turn	0.06	44.6	D	0.12	53.1	D
Through Movement	0.64	20.4	C	0.80	24.2	C
Right Turn	0.11	14.3	B	0.23	14.0	B
Southbound Approach	--	15.5	B	--	15.2	B
Left Turn	0.24	37.1	D	0.58	53.5	D
Through Movement	0.62	14.3	B	0.55	11.3	B
Eastbound Approach	--	34.8	C	--	47.3	D
Left Turn/Through Movement	0.53	36.0	D	0.51	48.2	D
Right Turn	0.06	29.4	C	0.05	42.1	D
Westbound Approach	--	50.6	D	--	58.2	E
Left Turn/Through Movement	0.86	61.8	E	0.77	65.2	E
Right Turn	0.43	33.0	C	0.33	44.8	D
Overall Intersection	0.64	23.0	C	0.76	23.3	C
Kaneohe Bay Drive and Mokulele Drive						
Northbound Approach	--	45.5	D	--	36.7	D
Left Turn	0.77	49.4	D	0.50	37.7	D
Through/Right Turn	0.21	32.9	C	0.18	34.2	C
Southbound Approach	0.03	31.4	C	0.11	33.6	C
Eastbound Approach	--	16.8	B	--	28.8	C
Left Turn	0.31	50.9	D	0.17	45.4	D
Through Movement	0.76	18.0	B	0.89	31.2	C
Right Turn	0.22	9.3	A	0.18	12.8	B
Westbound Shared Approach	--	20.4	C	--	20.7	C
Left Turn	0.46	47.4	D	0.24	42.2	D
Through Movement/Right Turn	0.83	18.8	B	0.82	19.8	B
Overall Intersection	0.79	21.9	C	0.71	25.9	C

Table 17

FUTURE TRAFFIC CONDITIONS WITH ALTERNATIVE B
HAWAIIAN MEMORIAL PARK EXPANSION WITH RESIDENTIAL RETIREMENT COMMUNITY

UNSIGNALIZED INTERSECTION ANALYSIS RESULTS

	AM Peak Hour		PM Peak Hour	
	Delay (seconds)	LOS	Delay (seconds)	LOS
Kamehameha Highway, Halekou Road and HMP Primary Driveway				
Kamehameha Highway				
Northbound Left Turn	11.5	B	11.9	B
Southbound Left Turn	10.5	B	13.6	B
Halekou Road				
Eastbound Approach	37.7	E	41.8	E
HMP Primary Driveway				
Westbound Approach	17.9	C	61.1	F
Westbound Left Turn/Through Movement	33.6	D	120.6	F
Westbound Right Turn	12.1	B	16.8	C
Kamehameha Highway, Mahinui Road and HMP Secondary Driveway				
Kamehameha Highway				
Northbound Left Turn	12.0	B	11.8	B
Southbound Left Turn	10.5	B	13.9	B
Mahinui Road				
Eastbound Approach	42.4	E	41.0	E
HMP Secondary Driveway				
Westbound Approach	14.8	C	18.3	C
Westbound Left Turn/Through Movement	27.9	D	50.0	E
Westbound Right Turn	12.2	B	16.7	C
Kaneohe Bay Drive and Namoku Street				
Kaneohe Bay Drive				
Eastbound Left Turn	9.9	A	9.8	A
Westbound Left Turn	9.7	A	9.8	A
Namoku Street				
Northbound Approach	26.1	D	23.0	C
Northbound Left Turn/Through Movement	90.6	F	83.2	F
Northbound Right Turn	16.2	C	16.6	C
Southbound Approach	25.5	D	28.2	D
Mokulele Drive and Namoku Street				
Mokulele Drive				
Northbound Left Turn	7.6	A	7.4	A
Southbound Left Turn	7.4	A	7.5	A
Namoku Street				
Eastbound Approach	11.9	B	11.3	B
Westbound Approach	12.2	B	11.9	B
Namoku Street and Lipalu Street				
Namoku Street				
Northbound Left Turn	7.4	A	7.5	A
Lipalu Street				
Eastbound Approach	9.5	A	9.6	A

Table 18

FUTURE TRAFFIC CONDITIONS WITH ALTERNATIVE B
HAWAIIAN MEMORIAL PARK EXPANSION WITH RESIDENTIAL RETIREMENT COMMUNITY

SIGNALIZED INTERSECTION ANALYSIS RESULTS

	AM Peak Hour			PM Peak Hour		
Intersection	v/c	Delay (seconds)	LOS	v/c	Delay (seconds)	LOS
Kamehameha Highway and Mokulele Drive						
Northbound Approach	--	20.1	C	--	23.3	C
Left Turn	0.06	44.6	D	0.12	53.1	D
Through Movement	0.64	20.4	C	0.80	24.2	C
Right Turn	0.12	14.4	B	0.23	14.1	B
Southbound Approach	--	15.5	B	--	15.2	B
Left Turn	0.25	37.2	D	0.58	53.5	D
Through Movement	0.62	14.3	B	0.55	11.3	B
Eastbound Approach	--	34.8	C	--	47.8	D
Left Turn/Through Movement	0.53	36.0	D	0.52	48.8	D
Right Turn	0.06	29.4	C	0.05	42.1	D
Westbound Approach	--	50.6	D	--	60.6	E
Left Turn/Through Movement	0.86	61.8	E	0.80	68.7	E
Right Turn	0.43	32.9	C	0.34	44.9	D
Overall Intersection	0.64	22.9	C	0.77	23.5	C
Kaneohe Bay Drive and Mokulele Drive						
Northbound Approach	--	46.1	D	--	37.0	D
Left Turn	0.77	50.1	D	0.52	38.1	D
Through/Right Turn	0.21	32.9	C	0.18	34.2	C
Southbound Approach	0.03	31.4	C	0.11	33.6	C
Eastbound Approach	--	16.7	B	--	29.9	C
Left Turn	0.31	50.9	D	0.17	45.4	D
Through Movement	0.76	18.0	B	0.89	32.5	C
Right Turn	0.23	9.4	A	0.18	12.8	B
Westbound Shared Approach	--	20.4	C	--	20.9	C
Left Turn	0.46	47.4	D	0.24	42.2	D
Through Movement/Right Turn	0.83	18.8	B	0.82	20.0	B
Overall Intersection	0.80	22.0	C	0.71	26.6	C

Table 19

FUTURE TRAFFIC CONDITIONS WITH ALTERNATIVE C
HAWAIIAN MEMORIAL PARK EXPANSION WITH RESIDENTIAL RETIREMENT COMMUNITY

UNSIGNALIZED INTERSECTION ANALYSIS RESULTS

	AM Peak Hour		PM Peak Hour	
	Delay (seconds)	LOS	Delay (seconds)	LOS
Kamehameha Highway, Halekou Road and HMP Primary Driveway				
Kamehameha Highway				
Northbound Left Turn	11.5	B	11.8	B
Southbound Left Turn	10.5	B	13.6	B
Halekou Road				
Eastbound Approach	37.9	E	41.4	E
HMP Primary Driveway				
Westbound Approach	17.8	C	63.3	F
Westbound Left Turn/Through Movement	33.3	D	124.1	F
Westbound Right Turn	12.1	B	16.7	C
Kamehameha Highway, Mahinui Road and HMP Secondary Driveway				
Kamehameha Highway				
Northbound Left Turn	12.0	B	11.8	B
Southbound Left Turn	10.5	B	13.9	B
Mahinui Road				
Eastbound Approach	42.4	E	41.0	E
HMP Secondary Driveway				
Westbound Approach	14.8	C	18.3	C
Westbound Left Turn/Through Movement	28.1	D	50.0	E
Westbound Right Turn	12.2	B	16.7	C
Kaneohe Bay Drive and Namoku Street				
Kaneohe Bay Drive				
Eastbound Left Turn	9.9	A	9.8	A
Westbound Left Turn	9.7	A	9.8	A
Namoku Street				
Northbound Approach	25.9	D	23.4	C
Northbound Left Turn/Through Movement	88.6	F	83.2	F
Northbound Right Turn	16.2	C	16.5	C
Southbound Approach	25.2	D	27.9	D
Mokulele Drive and Namoku Street				
Mokulele Drive				
Northbound Left Turn	7.6	A	7.4	A
Southbound Left Turn	7.4	A	7.5	A
Namoku Street				
Eastbound Approach	11.8	B	11.1	B
Westbound Approach	12.0	B	11.7	B
Namoku Street and Lipalu Street				
Namoku Street				
Northbound Left Turn	7.4	A	7.4	A
Lipalu Street				
Eastbound Approach	9.4	A	9.4	A

Table 20

FUTURE TRAFFIC CONDITIONS WITH ALTERNATIVE C
HAWAIIAN MEMORIAL PARK EXPANSION WITH RESIDENTIAL RETIREMENT COMMUNITY

SIGNALIZED INTERSECTION ANALYSIS RESULTS

	AM Peak Hour			PM Peak Hour		
Intersection	v/c	Delay (seconds)	LOS	v/c	Delay (seconds)	LOS
Kamehameha Highway and Mokulele Drive						
Northbound Approach	--	20.1	C	--	23.3	C
Left Turn	0.06	44.6	D	0.12	53.1	D
Through Movement	0.64	20.4	C	0.80	24.3	C
Right Turn	0.11	14.3	B	0.23	14.0	B
Southbound Approach	--	15.5	B	--	15.2	B
Left Turn	0.24	37.1	D	0.58	53.1	D
Through Movement	0.62	14.3	B	0.56	11.3	B
Eastbound Approach	--	34.7	C	--	47.1	D
Left Turn/Through Movement	0.53	35.9	D	0.50	47.9	D
Right Turn	0.06	29.4	C	0.05	42.1	D
Westbound Approach	--	49.7	D	--	57.0	E
Left Turn/Through Movement	0.85	60.3	E	0.76	63.4	E
Right Turn	0.42	32.9	C	0.33	44.8	D
Overall Intersection	0.64	22.8	C	0.76	23.1	C
Kaneohe Bay Drive and Mokulele Drive						
Northbound Approach	--	45.5	D	--	36.7	D
Left Turn	0.77	49.4	D	0.50	37.7	D
Through/Right Turn	0.21	32.9	C	0.18	34.2	C
Southbound Approach	0.03	31.4	C	0.11	33.6	C
Eastbound Approach	--	16.8	B	--	29.9	C
Left Turn	0.31	50.9	D	0.17	45.4	D
Through Movement	0.76	18.0	B	0.89	32.5	C
Right Turn	0.22	9.3	A	0.17	12.8	B
Westbound Shared Approach	--	20.4	C	--	20.9	C
Left Turn	0.46	47.4	D	0.24	42.2	D
Through Movement/Right Turn	0.83	18.8	B	0.82	20.0	B
Overall Intersection	0.79	22.0	C	0.71	26.6	C

B. Traffic Signal Peak Hour Warrants

The Manual of Uniform Traffic Control Devices (MUTCD) regular and modified traffic signal peak hour warrants assessment was undertaken for the unsignalized study intersections which have Level of Service F conditions to determine the need for signalization of the intersection. The peak hour warrant assessment is summarized in Table 21.

The Kamehameha Highway/Halekou Road/ HMP primary driveway intersection traffic volumes are adequate to meet the regular peak hour warrant for the morning peak hour; this intersection also qualifies according to the technical criteria for the modified peak hour warrant during both morning and afternoon peak hours. The traffic volumes at the intersection of Kaneohe Bay Drive and Namoku Street do not meet peak hour warrant technical criteria. This peak hour warrant assessment yields the same results as future traffic conditions without the project.

Table 21
Future Traffic Conditions With Project
Peak Hour Warrant Assessment

	Regular Peak Hour Warrant		Modified Peak Hour Warrant*	
	AM	PM	AM	PM
Kamehameha Highway, Halekou Road and HMP primary driveway	Yes	No	Yes	Yes
Kaneohe Bay Drive and Namoku Street	No	No	--	--

Note: * Speeds above 40 miles per hour on the major street.

C. Mitigation Measures

If traffic signals were installed at the intersection of Kamehameha Highway, Halekou Road and the HMP primary driveway, the turning movements at this intersection would be at Level of Service D or better. Overall, the intersection would operate with Level of Service B conditions. These analysis results apply to Alternatives A, B and C are presented in Tables 22, 23 and 24, respectively. Also, Kamehameha Highway posted speed limits should be enforced. These mitigation measures are identical to the future conditions without the project.

D. Project Traffic Percentages at Study Intersections

The percentages of the cumulative sum of existing Hawaiian Memorial Park traffic and net increase in future project traffic volumes to the total vehicles entering the intersections for the three Kamehameha Highway study intersections are provided in Table 25. The four other study intersections are located too far from the HMP driveways to identify the amount HMP traffic traveling through those intersections. The percentage of existing and future project traffic ranges between 1.4 percent and 5.1 percent. These estimated percentages attributable to HMP traffic could be utilized as the basis of fair share proportions for future traffic improvements.

The net increase in project traffic volume percentages at each study intersection is presented in Table 26 for Alternatives A, B and C. The proportion of the net increase ranges from 0.0 to 15.2 percent. The Namoku Street intersection with Lipalu Street and Mokulele Drive intersection with Namoku Street would have the highest percentages as a result of Alternative A and Alternative B because the existing traffic volumes at these two intersections are low in comparison the intersections along Kamehameha Highway and along Kaneohe Bay Drive. These percentages reflect the magnitude of changes that would be felt by residents living near these study intersections. However, turning movements at the Namoku Street/Lipalu Street intersection and Mokulele Drive/Namoku Street intersection would operate with no or little delay with Level of Service A or Level of Service B conditions.

Table 22

FUTURE TRAFFIC CONDITIONS WITH ALTERNATIVE A
HAWAIIAN MEMORIAL PARK EXPANSION WITH RESIDENTIAL SUBDIVISION

SIGNALIZED INTERSECTION ANALYSIS RESULTS WITH MITIGATION

	AM Peak Hour			PM Peak Hour		
Intersection	v/c	Delay (seconds)	LOS	v/c	Delay (seconds)	LOS
Kamehameha Highway and Mokulele Drive						
Northbound Approach	--	20.1	C	--	15.0	B
Left Turn	0.35	47.1	D	0.32	37.8	D
Through Movement/Right Turn	0.57	19.0	B	0.69	13.6	B
Southbound Approach	--	14.5	B	--	17.9	B
Left Turn	0.18	36.6	D	0.15	45.2	D
Through Movement	0.57	13.6	B	0.61	17.5	B
Eastbound Approach	0.34	32.0	C	0.31	35.5	D
Westbound Approach	--	29.4	C	--	34.0	C
Left Turn/Through Movement	0.03	29.1	C	0.14	33.9	C
Right Turn	0.07	29.4	C	0.15	34.0	C
Overall Intersection	0.49	18.0	B	0.57	17.3	B

Table 23

FUTURE TRAFFIC CONDITIONS WITH ALTERNATIVE B
HAWAIIAN MEMORIAL PARK EXPANSION WITH RESIDENTIAL RETIREMENT COMMUNITY

SIGNALIZED INTERSECTION ANALYSIS RESULTS WITH MITIGATION

	AM Peak Hour			PM Peak Hour		
Intersection	v/c	Delay (seconds)	LOS	v/c	Delay (seconds)	LOS
Kamehameha Highway and Mokulele Drive						
Northbound Approach	--	20.1	C	--	15.0	B
Left Turn	0.35	47.1	D	0.32	37.8	D
Through Movement/Right Turn	0.57	19.1	B	0.69	13.6	B
Southbound Approach	--	14.5	B	--	17.9	B
Left Turn	0.18	36.6	D	0.15	45.2	D
Through Movement	0.57	13.6	B	0.61	17.5	B
Eastbound Approach	0.34	32.0	C	0.31	35.5	D
Westbound Approach	--	29.4	C	--	34.0	C
Left Turn/Through Movement	0.03	29.1	C	0.14	33.9	C
Right Turn	0.07	29.4	C	0.15	34.0	C
Overall Intersection	0.49	18.1	B	0.57	17.3	B

Table 24

FUTURE TRAFFIC CONDITIONS WITH ALTERNATIVE C
HAWAIIAN MEMORIAL PARK EXPANSION WITH RESIDENTIAL RETIREMENT COMMUNITY

SIGNALIZED INTERSECTION ANALYSIS RESULTS WITH MITIGATION

	AM Peak Hour			PM Peak Hour		
Intersection	v/c	Delay (seconds)	LOS	v/c	Delay (seconds)	LOS
Kamehameha Highway and Mokulele Drive						
Northbound Approach	--	20.1	C	--	15.0	B
Left Turn	0.35	47.1	D	0.32	37.8	D
Through Movement/Right Turn	0.57	19.0	B	0.69	13.6	B
Southbound Approach	--	14.6	B	--	17.9	B
Left Turn	0.18	36.6	D	0.16	45.3	D
Through Movement	0.57	13.6	B	0.61	17.5	B
Eastbound Approach	0.34	32.0	C	0.31	35.5	D
Westbound Approach	--	29.4	C	--	34.0	C
Left Turn/Through Movement	0.03	29.1	C	0.14	34.0	C
Right Turn	0.07	29.4	C	0.15	34.0	C
Overall Intersection	0.49	18.0	B	0.57	17.3	B

Table 25
Hawaiian Memorial Park Expansion
Sum of Existing and Future Net Increase
Estimated Cumulative Project Traffic Percentage at Intersection

	Existing Traffic Conditions		Future Traffic Conditions without Project		Future Traffic Conditions with Alternative A		Future Traffic Conditions with Alternative B		Future Traffic Conditions with Alternative C	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Kamehameha Highway, Halekou Road and HMP Primary Driveway	4.3%	3.9%	4.1%	3.7%	4.9%	4.4%	5.1%	4.6%	4.8%	4.4%
Kamehameha Highway, Mahinui Road and HMP Secondary Driveway	1.5%	2.0%	1.4%	1.9%	2.2%	2.6%	2.4%	2.8%	2.1%	2.5%
Kamehameha Highway and Mokulele Drive	3.6%	3.4%	3.4%	3.3%	4.1%	4.0%	4.4%	4.2%	4.0%	3.9%
Kamehameha Bay Drive and Mokulele Drive	--	--	--	--	--	--	--	--	--	--
Kamehameha Bay Drive and Namoku Street	--	--	--	--	--	--	--	--	--	--
Mokulele Drive and Namoku Street	--	--	--	--	--	--	--	--	--	--
Namoku Street and Lipalu Street	--	--	--	--	--	--	--	--	--	--

Table 26
Hawaiian Memorial Park Expansion
Future Net Increase
Estimated Project Traffic Percentage at Intersection

	Future Traffic Conditions with Alternative A		Future Traffic Conditions with Alternative B		Future Traffic Conditions with Alternative C	
	AM	PM	AM	PM	AM	PM
Kamehameha Highway, Halekou Road and HMP Primary Driveway	0.8%	0.7%	1.0%	0.9%	0.8%	0.7%
Kamehameha Highway, Mahinui Road and HMP Secondary Driveway	0.8%	0.8%	1.0%	1.0%	0.7%	0.6%
Kamehameha Highway and Mokulele Drive	0.7%	0.8%	1.0%	1.0%	0.6%	0.6%
Kamehameha Bay Drive and Mokulele Drive	0.2%	0.3%	0.4%	0.4%	0.1%	0.1%
Kamehameha Bay Drive and Namoku Street	0.2%	0.3%	0.3%	0.5%	0.1%	0.1%
Mokulele Drive and Namoku Street	2.8%	3.7%	4.6%	6.1%	0.4%	0.4%
Namoku Street and Lipalu Street	7.5%	9.0%	12.3%	15.2%	0.0%	0.0%

VIII. FINDINGS AND RECOMMENDATIONS

The findings and proposed recommendations for this traffic study are listed below.

A. Existing Traffic Conditions

- Under existing traffic conditions, there are Level of Service F conditions for westbound left turn and through movements at the unsignalized intersection of Kamehameha Hghway, Halekou Road and the HMP primary driveway. The morning peak hour traffic volumes at the Kamehameha Highway, Halekou Road and the HMP primary driveway intersection meet the regular peak hour traffic signal warrant, but the afternoon peak hour traffic volumes do not satisfy the technical criteria.

- Police enforcement of the Kamehameha Highway posted speed limit of 35 miles per hour would be helpful in creating larger gap times for Halekou Road and HMP primary driveway left turn and through movements. Further study should be undertaken to determine if lowering the Kamehameha Highway posted speed limit of 45 miles per hour on the south side of the Halekou Interchange would contribute towards better motorists compliance to the posted 35 miles per hour speed limit in the vicinity of the Kamehameha Highway/Halekou Road/HMP primary driveway and Kamehameha Highway/Mahinui Road/HMP secondary driveway intersections.

- For the Kamehameha Hghway, Halekou Road and the HMP primary driveway, the modified peak hour traffic signal warrant (70 percent factor) can be utilized if Kamehameha Highway speeds continue to exceed 40 miles per hour. The morning and afternoon peak hour traffic volumes meet the modified technical criteria. If traffic signals are installed, the intersection would operate with overall Level of Service B conditions during the morning and afternoon peak hours.

- The Mahinui Road eastbound approach at the unsignalized intersection of Kamehameha Highway, Mahinui Road and the HMP secondary driveway is

at Level of Service E during the morning and afternoon peak hours. No traffic improvements are needed for the existing traffic conditions.

- The northbound left turn/through movement at the intersection of Kaneohe Bay Drive and Namoku Street has Level of Service F conditions during the morning and afternoon peak hours, but traffic volumes for this Namoku Street movement are low and do not meet the traffic signal warrant criteria. No traffic improvements are proposed for this intersection.

- The unsignalized intersections of Mokulele Drive with Namoku Street and Namoku Street with Lipalu Street operate with Level of Service B or better. Traffic improvements are not needed for the existing traffic conditions.

- The westbound left turn and through movement at the signalized intersection of Kamehameha Highway with Mokulele Drive and Kaneohe Bay Drive with Mokuele Drive experience Level of Service E conditions, but overall intersection operations are at Level of Service C. Overall, the signalized intersection of Kaneohe Bay Drive with Mokulele Drive is also at Level of Service C. Thus, no traffic improvements are proposed for these two signalized intersections.

B. Future Traffic Conditions Without Project

- The growth in the forecasted traffic volumes for the future traffic conditions without the project would slightly increase delays at the study intersections and need similar traffic improvements as the existing traffic conditions.

- The westbound left turn at the unsignalized intersection of Kamehameha Highway, Halekou Road and HMP primary driveway would continue to experience Level of Service F conditions. The morning peak hour traffic volumes meet the regular peak hour traffic signal warrant.

- Enforcement of Kamehameha Highway posted speed limit of 35 miles per hour would help create larger gap times for left turn and through movements

exiting at the Halekou Road and HMP primary driveway. Further study should be undertaken to determine if lowering the Kamehameha Highway posted speed limit of 45 miles per hour on the south side of the Halekou Interchange would contribute towards better motorist adherence to the lower 35 miles per hour speed limit posted on the north side of the interchange.

- If Kamehameha Higway operating speeds continue to exceed 40 miles per hour, then the modified peak hour traffic signal warrant can be applied to intersection of Kamehameha Highway, Halekou Road and HMP primary driveway. The technical criteria for the modified warrant is satisfied by both morning and afternoon peak hour traffic volumes. If traffic signals were installed at this intersection, then overall traffic operations would be at Level of Service B.

- The northbound left turn/through movement at the unsignalized intersection of Kaneohe Bay Drive and Namoku Street would also continue to experience Level of Service F conditions. However, the traffic volumes do not meet the regular or modified peak hour traffic signal warrants. No traffic improvements are proposed for this intersection.

- No traffic improvements would be needed at the unsignalized intersections of Kamehameha Highway/Mahinui Road/HMP secondary driveway, Mokulele Drive/Namoku Street and Namoku Street/Lipalu Street. Also, the signalized intersections of Kamehameha Highway/Mokulele Drive and Kaneohe Bay Drive/Mokulele Drive do not require traffic improvements.

C. Future Traffic Conditions With Project

- With Alternative A, the estimated new project trips onto the external roadway system would increase by 18 entering trips and 18 exiting trips during the morning peak hour period. Also, there would be an addition of 21 entering and 14 exiting project trips during the afternoon peak hour period.

- With Alternative B, new project traffic would consist of 33 entering trips and 14 exiting trips during the morning peak hour period. An increase of 21 entering project trips and 40 exiting project trips is estimated for the afternoon peak hour period.

- With Alternative C, the morning peak hour project trips would be 16 entering trips and 7 exiting trips. During the afternoon peak hour, there would be an addition of 10 entering and 19 exiting project trips on the external roadway system.

Although there are slight differences in the amount of delay in the analysis results for future traffic conditions with Alternative A, Alternative B and Alternative C, the Level of Service results are highly similar for all three alternatives. The following descriptions of the intersection analysis results and proposed traffic improvements are applicable to all three alternatives.

- For the unsignalized intersection of Kamehameha Highway, Halekou Road and the HMP primary driveway, the westbound left turn and through movement at the HMP primary driveway would be expected to operate with Level of Service F conditions. The Level of Service F delays already occur for this movement with the existing traffic conditions.

- Police enforcement of the Kamehameha Highway posted speed limit of 35 miles per hour would assist in creating larger gap times and crossing opportunities for left turn and through movements on Halekou Road and HMP primary driveway. Further study should be undertaken to determine if lowering of the existing Kamehameha Highway posted speed limit of 45 miles

per hour on the south side of Halekou Interchange would encourage better compliance to existing posted speed limit of 35 miles per hour in the vicinity of the Kamehameha Highay intersections at Halekou Road/HMP primary driveway and at Mahinui Road/HMP secondary driveway.

- If traffic signals were installed at the Kamehameha Highway intersection with Halekou Road and HMP primary driveway, the overall operations would be at Level of Service B during the morning peak hour period and afternoon peak hour period. The morning traffic volumes at this intersection satisfy the regular peak hour technical criteria. If the modified traffic signal peak hour warrant (70 percent factor) for highway speeds greater than 40 miles per hour is applied, the then morning and afternoon peak hour traffic volumes meet the modified technical criteria. Further traffic engineering warrant studies should be undertaken to better identify the need to install the traffic signal system at this intersection.

- At the Kaneohe Bay Drive and Namoku Street intersection, the northbound left turn and through movements operate with Level of Service F conditions during the morning and afternoon peak hours. The Level of Service F conditions for the northbound left turn and through movement are already experienced with the existing traffic conditions; however, there are less than ten vehicles per hour executing this movement during the morning and afternoon peak hour periods. No traffic improvements are recommended as the intersection traffic volumes do not meet the regular peak hour traffic signal warrants.

- Traffic improvements are not needed at the following locations:
  a) Mokulele Drive and Namoku Street unsignalized intersection,
  b) Namoku Street and Lipalu Street unsignalized intersection,
  c) Kamehameha Highway and Mokulele Drive signalized intersection and
  d) Kaneohe Bay and Mokulele Drive signalized intersection.

D. Project Traffic Percentages

- Cumulative sums of existing HMP traffic volumes and future net project traffic volumes can be calculated for the three Kamehameha Highway study intersections. As indicated in Table 25, the cumulative sums for existing and future HMP traffic volumes range between 1.4 percent and 5.1 percent of the total study intersection traffic volumes.

- If only future net project traffic increases with Alternative A, Alternative B or Alternative C are considered, then project traffic percentages range from 0.0 percent to 15.2 percent of the total traffic volumes at the various study intersections. The Namoku Street/Lipalu Street intersection and Mokulele Drive/Namoku Street intersection would have the higher percentages with Alternative A and Alternative B because the existing traffic volumes at these intersections are relatively low. However, these two unsignalized intersections would be expected to operate with Level of Service A and B conditions with or without the three proposed alternatives.

IX. REFERENCES

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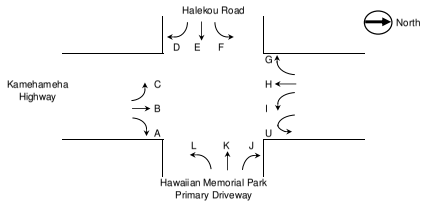
Intersection: Kamehameha Highway at Halekou Road and
Hawaiian Memorial Park Primary Driveway
Date: Thursday, April 12, 2007
Time: AM Peak Period
Counted by: YL, JH



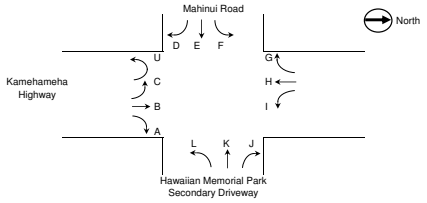
Time Period	A	B	C	D	E	F	G	H	I	U	J	K	L	Total	Hour
6:00 - 6:15 am	3	92	2	31	0	4	1	264	9	0	0	0	0	406	
6:15 - 6:30	4	107	3	37	1	2	1	289	4	0	2	1	0	451	
6:30 - 6:45	2	90	4	41	0	5	8	314	3	0	0	0	0	467	
6:45 - 7:00	2	119	7	37	0	9	6	300	3	0	6	0	2	491	1815
7:00 - 7:15	2	131	4	27	0	6	7	276	10	0	5	2	1	471	1880
7:15 - 7:30	5	214	12	21	0	12	11	276	11	0	5	0	4	571	2000
7:30 - 7:45	2	234	5	26	0	14	10	274	7	0	7	0	2	581	2114
7:45 - 8:00	5	219	9	22	1	9	14	240	17	0	3	0	2	541	2164
8:00 - 8:15	7	205	12	15	1	7	11	268	9	1	8	0	1	545	2238
8:15 - 8:30	7	198	10	17	0	8	6	242	0	1	3	1	1	494	2161
8:30 - 8:45	4	150	8	13	0	0	3	234	7	0	3	0	0	422	2002
8:45 - 9:00 am	9	193	11	23	0	7	7	193	9	0	2	1	4	459	1920
TOTAL	52	1952	87	310	3	83	85	3170	89	2	44	5	17	5493	
7:15 - 8:15 am	19	872	38	84	2	42	46	1058	44	1	23	0	9	2238	

Approach and Departure Time Period	ABC	DEF	GHIU	JKL	Hour ABC	Hour DEF	Hour GHIU	Hour JKL	AEI	BFJU	CGK	DHL	Hour AEI	Hour BFJU	Hour CGK	Hour DHL
6:00 - 6:15 am	97	35	274	0					12	96	3	295				
6:15 - 6:30	114	40	294	3					9	111	5	326				
6:30 - 6:45	96	46	325	0					5	95	12	355				
6:45 - 7:00	128	46	309	8	435	167	1202	11	5	134	13	339	31	436	33	1315
7:00 - 7:15	137	33	293	8	475	165	1221	19	12	142	13	304	31	482	43	1324
7:15 - 7:30	231	33	298	9	592	158	1225	25	16	231	23	301	38	602	61	1299
7:30 - 7:45	241	40	291	9	737	152	1191	34	9	255	15	302	42	762	64	1246
7:45 - 8:00	233	32	271	5	842	138	1153	31	23	231	23	264	60	859	74	1171
8:00 - 8:15	224	23	289	9	929	128	1149	32	17	221	23	284	65	938	84	1151
8:15 - 8:30	215	25	249	5	913	120	1100	28	7	210	17	260	56	917	78	1110
8:30 - 8:45	162	13	244	3	834	93	1053	22	11	153	11	247	58	815	74	1055
8:45 - 9:00 am	213	30	209	7	1047	123	1262	29	18	202	19	220	76	1017	93	1275
TOTAL	2091	396	3344	66					144	2079	177	3497				

APPENDIX A

MANUAL TRAFFIC COUNT DATA

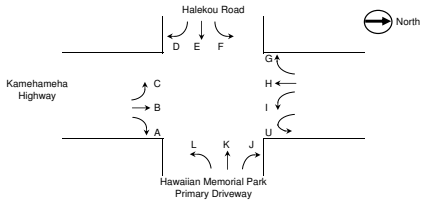
Intersection: Kamehameha Highway at Mahinui Road and Hawaiian Memorial Park Secondary Driveway
Date: Thursday, April 12, 2007
Time: AM Peak Period
Counted by: KN, JR



Time Period	A	B	C	U	D	E	F	G	H	I	J	K	L	Total	Hour
6:00 - 6:15 am	0	91	0	0	10	0	4	2	285	0	0	0	1	393	
6:15 - 6:30	0	107	3	0	7	0	6	3	291	0	0	0	0	417	
6:30 - 6:45	0	95	0	0	3	0	3	4	338	0	0	0	0	443	
6:45 - 7:00	1	139	2	1	7	0	7	1	319	2	1	0	0	480	1733
7:00 - 7:15	0	150	2	1	3	0	1	6	300	3	0	0	1	467	1807
7:15 - 7:30	0	232	2	1	7	2	7	3	319	3	1	0	0	577	1967
7:30 - 7:45	2	256	0	0	2	0	17	6	304	5	1	0	0	593	2117
7:45 - 8:00	1	238	1	0	1	0	11	10	291	2	3	0	0	558	2195
8:00 - 8:15	0	226	1	0	2	1	0	6	312	8	3	0	2	561	2289
8:15 - 8:30	0	220	4	1	0	0	4	3	241	2	3	0	0	478	2190
8:30 - 8:45	2	147	2	4	3	0	5	4	236	6	6	0	0	415	2012
8:45 - 9:00 am	0	200	1	4	1	1	12	3	208	5	4	0	3	442	1896
TOTAL	6	2101	18	12	46	4	77	51	3444	36	22	0	7	5431	
7:15 - 8:15 am	3	952	4	1	12	3	35	25	1226	18	8	0	2	2289	

Approach and Departure Time Period	ABCU	DEF	GHI	JKL	Hour ABCU	Hour DEF	Hour GHI	Hour JKL	AEI	BFJ	CGK	DHLU	Hour AEI	Hour BFJ	Hour CGK	Hour DHLU
6:00 - 6:15 am	91	14	287	1					0	95	2	296				
6:15 - 6:30	110	13	294	0					0	113	6	298				
6:30 - 6:45	95	6	342	0					0	98	4	341				
6:45 - 7:00	143	14	322	1	439	47	1245	2	3	147	3	327	3	453	15	1262
7:00 - 7:15	153	4	309	1	501	37	1267	2	3	151	8	305	6	509	21	1271
7:15 - 7:30	235	16	325	1	626	40	1298	3	5	240	5	327	11	636	20	1300
7:30 - 7:45	258	19	315	1	789	53	1271	4	7	274	6	306	18	812	22	1265
7:45 - 8:00	240	12	303	3	886	51	1252	6	3	252	11	292	18	917	30	1230
8:00 - 8:15	227	3	326	5	960	50	1269	10	9	229	7	316	24	995	29	1241
8:15 - 8:30	225	4	246	3	950	38	1190	12	2	227	7	242	21	982	31	1156
8:30 - 8:45	155	8	246	6	847	27	1121	17	8	158	6	243	22	866	31	1093
8:45 - 9:00 am	205	14	216	7	1052	41	1337	24	6	216	4	216	28	1082	35	1309
TOTAL	2125	127	3531	29					46	2200	69	3497				

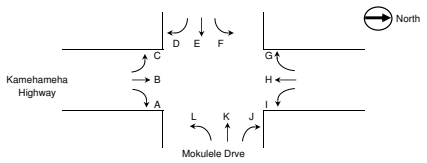
Intersection: Kamehameha Highway at Halekou Road and Hawaiian Memorial Park Primary Driveway
Date: Wednesday, April 11, 2007
Time: PM Peak Period
Counted by: YL, JH



Time Period	A	B	C	D	E	F	G	H	I	U	J	K	L	Total	Hour
3:15 - 3:30 pm	8	288	22	8	1	6	8	220	10	1	3	0	3	578	
3:30 - 3:45	9	373	27	9	0	7	5	246	5	0	27	0	7	715	
3:45 - 4:00	9	350	22	7	0	9	3	220	6	1	20	0	11	658	
4:00 - 4:15	2	344	26	9	1	7	18	250	2	0	20	0	14	693	2644
4:15 - 4:30	6	341	21	20	0	9	7	241	5	0	14	0	7	671	2737
4:30 - 4:45	3	364	22	15	0	7	14	274	2	0	2	0	4	707	2729
4:45 - 5:00	10	361	24	8	1	13	14	231	5	0	5	0	5	677	2748
5:00 - 5:15	10	338	20	15	0	9	6	230	6	0	14	0	8	656	2711
5:15 - 5:30	11	341	23	8	0	10	9	260	6	0	7	0	7	682	2722
5:30 - 5:45	14	332	33	12	0	9	8	210	3	0	3	0	3	627	2642
5:45 - 6:00	10	313	28	8	0	2	8	222	7	0	6	0	3	607	2572
6:00 - 6:15	5	280	21	8	0	2	5	178	2	0	7	1	2	511	2427
6:15 - 6:30 pm	8	280	20	5	0	3	7	210	4	3	5	1	3	549	2294
TOTAL	105	4305	309	132	3	93	112	2992	63	5	133	2	77	8331	
4:00 - 5:00 pm	21	1410	93	52	2	36	53	996	14	0	41	0	30	2748	

Approach and Departure Time Period	ABC	DEF	GHIU	JKL	Hour ABC	Hour DEF	Hour GHIU	Hour JKL	AEI	BFJU	CGK	DHL	Hour AEI	Hour BFJU	Hour CGK	Hour DHL
3:15 - 3:30 pm	318	15	239	6					19	298	30	231				
3:30 - 3:45	409	16	256	34					14	407	32	262				
3:45 - 4:00	381	16	230	31					15	380	25	238				
4:00 - 4:15	372	17	270	34	1480	64	995	105	5	371	44	273	53	1456	131	1004
4:15 - 4:30	368	29	253	21	1530	78	1009	120	11	364	28	268	45	1522	129	1041
4:30 - 4:45	389	22	290	6	1510	84	1043	92	5	373	36	293	36	1488	133	1072
4:45 - 5:00	395	22	250	10	1524	90	1063	71	16	379	38	244	37	1487	146	1078
5:00 - 5:15	368	24	242	22	1520	97	1035	59	16	361	26	253	48	1477	128	1058
5:15 - 5:30	375	18	275	14	1527	86	1057	52	17	358	32	275	54	1471	132	1065
5:30 - 5:45	379	21	221	6	1517	85	988	52	17	344	41	225	66	1442	137	997
5:45 - 6:00	351	10	237	9	1473	73	975	51	17	321	36	233	67	1384	135	986
6:00 - 6:15	306	10	185	10	1411	59	918	39	7	289	27	188	58	1312	136	921
6:15 - 6:30	308	8	224	9	1344	49	867	34	12	291	28	218	53	1245	132	864
TOTAL	4719	228	3172	212					171	4536	423	3201				

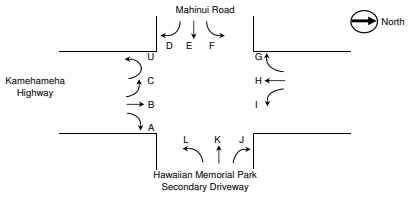
Intersection: Kamehameha Highway and Mokulele Drive
Date: Thursday, April 12, 2007
Time: AM Peak Period
Counted by: JE, JS



Time Period	A	B	C	D	E	F	G	H	I	J	K	L	Total	Hour
6:00 - 6:15 am	7	88	0	7	1	13	4	214	9	11	2	66	422	
6:15 - 6:30	6	107	0	11	1	14	4	217	6	18	3	66	453	
6:30 - 6:45	3	94	1	8	1	21	5	263	6	23	2	71	498	
6:45 - 7:00	15	130	2	14	4	21	1	240	11	26	4	68	536	1487
7:00 - 7:15	15	136	0	10	1	25	7	240	15	27	2	59	537	2024
7:15 - 7:30	20	218	2	10	4	22	9	269	18	39	6	46	663	2234
7:30 - 7:45	25	248	1	5	5	17	8	254	20	49	3	56	691	2427
7:45 - 8:00	13	238	1	4	4	20	10	235	15	33	5	64	642	2533
8:00 - 8:15	14	213	2	3	1	19	6	274	8	26	2	49	617	2613
8:15 - 8:30	12	212	3	3	3	16	11	204	8	16	3	39	530	2480
8:30 - 8:45	10	148	0	7	1	12	6	202	7	15	1	37	446	2235
8:45 - 9:00 am	13	200	3	8	2	7	10	178	11	9	3	30	474	2067
TOTAL	153	2032	15	90	28	207	81	2790	134	292	36	651	6087	
7:15 - 8:15 am	72	917	6	22	14	78	33	1032	61	147	16	215	2613	

Approach and Departure Time Period	ABC	DEF	GHI	JKL	Hour ABC	Hour DEF	Hour GHI	Hour JKL	AEI	BFJ	CGK	DHL	Hour AEI	Hour BFJ	Hour CGK	Hour DHL
5:00 - 5:15 am	95	21	227	79					17	112	6	287				
6:15 - 6:30	113	26	227	87					13	139	7	294				
6:30 - 6:45	98	30	274	96					10	138	8	342				
6:45 - 7:00	147	39	252	98	453	116	980	360	30	177	7	322	70	566	28	1245
7:00 - 7:15	151	36	262	88	509	131	1015	369	31	188	9	309	84	642	31	1267
7:15 - 7:30	240	36	296	91	636	141	1084	373	42	279	17	325	113	782	41	1298
7:30 - 7:45	274	27	282	108	812	138	1092	385	50	314	12	315	153	958	45	1271
7:45 - 8:00	252	28	260	102	917	127	1100	389	32	291	16	303	155	1072	54	1252
8:00 - 8:15	229	23	288	77	995	114	1126	378	23	258	10	326	147	1142	55	1269
8:15 - 8:30	227	22	223	58	982	100	1053	345	23	244	17	246	128	1107	55	1190
8:30 - 8:45	158	20	215	53	866	93	986	290	18	175	7	246	96	968	50	1121
8:45 - 9:00 am	216	17	199	42	830	82	925	230	26	216	16	216	90	893	50	1034
TOTAL	2200	325	3005	979					315	2531	132	3531				
7:15 - 8:15 am	995	114	1126	378					147	1142	55	1269				

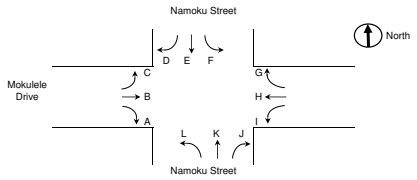
Intersection: Kamehameha Highway at Mahinui Road and
Hawaiian Memorial Park Secondary Driveway
Date: Wednesday, April 11, 2007
Time: PM Peak Period
Counted by: KN, JR



Time Period	A	B	C	U	D	E	F	G	H	I	J	K	L	Total	Hour
2:30 - 2:45 pm	0	0	0	0							0	0	0		
2:45 - 3:00	0	0	0	0							0	0	0		
3:00 - 3:15	0	0	0	0							0	0	0	0	
3:15 - 3:30	1	240	7	0	3	0	6	6	290	5	2	1	1	562	
3:30 - 3:45	1	381	4	0	1	0	5	9	272	8	4	0	2	687	
3:45 - 4:00	1	383	10	2	4	0	5	8	234	10	4	0	0	661	
4:00 - 4:15	1	365	5	1	3	0	7	13	271	9	19	0	0	694	2604
4:15 - 4:30	0	370	5	2	2	0	1	4	282	4	5	0	0	675	2717
4:30 - 4:45	1	370	6	5	0	1	6	6	316	3	5	0	0	719	2749
4:45 - 5:00	0	349	5	2	1	0	6	9	258	1	3	0	2	636	2724
5:00 - 5:15	1	358	10	2	2	1	5	8	269	9	3	0	1	669	2699
5:15 - 5:30	0	361	11	3	2	0	11	8	283	3	6	0	2	690	2714
5:30 - 5:45	1	370	6	0	1	0	3	5	235	6	1	0	1	629	2624
5:45 - 6:00	1	299	7	0	1	0	7	5	224	5	5	0	0	554	2542
6:00 - 6:15	1	281	10	4	0	0	7	5	188	2	5	0	1	504	2377
6:15 - 6:30 pm	1	283	7	3	1	0	10	9	217	0	6	0	0	537	2224
TOTAL	10	4410	93	24	21	2	79	95	3339	65	68	1	10	8217	
4:00 - 5:00 pm	2	1454	21	10	6	1	20	32	1127	17	32	0	2	2724	

Approach and Departure Time Period	ABCU	DEF	GHI	JKL	Hour ABCU	Hour DEF	Hour GHI	Hour JKL	AEI	BFJ	CGK	DHLU	Hour AEI	Hour BFJ	Hour CGK	Hour DHLU
2:30 - 2:45 pm	0	0	0	0					0	0	0	0				
2:45 - 3:00	0	0	0	0					0	0	0	0				
3:00 - 3:15	0	0	0	0					0	0	0	0				
3:15 - 3:30 pm	248	9	301	4	248	9	301	4	6	248	14	294	6	248	14	294
3:30 - 3:45	386	6	289	6	634	15	590	10	9	390	13	275	15	638	27	569
3:45 - 4:00	396	9	252	4	1030	24	842	14	11	392	18	240	26	1030	45	809
4:00 - 4:15	372	10	293	19	1402	34	1135	33	10	391	18	275	36	1421	63	1084
4:15 - 4:30	377	3	290	5	1531	28	1124	34	4	376	9	286	34	1549	58	1076
4:30 - 4:45	382	7	325	5	1527	29	1160	33	5	381	12	321	30	1540	57	1122
4:45 - 5:00	356	7	268	5	1487	27	1176	34	1	358	14	263	20	1506	53	1145
5:00 - 5:15	371	8	286	4	1486	25	1169	19	11	366	18	274	21	1481	53	1144
5:15 - 5:30	375	13	294	8	1484	35	1173	22	3	378	19	290	20	1483	63	1148
5:30 - 5:45	377	4	246	2	1479	32	1094	19	7	374	11	237	22	1476	62	1064
5:45 - 6:00	307	8	234	5	1430	33	1060	19	6	311	12	225	27	1429	60	1026
6:00 - 6:15	296	7	195	6	1355	32	969	21	3	293	15	193	19	1356	57	945
6:15 - 6:30 pm	294	11	226	6	1274	30	901	19	1	299	16	221	17	1277	54	876
TOTAL	4537	102	3499	79					77	4557	189	3394				

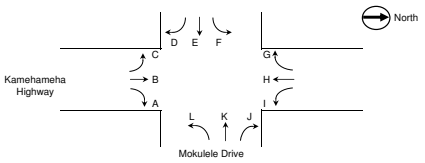
Intersection: Mokulele Drive and Namoku Street
Date: Thursday, April 19, 2007
Time: AM Peak Period
Counted by: YL



Time Period	A	B	C	D	E	F	G	H	I	J	K	L	Total	Hour
6:00 - 6:15 am	1	1	1	3	5	5	1	18	0	1	4	18	58	
6:15 - 6:30	4	2	0	2	6	0	1	19	0	0	9	12	55	
6:30 - 6:45	7	9	0	5	7	2	2	13	0	1	8	16	70	
6:45 - 7:00	6	12	3	4	9	5	4	20	1	3	15	13	95	220
7:00 - 7:15	7	18	0	10	9	2	7	20	0	1	11	8	93	313
7:15 - 7:30	5	24	4	7	9	9	16	27	0	3	14	12	130	388
7:30 - 7:45	7	13	5	10	14	11	14	40	0	7	20	10	151	469
7:45 - 8:00	13	22	4	5	14	8	13	41	2	1	6	8	137	511
8:00 - 8:15	9	14	2	6	11	6	6	19	1	3	6	10	93	511
8:15 - 8:30	14	7	0	6	8	3	3	13	2	0	5	8	69	450
8:30 - 8:45	8	14	3	7	10	3	3	10	1	1	3	10	73	372
8:45 - 9:00 am	6	9	0	3	12	1	1	13	1	0	5	6	57	292
TOTAL	87	145	22	68	114	55	71	253	8	21	106	131	1023	
7:15 - 8:15 am	34	73	15	28	48	34	49	127	3	14	46	40	511	

Approach and Departure Time Period	ABC	DEF	GHI	JKL	Hour ABC	Hour DEF	Hour GHI	Hour JKL	AEI	BFJ	CGK	DHL	Hour AEI	Hour BFJ	Hour CGK	Hour DHL
6:00 - 6:15 am	3	13	19	23					6	7	6	39				
6:15 - 6:30	6	8	20	21					10	2	10	33				
6:30 - 6:45	16	14	15	25					14	12	10	34				
6:45 - 7:00	21	18	25	31	46	53	79	100	16	20	22	37	46	41	48	143
7:00 - 7:15	25	21	27	20	68	61	87	97	16	21	18	38	56	55	60	142
7:15 - 7:30	33	25	43	29	95	78	110	105	14	36	34	46	60	89	84	155
7:30 - 7:45	25	35	54	37	104	99	149	117	21	31	39	60	67	108	113	181
7:45 - 8:00	39	27	56	15	122	108	180	101	29	31	23	54	80	119	114	198
8:00 - 8:15	25	23	26	19	122	110	179	100	21	23	14	35	85	121	110	195
8:15 - 8:30	21	17	18	13	110	102	154	84	24	10	8	27	95	95	84	176
8:30 - 8:45	25	20	14	14	110	87	114	61	19	18	9	27	93	82	54	143
8:45 - 9:00 am	15	16	15	11	125	103	129	72	19	10	6	22	112	92	60	165
TOTAL	254	237	332	258					209	221	199	452				

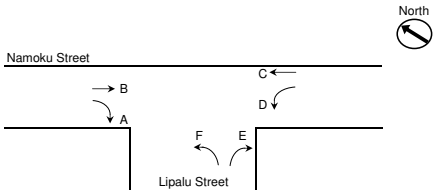
Intersection: Kamehameha Highway at Mokulele Drive
Date: Wednesday, April 11, 2007
Time: PM Peak Period
Counted by: JE, JS



Time Period	A	B	C	D	E	F	G	H	I	J	K	L	Total	Hour
3:15 - 3:30 pm	31	209	8	3	2	8	11	250	19	19	18	48	626	
3:30 - 3:45	35	353	2	1	0	15	17	247	16	23	2	41	752	
3:45 - 4:00	35	352	5	0	2	15	17	224	19	23	10	28	730	
4:00 - 4:15	60	328	3	4	4	15	15	258	32	22	6	31	778	2886
4:15 - 4:30	34	341	1	1	5	18	10	260	26	17	2	29	744	3004
4:30 - 4:45	47	332	2	5	1	13	13	287	30	13	7	33	783	3035
4:45 - 5:00	38	313	7	3	2	14	14	231	27	26	8	34	717	3022
5:00 - 5:15	46	319	1	2	4	9	20	247	21	17	4	37	727	2971
5:15 - 5:30	40	334	4	2	3	12	21	247	21	27	4	45	760	2987
5:30 - 5:45	47	323	4	3	3	8	12	213	21	20	3	30	687	2891
5:45 - 6:00	44	267	0	3	4	17	22	196	22	20	6	35	636	2810
6:00 - 6:15	45	243	5	6	3	12	13	167	25	22	8	22	571	2654
6:15 - 6:30 pm	43	253	3	5	1	14	15	186	17	21	6	35	599	2493
TOTAL	545	3967	45	38	34	170	200	3013	296	270	84	448	9110	
4:00 - 5:00 pm	179	1314	13	13	12	60	52	1036	115	78	23	127	3022	

Approach and Departure Time Period	ABC	DEF	GHI	JKL	Hour ABC	Hour DEF	Hour GHI	Hour JKL	AEI	BFJ	CGK	DHL	Hour AEI	Hour BFJ	Hour CGK	Hour DHL
3:15 - 3:30 pm	248	13	280	85					52	236	37	301				
3:30 - 3:45	390	16	280	66					51	391	21	289				
3:45 - 4:00	392	17	260	61					56	390	32	252				
4:00 - 4:15	391	23	305	59	1421	69	1125	271	96	365	24	293	255	1382	114	1135
4:15 - 4:30	376	24	296	48	1549	80	1141	234	65	376	13	290	268	1522	90	1124
4:30 - 4:45	381	19	330	53	1540	83	1191	221	78	358	22	325	295	1489	91	1160
4:45 - 5:00	358	19	272	68	1506	85	1203	228	67	353	29	268	306	1452	88	1176
5:00 - 5:15	366	15	288	58	1481	77	1186	227	71	345	25	286	281	1432	89	1169
5:15 - 5:30	378	17	289	76	1483	70	1179	255	64	373	29	294	280	1429	105	1173
5:30 - 5:45	374	14	246	53	1476	65	1095	255	71	351	19	246	273	1422	102	1094
5:45 - 6:00	311	24	240	61	1429	70	1063	248	70	304	28	234	276	1373	101	1060
6:00 - 6:15	293	21	205	52	1356	76	980	242	73	277	26	195	278	1305	102	969
6:15 - 6:30 pm	299	20	218	62	1277	79	909	228	61	288	24	226	275	1220	97	901
TOTAL	4557	242	3509	802					875	4407	329	3499				

Intersection: Namoku Street and Lipalu Street
Date: Thursday, April 19, 2007
Time: AM Peak Period
Counted by: JH

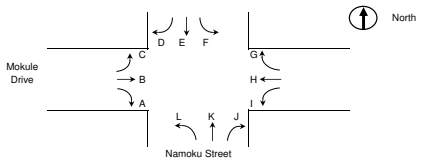


Time Period	A	B	C	D	E	F	Total	Hour
6:00 - 6:15 am	0	4	19	0	0	2	25	
6:15 - 6:30	1	5	17	1	0	4	28	
6:30 - 6:45	1	12	23	0	0	4	40	
6:45 - 7:00	0	15	19	0	0	3	37	130
7:00 - 7:15	2	14	16	0	3	1	36	141
7:15 - 7:30	1	12	22	0	1	6	42	155
7:30 - 7:45	1	21	25	1	0	7	55	170
7:45 - 8:00	1	30	15	1	0	2	49	182
8:00 - 8:15	1	19	18	0	0	1	39	185
8:15 - 8:30	4	17	13	0	0	1	35	178
8:30 - 8:45	1	15	11	0	1	1	29	152
8:45 - 9:00 am	1	16	12	0	0	1	30	133
TOTAL	14	180	210	3	5	33	445	
7:00 - 8:00 am	5	77	78	2	4	16	182	

Approach and Departure

Time Period	AB	CD	EF	Hour AB	Hour CD	Hour EF	AD	BE	CF	Hour AD	Hour BE	Hour CF
6:00 - 6:15 am	4	19	2				0	4	21			
6:15 - 6:30	6	18	4				2	5	21			
6:30 - 6:45	13	23	4				1	12	27			
6:45 - 7:00	15	19	3	38	79	13	0	15	22	3	36	91
7:00 - 7:15	16	16	4	50	76	15	2	17	17	5	49	87
7:15 - 7:30	13	22	7	57	80	18	1	13	28	4	57	94
7:30 - 7:45	22	26	7	66	83	21	2	21	32	5	66	99
7:45 - 8:00	31	16	2	82	80	20	2	30	17	7	81	94
8:00 - 8:15	20	18	1	86	82	17	1	19	19	6	83	96
8:15 - 8:30	21	13	1	94	73	11	4	17	14	9	87	82
8:30 - 8:45	16	11	2	88	58	6	1	16	12	8	82	62
8:45 - 9:00 am	17	12	1	74	54	5	1	16	13	7	68	58
TOTAL	194	213	38				17	185	243			

Intersection: Mokulele Drive at Namoku Street
Date: Wednesday, April 18, 2007
Time: PM Peak Period
Counted by: YL

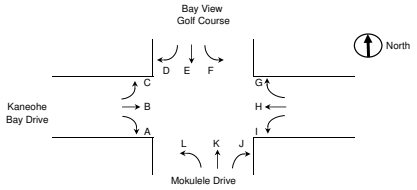


Time Period	A	B	C	D	E	F	G	H	I	J	K	L	Total	Hour
3:00 - 3:15 pm	6	15	3	7	17	3	7	14	2	3	3	11	91	
3:15 - 3:30	10	11	7	10	15	5	8	11	2	1	10	3	93	
3:30 - 3:45	12	29	7	9	13	8	12	12	0	2	10	8	122	
3:45 - 4:00	17	14	8	11	25	2	4	10	1	3	7	5	107	
4:00 - 4:15	12	27	5	14	12	17	6	17	3	1	8	14	136	458
4:15 - 4:30	10	16	3	16	16	6	7	13	1	2	8	7	105	470
4:30 - 4:45	21	16	6	15	16	8	8	11	2	0	8	13	124	472
4:45 - 5:00	13	18	2	9	17	9	8	10	3	0	7	8	104	469
5:00 - 5:15	14	17	5	7	20	11	9	11	1	3	12	12	122	455
5:15 - 5:30	16	16	4	9	13	6	10	21	2	3	9	12	121	471
5:30 - 5:45	15	17	2	14	15	12	6	15	2	1	11	8	118	465
5:45 - 6:00	14	17	4	11	12	5	6	7	1	0	9	5	91	452
6:00 - 6:15	18	19	3	15	18	14	3	9	2	1	5	5	112	442
6:15 - 6:30 pm	10	24	9	12	16	6	4	10	1	0	10	11	113	434
TOTAL	188	256	68	159	225	112	98	171	23	20	117	122	1559	
4:00 - 5:00 pm	56	77	16	54	61	40	29	51	9	3	31	42	469	

Approach and Departure

Time Period	ABC	DEF	GHI	JKL	Hour ABC	Hour DEF	Hour GHI	Hour JKL	AEI	BFJ	CGK	DHL	Hour AEI	Hour BFJ	Hour CGK	Hour DHL
3:00 - 3:15 pm	24	27	23	17					25	21	13	32				
3:15 - 3:30	28	30	21	14					27	17	25	24				
3:30 - 3:45	48	30	24	20					25	39	29	29				
3:45 - 4:00	39	38	15	15	139	125	83	66	43	19	19	26	120	96	86	111
4:00 - 4:15	44	43	26	23	159	141	86	72	27	45	19	45	122	120	92	124
4:15 - 4:30	29	38	21	17	160	149	86	75	27	24	18	36	122	127	85	136
4:30 - 4:45	43	39	21	21	155	158	83	76	39	24	22	39	136	112	78	146
4:45 - 5:00	33	35	21	15	149	155	89	76	33	27	17	27	126	120	76	147
5:00 - 5:15	36	38	21	27	141	150	84	80	35	31	26	30	134	106	83	132
5:15 - 5:30	36	28	33	24	148	140	96	87	31	25	23	42	138	107	88	138
5:30 - 5:45	34	41	23	20	139	142	98	86	32	30	19	37	131	113	85	136
5:45 - 6:00	35	28	14	14	141	135	91	85	27	22	19	23	125	108	87	132
6:00 - 6:15	40	47	14	11	145	144	84	69	38	34	11	29	128	111	72	131
6:15 - 6:30 pm	43	34	15	21	152	150	66	66	27	30	23	33	124	116	72	122
TOTAL	512	496	292	259					436	388	283	452				

Intersection: Kaneohe Bay Drive and Mokulele Drive
Date: Thursday, April 19, 2007
Time: AM Peak Period
Counted by: KN, JE



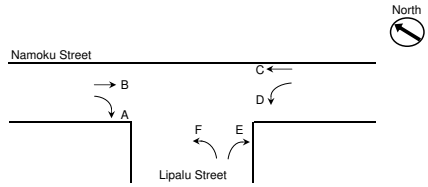
Time Period	A	B	C	D	E	F	G	H	I	J	K	L	Total	Hour
6:00 - 6:15 am	6	93	3	0	0	0	0	93	2	5	0	14	216	
6:15 - 6:30	11	101	2	0	0	0	0	109	9	5	0	26	263	
6:30 - 6:45	15	149	6	1	0	1	0	137	3	7	0	27	346	
6:45 - 7:00	26	200	0	2	0	0	1	174	3	18	3	33	460	1069
7:00 - 7:15	16	196	5	1	0	0	0	150	9	9	0	48	434	1503
7:15 - 7:30	31	214	4	2	1	0	0	213	10	16	0	38	529	1769
7:30 - 7:45	55	180	4	1	1	0	1	222	14	10	0	70	558	1981
7:45 - 8:00	80	159	4	2	0	0	2	212	19	21	1	63	563	2084
8:00 - 8:15	26	189	3	2	0	0	3	196	4	12	1	36	472	2122
8:15 - 8:30	17	146	4	0	0	0	0	34	0	8	1	20	230	1823
8:30 - 8:45	12	126	4	0	0	0	0	0	0	9	1	20	172	1437
8:45 - 9:00 am	12	127	3	2	0	0	2	130	4	4	0	20	304	1178
TOTAL	307	1880	42	13	2	1	9	1670	77	124	7	415	4331	
7:15 - 8:15 am	192	742	15	7	2	0	6	843	47	59	2	207	2122	

Approach and Departure

Time Period	ABC	DEF	GHI	JKL	Hour ABC	Hour DEF	Hour GHI	Hour JKL	AEI	BFJ	CGK	DHL	Hour AEI	Hour BFJ	Hour CGK	Hour DHL
6:00 - 6:15 am	102	0	95	19					8	98	3	107				
6:15 - 6:30	114	0	118	31					20	106	2	135				
6:30 - 6:45	170	2	140	34					18	157	6	165				
6:45 - 7:00	226	2	178	54	510	4	436	119	29	218	4	209	67	481	12	509
7:00 - 7:15	217	1	159	57	727	5	595	176	25	205	5	199	92	686	17	708
7:15 - 7:30	249	3	223	54	862	8	700	199	42	230	4	253	114	810	19	826
7:30 - 7:45	239	2	237	80	931	8	797	245	70	190	5	293	166	843	18	954
7:45 - 8:00	243	2	233	85	948	8	852	276	99	180	7	277	236	805	21	1022
8:00 - 8:15	218	2	203	49	949	9	896	268	30	201	7	234	241	801	23	1057
8:15 - 8:30	167	0	34	29	867	6	707	243	17	154	5	54	216	725	24	858
8:30 - 8:45	142	0	0	30	770	4	470	193	12	135	5	20	158	670	24	585
8:45 - 9:00 am	142	2	136	24	912	6	606	217	16	131	5	152	174	801	29	737
TOTAL	2229	16	1756	546					386	2005	58	2098				

Note: Movements D, E, F, G, H, and I data missed between 8:20 a.m. and 8:46 a.m.

Intersection: Namoku Street and Mikilihina Street
Date: Wednesday, April 18, 2007
Time: PM Peak Period
Counted by: JH

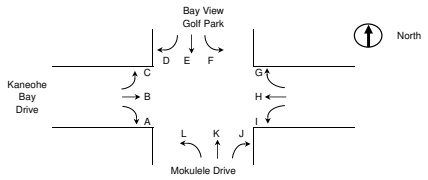


Time Period	A	B	C	D	E	F	Total	Hour
3:15 - 3:30 pm	7	44	25	0	3	3	82	
3:30 - 3:45	3	19	14	1	0	0	37	
3:45 - 4:00	3	31	13	0	1	4	52	
4:00 - 4:15	2	17	17	2	0	1	39	210
4:15 - 4:30	3	29	14	0	1	3	50	178
4:30 - 4:45	4	31	14	2	0	2	53	194
4:45 - 5:00	1	34	14	4	2	4	59	201
5:00 - 5:15	5	20	14	0	0	6	45	207
5:15 - 5:30	7	28	21	0	1	1	58	215
5:30 - 5:45	2	20	14	1	1	5	43	205
5:45 - 6:00	7	22	13	2	1	1	46	192
6:00 - 6:15	3	31	10	0	1	1	46	193
6:15 - 6:30 pm	4	21	20	0	1	1	47	182
TOTAL	51	347	203	12	12	32	657	
4:00 - 5:00 pm	10	111	59	8	3	10	201	

Approach and Departure

Time Period	AB	CD	EF	Hour AB	Hour CD	Hour EF	AD	BE	CF	Hour AD	Hour BE	Hour CF
3:15 - 3:30 pm	51	25	6				7	47	28			
3:30 - 3:45	22	15	0				4	19	14			
3:45 - 4:00	34	13	5				3	32	17			
4:00 - 4:15	19	19	1	126	72	12	4	17	18	18	115	77
4:15 - 4:30	32	14	4	107	61	10	3	30	17	14	98	66
4:30 - 4:45	35	16	2	120	62	12	6	31	16	16	110	68
4:45 - 5:00	35	18	6	121	67	13	5	36	18	18	114	69
5:00 - 5:15	25	14	6	127	62	18	5	20	20	19	117	71
5:15 - 5:30	35	21	2	130	69	16	7	29	22	23	116	76
5:30 - 5:45	22	15	6	117	68	20	3	21	19	20	106	79
5:45 - 6:00	29	15	2	111	65	16	9	23	14	24	93	75
6:00 - 6:15	34	10	2	120	61	12	3	32	11	22	105	66
6:15 - 6:30 pm	25	20	2	110	60	12	4	22	21	19	98	65
TOTAL	398	215	44				63	359	235			

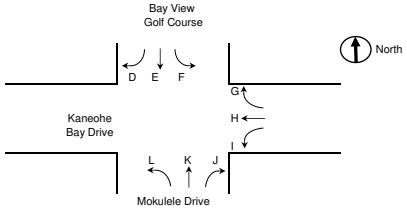
Intersection: Kaneohe Bay Drive at Mokulele Drive
Date: Wednesday, April 18, 2007
Time: PM Peak Period
Counted by: KN, JE



Time Period	A	B	C	D	E	F	G	H	I	J	K	L	Total	Hour
3:00 - 3:15 pm	28	155	2	3	1	1	0	159	7	16	4	18	394	
3:15 - 3:30	33	167	6	5	1	1	0	162	8	7	0	15	405	
3:30 - 3:45	28	181	2	4	1	0	5	209	5	10	2	20	467	
3:45 - 4:00	24	167	7	4	0	3	3	210	6	9	3	22	458	1724
4:00 - 4:15	21	180	6	9	2	0	2	188	9	8	1	39	465	1795
4:15 - 4:30	48	186	4	6	1	1	0	201	8	11	1	31	498	1888
4:30 - 4:45	19	186	1	7	0	1	2	200	13	8	1	25	463	1884
4:45 - 5:00	26	184	4	5	2	2	0	201	5	8	2	23	462	1888
5:00 - 5:15	39	180	7	3	1	1	1	221	9	15	1	40	518	1941
5:15 - 5:30	23	181	7	8	2	1	0	207	8	11	0	35	483	1926
5:30 - 5:45	28	196	8	7	1	1	0	196	8	9	0	20	474	1937
5:45 - 6:00	20	178	8	3	1	0	3	189	8	7	1	22	440	1915
6:00 - 6:15	29	180	16	10	2	6	3	181	8	11	2	25	473	1870
6:15 - 6:30 pm	28	172	5	4	1	2	3	156	8	10	2	26	417	1804
TOTAL	394	2493	83	78	16	20	22	2680	110	140	20	361	6417	
4:15 - 5:15 pm	132	736	16	21	4	5	3	823	35	42	5	119	1941	

Approach and Departure Time Period	ABC	DEF	GHI	JKL	Hour ABC	Hour DEF	Hour GHI	Hour JKL	AEI	BFJ	CGK	DHL	Hour AEI	Hour BFJ	Hour CGK	Hour DHL
3:00 - 3:15 pm	185	5	166	38					36	172	6	180				
3:15 - 3:30	206	7	170	22					42	175	6	182				
3:30 - 3:45	211	5	219	32					34	191	9	233				
3:45 - 4:00	198	7	219	34	800	24	774	126	30	179	13	236	142	717	34	831
4:00 - 4:15	207	11	199	48	822	30	807	136	32	188	9	236	138	733	37	887
4:15 - 4:30	238	8	209	43	854	31	846	157	57	198	5	238	153	756	36	943
4:30 - 4:45	206	8	215	34	849	34	842	159	32	195	4	232	151	760	31	942
4:45 - 5:00	214	9	206	33	865	36	829	158	33	194	6	229	154	775	24	935
5:00 - 5:15	226	5	231	56	884	30	861	166	49	196	9	264	171	783	24	963
5:15 - 5:30	211	11	215	46	857	33	867	169	33	193	7	250	147	778	26	975
5:30 - 5:45	232	9	204	29	883	34	856	164	37	206	8	223	152	789	30	966
5:45 - 6:00	206	4	200	30	875	29	850	161	29	185	12	214	148	780	36	951
6:00 - 6:15	225	18	192	38	874	42	811	143	39	197	21	216	138	781	48	903
6:15 - 6:30 pm	205	7	167	38	868	38	763	135	37	184	10	186	142	772	51	839
TOTAL	2970	114	2812	521					520	2653	125	3119				

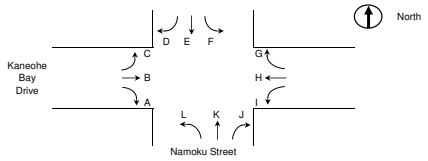
Intersection: Kaneohe Bay Drive and Mokulele Drive
Date: Thursday, April 26, 2007
Time: AM Peak Period
Counted by:



Time Period	A	B	C	D	E	F	I	J	K	L	Total	Hour
6:00 - 6:15 am	3	70	1	0	0	0	2	4	0	18	184	
6:15 - 6:30	14	97	4	1	0	1	11	3	0	19	261	
6:30 - 6:45	24	144	6	2	1	0	4	11	0	27	356	
6:45 - 7:00	18	196	1	1	1	0	5	13	2	33	411	1028
7:00 - 7:15	26	214	3	2	0	0	7	14	2	40	486	1514
7:15 - 7:30	35	237	2	2	0	2	17	15	0	47	549	1802
7:30 - 7:45	57	174	4	3	0	0	17	20	0	56	536	1982
7:45 - 8:00	88	193	2	2	0	0	13	9	0	76	612	2183
8:00 - 8:15	19	164	6	1	0	0	7	9	0	42	447	2144
8:15 - 8:30	11	155	6	1	0	0	4	8	0	22	360	1955
8:30 - 8:45	11	125	3	3	1	2	3	3	3	19	303	1722
8:45 - 9:00 am	11	132	1	1	2	0	3	7	2	19	314	1424
TOTAL	317	1901	39	19	5	5	93	116	9	418	4635	
7:00 - 8:00 am	206	818	11	9	0	2	54	58	2	219	2183	
7:15 - 8:15 am	199	768	14	8	0	2	54	53	0	221	2144	

Approach and Departure Time Period	ABC	DEF	GHI	JKL	Hour ABC	Hour JKL	AEI	BFJ	CGK	DHL	Hour AEI	Hour BFJ	Hour CGK	Hour DHL
6:00 - 6:15 am	74	0	88	22			5	74	1	104				
6:15 - 6:30	115	2	122	22			25	101	7	128				
6:30 - 6:45	174	3	141	38			29	155	6	166				
6:45 - 7:00	215	2	146	48	578	130	24	209	3	175	83	539	17	573
7:00 - 7:15	243	2	185	56	747	164	33	228	5	220	111	693	21	689
7:15 - 7:30	274	4	209	62	906	204	52	254	4	239	138	846	18	800
7:30 - 7:45	235	3	222	76	967	242	74	194	6	262	183	885	18	896
7:45 - 8:00	283	2	242	85	1035	279	101	202	2	307	260	878	17	1028
8:00 - 8:15	189	1	206	51	981	274	26	173	7	241	253	823	19	1049
8:15 - 8:30	172	1	157	30	879	242	15	163	7	175	216	732	22	985
8:30 - 8:45	139	6	133	25	783	191	15	130	8	150	157	668	24	873
8:45 - 9:00 am	144	3	139	28	927	219	16	139	4	155	173	807	28	1028
TOTAL	2257	29	1990	543			415	2022	60	2322				

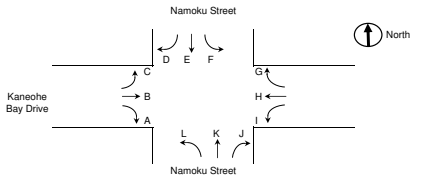
Intersection: Kaneohe Bay Drive at Namoku Street
Date: Wednesday, April 18, 2007
Time: PM Peak Period
Counted by: KL



Time Period	A	B	C	D	E	F	G	H	I	J	K	L	Total	Hour
2:30 - 2:45 pm	3	177	1	1	0	0	1	169	7	8	0	4	371	
2:45 - 3:00	5	141	1	1	0	0	1	156	11	12	0	3	331	
3:00 - 3:15	3	178	0	3	0	2	0	164	4	14	0	2	370	
3:15 - 3:30	0	166	0	4	0	2	1	171	11	13	0	1	369	
3:30 - 3:45	1	188	1	3	0	0	0	219	14	9	0	1	436	
3:45 - 4:00	2	177	0	0	0	0	0	209	5	14	0	2	409	
4:00 - 4:15	4	168	0	0	0	0	0	208	11	15	0	2	408	1622
4:15 - 4:30	4	196	0	1	0	0	0	200	7	9	0	3	420	1673
4:30 - 4:45	2	203	0	0	0	0	0	218	11	15	0	1	450	1687
4:45 - 5:00	5	199	0	0	0	1	0	209	6	13	0	0	433	1711
5:00 - 5:15	5	213	1	0	0	0	1	219	12	15	0	1	467	1770
5:15 - 5:30	2	174	0	0	0	0	0	215	11	10	0	2	414	1764
5:30 - 5:45	4	203	0	0	0	0	0	195	9	14	0	3	428	1742
5:45 - 6:00	2	178	0	2	0	0	0	196	12	8	0	2	400	1709
6:00 - 6:15	4	185	0	0	0	0	0	184	8	20	0	4	405	1647
6:15 - 6:30 pm	3	193	0	0	0	0	0	167	5	15	0	2	385	1618
TOTAL	49	2939	4	15	0	5	4	3099	144	204	0	33	6496	
4:15 - 5:15 pm	16	811	1	1	0	1	1	846	36	52	0	5	1770	

Approach and Departure Time Period	ABC	DEF	GHI	JKL	Hour ABC	Hour DEF	Hour GHI	Hour JKL	AEI	BFJ	CGK	DHL	Hour AEI	Hour BFJ	Hour CGK	Hour DHL
2:30 - 2:45 pm	181	1	177	12					10	185	2	174				
2:45 - 3:00	147	1	168	15					16	153	2	160				
3:00 - 3:15	181	5	168	16					7	194	0	169				
3:15 - 3:30	166	6	183	14	675	13	696	57	11	181	1	176	44	713	5	679
3:30 - 3:45	190	3	233	10	684	15	752	55	15	197	1	223	49	725	4	728
3:45 - 4:00	179	0	214	16	716	14	798	56	7	191	0	211	40	763	2	779
4:00 - 4:15	172	0	219	17	707	9	849	57	15	183	0	210	48	752	2	820
4:15 - 4:30	200	1	207	12	741	4	873	55	11	205	0	204	48	776	1	848
4:30 - 4:45	205	0	229	16	756	1	869	61	13	218	0	219	46	797	0	844
4:45 - 5:00	204	1	215	13	781	2	870	58	11	213	0	209	50	819	0	842
5:00 - 5:15	219	0	232	16	828	2	883	57	17	228	2	220	52	864	2	852
5:15 - 5:30	176	0	226	12	804	1	902	57	13	184	0	217	54	843	2	865
5:30 - 5:45	207	0	204	17	806	1	877	58	13	217	0	198	54	842	2	844
5:45 - 6:00	180	2	208	10	782	2	870	55	14	186	0	200	57	815	2	835
6:00 - 6:15	189	0	192	24	752	2	830	63	12	205	0	188	52	792	0	803
6:15 - 6:30 pm	196	0	172	17	772	2	776	68	8	208	0	169	47	816	0	755
TOTAL	2992	20	3247	237					193	3148	8	3147				

Intersection: Kaneohe Bay Drive and Namoku Street
Date: Thursday, April 19, 2007
Time: AM Peak Period
Counted by: KL



Time Period	A	B	C	D	E	F	G	H	I	J	K	L	Total	Hour
6:00 - 6:15 am	0	97	0	0	0	0	0	93	3	4	0	5	202	
6:15 - 6:30	1	100	2	0	0	0	0	113	4	6	0	2	228	
6:30 - 6:45	2	153	2	0	0	0	0	140	4	4	0	0	305	
6:45 - 7:00	2	208	2	0	0	0	2	171	9	10	0	4	408	941
7:00 - 7:15	2	204	3	0	0	0	1	162	10	14	0	2	398	1339
7:15 - 7:30	3	216	0	0	0	0	0	218	9	11	0	1	458	1569
7:30 - 7:45	1	196	0	1	0	0	0	241	7	16	0	0	462	1726
7:45 - 8:00	1	180	0	1	0	0	0	223	18	16	1	3	443	1761
8:00 - 8:15	2	195	0	0	0	0	0	212	9	15	0	3	436	1799
8:15 - 8:30	1	159	2	0	0	1	0	146	6	7	0	1	323	1664
8:30 - 8:45	3	131	0	0	0	0	0	127	3	9	0	2	275	1477
8:45 - 9:00 am	2	126	0	0	0	0	0	142	7	9	0	1	287	1321
TOTAL	20	1965	11	2	0	1	3	1988	89	121	1	24	4023	
7:15 - 8:15 am	7	787	0	2	0	0	0	894	43	58	1	7	1799	

Approach and Departure Time Period	ABC	DEF	GHI	JKL	Hour ABC	Hour DEF	Hour GHI	Hour JKL	AEI	BFJ	CGK	DHL	Hour AEI	Hour BFJ	Hour CGK	Hour DHL
6:00 - 6:15 am	97	0	96	9					3	101	0	98				
6:15 - 6:30	103	0	117	8					5	106	2	115				
6:30 - 6:45	157	0	144	4					6	157	2	140				
6:45 - 7:00	212	0	182	14	472	0	443	26	11	218	4	175	22	481	8	430
7:00 - 7:15	209	0	173	16	681	0	616	42	12	218	4	164	34	699	12	594
7:15 - 7:30	219	0	227	12	797	0	726	46	12	227	0	219	41	820	10	698
7:30 - 7:45	197	1	248	16	837	1	830	58	8	212	0	242	43	875	8	800
7:45 - 8:00	181	1	241	20	806	2	889	64	19	196	1	227	51	853	5	852
8:00 - 8:15	197	0	221	18	794	2	937	66	11	210	0	215	50	845	1	903
8:15 - 8:30	162	1	152	8	737	3	862	62	7	167	2	147	45	785	3	831
8:30 - 8:45	134	0	130	11	674	2	744	57	6	140	0	129	43	713	3	718
8:45 - 9:00 am	128	0	149	10	802	2	893	67	9	135	0	143	52	848	3	861
TOTAL	1996	3	2080	146					109	2087	15	2014				

APPENDIX B

LEVEL OF SERVICE DEFINITIONS

UNSIGNALIZED INTERSECTIONS
LEVEL OF SERVICE DEFINITIONS

Level of service for unsignalized intersections is defined by the amount of delay of each minor movement that must stop or yield to other major movements at the intersection. Level of service is defined for each of the individual turning movements that experience delays, but is not defined as a whole for unsignalized intersections. Stop signs are generally used to control movement at unsignalized intersections, as described below.

Two-Way Stop Controlled Intersections

At two-way stop controlled intersections, the approaches that are stop-controlled are considered as the minor street approach. The major street through and right turn movements generally have the highest priority at an unsignalized intersection and are not controlled by stop signs. A three-leg T-intersection is categorized as a two-way stop control intersection if the minor street approach (the stem of the 'T' intersection) is controlled by a stop sign. The estimation of delay at unsignalized two-way stop intersections is related to the acceptance of gaps by a driver waiting to enter into or exit from a minor street approach. Table B-1 shows the level of service criteria for two-way stop intersections.

Table B-1

LEVEL OF SERVICE CRITERIA
FOR
TWO-WAY STOP CONTROLLED INTERSECTIONS

Level of Service	Average Control Delay (seconds per vehicle)
A	0 – 10
B	> 10 – 15
C	> 15 – 25
D	> 25 – 35
E	> 35 – 50
F	> 50

Source: Highway Capacity Manual 2000

SIGNALIZED INTERSECTIONS
LEVEL OF SERVICE DEFINITIONS

Level of service for signalized intersections is defined in terms of control delay, which is a measure of driver discomfort, frustration, fuel consumption and increased travel time. Control delay is the component of delay that results when a traffic control signal causes vehicles to reduce speed or to stop at intersection. Total delay is defined as the difference between the actual travel time and the reference travel time that would occur under ideal, base conditions (absent of traffic control, geometric delays, incidents, or presence of other vehicles).

Delay experienced by motorists is affected by a number of factors that relate to control, geometrics, traffic, and incidents. Analytically, control delay is a complex technical measure that considers the quality of progression, cycle length, green phase-to-total cycle ratio, and the volume-to-capacity (v/c) ratio for each lane group.

The v/c ratio provides an indication of the utilization of the lane group capacity. The critical v/c ratio is an approximate indicator of the overall sufficiency of an intersection and is affected by the critical lane flow rates and traffic signal phasing. The six levels of service for signalized intersections are described below and summarized in Table B-2.

Level of Service A describes operations with low control delay between 0 to 10 seconds per vehicle, where there is extremely favorable progression. Most vehicles arrive during the green phase and many vehicles do not stop at all. Short cycle lengths may tend to contribute to low delays.

Level of Service B describes operations with control delays greater than 10 and up to 20 seconds per vehicle. There is generally good progression with short cycle lengths and slightly more vehicles stopping than in Level of Service A.

Level of Service C describes operations with control delays greater than 20 and up to 35 seconds per vehicle. These higher delays may result from fair progression, longer cycle lengths or a combination of both conditions. Cycle failure and overflow begins to occur at this level when a green phase is unable to serve all of the queued vehicles. The number of vehicles stopping increases, although many vehicles are still able to pass through the intersection without stopping.

Level of Service D describes operations with control delays greater than 35 and up to 55 seconds per vehicle. At this level, congestion becomes more noticeable. A combination of unfavorable progression, long cycle lengths and high v/c ratios may result in longer delays. Individual cycle failures become noticeable and the vehicles stopping become significant, although many vehicles pass through the intersection without stopping.

Level of Service E describes operations with control delays greater than 55 and up to 80 seconds per vehicle. Individual cycle failures are frequent and the high delay values are usually an indicator of poor progression, long cycle lengths and high v/c ratios.

Level of Service F describes operation with control delays greater that 80 seconds per vehicle. This level is considered unacceptable to most drivers and oversaturated conditions occur when arrival flow rates are greater than capacity of the lane group. There are many individual cycle failures related to high v/c ratios, poor progression, long cycle lengths or long red phase. The designation of Level of Service F does not automatically imply that the intersection, approach, or lane group is over capacity. Also, a Level of Service better than E does not necessarily imply that unused capacity is available.

Table B-2

LEVEL OF SERVICE CRITERIA FOR SIGNALIZED INTERSECTIONS

Level of Service	Average Control Delay (seconds per vehicle)
A	≤ 10
B	> 10 – 20
C	> 20 – 35
D	> 35 – 55
E	> 55 – 80
F	> 80

Source: Highway Capacity Manual 2000

APPENDIX C

COMPARISON OF ITE TRIP RATES WITH DERIVED CEMETERY AND DERIVED RETIREMENT COMMUNITY TRIP RATES

COMPARISON OF ITE AND DERIVED PHARMACY TRIP RATES

The Institute of Transportation Engineers (ITE) trip rates are based on national data. Manual traffic counts during April 2007 were collected at the Hawaiian Memorial Park and Pohai Nani Retirement Community to determine local Hawaii trip rates. Table C-1 provides the ITE trip rates for cemetery and retirement community.

Table C-1
ITE Trip Rates for Cemetery and Retirement Community

	Cemetery (Land Use Code 566) Trips per Acre		Continuing Care Retirement Community (Land Use Code 255) Trips per Unit	
	AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour
Enter	0.12	0.28	0.12	0.14
Exit	0.05	0.56	0.06	0.15
Total	0.17	0.84	0.18	0.29

Source: ITE, Trip Generation, Seventh Edition

The Hawaiian Memorial Park has 72 acres and the Hawaii State Veteran Cemetery has 122.5 acres, or a total of 194.5 acres. The Pohai Nani Retirement Community includes 184 senior apartments, 15 cottages, 10-resident care home and a 42-bed immediate and skilled nursing facility, or a combined total of 251 units/beds. Table C-2 presents the derived trip rates from the manual traffic counts. For the cemetery, the derived total morning peak hour trip rate of 0.68 is four times higher than the ITE rate of 0.17 and the derived afternoon peak hour trip rate of 0.83 is slightly less than the ITE rate of 0.84. For the retirement community, the derived total morning peak hour trip of 0.21 is about 17 percent higher than the ITE rate of 0.18. The afternoon derived total trip rate of 0.29 for the retirement community is the same as the ITE total

trip rate; however, the derived exit trip rate of 0.18 is slightly higher when compared to the ITE exit trip rate of 0.15.

Table C-2
Derived Trip Rates
(Based on Manual Counts at Hawaiian Memorial Park and Pohai Nani)

	Cemetery		Retirement Community	
	Trips per Acre		Trips per Unit	
	AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour
Enter	0.46	0.29	0.15	0.11
Exit	0.22	0.54	0.06	0.18
Total	0.68	0.83	0.21	0.29

The trip rates selected for this traffic study are shown in Table C-3. The morning derived trip rates for the cemetery was selected since they significantly higher than the ITE rates; however, the afternoon ITE trip rates was utilized since the total trip rates was slightly higher than the derived trip rates. For the retirement community, the derived trip rates were for the morning and afternoon peak hours were selected for use in the traffic study

Table C-3
Selected Trip Rates
(Based on Manual Counts at Hawaiian Memorial Park and Pohai Nani)

	Cemetery		Retirement Community	
	Trips per Acre		Trips per Unit	
	AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour
Enter	0.46	0.28	0.15	0.11
Exit	0.22	0.56	0.06	0.18
Total	0.68	0.84	0.21	0.29

APPENDIX D

LEVEL OF SERVICE PRINTOUTS

EXISTING TRAFFIC CONDITIONS

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*SU*	Intersection	*Kamehameha Hwy-HMP1-Halekou Rd*
Agency/Co.	*Perazim Consulting, LLC*	Jurisdiction	*Oahu*
Date Performed	*4/24/2008*	Analysis Year	*Existing Year 2007*
Analysis Time Period	*AM Peak Hour (7:15-8:15 am)*		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *HMP Primary Drwy-Halekou Rd* | North/South Street: *Kamehameha Highway*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*38*	*872*	*19*	*44*	*1058*	*46*
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*38*	*872*	*19*	*44*	*1058*	*46*
Percent Heavy Vehicles	*2*	--	--	*2*	--	--
Median Type	*Raised curb*					
RT Channelized			*0*			*0*
Lanes	*1*	*2*	*0*	*1*	*2*	*0*
Configuration	*L*	*T*	*TR*	*L*	*T*	*TR*
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*42*	*2*	*84*	*9*	*0*	*23*
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*42*	*2*	*84*	*9*	*0*	*23*
Percent Heavy Vehicles	*0*	*2*	*0*	*0*	*2*	*0*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*1*	*1*
Configuration		*LTR*		*LT*		*R*

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*L*	*L*	*LT*		*R*		*LTR*	
v (veh/h)	*38*	*44*	*9*		*23*		*128*	
C (m) (veh/h)	*628*	*757*	*155*		*565*		*267*	
v/c	*0.06*	*0.06*	*0.06*		*0.04*		*0.48*	
95% queue length	*0.19*	*0.19*	*0.18*		*0.13*		*2.66*	
Control Delay (s/veh)	*11.1*	*10.0*	*29.7*		*11.6*		*30.7*	
LOS	*B*	*B*	*D*		*B*		*D*	
Approach Delay (s/veh)	--	--	*16.7*			*30.7*		
Approach LOS	--	--	*C*			*D*		

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Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP1-Halekou Rd
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Existing Year 2007
Analysis Time Period	PM Peak Hour (4:00-5:00 pm)		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *HMP Primary Dwy-Halekou Rd* | North/South Street: *Kamehameha Highway*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	93	1410	21	14	996	53
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	93	1410	21	14	996	53
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Raised curb					
RT Channelized			0			0
Lanes	1	2	0	1	2	0
Configuration	L	T	TR	L	T	TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	36	2	52	30	0	41
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	36	2	52	30	0	41
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	1
Configuration		LTR		LT		R

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	L	L	LT		R		LTR	
v (veh/h)	93	14	30		41		90	
C (m) (veh/h)	659	471	75		377		210	
v/c	0.14	0.03	0.40		0.11		0.43	
95% queue length	0.49	0.09	1.85		0.37		2.17	
Control Delay (s/veh)	11.4	12.9	84.1		15.7		34.8	
LOS	B	B	F		C		D	
Approach Delay (s/veh)	--	--	44.6			34.8		
Approach LOS	--	--	E			D		

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Exstg 1-PM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP2-Mahinui
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Existing Year 2007
Analysis Time Period	AM Peak Hour (7:15-8:15 am)		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *HMP Secondary Dwy-Mahinui Rd* | North/South Street: *Kamehameha Hwy*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	5	952	3	18	1226	25
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	5	952	3	18	1226	25
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Raised curb					
RT Channelized			0			0
Lanes	1	2	0	0	2	0
Configuration	L	T	TR	LT		TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	35	3	12	2	0	8
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	35	3	12	2	0	8
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	1
Configuration		LTR		LT		R

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	L	LT	LT		R		LTR	
v (veh/h)	5	18	2		8		50	
C (m) (veh/h)	552	715	177		539		163	
v/c	0.01	0.03	0.01		0.01		0.31	
95% queue length	0.03	0.08	0.03		0.05		1.30	
Control Delay (s/veh)	11.6	10.2	25.6		11.8		36.8	
LOS	B	B	D		B		E	
Approach Delay (s/veh)	--	--	14.5			36.8		
Approach LOS	--	--	B			E		

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Exstg 2-AM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP2-Mahinui
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Existing Year 2007
Analysis Time Period	PM Peak Hour (4:00-5:00 pm)		

Project Description	Hawaiian Memorial Park Expansion		
East/West Street:	HMP Secondary Dwy-Mahinui Rd	North/South Street:	Kamehameha Hwy
Intersection Orientation:	North-South	Study Period (hrs):	1.00

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	31	1454	2	17	1127	32
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	31	1454	2	17	1127	32
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Raised curb					
RT Channelized			0			0
Lanes	1	2	0	0	2	0
Configuration	L	T	TR	LT		TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	20	1	6	2	0	32
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	20	1	6	2	0	32
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	1
Configuration		LTR		LT		R

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	L	LT	LT		R		LTR	
v (veh/h)	31	17	2		32		27	
C (m) (veh/h)	599	461	93		370		143	
v/c	0.05	0.04	0.02		0.09		0.19	
95% queue length	0.16	0.11	0.07		0.28		0.69	
Control Delay (s/veh)	11.3	13.1	44.6		15.7		36.0	
LOS	B	B	E		C		E	
Approach Delay (s/veh)	--	--	17.4			36.0		
Approach LOS	--	--	C			E		

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Exstg 2-PM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kaneohe Bay Dr and Namoku St
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Existing Year 2007
Analysis Time Period	AM Peak Hour (7:15-8:15 am)		

Project Description	Hawaiian Memorial Park Expansion		
East/West Street:	Kaneohe Bay Drive	North/South Street:	Namoku Street
Intersection Orientation:	East-West	Study Period (hrs):	1.00

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	0	787	7	43	894	0
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	0	787	7	43	894	0
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	7	1	58	0	0	2
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	7	1	58	0	0	2
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	1	0	1	0
Configuration	LT		R		LTR	

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR	LT		R		LTR	
v (veh/h)	0	43	8		58		2	
C (m) (veh/h)	759	827	61		393		343	
v/c	0.00	0.05	0.13		0.15		0.01	
95% queue length	0.00	0.16	0.45		0.52		0.02	
Control Delay (s/veh)	9.7	9.6	72.9		15.7		15.6	
LOS	A	A	F		C		C	
Approach Delay (s/veh)	--	--	22.7			15.6		
Approach LOS	--	--	C			C		

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Exstg 3-AM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kaneohe Bay Dr and Namoku St
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Existing Year 2007
Analysis Time Period	PM Peak Hour (4:15-5:15 pm)		

Project Description: Hawaiian Memorial Park Expansion

East/West Street: Kaneohe Bay Drive | North/South Street: Namoku Street

Intersection Orientation: East-West | Study Period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	1	811	16	36	846	1
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	1	811	16	36	846	1
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	5	0	52	1	0	1
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	5	0	52	1	0	1
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	1	0	1	0
Configuration	LT		R		LTR	

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR	LT		R		LTR	
v (veh/h)	1	36	5		52		2	
C (m) (veh/h)	790	804	64		379		93	
v/c	0.00	0.04	0.08		0.14		0.02	
95% queue length	0.00	0.14	0.25		0.48		0.07	
Control Delay (s/veh)	9.6	9.7	66.0		16.0		44.6	
LOS	A	A	F		C		E	
Approach Delay (s/veh)	--	--	20.4			44.6		
Approach LOS	--	--	C			E		

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Exstg 3-PM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Mokulele Dr and Namoku St
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Existing Year 2007
Analysis Time Period	AM Peak Hour (7:15-8:15 am)		

Project Description: Hawaiian Memorial Park Expansion

East/West Street: Mokulele Drive | North/South Street: Namoku Street

Intersection Orientation: North-South | Study Period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	15	73	34	3	127	49
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	15	73	34	3	127	49
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	34	48	28	40	46	14
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	34	48	28	40	46	14
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR		LTR			LTR	
v (veh/h)	15	3		100			110	
C (m) (veh/h)	1412	1497		625			658	
v/c	0.01	0.00		0.16			0.17	
95% queue length	0.03	0.01		0.57			0.60	
Control Delay (s/veh)	7.6	7.4		11.9			11.6	
LOS	A	A		B			B	
Approach Delay (s/veh)	--	--	11.9			11.6		
Approach LOS	--	--	B			B		

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Exstg 4-AM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*SU*	Intersection	*Mokulele Dr and Namoku St*
Agency/Co.	*Perazim Consulting, LLC*	Jurisdiction	*Oahu*
Date Performed	*4/24/2008*	Analysis Year	*Existing Year 2007*
Analysis Time Period	*PM Peak Hour (4:00-5:00 pm)*		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *Mokulele Drive* | North/South Street: *Namoku Street*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*16*	*77*	*56*	*9*	*51*	*29*
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*16*	*77*	*56*	*9*	*51*	*29*
Percent Heavy Vehicles	*0*	--	--	*0*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*1*	*0*
Configuration	*LTR*			*LTR*		
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*40*	*61*	*54*	*42*	*31*	*3*
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*40*	*61*	*54*	*42*	*31*	*3*
Percent Heavy Vehicles	*0*	*2*	*0*	*0*	*2*	*0*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*1*	*0*
Configuration		*LTR*			*LTR*	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*LTR*	*LTR*		*LTR*			*LTR*	
v (veh/h)	*16*	*9*		*76*			*155*	
C (m) (veh/h)	*1531*	*1464*		*622*			*747*	
v/c	*0.01*	*0.01*		*0.12*			*0.21*	
95% queue length	*0.03*	*0.02*		*0.42*			*0.78*	
Control Delay (s/veh)	*7.4*	*7.5*		*11.6*			*11.1*	
LOS	*A*	*A*		*B*			*B*	
Approach Delay (s/veh)	--	--	*11.6*			*11.1*		
Approach LOS	--	--	*B*			*B*		

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Exstg 4-PM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*SU*	Intersection	*Namoku St and Lipalu St*
Agency/Co.	*Perazim Consulting, LLC*	Jurisdiction	*Oahu*
Date Performed	*4/24/2008*	Analysis Year	*Existing Year 2007*
Analysis Time Period	*AM Peak Hour (7:15-8:15 am)*		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *Namoku Street* | North/South Street: *Lipalu Street*

Intersection Orientation: *East-West* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		*82*	*4*	*2*	*80*	
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*0*	*82*	*4*	*2*	*80*	*0*
Percent Heavy Vehicles	*0*	--	--	*0*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*1*	*0*
Configuration			*TR*	*LT*		
Upstream Signal		*0*			*0*	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*16*		*1*			
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*16*	*0*	*1*	*0*	*0*	*0*
Percent Heavy Vehicles	*0*	*0*	*0*	*0*	*0*	*0*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*0*	*0*
Configuration		*LR*				

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*LT*		*LR*				
v (veh/h)		*2*		*17*				
C (m) (veh/h)		*1523*		*834*				
v/c		*0.00*		*0.02*				
95% queue length		*0.00*		*0.06*				
Control Delay (s/veh)		*7.4*		*9.4*				
LOS		*A*		*A*				
Approach Delay (s/veh)	--	--	*9.4*					
Approach LOS	--	--	*A*					

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Exstg 5-AM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Namoku St and Lipalu St
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Existing Year 2007
Analysis Time Period	PM Peak Hour (4:00-5:00 pm)		

Project Description: Hawaiian Memorial Park Expansion

East/West Street: Namoku Street | North/South Street: Lipalu Street

Intersection Orientation: East-West | Study Period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		111	10	8	59	
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	0	111	10	8	59	0
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration			TR	LT		
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	10		3			
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	10	0	3	0	0	0
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	0	0	0	0	0
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		LT		LR				
v (veh/h)		8		13				
C (m) (veh/h)		1479		828				
v/c		0.01		0.02				
95% queue length		0.02		0.05				
Control Delay (s/veh)		7.4		9.4				
LOS		A		A				
Approach Delay (s/veh)	--	--	9.4					
Approach LOS	--	--	A					

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Exstg 5-PM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy and Mokulele Dr
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	AM Peak Hour (7:15-8:15 am)	Analysis Year	Existing Year 2007
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	0	1	1	0	1	1	1	2	1	1	2	0
Lane Group		LT	R		LT	R	L	T	R	L	TR	
Volume, V (vph)	78	14	22	215	16	147	6	917	72	61	1032	33
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Extension of Effective Green, e		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Arrival Type, AT		3	3		3	3	3	3	3	3	3	
Unit Extension, UE		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Filtering/Metering, I		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Initial Unmet Demand, Q_b		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width		12.0	12.0		12.0	12.0	12.0	12.0	12.0	12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B		0	0		0	0	0	0	0	0	0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EW Perm	02	03	04	Excl. Left	SB Only	Thru & RT	08
Timing	G = 24.0	G =	G =	G =	G = 6.0	G = 10.0	G = 48.0	G =
	Y = 6	Y =	Y =	Y =	Y =	Y =	Y = 6	Y =

Duration of Analysis, T = 1.00 | Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v		103	24		257	163	7	1019	80	68	1184	
Lane Group Capacity, c		196	388		304	388	108	1703	775	289	2049	
v/c Ratio, X		0.53	0.06		0.85	0.42	0.06	0.60	0.10	0.24	0.58	
Total Green Ratio, g/C		0.24	0.24		0.24	0.24	0.06	0.48	0.48	0.16	0.58	
Uniform Delay, d_1		33.0	29.3		36.2	32.1	44.4	19.0	14.2	36.7	13.3	
Progression Factor, PF		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Delay Calibration, k		0.13	0.11		0.38	0.11	0.11	0.19	0.11	0.11	0.17	
Incremental Delay, d_2		2.6	0.1		22.7	0.7	0.3	0.6	0.1	0.4	0.4	
Initial Queue Delay, d_3		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Control Delay		35.7	29.4		58.9	32.9	44.6	19.6	14.3	37.1	13.7	
Lane Group LOS		D	C		E	C	D	B	B	D	B	
Approach Delay	34.5			48.8			19.3			14.9		
Approach LOS	C			D			B			B		
Intersection Delay	22.4			X_c = 0.62			Intersection LOS			C		

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Exstg 6-AM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Dr and Mokulele Dr
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	PM Peak Hour (4:00-5:00 pm)	Analysis Year	Existing Year 2007
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	0	1	1	0	1	1	1	2	1	1	2	0
Lane Group		LT	R		LT	R	L	T	R	L	TR	
Volume, V (vph)	60	12	13	127	23	78	13	1314	179	115	1036	52
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Extension of Effective Green, e		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Arrival Type, AT		3	3		3	3	3	3	3	3	3	
Unit Extension, UE		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Filtering/Metering, I		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Initial Unmet Demand, Q_b		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width		12.0	12.0		12.0	12.0	12.0	12.0	12.0	12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B		0	0		0	0	0	0	0	0	0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EW Perm	02	03	04	Excl. Left	SB Only	Thru & RT	08
Timing	G = 20.0	G =	G =	G =	G = 8.0	G = 7.0	G = 66.0	G =
	Y = 6	Y =	Y =	Y =	Y =	Y = 6	Y = 7	Y =

Duration of Analysis, T = 1.00 Cycle Length, C = 120.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v		80	14		167	87	14	1460	199	128	1209	
Lane Group Capacity, c		162	269		222	269	120	1951	888	226	2320	
v/c Ratio, X		0.49	0.05		0.75	0.32	0.12	0.75	0.22	0.57	0.52	
Total Green Ratio, g/C		0.17	0.17		0.17	0.17	0.07	0.55	0.55	0.13	0.66	
Uniform Delay, d_1		45.4	42.0		47.6	44.0	52.7	20.6	13.9	49.4	10.7	
Progression Factor, PF		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Delay Calibration, k		0.11	0.11		0.31	0.11	0.11	0.30	0.11	0.16	0.13	
Incremental Delay, d_2		2.4	0.1		14.6	0.7	0.4	1.7	0.1	3.4	0.2	
Initial Queue Delay, d_3		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Control Delay		47.8	42.1		62.3	44.7	53.1	22.3	14.0	52.8	10.9	
Lane Group LOS		D	D		E	D	D	C	B	D	B	
Approach Delay	46.9			56.3			21.6			14.9		
Approach LOS	D			E			C			B		
Intersection Delay	22.2			X_c = 0.72			Intersection LOS			C		

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Exstg 6-PM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kaneohe Bay Dr and Mokulele Dr
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	AM Peak Hour (7:15-8:15 am)	Analysis Year	Existing Year 2007
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	1	1	1	1	1	0	1	1	0	0	1	0
Lane Group	L	T	R	L	TR		L	TR			LTR	
Volume, V (vph)	15	742	192	47	843	6	207	2	59	0	2	7
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1	2.0	2.0	2.0	2.0	2.0		2.0	2.0			2.0	
Extension of Effective Green, e	2.0	2.0	2.0	2.0	2.0		2.0	2.0			2.0	
Arrival Type, AT	3	3	3	3	3		3	3			3	
Unit Extension, UE	3.0	3.0	3.0	3.0	3.0		3.0	3.0			3.0	
Filtering/Metering, I	1.000	1.000	1.000	1.000	1.000		1.000	1.000			1.000	
Initial Unmet Demand, Q_b	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width	12.0	12.0	12.0	12.0	12.0		12.0	12.0			12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B	0	0	0	0	0		0	0			0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	Excl. Left	WB Only	Thru & RT	04	NS Perm	06	07	08
Timing	G = 3.0	G = 4.0	G = 60.0	G =	G = 21.0	G =	G =	G =
	Y =	Y =	Y = 6	Y =	Y = 6	Y =	Y =	Y =

Duration of Analysis, T = 0.25 Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v	17	824	213	52	944		230	68			10	
Lane Group Capacity, c	54	1118	969	126	1191		300	341			354	
v/c Ratio, X	0.31	0.74	0.22	0.41	0.79		0.77	0.20			0.03	
Total Green Ratio, g/C	0.03	0.60	0.60	0.07	0.64		0.21	0.21			0.21	
Uniform Delay, d_1	47.5	14.3	9.2	44.5	13.2		37.2	32.6			31.4	
Progression Factor, PF	1.000	1.000	1.000	1.000	1.000		1.000	1.000			1.000	
Delay Calibration, k	0.11	0.29	0.11	0.11	0.34		0.32	0.11			0.11	
Incremental Delay, d_2	3.3	2.6	0.1	2.2	3.8		11.3	0.3			0.0	
Initial Queue Delay, d_3	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	
Control Delay	50.8	16.9	9.3	46.7	16.9		48.5	32.9			31.4	
Lane Group LOS	D	B	A	D	B		D	C			C	
Approach Delay	16.0			18.5			44.9			31.4		
Approach LOS	B			B			D			C		
Intersection Delay	20.7			X_c = 0.77			Intersection LOS			C		

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Exstg 7-AM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kaneohe Bay Dr and Mokulele Dr
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	PM Peak Hour (4:15-5:15 pm)	Analysis Year	Existing Year 2007
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	1	1	1	1	1	0	1	1	0	0	1	0
Lane Group	L	T	R	L	TR		L	TR			LTR	
Volume, V (vph)	16	736	132	35	823	3	119	5	42	5	4	21
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1	2.0	2.0	2.0	2.0	2.0		2.0	2.0			2.0	
Extension of Effective Green, e	2.0	2.0	2.0	2.0	2.0		2.0	2.0			2.0	
Arrival Type, AT	3	3	3	3	3		3	3			3	
Unit Extension, UE	3.0	3.0	3.0	3.0	3.0		3.0	3.0			3.0	
Filtering/Metering, I	1.000	1.000	1.000	1.000	1.000		1.000	1.000			1.000	
Initial Unmet Demand, Q_b	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width	12.0	12.0	12.0	12.0	12.0		12.0	12.0			12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B	0	0	0	0	0		0	0			0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EB Only	WB Only	Thru & RT	04	NS Perm	06	07	08
Timing	G = 6.0	G = 10.0	G = 52.0	G =	G = 19.0	G =	G =	G =
	Y =	Y =	Y = 7	Y =	Y = 6	Y =	Y =	Y =

Duration of Analysis, T = 0.25 | Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v	18	818	147	39	917		132	53			33	
Lane Group Capacity, c	108	969	840	181	1154		266	312			313	
v/c Ratio, X	0.17	0.84	0.17	0.22	0.79		0.50	0.17			0.11	
Total Green Ratio, g/C	0.06	0.52	0.52	0.10	0.62		0.19	0.19			0.19	
Uniform Delay, d_1	44.6	20.5	12.7	41.4	14.2		36.2	33.9			33.5	
Progression Factor, PF	1.000	1.000	1.000	1.000	1.000		1.000	1.000			1.000	
Delay Calibration, k	0.11	0.38	0.11	0.11	0.34		0.11	0.11			0.11	
Incremental Delay, d_2	0.7	6.9	0.1	0.6	3.9		1.5	0.3			0.1	
Initial Queue Delay, d_3	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	
Control Delay	45.4	27.5	12.8	42.0	18.2		37.7	34.2			33.6	
Lane Group LOS	D	C	B	D	B		D	C			C	
Approach Delay	25.6			19.1			36.7			33.6		
Approach LOS	C			B			D			C		
Intersection Delay	23.8			X_c = 0.69			Intersection LOS			C		

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Exstg 7-PM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP1-Halekou Rd
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	AM Peak Hour (7:15-8:15 am)	Analysis Year	Existing Year 2007-Mitigation
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	0	1	0	0	1	1	1	2	0	1	2	0
Lane Group		LTR			LT	R	L	TR		L	TR	
Volume, V (vph)	42	2	84	9	0	23	38	872	19	44	1058	46
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1		2.0			2.0	2.0	2.0	2.0		2.0	2.0	
Extension of Effective Green, e		2.0			2.0	2.0	2.0	2.0		2.0	2.0	
Arrival Type, AT		3			3	3	3	3		3	3	
Unit Extension, UE		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Filtering/Metering, I		1.000			1.000	1.000	1.000	1.000		1.000	1.000	
Initial Unmet Demand, Q_b		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width		12.0			12.0	12.0	12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B		0			0	0	0	0		0	0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EW Perm	02	03	04	Excl. Left	SB Only	Thru & RT	08
Timing	G = 24.0	G =	G =	G =	G = 6.0	G = 10.0	G = 48.0	G =
	Y = 6	Y =	Y =	Y =	Y =	Y =	Y = 6	Y =

Duration of Analysis, T = 1.00 | Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v		128			9	23	38	891		44	1104	
Lane Group Capacity, c		374			364	388	108	1698		289	2046	
v/c Ratio, X		0.34			0.02	0.06	0.35	0.52		0.15	0.54	
Total Green Ratio, g/C		0.24			0.24	0.24	0.06	0.48		0.16	0.58	
Uniform Delay, d_1		31.5			29.1	29.3	45.1	18.1		36.2	12.8	
Progression Factor, PF		1.000			1.000	1.000	1.000	1.000		1.000	1.000	
Delay Calibration, k		0.11			0.11	0.11	0.11	0.13		0.11	0.14	
Incremental Delay, d_2		0.6			0.0	0.1	2.0	0.3		0.2	0.3	
Initial Queue Delay, d_3		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay		32.0			29.1	29.4	47.1	18.4		36.4	13.1	
Lane Group LOS		C			C	C	D	B		D	B	
Approach Delay	32.0			29.3			19.6			14.0		
Approach LOS	C			C			B			B		
Intersection Delay	17.6			X_c = 0.47			Intersection LOS			B		

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Exstg 8-AM

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP1-Halekou Rd
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	PM Peak Hour (4:00-5:00 pm)	Analysis Year	Existing Year 2007-Mitigation
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	0	1	0	0	1	1	1	2	0	1	2	0
Lane Group		LTR			LT	R	L	TR		L	TR	
Volume, V (vph)	36	2	52	30	0	41	93	1410	21	14	996	53
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1		2.0			2.0	2.0	2.0	2.0		2.0	2.0	
Extension of Effective Green, e		2.0			2.0	2.0	2.0	2.0		2.0	2.0	
Arrival Type, AT		3			3	3	3	3		3	3	
Unit Extension, UE		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Filtering/Metering, I		1.000			1.000	1.000	1.000	1.000		1.000	1.000	
Initial Unmet Demand, Q_b		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width		12.0			12.0	12.0	12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B		0			0	0	0	0		0	0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EW Perm	02	03	04	Excl. Left	NB Only	Thru & RT	08
Timing	G = 19.0	G =	G =	G =	G = 6.0	G = 10.0	G = 52.0	G =
	Y = 6	Y =	Y =	Y =	Y =	Y =	Y = 7	Y =

Duration of Analysis, T = 1.00 | Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v		90			30	41	93	1431		14	1049	
Lane Group Capacity, c		290			257	307	289	2195		108	1832	
v/c Ratio, X		0.31			0.12	0.13	0.32	0.65		0.13	0.57	
Total Green Ratio, g/C		0.19			0.19	0.19	0.16	0.62		0.06	0.52	
Uniform Delay, d_1		34.9			33.5	33.7	37.2	12.1		44.5	16.4	
Progression Factor, PF		1.000			1.000	1.000	1.000	1.000		1.000	1.000	
Delay Calibration, k		0.11			0.11	0.11	0.11	0.23		0.11	0.17	
Incremental Delay, d_2		0.6			0.2	0.2	0.6	0.7		0.5	0.4	
Initial Queue Delay, d_3		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay		35.5			33.8	33.9	37.8	12.8		45.1	16.8	
Lane Group LOS		D			C	C	D	B		D	B	
Approach Delay	35.5			33.8			14.3			17.2		
Approach LOS	D			C			B			B		
Intersection Delay	16.7			X_c = 0.54			Intersection LOS			B		

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FUTURE TRAFFIC CONDITIONS WITHOUT PROJECT

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP1-Halekou Rd
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Year without Project
Analysis Time Period	AM Peak Hour		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *HMP Primary Drwy-Halekou Rd* | North/South Street: *Kamehameha Highway*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	38	937	19	44	1122	46
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	38	937	19	44	1122	46
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Raised curb					
RT Channelized			0			0
Lanes	1	2	0	1	2	0
Configuration	L	T	TR	L	T	TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	42	2	84	9	0	23
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	42	2	84	9	0	23
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	1
Configuration		LTR		LT		R

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	L	L	LT		R		LTR	
v (veh/h)	38	44	9		23		128	
C (m) (veh/h)	594	715	141		539		245	
v/c	0.06	0.06	0.06		0.04		0.52	
95% queue length	0.20	0.20	0.20		0.13		3.12	
Control Delay (s/veh)	11.5	10.4	32.3		12.0		35.5	
LOS	B	B	D		B		E	
Approach Delay (s/veh)	--	--	17.7			35.5		
Approach LOS	--	--	C			E		

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FwoutPjt 1-AM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP1-Halekou Rd
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Year without Project
Analysis Time Period	PM Peak Hour		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *HMP Primary Dwy-Halekou Rd* | North/South Street: *Kamehameha Highway*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	93	1492	21	14	1064	53
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	93	1492	21	14	1064	53
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Raised curb					
RT Channelized			0			0
Lanes	1	2	0	1	2	0
Configuration	L	T	TR	L	T	TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	36	2	52	30	0	41
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	36	2	52	30	0	41
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	1
Configuration		LTR		LT		R

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	L	L	LT		R		LTR	
v (veh/h)	93	14	30		41		90	
C (m) (veh/h)	621	438	66		355		192	
v/c	0.15	0.03	0.45		0.12		0.47	
95% queue length	0.53	0.10	2.22		0.39		2.52	
Control Delay (s/veh)	11.8	13.5	103.1		16.5		40.0	
LOS	B	B	F		C		E	
Approach Delay (s/veh)	--	--	53.1			40.0		
Approach LOS	--	--	F			E		

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FwoutPjt 1-PM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP2-Mahinui
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Year without Project
Analysis Time Period	AM Peak Hour		

Project Description	Hawaiian Memorial Park Expansion		
East/West Street:	HMP Secondary Dwy-Mahinui Rd	North/South Street:	Kamehameha Hwy
Intersection Orientation:	North-South	Study Period (hrs):	1.00

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	5	1017	3	18	1290	25
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	5	1017	3	18	1290	25
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Raised curb					
RT Channelized			0			0
Lanes	1	2	0	0	2	0
Configuration	L	T	TR	LT		TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	35	3	12	2	0	8
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	35	3	12	2	0	8
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	1
Configuration		LTR		LT		R

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	L	LT	LT		R		LTR	
v (veh/h)	5	18	2		8		50	
C (m) (veh/h)	522	676	162		514		149	
v/c	0.01	0.03	0.01		0.02		0.34	
95% queue length	0.03	0.08	0.04		0.05		1.47	
Control Delay (s/veh)	12.0	10.5	27.5		12.1		41.2	
LOS	B	B	D		B		E	
Approach Delay (s/veh)	--	--	15.2			41.2		
Approach LOS	--	--	C			E		

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FwoutPjt 2-AM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP2-Mahinui
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Year without Project
Analysis Time Period	PM Peak Hour		

Project Description	Hawaiian Memorial Park Expansion		
East/West Street:	HMP Secondary Dwy-Mahinui Rd	North/South Street:	Kamehameha Hwy
Intersection Orientation:	North-South	Study Period (hrs):	1.00

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	31	1536	2	17	1195	32
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	31	1536	2	17	1195	32
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Raised curb					
RT Channelized			0			0
Lanes	1	2	0	0	2	0
Configuration	L	T	TR	LT		TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	20	1	6	2	0	32
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	20	1	6	2	0	32
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	1
Configuration		LTR		LT		R

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	L	LT	LT		R		LTR	
v (veh/h)	31	17	2		32		27	
C (m) (veh/h)	564	428	83		348		130	
v/c	0.05	0.04	0.02		0.09		0.21	
95% queue length	0.17	0.12	0.07		0.30		0.77	
Control Delay (s/veh)	11.8	13.8	49.4		16.4		39.9	
LOS	B	B	E		C		E	
Approach Delay (s/veh)	--	--	18.3			39.9		
Approach LOS	--	--	C			E		

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FwoutPjt 2-PM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kaneohe Bay Dr and Namoku St
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Year without Project
Analysis Time Period	AM Peak Hour		

Project Description	Hawaiian Memorial Park Expansion		
East/West Street:	Kaneohe Bay Drive	North/South Street:	Namoku Street
Intersection Orientation:	East-West	Study Period (hrs):	1.00

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	3	811	7	43	921	1
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	3	811	7	43	921	1
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	8	1	58	1	1	13
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	8	1	58	1	1	13
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	1	0	1	0
Configuration	LT		R		LTR	

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR	LT		R		LTR	
v (veh/h)	3	43	9		58		15	
C (m) (veh/h)	741	810	52		381		193	
v/c	0.00	0.05	0.17		0.15		0.08	
95% queue length	0.01	0.17	0.61		0.54		0.25	
Control Delay (s/veh)	9.9	9.7	88.6		16.1		25.2	
LOS	A	A	F		C		D	
Approach Delay (s/veh)	--	--	25.9			25.2		
Approach LOS	--	--	D			D		

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FwoutPjt 3-AM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kaneohe Bay Dr and Namoku St
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Year without Project
Analysis Time Period	PM Peak Hour		

Project Description	Hawaiian Memorial Park Expansion		
East/West Street:	Kaneohe Bay Drive	North/South Street:	Namoku Street
Intersection Orientation:	East-West	Study Period (hrs):	1.00

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	15	834	17	36	871	2
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	15	834	17	36	871	2
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	6	0	52	1	1	8
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	6	0	52	1	1	8
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	1	0	1	0
Configuration	LT		R		LTR	

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR	LT		R		LTR	
v (veh/h)	15	36	6		52		10	
C (m) (veh/h)	773	788	53		367		167	
v/c	0.02	0.05	0.11		0.14		0.06	
95% queue length	0.06	0.14	0.38		0.49		0.19	
Control Delay (s/veh)	9.7	9.8	81.5		16.4		27.9	
LOS	A	A	F		C		D	
Approach Delay (s/veh)	--	--	23.2			27.9		
Approach LOS	--	--	C			D		

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FwoutPjt 3-PM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*SU*	Intersection	*Mokulele Dr and Namoku St*
Agency/Co.	*Perazim Consulting, LLC*	Jurisdiction	*Oahu*
Date Performed	*4/24/2008*	Analysis Year	*Future Year without Project*
Analysis Time Period	*AM Peak Hour*		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *Mokulele Drive* | North/South Street: *Namoku Street*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	15	74	34	3	129	51
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	15	74	34	3	129	51
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	35	48	28	40	46	14
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	35	48	28	40	46	14
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR		LTR			LTR	
v (veh/h)	15	3		100			111	
C (m) (veh/h)	1408	1495		622			655	
v/c	0.01	0.00		0.16			0.17	
95% queue length	0.03	0.01		0.57			0.61	
Control Delay (s/veh)	7.6	7.4		11.9			11.6	
LOS	A	A		B			B	
Approach Delay (s/veh)	--	--	11.9			11.6		
Approach LOS	--	--	B			B		

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FwoutPjt 4-AM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*SU*	Intersection	*Mokulele Dr and Namoku St*
Agency/Co.	*Perazim Consulting, LLC*	Jurisdiction	*Oahu*
Date Performed	*3/24/2008*	Analysis Year	*Future Year without Project*
Analysis Time Period	*PM Peak Hour*		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *Mokulele Drive* | North/South Street: *Namoku Street*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	16	78	56	9	53	30
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	16	78	56	9	53	30
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	41	61	54	42	31	3
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	41	61	54	42	31	3
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR		LTR			LTR	
v (veh/h)	16	9		76			156	
C (m) (veh/h)	1527	1463		618			744	
v/c	0.01	0.01		0.12			0.21	
95% queue length	0.03	0.02		0.42			0.79	
Control Delay (s/veh)	7.4	7.5		11.6			11.1	
LOS	A	A		B			B	
Approach Delay (s/veh)	--	--	11.6			11.1		
Approach LOS	--	--	B			B		

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FwoutPjt 4-PM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*SU*	Intersection	*Namoku St and Lipalu St*
Agency/Co.	*Perazim Consulting, LLC*	Jurisdiction	*Oahu*
Date Performed	*4/24/2008*	Analysis Year	*Future Year without Project*
Analysis Time Period	*AM Peak Hour*		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *Namoku Street* | North/South Street: *Lipalu Street*

Intersection Orientation: *East-West* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		82	4	2	80	
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	0	82	4	2	80	0
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration			TR	LT		
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	16		1			
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	16	0	1	0	0	0
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	0	0	0	0	0
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		LT		LR				
v (veh/h)		2		17				
C (m) (veh/h)		1523		834				
v/c		0.00		0.02				
95% queue length		0.00		0.06				
Control Delay (s/veh)		7.4		9.4				
LOS		A		A				
Approach Delay (s/veh)	--	--	9.4					
Approach LOS	--	--	A					

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FwoutPjt 5-AM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*SU*	Intersection	*Namoku St and Lipalu St*
Agency/Co.	*Perazim Consulting, LLC*	Jurisdiction	*Oahu*
Date Performed	*4/24/2008*	Analysis Year	*Future Year without Project*
Analysis Time Period	*PM Peak Hour*		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *Namoku Street* | North/South Street: *Lipalu Street*

Intersection Orientation: *East-West* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		111	10	8	59	
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	0	111	10	8	59	0
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration			TR	LT		
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	10		3			
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	10	0	3	0	0	0
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	0	0	0	0	0
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		LT		LR				
v (veh/h)		8		13				
C (m) (veh/h)		1479		828				
v/c		0.01		0.02				
95% queue length		0.02		0.05				
Control Delay (s/veh)		7.4		9.4				
LOS		A		A				
Approach Delay (s/veh)	--	--	9.4					
Approach LOS	--	--	A					

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FwoutPjt 5-PM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Dr and Mokulele Dr
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	AM Peak Hour	Analysis Year	Future Year without Project
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	0	1	1	0	1	1	1	2	1	1	2	0
Lane Group		LT	R		LT	R	L	T	R	L	TR	
Volume, V (vph)	78	14	22	216	16	148	6	981	73	61	1095	33
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Extension of Effective Green, e		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Arrival Type, AT		3	3		3	3	3	3	3	3	3	
Unit Extension, UE		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Filtering/Metering, I		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Initial Unmet Demand, Q_b		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width		12.0	12.0		12.0	12.0	12.0	12.0	12.0	12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B		0	0		0	0	0	0	0	0	0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EW Perm	02	03	04	Excl. Left	SB Only	Thru & RT	08
Timing	G = 24.0	G =	G =	G =	G = 6.0	G = 10.0	G = 48.0	G =
	Y = 6	Y =	Y =	Y =	Y =	Y =	Y = 6	Y =

Duration of Analysis, T = 1.00 | Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v		103	24		258	164	7	1090	81	68	1254	
Lane Group Capacity, c		195	388		304	388	108	1703	775	289	2049	
v/c Ratio, X		0.53	0.06		0.85	0.42	0.06	0.64	0.10	0.24	0.61	
Total Green Ratio, g/C		0.24	0.24		0.24	0.24	0.06	0.48	0.48	0.16	0.58	
Uniform Delay, d_1		33.1	29.3		36.3	32.1	44.4	19.5	14.2	36.7	13.7	
Progression Factor, PF		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Delay Calibration, k		0.13	0.11		0.38	0.11	0.11	0.22	0.11	0.11	0.20	
Incremental Delay, d_2		2.7	0.1		23.4	0.7	0.3	0.8	0.1	0.4	0.5	
Initial Queue Delay, d_3		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Control Delay		35.8	29.4		59.6	32.9	44.6	20.3	14.3	37.1	14.2	
Lane Group LOS		D	C		E	C	D	C	B	D	B	
Approach Delay	34.6			49.2			20.1			15.4		
Approach LOS	C			D			C			B		
Intersection Delay	22.7			X_c = 0.64			Intersection LOS			C		

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FwoutPjt 6-AM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Dr and Mokulele Dr
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	PM Peak Hour	Analysis Year	Future Year without Project
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	0	1	1	0	1	1	1	2	1	1	2	0
Lane Group		LT	R		LT	R	L	T	R	L	TR	
Volume, V (vph)	60	12	13	128	23	79	13	1395	180	115	1103	52
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Extension of Effective Green, e		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Arrival Type, AT		3	3		3	3	3	3	3	3	3	
Unit Extension, UE		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Filtering/Metering, I		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Initial Unmet Demand, Q_b		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width		12.0	12.0		12.0	12.0	12.0	12.0	12.0	12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B		0	0		0	0	0	0	0	0	0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EW Perm	02	03	04	Excl. Left	SB Only	Thru & RT	08
Timing	G = 20.0	G =	G =	G =	G = 8.0	G = 7.0	G = 66.0	G =
	Y = 6	Y =	Y =	Y =	Y =	Y = 6	Y = 7	Y =

Duration of Analysis, T = 1.00 | Cycle Length, C = 120.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v		80	14		168	88	14	1550	200	128	1284	
Lane Group Capacity, c		161	269		222	269	120	1951	888	226	2321	
v/c Ratio, X		0.50	0.05		0.76	0.33	0.12	0.79	0.23	0.57	0.55	
Total Green Ratio, g/C		0.17	0.17		0.17	0.17	0.07	0.55	0.55	0.13	0.66	
Uniform Delay, d_1		45.4	42.0		47.7	44.1	52.7	21.6	13.9	49.4	11.0	
Progression Factor, PF		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Delay Calibration, k		0.11	0.11		0.31	0.11	0.11	0.34	0.11	0.16	0.15	
Incremental Delay, d_2		2.4	0.1		15.1	0.7	0.4	2.4	0.1	3.4	0.3	
Initial Queue Delay, d_3		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Control Delay		47.9	42.1		62.8	44.8	53.1	24.0	14.0	52.8	11.3	
Lane Group LOS		D	D		E	D	D	C	B	D	B	
Approach Delay	47.0			56.6			23.1			15.1		
Approach LOS	D			E			C			B		
Intersection Delay	22.9			X_c = 0.75			Intersection LOS			C		

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FwoutPjt 6-PM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kaneohe Bay Dr and Mokulele Dr
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	AM Peak Hour	Analysis Year	Future Year without Project
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	1	1	1	1	1	0	1	1	0	0	1	0
Lane Group	L	T	R	L	TR		L	TR			LTR	
Volume, V (vph)	15	767	192	51	878	6	207	2	61	0	2	7
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1	2.0	2.0	2.0	2.0	2.0		2.0	2.0			2.0	
Extension of Effective Green, e	2.0	2.0	2.0	2.0	2.0		2.0	2.0			2.0	
Arrival Type, AT	3	3	3	3	3		3	3			3	
Unit Extension, UE	3.0	3.0	3.0	3.0	3.0		3.0	3.0			3.0	
Filtering/Metering, I	1.000	1.000	1.000	1.000	1.000		1.000	1.000			1.000	
Initial Unmet Demand, Q_b	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width	12.0	12.0	12.0	12.0	12.0		12.0	12.0			12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B	0	0	0	0	0		0	0			0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	Excl. Left	WB Only	Thru & RT	04	NS Perm	06	07	08
Timing	G = 3.0	G = 4.0	G = 60.0	G =	G = 21.0	G =	G =	G =
	Y =	Y =	Y = 6	Y =	Y = 6	Y =	Y =	Y =

Duration of Analysis, T = 1.00 | Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v	17	852	213	57	983		230	70			10	
Lane Group Capacity, c	54	1118	969	126	1191		300	341			354	
v/c Ratio, X	0.31	0.76	0.22	0.45	0.83		0.77	0.21			0.03	
Total Green Ratio, g/C	0.03	0.60	0.60	0.07	0.64		0.21	0.21			0.21	
Uniform Delay, d_1	47.5	14.7	9.2	44.7	13.7		37.2	32.6			31.4	
Progression Factor, PF	1.000	1.000	1.000	1.000	1.000		1.000	1.000			1.000	
Delay Calibration, k	0.11	0.31	0.11	0.11	0.36		0.32	0.11			0.11	
Incremental Delay, d_2	3.4	3.2	0.1	2.6	5.1		12.2	0.3			0.0	
Initial Queue Delay, d_3	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	
Control Delay	50.9	18.0	9.3	47.2	18.8		49.4	32.9			31.4	
Lane Group LOS	D	B	A	D	B		D	C			C	
Approach Delay	16.8			20.4			45.5			31.4		
Approach LOS	B			C			D			C		
Intersection Delay	21.9			X_c = 0.79			Intersection LOS			C		

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FwoutPjt 7-AM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kaneohe Bay Dr and Mokulele Dr
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	PM Peak Hour	Analysis Year	Future Year without Project
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	1	1	1	1	1	0	1	1	0	0	1	0
Lane Group	L	T	R	L	TR		L	TR			LTR	
Volume, V (vph)	16	772	132	38	853	3	119	5	44	5	4	21
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1	2.0	2.0	2.0	2.0	2.0		2.0	2.0			2.0	
Extension of Effective Green, e	2.0	2.0	2.0	2.0	2.0		2.0	2.0			2.0	
Arrival Type, AT	3	3	3	3	3		3	3			3	
Unit Extension, UE	3.0	3.0	3.0	3.0	3.0		3.0	3.0			3.0	
Filtering/Metering, I	1.000	1.000	1.000	1.000	1.000		1.000	1.000			1.000	
Initial Unmet Demand, Q_b	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width	12.0	12.0	12.0	12.0	12.0		12.0	12.0			12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B	0	0	0	0	0		0	0			0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EB Only	WB Only	Thru & RT	04	NS Perm	06	07	08
Timing	G = 6.0	G = 10.0	G = 52.0	G =	G = 19.0	G =	G =	G =
	Y =	Y =	Y = 7	Y =	Y = 6	Y =	Y =	Y =

Duration of Analysis, T = 1.00 | Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v	18	858	147	42	951		132	55			33	
Lane Group Capacity, c	108	969	840	181	1154		266	312			313	
v/c Ratio, X	0.17	0.89	0.17	0.23	0.82		0.50	0.18			0.11	
Total Green Ratio, g/C	0.06	0.52	0.52	0.10	0.62		0.19	0.19			0.19	
Uniform Delay, d_1	44.6	21.4	12.7	41.5	14.8		36.2	33.9			33.5	
Progression Factor, PF	1.000	1.000	1.000	1.000	1.000		1.000	1.000			1.000	
Delay Calibration, k	0.11	0.41	0.11	0.11	0.36		0.11	0.11			0.11	
Incremental Delay, d_2	0.7	11.2	0.1	0.7	5.2		1.5	0.3			0.1	
Initial Queue Delay, d_3	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	
Control Delay	45.4	32.5	12.8	42.1	20.0		37.7	34.2			33.6	
Lane Group LOS	D	C	B	D	B		D	C			C	
Approach Delay	29.9			20.9			36.7			33.6		
Approach LOS	C			C			D			C		
Intersection Delay	26.5			X_c = 0.71			Intersection LOS			C		

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FwoutPjt 7-PM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP1-Halekou Rd
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	AM Peak Hour	Analysis Year	Future Year without Project
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	0	1	0	0	1	1	1	2	0	1	2	0
Lane Group		LTR			LT	R	L	TR		L	TR	
Volume, V (vph)	42	2	84	9	0	23	38	937	19	44	1122	46
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1		2.0			2.0	2.0	2.0	2.0		2.0	2.0	
Extension of Effective Green, e		2.0			2.0	2.0	2.0	2.0		2.0	2.0	
Arrival Type, AT		3			3	3	3	3		3	3	
Unit Extension, UE		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Filtering/Metering, I		1.000			1.000	1.000	1.000	1.000		1.000	1.000	
Initial Unmet Demand, Q_b		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width		12.0			12.0	12.0	12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B		0			0	0	0	0		0	0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EW Perm	02	03	04	Excl. Left	SB Only	Thru & RT	08
Timing	G = 24.0	G =	G =	G =	G = 6.0	G = 10.0	G = 48.0	G =
	Y = 6	Y =	Y =	Y =	Y =	Y =	Y = 6	Y =

Duration of Analysis, T = 1.00 | Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v		128			9	23	38	956		44	1168	
Lane Group Capacity, c		374			364	388	108	1698		289	2046	
v/c Ratio, X		0.34			0.02	0.06	0.35	0.56		0.15	0.57	
Total Green Ratio, g/C		0.24			0.24	0.24	0.06	0.48		0.16	0.58	
Uniform Delay, d_1		31.5			29.1	29.3	45.1	18.5		36.2	13.2	
Progression Factor, PF		1.000			1.000	1.000	1.000	1.000		1.000	1.000	
Delay Calibration, k		0.11			0.11	0.11	0.11	0.16		0.11	0.17	
Incremental Delay, d_2		0.6			0.0	0.1	2.0	0.4		0.2	0.4	
Initial Queue Delay, d_3		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay		32.0			29.1	29.4	47.1	19.0		36.4	13.6	
Lane Group LOS		C			C	C	D	B		D	B	
Approach Delay	32.0			29.3			20.0			14.4		
Approach LOS	C			C			C			B		
Intersection Delay	17.9			X_c = 0.49			Intersection LOS			B		

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FwoutPjt 8-AM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP1-Halekou Rd
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	PM Peak Hour	Analysis Year	Future Year without Project
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	0	1	0	0	1	1	1	2	0	1	2	0
Lane Group		LTR			LT	R	L	TR		L	TR	
Volume, V (vph)	36	2	52	30	1	41	93	1492	21	14	1064	53
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1		2.0			2.0	2.0	2.0	2.0		2.0	2.0	
Extension of Effective Green, e		2.0			2.0	2.0	2.0	2.0		2.0	2.0	
Arrival Type, AT		3			3	3	3	3		3	3	
Unit Extension, UE		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Filtering/Metering, I		1.000			1.000	1.000	1.000	1.000		1.000	1.000	
Initial Unmet Demand, Q_b		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width		12.0			12.0	12.0	12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B		0			0	0	0	0		0	0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EW Perm	02	03	04	Excl. Left	NB Only	Thru & RT	08
Timing	G = 19.0	G =	G =	G =	G = 6.0	G = 10.0	G = 52.0	G =
	Y = 6	Y =	Y =	Y =	Y =	Y =	Y = 7	Y =

Duration of Analysis, T = 1.00 | Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v		90			31	41	93	1513		14	1117	
Lane Group Capacity, c		289			259	307	289	2195		108	1833	
v/c Ratio, X		0.31			0.12	0.13	0.32	0.69		0.13	0.61	
Total Green Ratio, g/C		0.19			0.19	0.19	0.16	0.62		0.06	0.52	
Uniform Delay, d_1		34.9			33.6	33.7	37.2	12.6		44.5	16.9	
Progression Factor, PF		1.000			1.000	1.000	1.000	1.000		1.000	1.000	
Delay Calibration, k		0.11			0.11	0.11	0.11	0.26		0.11	0.20	
Incremental Delay, d_2		0.6			0.2	0.2	0.6	0.9		0.5	0.6	
Initial Queue Delay, d_3		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay		35.5			33.8	33.9	37.8	13.5		45.1	17.5	
Lane Group LOS		D			C	C	D	B		D	B	
Approach Delay	35.5			33.8			15.0			17.8		
Approach LOS	D			C			B			B		
Intersection Delay	17.2			X_c = 0.57			Intersection LOS			B		

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FwoutPjt 8-PM

FUTURE TRAFFIC CONDITIONS WITH ALTERNATIVE A

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*SU*	Intersection	*Kamehameha Hwy-HMP1-Halekou Rd*
Agency/Co.	*Perazim Consulting, LLC*	Jurisdiction	*Oahu*
Date Performed	*4/24/2008*	Analysis Year	*Future Yr with Alternative A*
Analysis Time Period	*AM Peak Hour*		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *HMP Primary Drwy-Halekou Rd* | North/South Street: *Kamehameha Highway*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*38*	*939*	*22*	*51*	*1124*	*46*
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*38*	*939*	*22*	*51*	*1124*	*46*
Percent Heavy Vehicles	*2*	--	--	*2*	--	--
Median Type	*Raised curb*					
RT Channelized			*0*			*0*
Lanes	*1*	*2*	*0*	*1*	*2*	*0*
Configuration	*L*	*T*	*TR*	*L*	*T*	*TR*
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*42*	*3*	*84*	*10*	*0*	*27*
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*42*	*3*	*84*	*10*	*0*	*27*
Percent Heavy Vehicles	*0*	*2*	*0*	*0*	*2*	*0*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*1*	*1*
Configuration		*LTR*		*LT*		*R*

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*L*	*L*	*LT*		*R*		*LTR*	
v (veh/h)	*38*	*51*	*10*		*27*		*129*	
C (m) (veh/h)	*593*	*712*	*137*		*537*		*238*	
v/c	*0.06*	*0.07*	*0.07*		*0.05*		*0.54*	
95% queue length	*0.21*	*0.23*	*0.24*		*0.16*		*3.35*	
Control Delay (s/veh)	*11.5*	*10.4*	*33.3*		*12.1*		*37.7*	
LOS	*B*	*B*	*D*		*B*		*E*	
Approach Delay (s/veh)	--	--	*17.8*			*37.7*		
Approach LOS	--	--	*C*			*E*		

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Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP1-Halekou Rd
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Yr with Alternative A
Analysis Time Period	AM Peak Hour		

Project Description: Hawaiian Memorial Park Expansion

East/West Street: HMP Primary Dwy-Halekou Rd | North/South Street: Kamehameha Highway

Intersection Orientation: North-South | Study Period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	93	1495	24	16	1066	53
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	93	1495	24	16	1066	53
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Raised curb					
RT Channelized			0			0
Lanes	1	2	0	1	2	0
Configuration	L	T	TR	L	T	TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	36	2	52	35	0	47
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	36	2	52	35	0	47
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	1
Configuration		LTR		LT		R

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	L	L	LT		R		LTR	
v (veh/h)	93	16	35		47		90	
C (m) (veh/h)	620	435	66		353		188	
v/c	0.15	0.04	0.53		0.13		0.48	
95% queue length	0.53	0.11	2.86		0.46		2.62	
Control Delay (s/veh)	11.8	13.6	117.2		16.8		41.4	
LOS	B	B	F		C		E	
Approach Delay (s/veh)	--	--	59.6			41.4		
Approach LOS	--	--	F			E		

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FwithAltA 1-PM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP2-Mahinui
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Yr with Altenative A
Analysis Time Period	AM Peak Hour		

Project Description: Hawaiian Memorial Park Expansion

East/West Street: HMP Secondary Dwy-Mahinui Rd | North/South Street: Kamehameha Hwy

Intersection Orientation: North-South | Study Period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	5	1022	4	20	1299	25
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	5	1022	4	20	1299	25
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Raised curb					
RT Channelized			0			0
Lanes	1	2	0	0	2	0
Configuration	L	T	TR	LT		TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	35	3	12	2	0	10
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	35	3	12	2	0	10
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	1
Configuration		LTR		LT		R

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	L	LT	LT		R		LTR	
v (veh/h)	5	20	2		10		50	
C (m) (veh/h)	518	673	160		512		146	
v/c	0.01	0.03	0.01		0.02		0.34	
95% queue length	0.03	0.09	0.04		0.06		1.51	
Control Delay (s/veh)	12.0	10.5	27.8		12.2		42.4	
LOS	B	B	D		B		E	
Approach Delay (s/veh)	--	--	14.8			42.4		
Approach LOS	--	--	B			E		

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FwithAltA 2-AM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP2-Mahinui
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Yr with Alternative A
Analysis Time Period	PM Peak Hour		

Project Description: Hawaiian Memorial Park Expansion

East/West Street: HMP Secondary Dwy-Mahinui Rd | North/South Street: Kamehameha Hwy

Intersection Orientation: North-South | Study Period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	31	1545	2	20	1199	32
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	31	1545	2	20	1199	32
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Raised curb					
RT Channelized			0			0
Lanes	1	2	0	0	2	0
Configuration	L	T	TR	LT		TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	20	1	6	2	0	38
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	20	1	6	2	0	38
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	1
Configuration		LTR		LT		R

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	L	LT	LT		R		LTR	
v (veh/h)	31	20	2		38		27	
C (m) (veh/h)	562	425	82		346		127	
v/c	0.06	0.05	0.02		0.11		0.21	
95% queue length	0.18	0.15	0.07		0.37		0.80	
Control Delay (s/veh)	11.8	13.9	50.0		16.7		41.0	
LOS	B	B	E		C		E	
Approach Delay (s/veh)	--	--	18.4			41.0		
Approach LOS	--	--	C			E		

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FwithAltA 2-PM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kaneohe Bay Dr and Namoku St
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Yr with Alternative A
Analysis Time Period	AM Peak Hour		

Project Description: Hawaiian Memorial Park Expansion

East/West Street: Kaneohe Bay Drive | North/South Street: Namoku Street

Intersection Orientation: East-West | Study Period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	3	812	7	44	922	1
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	3	812	7	44	922	1
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	8	1	59	1	1	13
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	8	1	59	1	1	13
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	1	0	1	0
Configuration	LT		R		LTR	

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR	LT		R		LTR	
v (veh/h)	3	44	9		59		15	
C (m) (veh/h)	740	810	52		380		193	
v/c	0.00	0.05	0.17		0.16		0.08	
95% queue length	0.01	0.17	0.61		0.55		0.25	
Control Delay (s/veh)	9.9	9.7	88.6		16.2		25.2	
LOS	A	A	F		C		D	
Approach Delay (s/veh)	--	--	25.8			25.2		
Approach LOS	--	--	D			D		

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FwithAltA 3-AM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kaneohe Bay Dr and Namoku St
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Yr with Alternative A
Analysis Time Period	PM Peak Hour		

Project Description: Hawaiian Memorial Park Expansion

East/West Street: Kaneohe Bay Drive | North/South Street: Namoku Street

Intersection Orientation: East-West | Study Period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	15	835	17	39	872	2
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	15	835	17	39	872	2
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	6	0	53	1	1	8
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	6	0	53	1	1	8
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	1	0	1	0
Configuration	LT		R		LTR	

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR	LT		R		LTR	
v (veh/h)	15	39	6		53		10	
C (m) (veh/h)	772	787	52		366		165	
v/c	0.02	0.05	0.12		0.14		0.06	
95% queue length	0.06	0.16	0.38		0.51		0.19	
Control Delay (s/veh)	9.8	9.8	83.2		16.5		28.2	
LOS	A	A	F		C		D	
Approach Delay (s/veh)	--	--	23.3			28.2		
Approach LOS	--	--	C			D		

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FwithAltA 3-PM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Mokulele Dr and Namoku St
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Yr with Alternative A
Analysis Time Period	AM Peak Hour		

Project Description: Hawaiian Memorial Park Expansion

East/West Street: Mokulele Drive | North/South Street: Namoku Street

Intersection Orientation: North-South | Study Period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	15	75	35	4	130	51
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	15	75	35	4	130	51
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	35	49	28	44	51	15
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	35	49	28	44	51	15
Percent Heavy Vehicles	2	0	0	2	0	0
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR		LTR			LTR	
v (veh/h)	15	4		110			112	
C (m) (veh/h)	1407	1493		616			647	
v/c	0.01	0.00		0.18			0.17	
95% queue length	0.03	0.01		0.65			0.63	
Control Delay (s/veh)	7.6	7.4		12.1			11.7	
LOS	A	A		B			B	
Approach Delay (s/veh)	--	--	12.1			11.7		
Approach LOS	--	--	B			B		

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FwithAltA 4-AM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*SU*	Intersection	*Mokulele Dr and Namoku St*
Agency/Co.	*Perazim Consulting, LLC*	Jurisdiction	*Oahu*
Date Performed	*4/24/2008*	Analysis Year	*Future Yr with Alternative A*
Analysis Time Period	*PM Peak Hour*		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *Mokulele Drive* | North/South Street: *Namoku Street*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	16	79	61	11	54	30
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	16	79	61	11	54	30
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	41	64	54	45	33	4
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	41	64	54	45	33	4
Percent Heavy Vehicles	2	0	0	2	0	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR		LTR			LTR	
v (veh/h)	16	11		82			159	
C (m) (veh/h)	1526	1456		609			733	
v/c	0.01	0.01		0.13			0.22	
95% queue length	0.03	0.02		0.47			0.83	
Control Delay (s/veh)	7.4	7.5		11.8			11.3	
LOS	A	A		B			B	
Approach Delay (s/veh)	--	--	11.8			11.3		
Approach LOS	--	--	B			B		

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FwithAltA 4-PM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*SU*	Intersection	*Namoku St and Lipalu St*
Agency/Co.	*Perazim Consulting, LLC*	Jurisdiction	*Oahu*
Date Performed	*4/24/2008*	Analysis Year	*Future Yr with Alternative A*
Analysis Time Period	*AM Peak Hour*		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *Namoku Street* | North/South Street: *Lipalu Street*

Intersection Orientation: *East-West* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		82	7	3	80	
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	0	82	7	3	80	0
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration			TR	LT		
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	26		2			
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	26	0	2	0	0	0
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	0	0	0	0	0
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		LT		LR				
v (veh/h)		3		28				
C (m) (veh/h)		1519		831				
v/c		0.00		0.03				
95% queue length		0.01		0.10				
Control Delay (s/veh)		7.4		9.5				
LOS		A		A				
Approach Delay (s/veh)	--	--	9.5					
Approach LOS	--	--	A					

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FwithAltA 5-AM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*SU*	Intersection	*Namoku St and Lipalu St*
Agency/Co.	*Perazim Consulting, LLC*	Jurisdiction	*Oahu*
Date Performed	*4/24/2008*	Analysis Year	*Future Yr with Alternative A*
Analysis Time Period	*PM Peak Hour*		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *Namoku Street* | North/South Street: *Lipalu Street*

Intersection Orientation: *East-West* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		111	20	11	59	
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	0	111	20	11	59	0
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration			TR	LT		
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	16		4			
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	16	0	4	0	0	0
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	0	0	0	0	0
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		LT		LR				
v (veh/h)		11		20				
C (m) (veh/h)		1467		811				
v/c		0.01		0.02				
95% queue length		0.02		0.08				
Control Delay (s/veh)		7.5		9.6				
LOS		A		A				
Approach Delay (s/veh)	--	--	9.6					
Approach LOS	--	--	A					

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FwithAltA 5-PM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	*SU*	Intersection	*Kamehameha Dr and Mokulele Dr*
Agency or Co.	*Perazim Consulting, LLC*	Area Type	*All other areas*
Date Performed	*4/24/2008*	Jurisdiction	*Oahu*
Time Period	*AM Peak Hour*	Analysis Year	*Future Yr with Alternative A*
		Project ID	*Hawaiian Memorial Park Expansion*

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	0	1	1	0	1	1	1	2	1	1	2	0
Lane Group		LT	R		LT	R	L	T	R	L	TR	
Volume, V (vph)	78	14	22	219	16	150	6	986	75	61	1103	33
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Extension of Effective Green, e		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Arrival Type, AT		3	3		3	3	3	3	3	3	3	
Unit Extension, UE		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Filtering/Metering, I		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Initial Unmet Demand, Q_b		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width		12.0	12.0		12.0	12.0	12.0	12.0	12.0	12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B		0	0		0	0	0	0	0	0	0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EW Perm	02	03	04	Excl. Left	SB Only	Thru & RT	08
Timing	G = 24.0	G =	G =	G =	G = 6.0	G = 10.0	G = 48.0	G =
	Y = 6	Y =	Y =	Y =	Y =	Y =	Y = 6	Y =

Duration of Analysis, T = *1.00* | Cycle Length, C = *100.0*

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v		103	24		261	167	7	1096	83	68	1263	
Lane Group Capacity, c		193	388		304	388	108	1703	775	289	2049	
v/c Ratio, X		0.53	0.06		0.86	0.43	0.06	0.64	0.11	0.24	0.62	
Total Green Ratio, g/C		0.24	0.24		0.24	0.24	0.06	0.48	0.48	0.16	0.58	
Uniform Delay, d_1		33.1	29.3		36.4	32.2	44.4	19.6	14.3	36.7	13.7	
Progression Factor, PF		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Delay Calibration, k		0.14	0.11		0.39	0.11	0.11	0.22	0.11	0.11	0.20	
Incremental Delay, d_2		2.9	0.1		25.5	0.8	0.3	0.8	0.1	0.4	0.6	
Initial Queue Delay, d_3		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Control Delay		36.0	29.4		61.8	33.0	44.6	20.4	14.3	37.1	14.3	
Lane Group LOS		D	C		E	C	D	C	B	D	B	
Approach Delay	34.8			50.6			20.1			15.5		
Approach LOS	C			D			C			B		
Intersection Delay	23.0			X_c = 0.64			Intersection LOS			C		

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FwithAltA 6-AM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Dr and Mokulele Dr
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	PM Peak Hour	Analysis Year	Future Yr with Alternative A
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	0	1	1	0	1	1	1	2	1	1	2	0
Lane Group		LT	R		LT	R	L	T	R	L	TR	
Volume, V (vph)	60	12	13	131	23	80	13	1406	184	119	1107	52
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Extension of Effective Green, e		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Arrival Type, AT		3	3		3	3	3	3	3	3	3	
Unit Extension, UE		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Filtering/Metering, I		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Initial Unmet Demand, Q_b		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width		12.0	12.0		12.0	12.0	12.0	12.0	12.0	12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B		0	0		0	0	0	0	0	0	0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EW Perm	02	03	04	Excl. Left	SB Only	Thru & RT	08
Timing	G = 20.0	G =	G =	G =	G = 8.0	G = 7.0	G = 66.0	G =
	Y = 6	Y =	Y =	Y =	Y =	Y = 6	Y = 7	Y =

Duration of Analysis, T = 1.00 Cycle Length, C = 120.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v		80	14		172	89	14	1562	204	132	1288	
Lane Group Capacity, c		158	269		222	269	120	1951	888	226	2321	
v/c Ratio, X		0.51	0.05		0.77	0.33	0.12	0.80	0.23	0.58	0.55	
Total Green Ratio, g/C		0.17	0.17		0.17	0.17	0.07	0.55	0.55	0.13	0.66	
Uniform Delay, d_1		45.5	42.0		47.8	44.1	52.7	21.7	13.9	49.6	11.0	
Progression Factor, PF		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Delay Calibration, k		0.11	0.11		0.32	0.11	0.11	0.34	0.11	0.18	0.15	
Incremental Delay, d_2		2.7	0.1		17.3	0.7	0.4	2.5	0.1	3.9	0.3	
Initial Queue Delay, d_3		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Control Delay		48.2	42.1		65.2	44.8	53.1	24.2	14.0	53.5	11.3	
Lane Group LOS		D	D		E	D	D	C	B	D	B	
Approach Delay	47.3			58.2			23.3			15.2		
Approach LOS	D			E			C			B		
Intersection Delay	23.3			X_c = 0.76			Intersection LOS			C		

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FwithAltA 6-PM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kaneohe Bay Dr and Mokulele Dr
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	AM Peak Hour	Analysis Year	Future Yr with Alternative A
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	1	1	1	1	1	0	1	1	0	0	1	0
Lane Group	L	T	R	L	TR		L	TR			LTR	
Volume, V (vph)	15	767	193	52	878	6	207	2	62	0	2	7
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1	2.0	2.0	2.0	2.0	2.0		2.0	2.0			2.0	
Extension of Effective Green, e	2.0	2.0	2.0	2.0	2.0		2.0	2.0			2.0	
Arrival Type, AT	3	3	3	3	3		3	3			3	
Unit Extension, UE	3.0	3.0	3.0	3.0	3.0		3.0	3.0			3.0	
Filtering/Metering, I	1.000	1.000	1.000	1.000	1.000		1.000	1.000			1.000	
Initial Unmet Demand, Q_b	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width	12.0	12.0	12.0	12.0	12.0		12.0	12.0			12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B	0	0	0	0	0		0	0			0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	Excl. Left	WB Only	Thru & RT	04	NS Perm	06	07	08
Timing	G = 3.0	G = 4.0	G = 60.0	G =	G = 21.0	G =	G =	G =
	Y =	Y =	Y = 6	Y =	Y = 6	Y =	Y =	Y =

Duration of Analysis, T = 1.00 Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v	17	852	214	58	983		230	71			10	
Lane Group Capacity, c	54	1118	969	126	1191		300	341			354	
v/c Ratio, X	0.31	0.76	0.22	0.46	0.83		0.77	0.21			0.03	
Total Green Ratio, g/C	0.03	0.60	0.60	0.07	0.64		0.21	0.21			0.21	
Uniform Delay, d_1	47.5	14.7	9.2	44.7	13.7		37.2	32.6			31.4	
Progression Factor, PF	1.000	1.000	1.000	1.000	1.000		1.000	1.000			1.000	
Delay Calibration, k	0.11	0.31	0.11	0.11	0.36		0.32	0.11			0.11	
Incremental Delay, d_2	3.4	3.2	0.1	2.7	5.1		12.2	0.3			0.0	
Initial Queue Delay, d_3	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	
Control Delay	50.9	18.0	9.3	47.4	18.8		49.4	32.9			31.4	
Lane Group LOS	D	B	A	D	B		D	C			C	
Approach Delay	16.8			20.4			45.5			31.4		
Approach LOS	B			C			D			C		
Intersection Delay	21.9			X_c = 0.79			Intersection LOS			C		

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FwithAltA 7-AM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kaneohe Bay Dr and Mokulele Dr
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	PM Peak Hour	Analysis Year	Future Yr with Alternative A
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	1	1	1	1	1	0	1	1	0	0	1	0
Lane Group	L	T	R	L	TR		L	TR			LTR	
Volume, V (vph)	16	772	134	39	853	3	119	5	45	5	4	21
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1	2.0	2.0	2.0	2.0	2.0		2.0	2.0			2.0	
Extension of Effective Green, e	2.0	2.0	2.0	2.0	2.0		2.0	2.0			2.0	
Arrival Type, AT	3	3	3	3	3		3	3			3	
Unit Extension, UE	3.0	3.0	3.0	3.0	3.0		3.0	3.0			3.0	
Filtering/Metering, I	1.000	1.000	1.000	1.000	1.000		1.000	1.000			1.000	
Initial Unmet Demand, Q_b	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width	12.0	12.0	12.0	12.0	12.0		12.0	12.0			12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B	0	0	0	0	0		0	0			0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EB Only	WB Only	Thru & RT	04	NS Perm	06	07	08
Timing	G = 6.0	G = 10.0	G = 52.0	G =	G = 19.0	G =	G =	G =
	Y =	Y =	Y = 7	Y =	Y = 6	Y =	Y =	Y =

Duration of Analysis, T = 0.25 | Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v	18	858	149	43	951		132	56			33	
Lane Group Capacity, c	108	969	840	181	1154		266	312			313	
v/c Ratio, X	0.17	0.89	0.18	0.24	0.82		0.50	0.18			0.11	
Total Green Ratio, g/C	0.06	0.52	0.52	0.10	0.62		0.19	0.19			0.19	
Uniform Delay, d_1	44.6	21.4	12.7	41.5	14.8		36.2	34.0			33.5	
Progression Factor, PF	1.000	1.000	1.000	1.000	1.000		1.000	1.000			1.000	
Delay Calibration, k	0.11	0.41	0.11	0.11	0.36		0.11	0.11			0.11	
Incremental Delay, d_2	0.7	9.9	0.1	0.7	5.0		1.5	0.3			0.1	
Initial Queue Delay, d_3	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	
Control Delay	45.4	31.2	12.8	42.2	19.8		37.7	34.2			33.6	
Lane Group LOS	D	C	B	D	B		D	C			C	
Approach Delay	28.8			20.7			36.7			33.6		
Approach LOS	C			C			D			C		
Intersection Delay	25.9			X_c = 0.71			Intersection LOS			C		

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FwithAltA 7-PM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP1-Halekou Rd
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	AM Peak Hour	Analysis Year	Future Yr with Alt A & Mitigtn
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	0	1	0	0	1	1	1	2	0	1	2	0
Lane Group		LTR			LT	R	L	TR		L	TR	
Volume, V (vph)	42	3	84	10	0	27	38	939	22	51	1124	46
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1		2.0			2.0	2.0	2.0	2.0		2.0	2.0	
Extension of Effective Green, e		2.0			2.0	2.0	2.0	2.0		2.0	2.0	
Arrival Type, AT		3			3	3	3	3		3	3	
Unit Extension, UE		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Filtering/Metering, I		1.000			1.000	1.000	1.000	1.000		1.000	1.000	
Initial Unmet Demand, Q_b		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width		12.0			12.0	12.0	12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B		0			0	0	0	0		0	0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EW Perm	02	03	04	Excl. Left	SB Only	Thru & RT	08
Timing	G = 24.0	G =	G =	G =	G = 6.0	G = 10.0	G = 48.0	G =
	Y = 6	Y =	Y =	Y =	Y =	Y =	Y = 6	Y =

Duration of Analysis, T = 1.00 | Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v		129			10	27	38	961		51	1170	
Lane Group Capacity, c		375			361	388	108	1697		289	2046	
v/c Ratio, X		0.34			0.03	0.07	0.35	0.57		0.18	0.57	
Total Green Ratio, g/C		0.24			0.24	0.24	0.06	0.48		0.16	0.58	
Uniform Delay, d_1		31.5			29.1	29.4	45.1	18.6		36.3	13.2	
Progression Factor, PF		1.000			1.000	1.000	1.000	1.000		1.000	1.000	
Delay Calibration, k		0.11			0.11	0.11	0.11	0.16		0.11	0.17	
Incremental Delay, d_2		0.6			0.0	0.1	2.0	0.4		0.3	0.4	
Initial Queue Delay, d_3		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay		32.0			29.1	29.4	47.1	19.0		36.6	13.6	
Lane Group LOS		C			C	C	D	B		D	B	
Approach Delay	32.0			29.4			20.1			14.5		
Approach LOS	C			C			C			B		
Intersection Delay	18.0			X_c = 0.49			Intersection LOS			B		

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FwithAltA 8-AM

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP1-Halekou Rd
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	PM Peak Hour	Analysis Year	Future Yr with Alt A & Mitigtn
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	0	1	0	0	1	1	1	2	0	1	2	0
Lane Group		LTR			LT	R	L	TR		L	TR	
Volume, V (vph)	36	2	52	35	0	47	93	1495	24	16	1066	53
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1		2.0			2.0	2.0	2.0	2.0		2.0	2.0	
Extension of Effective Green, e		2.0			2.0	2.0	2.0	2.0		2.0	2.0	
Arrival Type, AT		3			3	3	3	3		3	3	
Unit Extension, UE		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Filtering/Metering, I		1.000			1.000	1.000	1.000	1.000		1.000	1.000	
Initial Unmet Demand, Q_b		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width		12.0			12.0	12.0	12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B		0			0	0	0	0		0	0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EW Perm	02	03	04	Excl. Left	NB Only	Thru & RT	08
Timing	G = 19.0	G =	G =	G =	G = 6.0	G = 10.0	G = 52.0	G =
	Y = 6	Y =	Y =	Y =	Y =	Y =	Y = 7	Y =

Duration of Analysis, T = 1.00 | Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v		90			35	47	93	1519		16	1119	
Lane Group Capacity, c		289			253	307	289	2194		108	1833	
v/c Ratio, X		0.31			0.14	0.15	0.32	0.69		0.15	0.61	
Total Green Ratio, g/C		0.19			0.19	0.19	0.16	0.62		0.06	0.52	
Uniform Delay, d_1		34.9			33.7	33.8	37.2	12.7		44.6	16.9	
Progression Factor, PF		1.000			1.000	1.000	1.000	1.000		1.000	1.000	
Delay Calibration, k		0.11			0.11	0.11	0.11	0.26		0.11	0.20	
Incremental Delay, d_2		0.6			0.3	0.2	0.6	1.0		0.6	0.6	
Initial Queue Delay, d_3		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay		35.5			33.9	34.0	37.8	13.6		45.2	17.5	
Lane Group LOS		D			C	C	D	B		D	B	
Approach Delay	35.5			34.0			15.0			17.9		
Approach LOS	D			C			B			B		
Intersection Delay	17.3			X_c = 0.57			Intersection LOS			B		

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FUTURE TRAFFIC CONDITIONS WITH ALTERNATIVE B

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP1-Halekou Rd
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Yr with Alternative B
Analysis Time Period	AM Peak Hour		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *HMP Primary Drwy-Halekou Rd* | North/South Street: *Kamehameha Highway*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	38	945	22	51	1124	46
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	38	945	22	51	1124	46
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Raised curb					
RT Channelized			0			0
Lanes	1	2	0	1	2	0
Configuration	L	T	TR	L	T	TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	42	3	84	10	0	27
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	42	3	84	10	0	27
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	1
Configuration		LTR		LT		R

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	L	L	LT		R		LTR	
v (veh/h)	38	51	10		27		129	
C (m) (veh/h)	593	708	136		534		238	
v/c	0.06	0.07	0.07		0.05		0.54	
95% queue length	0.21	0.23	0.24		0.16		3.35	
Control Delay (s/veh)	11.5	10.5	33.6		12.1		37.7	
LOS	B	B	D		B		E	
Approach Delay (s/veh)	--	--	17.9			37.7		
Approach LOS	--	--	C			E		

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FwithAltB 1-AM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP1-Halekou Rd
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Yr with Alternative B
Analysis Time Period	AM Peak Hour		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *HMP Primary Dwy-Halekou Rd* | North/South Street: *Kamehameha Highway*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	93	1496	24	16	1071	53
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	93	1496	24	16	1071	53
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Raised curb					
RT Channelized			0			0
Lanes	1	2	0	1	2	0
Configuration	L	T	TR	L	T	TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	36	2	52	35	0	47
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	36	2	52	35	0	47
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	1
Configuration		LTR		LT		R

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	L	L	LT		R		LTR	
v (veh/h)	93	16	35		47		90	
C (m) (veh/h)	617	435	65		353		187	
v/c	0.15	0.04	0.54		0.13		0.48	
95% queue length	0.53	0.11	2.93		0.46		2.64	
Control Delay (s/veh)	11.9	13.6	120.6		16.8		41.8	
LOS	B	B	F		C		E	
Approach Delay (s/veh)	--	--	61.1			41.8		
Approach LOS	--	--	F			E		

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FwithAltB 1-PM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP2-Mahinui
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Yr with Altenative B
Analysis Time Period	AM Peak Hour		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *HMP Secondary Dwy-Mahinui Rd* | North/South Street: *Kamehameha Hwy*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	5	1028	4	20	1299	25
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	5	1028	4	20	1299	25
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Raised curb					
RT Channelized			0			0
Lanes	1	2	0	0	2	0
Configuration	L	T	TR	LT		TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	35	3	12	2	0	10
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	35	3	12	2	0	10
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	1
Configuration		LTR		LT		R

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	L	LT	LT		R		LTR	
v (veh/h)	5	20	2		10		50	
C (m) (veh/h)	518	669	159		509		146	
v/c	0.01	0.03	0.01		0.02		0.34	
95% queue length	0.03	0.09	0.04		0.06		1.51	
Control Delay (s/veh)	12.0	10.5	27.9		12.2		42.4	
LOS	B	B	D		B		E	
Approach Delay (s/veh)	--	--	14.8			42.4		
Approach LOS	--	--	B			E		

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FwithAltB 2-AM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP2-Mahinui
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Yr with Alternative C
Analysis Time Period	PM Peak Hour		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *HMP Secondary Dwy-Mahinui Rd* | North/South Street: *Kamehameha Hwy*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	31	1542	2	20	1198	32
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	31	1542	2	20	1198	32
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Raised curb					
RT Channelized			0			0
Lanes	1	2	0	0	2	0
Configuration	L	T	TR	LT		TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	20	1	6	2	0	39
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	20	1	6	2	0	39
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	1
Configuration		LTR		LT		R

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	L	LT	LT		R		LTR	
v (veh/h)	31	20	2		39		27	
C (m) (veh/h)	562	426	82		347		127	
v/c	0.06	0.05	0.02		0.11		0.21	
95% queue length	0.18	0.15	0.07		0.38		0.80	
Control Delay (s/veh)	11.8	13.9	50.0		16.7		41.0	
LOS	B	B	E		C		E	
Approach Delay (s/veh)	--	--	18.3			41.0		
Approach LOS	--	--	C			E		

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FwithAltC 2-PM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kaneohe Bay Dr and Namoku St
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Yr with Alternative B
Analysis Time Period	AM Peak Hour		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *Kaneohe Bay Drive* | North/South Street: *Namoku Street*

Intersection Orientation: *East-West* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	3	812	7	45	922	1
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	3	812	7	45	922	1
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	8	1	59	1	1	13
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	8	1	59	1	1	13
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	1	0	1	0
Configuration	LT		R		LTR	

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR	LT		R		LTR	
v (veh/h)	3	45	9		59		15	
C (m) (veh/h)	740	810	51		380		191	
v/c	0.00	0.06	0.18		0.16		0.08	
95% queue length	0.01	0.18	0.62		0.55		0.25	
Control Delay (s/veh)	9.9	9.7	90.6		16.2		25.5	
LOS	A	A	F		C		D	
Approach Delay (s/veh)	--	--	26.1			25.5		
Approach LOS	--	--	D			D		

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FwithAltB 3-AM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kaneohe Bay Dr and Namoku St
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Yr with Alternative B
Analysis Time Period	PM Peak Hour		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *Kaneohe Bay Drive* | North/South Street: *Namoku Street*

Intersection Orientation: *East-West* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	15	835	17	38	872	2
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	15	835	17	38	872	2
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	6	0	57	1	1	8
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	6	0	57	1	1	8
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	1	0	1	0
Configuration	LT		R		LTR	

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR	LT		R		LTR	
v (veh/h)	15	38	6		57		10	
C (m) (veh/h)	772	787	52		366		165	
v/c	0.02	0.05	0.12		0.16		0.06	
95% queue length	0.06	0.15	0.38		0.55		0.19	
Control Delay (s/veh)	9.8	9.8	83.2		16.6		28.2	
LOS	A	A	F		C		D	
Approach Delay (s/veh)	--	--	23.0			28.2		
Approach LOS	--	--	C			D		

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FwithAltB 3-PM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*SU*	Intersection	*Mokulele Dr and Namoku St*
Agency/Co.	*Perazim Consulting, LLC*	Jurisdiction	*Oahu*
Date Performed	*4/24/2008*	Analysis Year	
Analysis Time Period	*AM Peak Hour*		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *Mokulele Drive* | North/South Street: *Namoku Street*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	15	75	44	8	130	51
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	15	75	44	8	130	51
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	35	50	28	43	47	16
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	35	50	28	43	47	16
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR		LTR			LTR	
v (veh/h)	15	8		106			113	
C (m) (veh/h)	1407	1482		607			635	
v/c	0.01	0.01		0.17			0.18	
95% queue length	0.03	0.02		0.63			0.65	
Control Delay (s/veh)	7.6	7.4		12.2			11.9	
LOS	A	A		B			B	
Approach Delay (s/veh)	--	--	12.2			11.9		
Approach LOS	--	--	B			B		

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FwithAltB 4-AM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*SU*	Intersection	*Mokulele Dr and Namoku St*
Agency/Co.	*Perazim Consulting, LLC*	Jurisdiction	*Oahu*
Date Performed	*4/24/2008*	Analysis Year	*Future Yr with Alternative B*
Analysis Time Period	*PM Peak Hour*		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *Mokulele Drive* | North/South Street: *Namoku Street*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	16	79	62	11	54	30
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	16	79	62	11	54	30
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	41	64	54	52	35	7
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	41	64	54	52	35	7
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR		LTR			LTR	
v (veh/h)	16	11		94			159	
C (m) (veh/h)	1526	1455		615			729	
v/c	0.01	0.01		0.15			0.22	
95% queue length	0.03	0.02		0.54			0.83	
Control Delay (s/veh)	7.4	7.5		11.9			11.3	
LOS	A	A		B			B	
Approach Delay (s/veh)	--	--	11.9			11.3		
Approach LOS	--	--	B			B		

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FwithAltB 4-PM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*SU*	Intersection	*Namoku St and Lipalu St*
Agency/Co.	*Perazim Consulting, LLC*	Jurisdiction	*Oahu*
Date Performed	*4/24/2008*	Analysis Year	*Future Yr with Alternative B*
Analysis Time Period	*AM Peak Hour*		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *Namoku Street* | North/South Street: *Lipalu Street*

Intersection Orientation: *East-West* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		82	21	4	80	
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	0	82	21	4	80	0
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration			TR	LT		
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	22		2			
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	22	0	2	0	0	0
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	0	0	0	0	0
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		LT		LR				
v (veh/h)		4		24				
C (m) (veh/h)		1502		823				
v/c		0.00		0.03				
95% queue length		0.01		0.09				
Control Delay (s/veh)		7.4		9.5				
LOS		A		A				
Approach Delay (s/veh)	--	--	9.5					
Approach LOS	--	--	A					

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FwithAltB 5-AM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*SU*	Intersection	*Namoku St and Lipalu St*
Agency/Co.	*Perazim Consulting, LLC*	Jurisdiction	*Oahu*
Date Performed	*4/24/2008*	Analysis Year	*Future Yr with Alternative B*
Analysis Time Period	*PM Peak Hour*		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *Namoku Street* | North/South Street: *Lipalu Street*

Intersection Orientation: *East-West* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		111	21	10	59	
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	0	111	21	10	59	0
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration			TR	LT		
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	28		8			
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	28	0	8	0	0	0
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	0	0	0	0	0
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		LT		LR				
v (veh/h)		10		36				
C (m) (veh/h)		1466		816				
v/c		0.01		0.04				
95% queue length		0.02		0.14				
Control Delay (s/veh)		7.5		9.6				
LOS		A		A				
Approach Delay (s/veh)	--	--	9.6					
Approach LOS	--	--	A					

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FwithAltB 5-PM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Dr and Mokulele Dr
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	AM Peak Hour	Analysis Year	Future Yr with Alternative B
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	0	1	1	0	1	1	1	2	1	1	2	0
Lane Group		LT	R		LT	R	L	T	R	L	TR	
Volume, V (vph)	78	14	22	219	16	149	6	986	81	64	1103	33
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Extension of Effective Green, e		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Arrival Type, AT		3	3		3	3	3	3	3	3	3	
Unit Extension, UE		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Filtering/Metering, I		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Initial Unmet Demand, Q_b		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width		12.0	12.0		12.0	12.0	12.0	12.0	12.0	12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B		0	0		0	0	0	0	0	0	0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EW Perm	02	03	04	Excl. Left	SB Only	Thru & RT	08
Timing	G = 24.0	G =	G =	G =	G = 6.0	G = 10.0	G = 48.0	G =
	Y = 6	Y =	Y =	Y =	Y =	Y =	Y = 6	Y =

Duration of Analysis, T = 1.00 | Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v		103	24		261	166	7	1096	90	71	1263	
Lane Group Capacity, c		193	388		304	388	108	1703	775	289	2049	
v/c Ratio, X		0.53	0.06		0.86	0.43	0.06	0.64	0.12	0.25	0.62	
Total Green Ratio, g/C		0.24	0.24		0.24	0.24	0.06	0.48	0.48	0.16	0.58	
Uniform Delay, d_1		33.1	29.3		36.4	32.2	44.4	19.6	14.3	36.7	13.7	
Progression Factor, PF		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Delay Calibration, k		0.14	0.11		0.39	0.11	0.11	0.22	0.11	0.11	0.20	
Incremental Delay, d_2		2.9	0.1		25.5	0.8	0.3	0.8	0.1	0.4	0.6	
Initial Queue Delay, d_3		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Control Delay		36.0	29.4		61.8	32.9	44.6	20.4	14.4	37.2	14.3	
Lane Group LOS		D	C		E	C	D	C	B	D	B	
Approach Delay	34.8			50.6			20.1			15.5		
Approach LOS	C			D			C			B		
Intersection Delay	22.9			X_c = 0.64			Intersection LOS			C		

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FwithAltB 6-AM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Dr and Mokulele Dr
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	PM Peak Hour	Analysis Year	Future Yr with Alternative B
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	0	1	1	0	1	1	1	2	1	1	2	0
Lane Group		LT	R		LT	R	L	T	R	L	TR	
Volume, V (vph)	60	12	13	136	23	82	13	1406	185	119	1107	52
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Extension of Effective Green, e		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Arrival Type, AT		3	3		3	3	3	3	3	3	3	
Unit Extension, UE		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Filtering/Metering, I		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Initial Unmet Demand, Q_b		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width		12.0	12.0		12.0	12.0	12.0	12.0	12.0	12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B		0	0		0	0	0	0	0	0	0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EW Perm	02	03	04	Excl. Left	SB Only	Thru & RT	08
Timing	G = 20.0	G =	G =	G =	G = 8.0	G = 7.0	G = 66.0	G =
	Y = 6	Y =	Y =	Y =	Y =	Y = 6	Y = 7	Y =

Duration of Analysis, T = 1.00 | Cycle Length, C = 120.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v		80	14		177	91	14	1562	206	132	1288	
Lane Group Capacity, c		154	269		222	269	120	1951	888	226	2321	
v/c Ratio, X		0.52	0.05		0.80	0.34	0.12	0.80	0.23	0.58	0.55	
Total Green Ratio, g/C		0.17	0.17		0.17	0.17	0.07	0.55	0.55	0.13	0.66	
Uniform Delay, d_1		45.6	42.0		48.1	44.2	52.7	21.7	13.9	49.6	11.0	
Progression Factor, PF		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Delay Calibration, k		0.13	0.11		0.34	0.11	0.11	0.34	0.11	0.18	0.15	
Incremental Delay, d_2		3.2	0.1		20.6	0.8	0.4	2.5	0.1	3.9	0.3	
Initial Queue Delay, d_3		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Control Delay		48.8	42.1		68.7	44.9	53.1	24.2	14.1	53.5	11.3	
Lane Group LOS		D	D		E	D	D	C	B	D	B	
Approach Delay	47.8			60.6			23.3			15.2		
Approach LOS	D			E			C			B		
Intersection Delay	23.5			X_c = 0.77			Intersection LOS			C		

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FwithAltB 6-PM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kaneohe Bay Dr and Mokulele Dr
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	AM Peak Hour	Analysis Year	Future Yr with Alternative B
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	1	1	1	1	1	0	1	1	0	0	1	0
Lane Group	L	T	R	L	TR		L	TR			LTR	
Volume, V (vph)	15	767	197	52	878	6	209	2	62	0	2	7
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1	2.0	2.0	2.0	2.0	2.0		2.0	2.0			2.0	
Extension of Effective Green, e	2.0	2.0	2.0	2.0	2.0		2.0	2.0			2.0	
Arrival Type, AT	3	3	3	3	3		3	3			3	
Unit Extension, UE	3.0	3.0	3.0	3.0	3.0		3.0	3.0			3.0	
Filtering/Metering, I	1.000	1.000	1.000	1.000	1.000		1.000	1.000			1.000	
Initial Unmet Demand, Q_b	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width	12.0	12.0	12.0	12.0	12.0		12.0	12.0			12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B	0	0	0	0	0		0	0			0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	Excl. Left	WB Only	Thru & RT	04	NS Perm	06	07	08
Timing	G = 3.0	G = 4.0	G = 60.0	G =	G = 21.0	G =	G =	G =
	Y =	Y =	Y = 6	Y =	Y = 6	Y =	Y =	Y =

Duration of Analysis, T = 1.00 Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v	17	852	219	58	983		232	71			10	
Lane Group Capacity, c	54	1118	969	126	1191		300	341			354	
v/c Ratio, X	0.31	0.76	0.23	0.46	0.83		0.77	0.21			0.03	
Total Green Ratio, g/C	0.03	0.60	0.60	0.07	0.64		0.21	0.21			0.21	
Uniform Delay, d_1	47.5	14.7	9.3	44.7	13.7		37.3	32.6			31.4	
Progression Factor, PF	1.000	1.000	1.000	1.000	1.000		1.000	1.000			1.000	
Delay Calibration, k	0.11	0.31	0.11	0.11	0.36		0.32	0.11			0.11	
Incremental Delay, d_2	3.4	3.2	0.1	2.7	5.1		12.8	0.3			0.0	
Initial Queue Delay, d_3	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	
Control Delay	50.9	18.0	9.4	47.4	18.8		50.1	32.9			31.4	
Lane Group LOS	D	B	A	D	B		D	C			C	
Approach Delay	16.7			20.4			46.1			31.4		
Approach LOS	B			C			D			C		
Intersection Delay	22.0			X_c = 0.80			Intersection LOS			C		

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FwithAltB 7-AM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kaneohe Bay Dr and Mokulele Dr
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	PM Peak Hour	Analysis Year	Future Yr with Alternative B
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	1	1	1	1	1	0	1	1	0	0	1	0
Lane Group	L	T	R	L	TR		L	TR			LTR	
Volume, V (vph)	16	772	134	39	853	3	123	5	45	5	4	21
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1	2.0	2.0	2.0	2.0	2.0		2.0	2.0			2.0	
Extension of Effective Green, e	2.0	2.0	2.0	2.0	2.0		2.0	2.0			2.0	
Arrival Type, AT	3	3	3	3	3		3	3			3	
Unit Extension, UE	3.0	3.0	3.0	3.0	3.0		3.0	3.0			3.0	
Filtering/Metering, I	1.000	1.000	1.000	1.000	1.000		1.000	1.000			1.000	
Initial Unmet Demand, Q_b	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width	12.0	12.0	12.0	12.0	12.0		12.0	12.0			12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B	0	0	0	0	0		0	0			0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EB Only	WB Only	Thru & RT	04	NS Perm	06	07	08
Timing	G = 6.0	G = 10.0	G = 52.0	G =	G = 19.0	G =	G =	G =
	Y =	Y =	Y = 7	Y =	Y = 6	Y =	Y =	Y =

Duration of Analysis, T = 1.00 Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v	18	858	149	43	951		137	56			33	
Lane Group Capacity, c	108	969	840	181	1154		266	312			313	
v/c Ratio, X	0.17	0.89	0.18	0.24	0.82		0.52	0.18			0.11	
Total Green Ratio, g/C	0.06	0.52	0.52	0.10	0.62		0.19	0.19			0.19	
Uniform Delay, d_1	44.6	21.4	12.7	41.5	14.8		36.4	34.0			33.5	
Progression Factor, PF	1.000	1.000	1.000	1.000	1.000		1.000	1.000			1.000	
Delay Calibration, k	0.11	0.41	0.11	0.11	0.36		0.12	0.11			0.11	
Incremental Delay, d_2	0.7	11.2	0.1	0.7	5.2		1.7	0.3			0.1	
Initial Queue Delay, d_3	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	
Control Delay	45.4	32.5	12.8	42.2	20.0		38.1	34.2			33.6	
Lane Group LOS	D	C	B	D	B		D	C			C	
Approach Delay	29.9			20.9			37.0			33.6		
Approach LOS	C			C			D			C		
Intersection Delay	26.6			X_c = 0.71			Intersection LOS			C		

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FwithAltB 7-PM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP1-Halekou Rd
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	AM Peak Hour	Analysis Year	Future Yr with Alt B & Mitigtn
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	0	1	0	0	1	1	1	2	0	1	2	0
Lane Group		LTR			LT	R	L	TR		L	TR	
Volume, V (vph)	42	3	84	10	0	27	38	945	22	51	1124	46
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1		2.0			2.0	2.0	2.0	2.0		2.0	2.0	
Extension of Effective Green, e		2.0			2.0	2.0	2.0	2.0		2.0	2.0	
Arrival Type, AT		3			3	3	3	3		3	3	
Unit Extension, UE		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Filtering/Metering, I		1.000			1.000	1.000	1.000	1.000		1.000	1.000	
Initial Unmet Demand, Q_b		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width		12.0			12.0	12.0	12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B		0			0	0	0	0		0	0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EW Perm	02	03	04	Excl. Left	SB Only	Thru & RT	08
Timing	G = 24.0	G =	G =	G =	G = 6.0	G = 10.0	G = 48.0	G =
	Y = 6	Y =	Y =	Y =	Y =	Y =	Y = 6	Y =

Duration of Analysis, T = 1.00 | Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v		129			10	27	38	967		51	1170	
Lane Group Capacity, c		375			361	388	108	1697		289	2046	
v/c Ratio, X		0.34			0.03	0.07	0.35	0.57		0.18	0.57	
Total Green Ratio, g/C		0.24			0.24	0.24	0.06	0.48		0.16	0.58	
Uniform Delay, d_1		31.5			29.1	29.4	45.1	18.6		36.3	13.2	
Progression Factor, PF		1.000			1.000	1.000	1.000	1.000		1.000	1.000	
Delay Calibration, k		0.11			0.11	0.11	0.11	0.16		0.11	0.17	
Incremental Delay, d_2		0.6			0.0	0.1	2.0	0.5		0.3	0.4	
Initial Queue Delay, d_3		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay		32.0			29.1	29.4	47.1	19.1		36.6	13.6	
Lane Group LOS		C			C	C	D	B		D	B	
Approach Delay	32.0			29.4			20.1			14.5		
Approach LOS	C			C			C			B		
Intersection Delay	18.1			X_c = 0.49			Intersection LOS			B		

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FwithAltB 8-AM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP1-Halekou Rd
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	PM Peak Hour	Analysis Year	Future Yr with Alt B & Mitigtn
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	0	1	0	0	1	1	1	2	0	1	2	0
Lane Group		LTR			LT	R	L	TR		L	TR	
Volume, V (vph)	36	2	52	35	0	47	93	1496	24	16	1071	53
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1		2.0			2.0	2.0	2.0	2.0		2.0	2.0	
Extension of Effective Green, e		2.0			2.0	2.0	2.0	2.0		2.0	2.0	
Arrival Type, AT		3			3	3	3	3		3	3	
Unit Extension, UE		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Filtering/Metering, I		1.000			1.000	1.000	1.000	1.000		1.000	1.000	
Initial Unmet Demand, Q_b		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width		12.0			12.0	12.0	12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B		0			0	0	0	0		0	0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EW Perm	02	03	04	Excl. Left	NB Only	Thru & RT	08
Timing	G = 19.0	G =	G =	G =	G = 6.0	G = 10.0	G = 52.0	G =
	Y = 6	Y =	Y =	Y =	Y =	Y =	Y = 7	Y =

Duration of Analysis, T = 1.00 | Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v		90			35	47	93	1520		16	1124	
Lane Group Capacity, c		289			253	307	289	2194		108	1833	
v/c Ratio, X		0.31			0.14	0.15	0.32	0.69		0.15	0.61	
Total Green Ratio, g/C		0.19			0.19	0.19	0.16	0.62		0.06	0.52	
Uniform Delay, d_1		34.9			33.7	33.8	37.2	12.7		44.6	16.9	
Progression Factor, PF		1.000			1.000	1.000	1.000	1.000		1.000	1.000	
Delay Calibration, k		0.11			0.11	0.11	0.11	0.26		0.11	0.20	
Incremental Delay, d_2		0.6			0.3	0.2	0.6	1.0		0.6	0.6	
Initial Queue Delay, d_3		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay		35.5			33.9	34.0	37.8	13.6		45.2	17.5	
Lane Group LOS		D			C	C	D	B		D	B	
Approach Delay	35.5			34.0			15.0			17.9		
Approach LOS	D			C			B			B		
Intersection Delay	17.3			X_c = 0.57			Intersection LOS			B		

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FwithAltB 8-PM

FUTURE TRAFFIC CONDITIONS WITH ALTERNATIVE C

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*SU*	Intersection	*Kamehameha Hwy-HMP1-Halekou Rd*
Agency/Co.	*Perazim Consulting, LLC*	Jurisdiction	*Oahu*
Date Performed	*4/24/2008*	Analysis Year	*Future Yr with Alternative C*
Analysis Time Period	*AM Peak Hour*		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *HMP Primary Drwy-Halekou Rd* | North/South Street: *Kamehameha Highway*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	38	938	22	52	1122	46
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	38	938	22	52	1122	46
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Raised curb					
RT Channelized			0			0
Lanes	1	2	0	1	2	0
Configuration	L	T	TR	L	T	TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	42	3	84	10	0	27
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	42	3	84	10	0	27
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	1
Configuration		LTR		LT		R

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	L	L	LT		R		LTR	
v (veh/h)	38	52	10		27		129	
C (m) (veh/h)	594	712	137		537		237	
v/c	0.06	0.07	0.07		0.05		0.54	
95% queue length	0.20	0.24	0.24		0.16		3.37	
Control Delay (s/veh)	11.5	10.5	33.3		12.1		37.9	
LOS	B	B	D		B		E	
Approach Delay (s/veh)	--	--	17.8			37.9		
Approach LOS	--	--	C			E		

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Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP1-Halekou Rd
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Yr with Alternative C
Analysis Time Period	PM Peak Hour		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *HMP Primary Dwy-Halekou Rd* | North/South Street: *Kamehameha Highway*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	93	1492	25	17	1064	53
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	93	1492	25	17	1064	53
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Raised curb					
RT Channelized			0			0
Lanes	1	2	0	1	2	0
Configuration	L	T	TR	L	T	TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	36	2	52	36	0	47
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	36	2	52	36	0	47
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	1
Configuration		LTR		LT		R

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	L	L	LT		R		LTR	
v (veh/h)	93	17	36		47		90	
C (m) (veh/h)	621	436	65		354		188	
v/c	0.15	0.04	0.55		0.13		0.48	
95% queue length	0.53	0.12	3.07		0.46		2.62	
Control Delay (s/veh)	11.8	13.6	124.1		16.7		41.4	
LOS	B	B	F		C		E	
Approach Delay (s/veh)	--	--	63.3			41.4		
Approach LOS	--	--	F			E		

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FwithAltC 1-PM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP2-Mahinui
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Yr with Altenative C
Analysis Time Period	AM Peak Hour		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *HMP Secondary Dwy-Mahinui Rd* | North/South Street: *Kamehameha Hwy*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	5	1021	4	21	1298	25
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	5	1021	4	21	1298	25
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Raised curb					
RT Channelized			0			0
Lanes	1	2	0	0	2	0
Configuration	L	T	TR	LT		TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	35	3	12	2	0	10
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	35	3	12	2	0	10
Percent Heavy Vehicles	0	2	0	2	0	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	1
Configuration		LTR		LT		R

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	L	LT	LT		R		LTR	
v (veh/h)	5	21	2		10		50	
C (m) (veh/h)	518	673	158		512		146	
v/c	0.01	0.03	0.01		0.02		0.34	
95% queue length	0.03	0.10	0.04		0.06		1.51	
Control Delay (s/veh)	12.0	10.5	28.1		12.2		42.4	
LOS	B	B	D		B		E	
Approach Delay (s/veh)	--	--	14.8			42.4		
Approach LOS	--	--	B			E		

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FwithAltC 2-AM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP2-Mahinui
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Yr with Alternative C
Analysis Time Period	PM Peak Hour		

Project Description: Hawaiian Memorial Park Expansion

East/West Street: HMP Secondary Dwy-Mahinui Rd | North/South Street: Kamehameha Hwy

Intersection Orientation: North-South | Study Period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	31	1542	2	20	1198	32
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	31	1542	2	20	1198	32
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Raised curb					
RT Channelized			0			0
Lanes	1	2	0	0	2	0
Configuration	L	T	TR	LT		TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	20	1	6	2	0	39
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	20	1	6	2	0	39
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	1
Configuration		LTR		LT		R

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	L	LT	LT		R		LTR	
v (veh/h)	31	20	2		39		27	
C (m) (veh/h)	562	426	82		347		127	
v/c	0.06	0.05	0.02		0.11		0.21	
95% queue length	0.18	0.15	0.07		0.38		0.80	
Control Delay (s/veh)	11.8	13.9	50.0		16.7		41.0	
LOS	B	B	E		C		E	
Approach Delay (s/veh)	--	--	18.3			41.0		
Approach LOS	--	--	C			E		

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FwithAltC 2-PM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kaneohe Bay Dr and Namoku St
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	
Analysis Time Period	AM Peak Hour		

Project Description: Hawaiian Memorial Park Expansion

East/West Street: Kaneohe Bay Drive | North/South Street: Namoku Street

Intersection Orientation: East-West | Study Period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	3	812	7	43	922	1
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	3	812	7	43	922	1
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	8	1	58	1	1	13
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	8	1	58	1	1	13
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	1	0	1	0
Configuration	LT		R		LTR	

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR	LT		R		LTR	
v (veh/h)	3	43	9		58		15	
C (m) (veh/h)	740	810	52		380		193	
v/c	0.00	0.05	0.17		0.15		0.08	
95% queue length	0.01	0.17	0.61		0.54		0.25	
Control Delay (s/veh)	9.9	9.7	88.6		16.2		25.2	
LOS	A	A	F		C		D	
Approach Delay (s/veh)	--	--	25.9			25.2		
Approach LOS	--	--	D			D		

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FwithAltC 3-AM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Kaneohe Bay Dr and Namoku St
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Yr with Alternative C
Analysis Time Period	PM Peak Hour		

Project Description: Hawaiian Memorial Park Expansion

East/West Street: Kaneohe Bay Drive | North/South Street: Namoku Street

Intersection Orientation: East-West | Study Period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	15	835	17	36	872	2
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	15	835	17	36	872	2
Percent Heavy Vehicles	2	--	--	2	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	6	0	52	1	1	8
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	6	0	52	1	1	8
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	1	0	1	0
Configuration	LT		R		LTR	

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR	LT		R		LTR	
v (veh/h)	15	36	6		52		10	
C (m) (veh/h)	772	787	52		366		167	
v/c	0.02	0.05	0.12		0.14		0.06	
95% queue length	0.06	0.14	0.38		0.50		0.19	
Control Delay (s/veh)	9.8	9.8	83.2		16.5		27.9	
LOS	A	A	F		C		D	
Approach Delay (s/veh)	--	--	23.4			27.9		
Approach LOS	--	--	C			D		

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FwithAltC 3-PM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	SU	Intersection	Mokulele Dr and Namoku St
Agency/Co.	Perazim Consulting, LLC	Jurisdiction	Oahu
Date Performed	4/24/2008	Analysis Year	Future Yr with Alternative C
Analysis Time Period	AM Peak Hour		

Project Description: Hawaiian Memorial Park Expansion

East/West Street: Mokulele Drive | North/South Street: Namoku Street

Intersection Orientation: North-South | Study Period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	15	75	34	3	130	51
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	15	75	34	3	130	51
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	35	58	28	40	46	14
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	35	58	28	40	46	14
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR		LTR			LTR	
v (veh/h)	15	3		100			121	
C (m) (veh/h)	1407	1494		614			648	
v/c	0.01	0.00		0.16			0.19	
95% queue length	0.03	0.01		0.58			0.69	
Control Delay (s/veh)	7.6	7.4		12.0			11.8	
LOS	A	A		B			B	
Approach Delay (s/veh)	--	--	12.0			11.8		
Approach LOS	--	--	B			B		

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Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*SU*	Intersection	*Mokulele Dr and Namoku St*
Agency/Co.	*Perazim Consulting, LLC*	Jurisdiction	*Oahu*
Date Performed	*4/24/2008*	Analysis Year	*Future Yr with Alternative C*
Analysis Time Period	*PM Peak Hour*		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *Mokulele Drive* | North/South Street: *Namoku Street*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	16	79	56	9	54	30
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	16	79	56	9	54	30
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	41	61	54	42	31	3
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	41	61	54	42	31	3
Percent Heavy Vehicles	0	2	0	0	2	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR		LTR			LTR	
v (veh/h)	16	9		76			156	
C (m) (veh/h)	1526	1462		617			742	
v/c	0.01	0.01		0.12			0.21	
95% queue length	0.03	0.02		0.42			0.80	
Control Delay (s/veh)	7.4	7.5		11.7			11.1	
LOS	A	A		B			B	
Approach Delay (s/veh)	--	--	11.7			11.1		
Approach LOS	--	--	B			B		

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FwithAltC 4-PM

Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*SU*	Intersection	*Namoku St and Lipalu St*
Agency/Co.	*Perazim Consulting, LLC*	Jurisdiction	*Oahu*
Date Performed	*4/24/2008*	Analysis Year	*Future Yr with Alternative C*
Analysis Time Period	*AM Peak Hour*		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *Namoku Street* | North/South Street: *Lipalu Street*

Intersection Orientation: *East-West* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		82	4	2	80	
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	0	82	4	2	80	0
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration			TR	LT		
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	16		1			
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	16	0	1	0	0	0
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	0	0	0	0	0
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		LT		LR				
v (veh/h)		2		17				
C (m) (veh/h)		1523		834				
v/c		0.00		0.02				
95% queue length		0.00		0.06				
Control Delay (s/veh)		7.4		9.4				
LOS		A		A				
Approach Delay (s/veh)	--	--	9.4					
Approach LOS	--	--	A					

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Unsignalized Intersection

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*SU*	Intersection	*Namoku St and Lipalu St*
Agency/Co.	*Perazim Consulting, LLC*	Jurisdiction	*Oahu*
Date Performed	*4/24/2008*	Analysis Year	*Future Yr with Alternative C*
Analysis Time Period	*PM Peak Hour*		

Project Description *Hawaiian Memorial Park Expansion*

East/West Street: *Namoku Street* | North/South Street: *Lipalu Street*

Intersection Orientation: *East-West* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		111	10	8	59	
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	0	111	10	8	59	0
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration			TR	LT		
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	10		3			
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	10	0	3	0	0	0
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	0	0	0	0	0
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		LT		LR				
v (veh/h)		8		13				
C (m) (veh/h)		1479		828				
v/c		0.01		0.02				
95% queue length		0.02		0.05				
Control Delay (s/veh)		7.4		9.4				
LOS		A		A				
Approach Delay (s/veh)	--	--	9.4					
Approach LOS	--	--	A					

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FwithAltC 5-PM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	*SU*	Intersection	*Kamehameha Dr and Mokulele Dr*
Agency or Co.	*Perazim Consulting, LLC*	Area Type	*All other areas*
Date Performed	*4/24/2008*	Jurisdiction	*Oahu*
Time Period	*AM Peak Hour*	Analysis Year	*Future Yr with Alternative C*
		Project ID	*Hawaiian Memorial Park Expansion*

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	0	1	1	0	1	1	1	2	1	1	2	0
Lane Group		LT	R		LT	R	L	T	R	L	TR	
Volume, V (vph)	78	14	22	217	16	148	6	986	74	61	1105	33
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Extension of Effective Green, e		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Arrival Type, AT		3	3		3	3	3	3	3	3	3	
Unit Extension, UE		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Filtering/Metering, I		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Initial Unmet Demand, Q_b		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width		12.0	12.0		12.0	12.0	12.0	12.0	12.0	12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B		0	0		0	0	0	0	0	0	0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EW Perm	02	03	04	Excl. Left	SB Only	Thru & RT	08
Timing	G = 24.0	G =	G =	G =	G = 6.0	G = 10.0	G = 48.0	G =
	Y = 6	Y =	Y =	Y =	Y =	Y =	Y = 6	Y =

Duration of Analysis, T = *1.00* | Cycle Length, C = *100.0*

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v		103	24		259	164	7	1096	82	68	1265	
Lane Group Capacity, c		194	388		304	388	108	1703	775	289	2049	
v/c Ratio, X		0.53	0.06		0.85	0.42	0.06	0.64	0.11	0.24	0.62	
Total Green Ratio, g/C		0.24	0.24		0.24	0.24	0.06	0.48	0.48	0.16	0.58	
Uniform Delay, d_1		33.1	29.3		36.3	32.1	44.4	19.6	14.2	36.7	13.7	
Progression Factor, PF		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Delay Calibration, k		0.13	0.11		0.38	0.11	0.11	0.22	0.11	0.11	0.20	
Incremental Delay, d_2		2.8	0.1		24.0	0.7	0.3	0.8	0.1	0.4	0.6	
Initial Queue Delay, d_3		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Control Delay		35.9	29.4		60.3	32.9	44.6	20.4	14.3	37.1	14.3	
Lane Group LOS		D	C		E	C	D	C	B	D	B	
Approach Delay	34.7			49.7			20.1			15.5		
Approach LOS	C			D			C			B		
Intersection Delay	22.8			X_c = 0.64			Intersection LOS			C		

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FwithAltC 6-AM

Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Dr and Mokulele Dr
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	PM Peak Hour	Analysis Year	Future Yr with Alternative C
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	0	1	1	0	1	1	1	2	1	1	2	0
Lane Group		LT	R		LT	R	L	T	R	L	TR	
Volume, V (vph)	60	12	13	129	23	79	13	1407	181	117	1108	52
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Extension of Effective Green, e		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Arrival Type, AT		3	3		3	3	3	3	3	3	3	
Unit Extension, UE		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Filtering/Metering, I		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Initial Unmet Demand, Q_b		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width		12.0	12.0		12.0	12.0	12.0	12.0	12.0	12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B		0	0		0	0	0	0	0	0	0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EW Perm	02	03	04	Excl. Left	SB Only	Thru & RT	08
Timing	G = 20.0	G =	G =	G =	G = 8.0	G = 7.0	G = 66.0	G =
	Y = 6	Y =	Y =	Y =	Y =	Y = 6	Y = 7	Y =

Duration of Analysis, T = 1.00 Cycle Length, C = 120.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v		80	14		169	88	14	1563	201	130	1289	
Lane Group Capacity, c		160	269		222	269	120	1951	888	226	2321	
v/c Ratio, X		0.50	0.05		0.76	0.33	0.12	0.80	0.23	0.58	0.56	
Total Green Ratio, g/C		0.17	0.17		0.17	0.17	0.07	0.55	0.55	0.13	0.66	
Uniform Delay, d_1		45.5	42.0		47.7	44.1	52.7	21.7	13.9	49.5	11.0	
Progression Factor, PF		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Delay Calibration, k		0.11	0.11		0.31	0.11	0.11	0.34	0.11	0.17	0.15	
Incremental Delay, d_2		2.5	0.1		15.7	0.7	0.4	2.5	0.1	3.6	0.3	
Initial Queue Delay, d_3		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Control Delay		47.9	42.1		63.4	44.8	53.1	24.3	14.0	53.1	11.3	
Lane Group LOS		D	D		E	D	D	C	B	D	B	
Approach Delay	47.1			57.0			23.3			15.2		
Approach LOS	D			E			C			B		
Intersection Delay	23.1			X_c = 0.76			Intersection LOS			C		

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Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kaneohe Bay Dr and Mokulele Dr
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	AM Peak Hour	Analysis Year	Future Yr with Alternative C
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	1	1	1	1	1	0	1	1	0	0	1	0
Lane Group	L	T	R	L	TR		L	TR			LTR	
Volume, V (vph)	15	767	192	52	878	6	207	2	62	0	2	7
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1	2.0	2.0	2.0	2.0	2.0		2.0	2.0			2.0	
Extension of Effective Green, e	2.0	2.0	2.0	2.0	2.0		2.0	2.0			2.0	
Arrival Type, AT	3	3	3	3	3		3	3			3	
Unit Extension, UE	3.0	3.0	3.0	3.0	3.0		3.0	3.0			3.0	
Filtering/Metering, I	1.000	1.000	1.000	1.000	1.000		1.000	1.000			1.000	
Initial Unmet Demand, Q_b	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width	12.0	12.0	12.0	12.0	12.0		12.0	12.0			12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B	0	0	0	0	0		0	0			0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	Excl. Left	WB Only	Thru & RT	04	NS Perm	06	07	08
Timing	G = 3.0	G = 4.0	G = 60.0	G =	G = 21.0	G =	G =	G =
	Y =	Y =	Y = 6	Y =	Y = 6	Y =	Y =	Y =

Duration of Analysis, T = 1.00 Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v	17	852	213	58	983		230	71			10	
Lane Group Capacity, c	54	1118	969	126	1191		300	341			354	
v/c Ratio, X	0.31	0.76	0.22	0.46	0.83		0.77	0.21			0.03	
Total Green Ratio, g/C	0.03	0.60	0.60	0.07	0.64		0.21	0.21			0.21	
Uniform Delay, d_1	47.5	14.7	9.2	44.7	13.7		37.2	32.6			31.4	
Progression Factor, PF	1.000	1.000	1.000	1.000	1.000		1.000	1.000			1.000	
Delay Calibration, k	0.11	0.31	0.11	0.11	0.36		0.32	0.11			0.11	
Incremental Delay, d_2	3.4	3.2	0.1	2.7	5.1		12.2	0.3			0.0	
Initial Queue Delay, d_3	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	
Control Delay	50.9	18.0	9.3	47.4	18.8		49.4	32.9			31.4	
Lane Group LOS	D	B	A	D	B		D	C			C	
Approach Delay	16.8			20.4			45.5			31.4		
Approach LOS	B			C			D			C		
Intersection Delay	22.0			X_c = 0.79			Intersection LOS			C		

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Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kaneohe Bay Dr and Mokulele Dr
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	PM Peak Hour	Analysis Year	Future Yr with Alternative C
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	1	1	1	1	1	0	1	1	0	0	1	0
Lane Group	L	T	R	L	TR		L	TR			LTR	
Volume, V (vph)	16	772	132	39	853	3	119	5	45	5	4	21
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1	2.0	2.0	2.0	2.0	2.0		2.0	2.0			2.0	
Extension of Effective Green, e	2.0	2.0	2.0	2.0	2.0		2.0	2.0			2.0	
Arrival Type, AT	3	3	3	3	3		3	3			3	
Unit Extension, UE	3.0	3.0	3.0	3.0	3.0		3.0	3.0			3.0	
Filtering/Metering, I	1.000	1.000	1.000	1.000	1.000		1.000	1.000			1.000	
Initial Unmet Demand, Q_b	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width	12.0	12.0	12.0	12.0	12.0		12.0	12.0			12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B	0	0	0	0	0		0	0			0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EB Only	WB Only	Thru & RT	04	NS Perm	06	07	08
Timing	G = 6.0	G = 10.0	G = 52.0	G =	G = 19.0	G =	G =	G =
	Y =	Y =	Y = 7	Y =	Y = 6	Y =	Y =	Y =

Duration of Analysis, T = 1.00 | Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v	18	858	147	43	951		132	56			33	
Lane Group Capacity, c	108	969	840	181	1154		266	312			313	
v/c Ratio, X	0.17	0.89	0.17	0.24	0.82		0.50	0.18			0.11	
Total Green Ratio, g/C	0.06	0.52	0.52	0.10	0.62		0.19	0.19			0.19	
Uniform Delay, d_1	44.6	21.4	12.7	41.5	14.8		36.2	34.0			33.5	
Progression Factor, PF	1.000	1.000	1.000	1.000	1.000		1.000	1.000			1.000	
Delay Calibration, k	0.11	0.41	0.11	0.11	0.36		0.11	0.11			0.11	
Incremental Delay, d_2	0.7	11.2	0.1	0.7	5.2		1.5	0.3			0.1	
Initial Queue Delay, d_3	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	
Control Delay	45.4	32.5	12.8	42.2	20.0		37.7	34.2			33.6	
Lane Group LOS	D	C	B	D	B		D	C			C	
Approach Delay	29.9			20.9			36.7			33.6		
Approach LOS	C			C			D			C		
Intersection Delay	26.6			X_c = 0.71			Intersection LOS			C		

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Signalized Intersection

HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP1-Halekou Rd
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	AM Peak Hour	Analysis Year	Future Yr with Alt C & Mitigtn
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	0	1	0	0	1	1	1	2	0	1	2	0
Lane Group		LTR			LT	R	L	TR		L	TR	
Volume, V (vph)	42	3	84	10	0	27	38	938	22	52	1122	46
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1		2.0			2.0	2.0	2.0	2.0		2.0	2.0	
Extension of Effective Green, e		2.0			2.0	2.0	2.0	2.0		2.0	2.0	
Arrival Type, AT		3			3	3	3	3		3	3	
Unit Extension, UE		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Filtering/Metering, I		1.000			1.000	1.000	1.000	1.000		1.000	1.000	
Initial Unmet Demand, Q_b		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width		12.0			12.0	12.0	12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B		0			0	0	0	0		0	0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EW Perm	02	03	04	Excl. Left	SB Only	Thru & RT	08
Timing	G = 24.0	G =	G =	G =	G = 6.0	G = 10.0	G = 48.0	G =
	Y = 6	Y =	Y =	Y =	Y =	Y =	Y = 6	Y =

Duration of Analysis, T = 1.00 | Cycle Length, C = 100.0

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v		129			10	27	38	960		52	1168	
Lane Group Capacity, c		375			361	388	108	1697		289	2046	
v/c Ratio, X		0.34			0.03	0.07	0.35	0.57		0.18	0.57	
Total Green Ratio, g/C		0.24			0.24	0.24	0.06	0.48		0.16	0.58	
Uniform Delay, d_1		31.5			29.1	29.4	45.1	18.6		36.3	13.2	
Progression Factor, PF		1.000			1.000	1.000	1.000	1.000		1.000	1.000	
Delay Calibration, k		0.11			0.11	0.11	0.11	0.16		0.11	0.17	
Incremental Delay, d_2		0.6			0.0	0.1	2.0	0.4		0.3	0.4	
Initial Queue Delay, d_3		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay		32.0			29.1	29.4	47.1	19.0		36.6	13.6	
Lane Group LOS		C			C	C	D	B		D	B	
Approach Delay	32.0			29.4			20.1			14.6		
Approach LOS	C			C			C			B		
Intersection Delay	18.0			X_c = 0.49			Intersection LOS			B		

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HCS+™ DETAILED REPORT

General Information		Site Information	
Analyst	SU	Intersection	Kamehameha Hwy-HMP1-Halekou Rd
Agency or Co.	Perazim Consulting, LLC	Area Type	All other areas
Date Performed	4/24/2008	Jurisdiction	Oahu
Time Period	PM Peak Hour	Analysis Year	Future with Alt C & Mitigtn
		Project ID	Hawaiian Memorial Park Expansion

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of Lanes, N_1	0	1	0	0	1	1	1	2	0	1	2	0
Lane Group		LTR			LT	R	L	TR		L	TR	
Volume, V (vph)	36	2	52	36	0	47	93	1492	25	17	1064	53
% Heavy Vehicles, %HV	0	2	0	0	2	0	0	2	0	0	2	0
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Pretimed (P) or Actuated (A)	A	A	A	A	A	A	A	A	A	A	A	A
Start-up Lost Time, l_1		2.0			2.0	2.0	2.0	2.0		2.0	2.0	
Extension of Effective Green, e		2.0			2.0	2.0	2.0	2.0		2.0	2.0	
Arrival Type, AT		3			3	3	3	3		3	3	
Unit Extension, UE		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Filtering/Metering, I		1.000			1.000	1.000	1.000	1.000		1.000	1.000	
Initial Unmet Demand, Q_b		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Ped / Bike / RTOR Volumes	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width		12.0			12.0	12.0	12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking Maneuvers, N_m												
Buses Stopping, N_B		0			0	0	0	0		0	0	
Min. Time for Pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	EW Perm	02	03	04	Excl. Left	NB Only	Thru & RT	08
Timing	G = 19.0	G =	G =	G =	G = 6.0	G = 10.0	G = 52.0	G =
	Y = 6	Y =	Y =	Y =	Y =	Y =	Y = 7	Y =
Duration of Analysis, T = 1.00						Cycle Length, C = 100.0		

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted Flow Rate, v		90			36	47	93	1517		17	1117	
Lane Group Capacity, c		289			252	307	289	2194		108	1833	
v/c Ratio, X		0.31			0.14	0.15	0.32	0.69		0.16	0.61	
Total Green Ratio, g/C		0.19			0.19	0.19	0.16	0.62		0.06	0.52	
Uniform Delay, d_1		34.9			33.7	33.8	37.2	12.6		44.6	16.9	
Progression Factor, PF		1.000			1.000	1.000	1.000	1.000		1.000	1.000	
Delay Calibration, k		0.11			0.11	0.11	0.11	0.26		0.11	0.20	
Incremental Delay, d_2		0.6			0.3	0.2	0.6	1.0		0.7	0.6	
Initial Queue Delay, d_3		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay		35.5			34.0	34.0	37.8	13.6		45.3	17.5	
Lane Group LOS		D			C	C	D	B		D	B	
Approach Delay	35.5			34.0			15.0			17.9		
Approach LOS	D			C			B			B		
Intersection Delay	17.3			X_c = 0.57			Intersection LOS			B		

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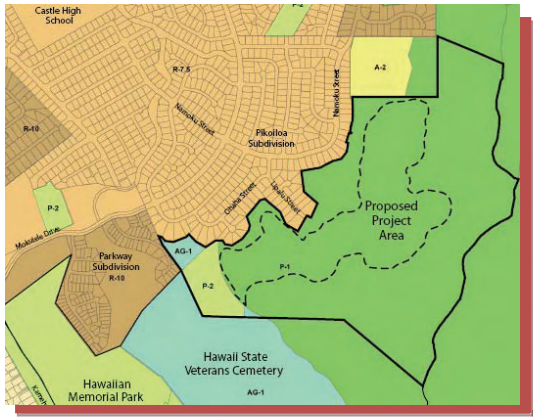
L. TMDL Analysis Report

(Element Environmental, LLC)

TMDL Analysis Report

Kawa Stream TMDL Analysis for Hawaiian Memorial Park Expansion
Kaneohe, Oahu, Hawaii



Prepared for:

Helber Hastert & Fee, Planners, Inc.

Helber Hastert & Fee
PLANNERS

Prepared by:

element environmental llc
environmental · engineering · water resources
62-180 Emerson Road
Haleiwa, HI 96712

September 2008

Question to Answer: Since the proposed cemetery development is located within an impaired water body (Kawa Stream) for which TMDLs have been developed, we are asked to demonstrate how the proposed project will contribute to the achievement of the pollutant load reductions suggested in the Kawa Stream TMDL technical studies (Oceanit, 2002; DOH, 2005).

Response to Question: We use the DOH TMDL methodology (DOH, 2005) to calculate the incremental change in TSS, TN and TP load to Kawa Stream resulting from the proposed expansion of the Hawaiian Memorial Cemetery. The salient facts with respect to the proposed development include:

- The proposed 56.6-acre development will contain 25.8 acres of cemetery, 15.3 acres of vegetative buffer, 9.5 acres of cultural preserve, 4.8 acres of impervious land (mausoleums, roadways, etc.) and 1.2 acres of retention features.
- A total of 4.8 acres, or about 8.5%, of the proposed development is considered impervious for the purposes of calculating runoff in the TMDL analysis.
- The developer is required to capture the excess runoff generated from the proposed development area by the 10 year, one-hour duration storm event (2.5 inches/hour).
- The required on-site retention volume to capture this excess runoff is calculated to be 78,772 cubic feet (589,215 gallons).
- The retention areas will consist of 1.20-acres of depressed turf or grassy planted areas with a maximum depth of 18 inches that are scattered throughout the cemetery.
- The soils on the project site have permeability rates that range from 2.0 to 6.3 inches/hour (Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii Soil Conservation Service), resulting in an estimated time of between 2.86 to 9 hours for the retained runoff to percolate into the soil from a filled retention basin.

The revised TMDL document (DOH, 2005) allocated the calculated stormwater runoff volume to the various land-uses and sub-basins present within the Kawa watershed. The vast majority of the proposed cemetery expansion will be located within Basin 4 of the watershed. Basin 4 is comprised in part of 135.25 acres of forest land (Table 3.1; DOH, 2005), from which 1.15 million cubic feet (~8.6 million gallons) of storm runoff is generated (Table 4.3). The proposed development will convert 56.6 acres (~42%) of the existing forest land within the Basin 4 watershed into cemetery and associated vegetative buffer and preserve lands. The runoff volume calculated in the original TMDL analysis for the 56.6 acres of land to undergo conversion was 0.481 million cubic feet (~3.6 million gallons/13.63 million liters). The mass of nutrients calculated by the original TMDL analysis to originate from the 56.6 area to be developed was calculated by multiplying the estimated runoff volume by the runoff concentration (Table 5.1; DOH, 2005) associated with forest land for the "Storm Runoff Sources" scenario (Table 1 below).

Table 1: Estimated Mass of TSS and Nutrients Entering Kawa Stream from 56.6-Acres of Forest Land Under Existing Conditions

Land Use	Runoff Concentrations (mg/L)			Estimated Runoff from 56.6 acres land (liters)	Mass in Runoff (Kg)		
	TSS	Total N	Total P		TSS	Total N	Total P
Forest Land	10	0.5	0.1	13,630,000	136.3	6.815	1.363

The runoff to Kawa stream resulting from the proposed development was calculated using the same methodology used in the revised TMDL analysis (DOH, 2005). The daily rainfall record from rainfall station 838.1 from November 1999 to October 2000 was used to calculate runoff on a daily basis for the proposed 56.6-acre development. In order to adjust the daily rainfall collected at the reference station (838.1, elevation 50 feet) to the estimated value of rainfall for Basin 4, with an estimated average elevation of 600 feet, the daily reference station rainfall was multiplied by the following relation [1]:

[1] Adjusted Basin Rainfall (inches) = [rainfall*(1 + 0.000864*600 ft)/(1 + 0.000864*50 ft] = 1.456*reference station daily rainfall

The TMDL analysis used the following rational formula runoff expression that is used for determination of pollutant loads in the City and County of Honolulu MS4 permit application:

[2] $R = (P) * (p_r) * (R_v) * A$

[3] $R_v = 0.05 + 0.9f_I$

where:

R = Runoff volume

P = Adjusted Daily Basin Rainfall (ft)

p_r = Fraction of rainfall that produces runoff (0.9 used by Honolulu)

R_v = Mean runoff coefficient

A = Area of Proposed Development (56.6 acres)

f_I = Fraction of area that is effectively impervious.

The fraction impervious area (f_I) in equation 3 for the proposed development is 0.085, which leads to a mean runoff coefficient (R_v) value for the development of 0.1265. No carryover of stored water was assumed during consecutive days of rainfall since the retention basins are designed to completely infiltrate their contents in less than 10 hours. The total volume of runoff produced by the 56.6 acre cemetery expansion was calculated on a daily basis and compared to the volume of retention designed for the proposed development (Appendix). This analysis shows that the proposed retention system, which was developed to satisfy the City and County of Honolulu's design 10-year one-hour duration (2.5 inches/hour) storm event, will capture all of the runoff generated by the daily rainfall events used to generate the Kawa watershed TMDLs. The maximum adjusted daily rainfall for the TMDL period occurred on 9/28/00 (3.01 inches) which generated 518,060 gallons of runoff from the 56.6-acre proposed development area. This runoff volume is less than the designed storage volume (589,215 gallons) of the retention systems that will be constructed within the proposed cemetery expansion area. It is interesting to note that the designed retention system will also capture all of the runoff associated with the Wet Season 2% Rainfall Event (2.30 inches) that was used to calculate runoff and pollutant load contributions in the recently completed TMDL analysis for the adjacent Kaneohe Stream watershed (DOH, 2008). Since no runoff will reach Kawa stream according to these TMDL-based calculations, a net reduction of 136.3 kg TSS, 6.82 kg total N, and 1.363 kg will result from the proposed cemetery expansion.

Table 2 summarizes the reductions required from all of the nonpoint sources (including the existing Hawaiian Memorial Park) located within the Kawa watershed in the TMDL study (DOH, 2005). The proposed development achieves approximately 27.5% of the net reduction in TSS, 17.5% of the net reduction in total nitrogen, and 17% of the net reduction in total phosphorus required for all nonpoint source areas located within the Kawa watershed by the TMDL study.

Table 2: Comparison of Load Reductions Achieved by Proposed Project to Total Reductions Required by TMDL

Load Allocations to Nonpoint Sources in Kawa Watershed						
Scenario	Existing Loads (Kg)			Reductions Required by TMDL (Kg)		
	TSS	TN	TP	TSS	TN	TP
Annual Storm Runoff	1,286	59	15	496	39	8
Net Mass TSS and Nutrients Reduced Entering Kawa Stream- 10 Year Retention Basin Design				136.3	6.82	1.363
Percentage of the Total Reduction Required by TMDL Achieved by the Proposed Project				27.5%	17.5%	17.0%

In order to evaluate potential changes to dry and wet season baseflow water quality resulting from the proposed development, baseline monitoring will be initiated at Station 16 (DOH's Monitoring Station 6). This proposed monitoring station is located in the upper portion of the Kawa watershed that receives baseflow from sub-basin 4 of the TMDL analysis (the area directly impacted by the proposed expansion) (Figure 1).

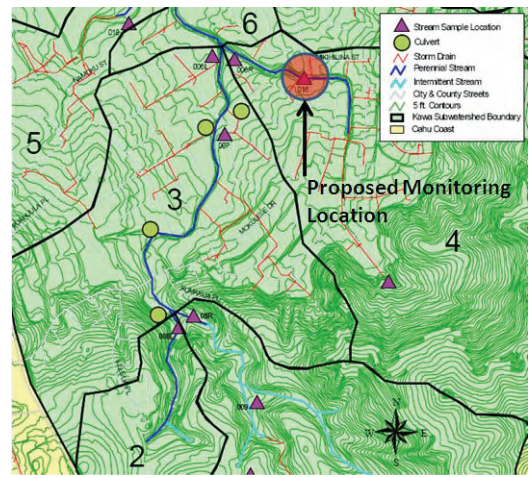


FIGURE 1: Proposed Stream Monitoring Location

In order to re-establish the baseline (pre-construction) water quality conditions at this sampling location, a minimum of four rounds of sampling should be conducted prior to the initiation of construction. In addition, quarterly groundwater monitoring will be conducted during construction activities and for the first three years of operation of the expanded cemetery. The streamflow volume will be measured at the time of sampling. The stream samples will be analyzed for the following field parameters: pH, temperature, salinity, and conductivity. The samples will be submitted to an analytical laboratory for analysis of the following constituents: total nitrogen, nitrate + nitrite nitrogen, total phosphorous and total suspended sediment. The data collected will be compared to the dry and wet season baseline water quality data collected by DOH and Oceanit between 1999 and 2000.

References:

Hawaii Department of Health, Environmental Planning Office 2005. Allocations of Total Maximum Daily Loads of Total Suspended Solids, Nitrogen and Phosphorus for Kawa Stream Kaneohe, Hawaii. Report dated June 2005.

Hawaii Department of Health, Environmental Planning Office 2008. Total Maximum Daily Loads (TMDLs) for Total Suspended Solids, Nitrogen and Phosphorus in Kaneohe Stream, Kaneohe, Hawaii. Report dated August 2008.

Oceanit, 2002. Total Maximum Daily Loads of Total Suspended Solids, Nitrogen and Phosphorus for Kawa Stream, Kaneohe, Hawaii. Report dated March 2002.

APPENDIX A

Date	Reference Rainfall (Stn 838.1)	Adjusted Rainfall for Basin 4	Volume of Rainfall on 56.6 Acre Development (gallon)	Estimated Runoff with 8.5% Impermeable Surface (gallon)	On-Development Retention Storage Volume (10-Year Design Storm) (gallon)	Net Runoff to Kawa Stream from Development
11/1/1999	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
11/2/1999	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
11/3/1999	0.13	0.19	285,772	32,535	589,215	NO RUNOFF
11/4/1999	0.22	0.32	483,615	55,060	589,215	NO RUNOFF
11/5/1999	0.12	0.17	263,790	30,032	589,215	NO RUNOFF
11/6/1999	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
11/7/1999	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
11/8/1999	0.05	0.07	109,912	12,514	589,215	NO RUNOFF
11/9/1999	0.05	0.07	109,912	12,514	589,215	NO RUNOFF
11/10/1999	0.08	0.12	175,860	20,022	589,215	NO RUNOFF
11/11/1999	0.07	0.10	153,877	17,519	589,215	NO RUNOFF
11/12/1999	0.10	0.15	219,825	25,027	589,215	NO RUNOFF
11/13/1999	0.00	0.00	0	0	589,215	NO RUNOFF
11/14/1999	0.07	0.10	153,877	17,519	589,215	NO RUNOFF
11/15/1999	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
11/16/1999	0.00	0.00	0	0	589,215	NO RUNOFF
11/17/1999	0.00	0.00	0	0	589,215	NO RUNOFF
11/18/1999	0.11	0.16	241,807	27,530	589,215	NO RUNOFF
11/19/1999	0.05	0.07	109,912	12,514	589,215	NO RUNOFF
11/20/1999	0.07	0.10	153,877	17,519	589,215	NO RUNOFF
11/21/1999	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
11/22/1999	0.00	0.00	0	0	589,215	NO RUNOFF
11/23/1999	0.00	0.00	0	0	589,215	NO RUNOFF
11/24/1999	0.00	0.00	0	0	589,215	NO RUNOFF
11/25/1999	0.00	0.00	0	0	589,215	NO RUNOFF
11/26/1999	0.08	0.12	175,860	20,022	589,215	NO RUNOFF
11/27/1999	0.00	0.00	0	0	589,215	NO RUNOFF
11/28/1999	0.05	0.07	109,912	12,514	589,215	NO RUNOFF
11/29/1999	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
11/30/1999	0.00	0.00	0	0	589,215	NO RUNOFF
12/1/1999	0.45	0.66	989,212	112,622	589,215	NO RUNOFF
12/2/1999	0.57	0.83	1,253,002	142,654	589,215	NO RUNOFF
12/3/1999	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
12/4/1999	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
12/5/1999	0.21	0.31	461,632	52,557	589,215	NO RUNOFF

Date	Reference Rainfall (Stn 838.1)	Adjusted Rainfall for Basin 4	Volume of Rainfall on 56.6 Acre Development (gallon)	Estimated Runoff with 8.5% Impermeable Surface (gallon)	On-Development Retention Storage Volume (10-Year Design Storm) (gallon)	Net Runoff to Kawa Stream from Development
12/6/1999	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
12/7/1999	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
12/8/1999	0.00	0.00	0	0	589,215	NO RUNOFF
12/9/1999	0.06	0.09	131,895	15,016	589,215	NO RUNOFF
12/10/1999	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
12/11/1999	2.02	2.94	4,440,465	505,547	589,215	NO RUNOFF
12/12/1999	0.54	0.79	1,187,055	135,146	589,215	NO RUNOFF
12/13/1999	0.12	0.17	263,790	30,032	589,215	NO RUNOFF
12/14/1999	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
12/15/1999	0.39	0.57	857,317	97,606	589,215	NO RUNOFF
12/16/1999	0.00	0.00	0	0	589,215	NO RUNOFF
12/17/1999	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
12/18/1999	0.60	0.87	1,318,950	150,162	589,215	NO RUNOFF
12/19/1999	0.05	0.07	109,912	12,514	589,215	NO RUNOFF
12/20/1999	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
12/21/1999	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
12/22/1999	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
12/23/1999	0.50	0.73	1,099,125	125,135	589,215	NO RUNOFF
12/24/1999	0.15	0.22	329,737	37,541	589,215	NO RUNOFF
12/25/1999	0.00	0.00	0	0	589,215	NO RUNOFF
12/26/1999	0.10	0.15	219,825	25,027	589,215	NO RUNOFF
12/27/1999	0.46	0.67	1,011,195	115,125	589,215	NO RUNOFF
12/28/1999	0.00	0.00	0	0	589,215	NO RUNOFF
12/29/1999	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
12/30/1999	0.20	0.29	439,650	50,054	589,215	NO RUNOFF
12/31/1999	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
1/1/2000	0.00	0.00	0	0	589,215	NO RUNOFF
1/2/2000	0.00	0.00	0	0	589,215	NO RUNOFF
1/3/2000	0.00	0.00	0	0	589,215	NO RUNOFF
1/4/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
1/5/2000	0.00	0.00	0	0	589,215	NO RUNOFF
1/6/2000	0.12	0.17	263,790	30,032	589,215	NO RUNOFF
1/7/2000	0.06	0.09	131,895	15,016	589,215	NO RUNOFF
1/8/2000	0.00	0.00	0	0	589,215	NO RUNOFF
1/9/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
1/10/2000	0.11	0.16	241,807	27,530	589,215	NO RUNOFF
1/11/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
1/12/2000	0.11	0.16	241,807	27,530	589,215	NO RUNOFF
1/13/2000	0.05	0.07	109,912	12,514	589,215	NO RUNOFF

Date	Reference Rainfall (Stn 838.1)	Adjusted Rainfall for Basin 4	Volume of Rainfall on 56.6 Acre Development (gallon)	Estimated Runoff with 8.5% Impermeable Surface (gallon)	On-Development Retention Storage Volume (10-Year Design Storm) (gallon)	Net Runoff to Kawa Stream from Development
1/14/2000	0.64	0.93	1,406,880	160,173	589,215	NO RUNOFF
1/15/2000	0.23	0.33	505,597	57,562	589,215	NO RUNOFF
1/16/2000	0.17	0.25	373,702	42,546	589,215	NO RUNOFF
1/17/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
1/18/2000	0.13	0.19	285,772	32,535	589,215	NO RUNOFF
1/19/2000	0.16	0.23	351,720	40,043	589,215	NO RUNOFF
1/20/2000	1.74	2.53	3,824,955	435,471	589,215	NO RUNOFF
1/21/2000	0.45	0.66	989,212	112,622	589,215	NO RUNOFF
1/22/2000	0.05	0.07	109,912	12,514	589,215	NO RUNOFF
1/23/2000	0.00	0.00	0	0	589,215	NO RUNOFF
1/24/2000	0.00	0.00	0	0	589,215	NO RUNOFF
1/25/2000	0.00	0.00	0	0	589,215	NO RUNOFF
1/26/2000	0.00	0.00	0	0	589,215	NO RUNOFF
1/27/2000	0.41	0.60	901,282	102,611	589,215	NO RUNOFF
1/28/2000	0.00	0.00	0	0	589,215	NO RUNOFF
1/29/2000	0.00	0.00	0	0	589,215	NO RUNOFF
1/30/2000	0.00	0.00	0	0	589,215	NO RUNOFF
1/31/2000	0.00	0.00	0	0	589,215	NO RUNOFF
2/1/2000	0.17	0.25	373,702	42,546	589,215	NO RUNOFF
2/2/2000	0.00	0.00	0	0	589,215	NO RUNOFF
2/3/2000	0.00	0.00	0	0	589,215	NO RUNOFF
2/4/2000	0.00	0.00	0	0	589,215	NO RUNOFF
2/5/2000	0.00	0.00	0	0	589,215	NO RUNOFF
2/6/2000	0.00	0.00	0	0	589,215	NO RUNOFF
2/7/2000	0.00	0.00	0	0	589,215	NO RUNOFF
2/8/2000	0.00	0.00	0	0	589,215	NO RUNOFF
2/9/2000	0.00	0.00	0	0	589,215	NO RUNOFF
2/10/2000	0.00	0.00	0	0	589,215	NO RUNOFF
2/11/2000	0.00	0.00	0	0	589,215	NO RUNOFF
2/12/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
2/13/2000	0.00	0.00	0	0	589,215	NO RUNOFF
2/14/2000	0.00	0.00	0	0	589,215	NO RUNOFF
2/15/2000	0.00	0.00	0	0	589,215	NO RUNOFF
2/16/2000	0.00	0.00	0	0	589,215	NO RUNOFF
2/17/2000	0.00	0.00	0	0	589,215	NO RUNOFF
2/18/2000	0.00	0.00	0	0	589,215	NO RUNOFF
2/19/2000	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
2/20/2000	0.00	0.00	0	0	589,215	NO RUNOFF
2/21/2000	0.00	0.00	0	0	589,215	NO RUNOFF

Date	Reference Rainfall (Stn 838.1)	Adjusted Rainfall for Basin 4	Volume of Rainfall on 56.6 Acre Development (gallon)	Estimated Runoff with 8.5% Impermeable Surface (gallon)	On-Development Retention Storage Volume (10-Year Design Storm) (gallon)	Net Runoff to Kawa Stream from Development
2/22/2000	0.08	0.12	175,860	20,022	589,215	NO RUNOFF
2/23/2000	0.00	0.00	0	0	589,215	NO RUNOFF
2/24/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
2/25/2000	0.00	0.00	0	0	589,215	NO RUNOFF
2/26/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
2/27/2000	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
2/28/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
2/29/2000	0.00	0.00	0	0	589,215	NO RUNOFF
3/1/2000	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
3/2/2000	0.00	0.00	0	0	589,215	NO RUNOFF
3/3/2000	0.00	0.00	0	0	589,215	NO RUNOFF
3/4/2000	0.00	0.00	0	0	589,215	NO RUNOFF
3/5/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
3/6/2000	0.00	0.00	0	0	589,215	NO RUNOFF
3/7/2000	0.00	0.00	0	0	589,215	NO RUNOFF
3/8/2000	0.00	0.00	0	0	589,215	NO RUNOFF
3/9/2000	0.00	0.00	0	0	589,215	NO RUNOFF
3/10/2000	0.00	0.00	0	0	589,215	NO RUNOFF
3/11/2000	0.00	0.00	0	0	589,215	NO RUNOFF
3/12/2000	0.00	0.00	0	0	589,215	NO RUNOFF
3/13/2000	0.00	0.00	0	0	589,215	NO RUNOFF
3/14/2000	0.00	0.00	0	0	589,215	NO RUNOFF
3/15/2000	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
3/16/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
3/17/2000	0.00	0.00	0	0	589,215	NO RUNOFF
3/18/2000	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
3/19/2000	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
3/20/2000	0.00	0.00	0	0	589,215	NO RUNOFF
3/21/2000	0.00	0.00	0	0	589,215	NO RUNOFF
3/22/2000	0.06	0.09	131,895	15,016	589,215	NO RUNOFF
3/23/2000	0.10	0.15	219,825	25,027	589,215	NO RUNOFF
3/24/2000	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
3/25/2000	0.09	0.13	197,842	22,524	589,215	NO RUNOFF
3/26/2000	0.23	0.33	505,597	57,562	589,215	NO RUNOFF
3/27/2000	0.48	0.70	1,055,160	120,130	589,215	NO RUNOFF
3/28/2000	0.20	0.29	439,650	50,054	589,215	NO RUNOFF
3/29/2000	0.05	0.07	109,912	12,514	589,215	NO RUNOFF
3/30/2000	0.27	0.39	593,527	67,573	589,215	NO RUNOFF
3/31/2000	0.44	0.64	967,230	110,119	589,215	NO RUNOFF

Date	Reference Rainfall (Stn 838.1)	Adjusted Rainfall for Basin 4	Volume of Rainfall on 56.6 Acre Development (gallon)	Estimated Runoff with 8.5% Impermeable Surface (gallon)	On-Development Retention Storage Volume (10-Year Design Storm) (gallon)	Net Runoff to Kawa Stream from Development
4/1/2000	1.31	1.91	2,879,707	327,855	589,215	NO RUNOFF
4/2/2000	0.19	0.28	417,667	47,551	589,215	NO RUNOFF
4/3/2000	0.67	0.98	1,472,827	167,681	589,215	NO RUNOFF
4/4/2000	0.05	0.07	109,912	12,514	589,215	NO RUNOFF
4/5/2000	0.08	0.12	175,860	20,022	589,215	NO RUNOFF
4/6/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
4/7/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
4/8/2000	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
4/9/2000	0.36	0.52	791,370	90,097	589,215	NO RUNOFF
4/10/2000	0.06	0.09	131,895	15,016	589,215	NO RUNOFF
4/11/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
4/12/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
4/13/2000	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
4/14/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
4/15/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
4/16/2000	0.00	0.00	0	0	589,215	NO RUNOFF
4/17/2000	0.10	0.15	219,825	25,027	589,215	NO RUNOFF
4/18/2000	0.07	0.10	153,877	17,519	589,215	NO RUNOFF
4/19/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
4/20/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
4/21/2000	0.10	0.15	219,825	25,027	589,215	NO RUNOFF
4/22/2000	0.00	0.00	0	0	589,215	NO RUNOFF
4/23/2000	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
4/24/2000	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
4/25/2000	0.06	0.09	131,895	15,016	589,215	NO RUNOFF
4/26/2000	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
4/27/2000	0.07	0.10	153,877	17,519	589,215	NO RUNOFF
4/28/2000	0.00	0.00	0	0	589,215	NO RUNOFF
4/29/2000	0.00	0.00	0	0	589,215	NO RUNOFF
4/30/2000	0.00	0.00	0	0	589,215	NO RUNOFF
5/1/2000	0.00	0.00	0	0	589,215	NO RUNOFF
5/2/2000	0.00	0.00	0	0	589,215	NO RUNOFF
5/3/2000	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
5/4/2000	0.00	0.00	0	0	589,215	NO RUNOFF
5/5/2000	0.00	0.00	0	0	589,215	NO RUNOFF
5/6/2000	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
5/7/2000	0.09	0.13	197,842	22,524	589,215	NO RUNOFF
5/8/2000	0.00	0.00	0	0	589,215	NO RUNOFF
5/9/2000	0.00	0.00	0	0	589,215	NO RUNOFF

Date	Reference Rainfall (Stn 838.1)	Adjusted Rainfall for Basin 4	Volume of Rainfall on 56.6 Acre Development (gallon)	Estimated Runoff with 8.5% Impermeable Surface (gallon)	On-Development Retention Storage Volume (10-Year Design Storm) (gallon)	Net Runoff to Kawa Stream from Development
5/10/2000	0.00	0.00	0	0	589,215	NO RUNOFF
5/11/2000	0.05	0.07	109,912	12,514	589,215	NO RUNOFF
5/12/2000	0.25	0.36	549,562	62,568	589,215	NO RUNOFF
5/13/2000	0.07	0.10	153,877	17,519	589,215	NO RUNOFF
5/14/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
5/15/2000	0.00	0.00	0	0	589,215	NO RUNOFF
5/16/2000	0.00	0.00	0	0	589,215	NO RUNOFF
5/17/2000	0.61	0.89	1,340,932	152,665	589,215	NO RUNOFF
5/18/2000	0.00	0.00	0	0	589,215	NO RUNOFF
5/19/2000	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
5/20/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
5/21/2000	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
5/22/2000	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
5/23/2000	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
5/24/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
5/25/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
5/26/2000	0.00	0.00	0	0	589,215	NO RUNOFF
5/27/2000	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
5/28/2000	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
5/29/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
5/30/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
5/31/2000	0.05	0.07	109,912	12,514	589,215	NO RUNOFF
6/1/2000	0.06	0.09	131,895	15,016	589,215	NO RUNOFF
6/2/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
6/3/2000	0.00	0.00	0	0	589,215	NO RUNOFF
6/4/2000	0.00	0.00	0	0	589,215	NO RUNOFF
6/5/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
6/6/2000	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
6/7/2000	0.20	0.29	439,650	50,054	589,215	NO RUNOFF
6/8/2000	0.18	0.26	395,685	45,049	589,215	NO RUNOFF
6/9/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
6/10/2000	0.00	0.00	0	0	589,215	NO RUNOFF
6/11/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
6/12/2000	0.00	0.00	0	0	589,215	NO RUNOFF
6/13/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
6/14/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
6/15/2000	0.00	0.00	0	0	589,215	NO RUNOFF
6/16/2000	0.00	0.00	0	0	589,215	NO RUNOFF
6/17/2000	0.07	0.10	153,877	17,519	589,215	NO RUNOFF

Date	Reference Rainfall (Stn 838.1)	Adjusted Rainfall for Basin 4	Volume of Rainfall on 56.6 Acre Development (gallon)	Estimated Runoff with 8.5% Impermeable Surface (gallon)	On-Development Retention Storage Volume (10-Year Design Storm) (gallon)	Net Runoff to Kawa Stream from Development
6/18/2000	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
6/19/2000	0.00	0.00	0	0	589,215	NO RUNOFF
6/20/2000	0.00	0.00	0	0	589,215	NO RUNOFF
6/21/2000	0.08	0.12	175,860	20,022	589,215	NO RUNOFF
6/22/2000	0.05	0.07	109,912	12,514	589,215	NO RUNOFF
6/23/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
6/24/2000	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
6/25/2000	0.07	0.10	153,877	17,519	589,215	NO RUNOFF
6/26/2000	0.06	0.09	131,895	15,016	589,215	NO RUNOFF
6/27/2000	0.00	0.00	0	0	589,215	NO RUNOFF
6/28/2000	0.15	0.22	329,737	37,541	589,215	NO RUNOFF
6/29/2000	0.05	0.07	109,912	12,514	589,215	NO RUNOFF
6/30/2000	0.07	0.10	153,877	17,519	589,215	NO RUNOFF
7/1/2000	0.13	0.19	285,772	32,535	589,215	NO RUNOFF
7/2/2000	0.31	0.45	681,457	77,584	589,215	NO RUNOFF
7/3/2000	0.05	0.07	109,912	12,514	589,215	NO RUNOFF
7/4/2000	0.05	0.07	109,912	12,514	589,215	NO RUNOFF
7/5/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
7/6/2000	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
7/7/2000	0.00	0.00	0	0	589,215	NO RUNOFF
7/8/2000	0.00	0.00	0	0	589,215	NO RUNOFF
7/9/2000	0.00	0.00	0	0	589,215	NO RUNOFF
7/10/2000	0.00	0.00	0	0	589,215	NO RUNOFF
7/11/2000	0.10	0.15	219,825	25,027	589,215	NO RUNOFF
7/12/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
7/13/2000	0.00	0.00	0	0	589,215	NO RUNOFF
7/14/2000	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
7/15/2000	0.20	0.29	439,650	50,054	589,215	NO RUNOFF
7/16/2000	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
7/17/2000	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
7/18/2000	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
7/19/2000	0.00	0.00	0	0	589,215	NO RUNOFF
7/20/2000	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
7/21/2000	0.38	0.55	835,335	95,103	589,215	NO RUNOFF
7/22/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
7/23/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
7/24/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
7/25/2000	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
7/26/2000	0.10	0.15	219,825	25,027	589,215	NO RUNOFF

Date	Reference Rainfall (Stn 838.1)	Adjusted Rainfall for Basin 4	Volume of Rainfall on 56.6 Acre Development (gallon)	Estimated Runoff with 8.5% Impermeable Surface (gallon)	On-Development Retention Storage Volume (10-Year Design Storm) (gallon)	Net Runoff to Kawa Stream from Development
7/27/2000	0.05	0.07	109,912	12,514	589,215	NO RUNOFF
7/28/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
7/29/2000	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
7/30/2000	0.00	0.00	0	0	589,215	NO RUNOFF
7/31/2000	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
8/1/2000	0.14	0.20	307,755	35,038	589,215	NO RUNOFF
8/2/2000	0.10	0.15	219,825	25,027	589,215	NO RUNOFF
8/3/2000	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
8/4/2000	0.00	0.00	0	0	589,215	NO RUNOFF
8/5/2000	0.15	0.22	329,737	37,541	589,215	NO RUNOFF
8/6/2000	0.00	0.00	0	0	589,215	NO RUNOFF
8/7/2000	0.00	0.00	0	0	589,215	NO RUNOFF
8/8/2000	0.00	0.00	0	0	589,215	NO RUNOFF
8/9/2000	0.00	0.00	0	0	589,215	NO RUNOFF
8/10/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
8/11/2000	0.00	0.00	0	0	589,215	NO RUNOFF
8/12/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
8/13/2000	0.00	0.00	0	0	589,215	NO RUNOFF
8/14/2000	0.00	0.00	0	0	589,215	NO RUNOFF
8/15/2000	0.00	0.00	0	0	589,215	NO RUNOFF
8/16/2000	0.00	0.00	0	0	589,215	NO RUNOFF
8/17/2000	0.20	0.29	439,650	50,054	589,215	NO RUNOFF
8/18/2000	0.27	0.39	593,527	67,573	589,215	NO RUNOFF
8/19/2000	0.00	0.00	0	0	589,215	NO RUNOFF
8/20/2000	0.10	0.15	219,825	25,027	589,215	NO RUNOFF
8/21/2000	1.50	2.18	3,297,375	375,406	589,215	NO RUNOFF
8/22/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
8/23/2000	0.00	0.00	0	0	589,215	NO RUNOFF
8/24/2000	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
8/25/2000	0.00	0.00	0	0	589,215	NO RUNOFF
8/26/2000	0.00	0.00	0	0	589,215	NO RUNOFF
8/27/2000	0.11	0.16	241,807	27,530	589,215	NO RUNOFF
8/28/2000	0.14	0.20	307,755	35,038	589,215	NO RUNOFF
8/29/2000	0.19	0.28	417,667	47,551	589,215	NO RUNOFF
8/30/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
8/31/2000	0.00	0.00	0	0	589,215	NO RUNOFF
9/1/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
9/2/2000	0.00	0.00	0	0	589,215	NO RUNOFF
9/3/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF

Date	Reference Rainfall (Stn 838.1)	Adjusted Rainfall for Basin 4	Volume of Rainfall on 56.6 Acre Development (gallon)	Estimated Runoff with 8.5% Impermeable Surface (gallon)	On-Development Retention Storage Volume (10-Year Design Storm) (gallon)	Net Runoff to Kawa Stream from Development
9/4/2000	0.00	0.00	0	0	589,215	NO RUNOFF
9/5/2000	0.19	0.28	417,667	47,551	589,215	NO RUNOFF
9/6/2000	0.44	0.64	967,230	110,119	589,215	NO RUNOFF
9/7/2000	0.05	0.07	109,912	12,514	589,215	NO RUNOFF
9/8/2000	0.14	0.20	307,755	35,038	589,215	NO RUNOFF
9/9/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
9/10/2000	0.00	0.00	0	0	589,215	NO RUNOFF
9/11/2000	0.03	0.04	65,947	7,508	589,215	NO RUNOFF
9/12/2000	0.09	0.13	197,842	22,524	589,215	NO RUNOFF
9/13/2000	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
9/14/2000	1.29	1.88	2,835,742	322,849	589,215	NO RUNOFF
9/15/2000	0.05	0.07	109,912	12,514	589,215	NO RUNOFF
9/16/2000	0.00	0.00	0	0	589,215	NO RUNOFF
9/17/2000	0.00	0.00	0	0	589,215	NO RUNOFF
9/18/2000	0.14	0.20	307,755	35,038	589,215	NO RUNOFF
9/19/2000	0.00	0.00	0	0	589,215	NO RUNOFF
9/20/2000	0.25	0.36	549,562	62,568	589,215	NO RUNOFF
9/21/2000	0.21	0.31	461,632	52,557	589,215	NO RUNOFF
9/22/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
9/23/2000	0.00	0.00	0	0	589,215	NO RUNOFF
9/24/2000	0.00	0.00	0	0	589,215	NO RUNOFF
9/25/2000	0.00	0.00	0	0	589,215	NO RUNOFF
9/26/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
9/27/2000	0.30	0.44	659,475	75,081	589,215	NO RUNOFF
9/28/2000	2.07	3.01	4,550,377	518,060	589,215	NO RUNOFF
9/29/2000	0.20	0.29	439,650	50,054	589,215	NO RUNOFF
9/30/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
10/1/2000	0.00	0.00	0	0	589,215	NO RUNOFF
10/2/2000	0.00	0.00	0	0	589,215	NO RUNOFF
10/3/2000	0.00	0.00	0	0	589,215	NO RUNOFF
10/4/2000	0.00	0.00	0	0	589,215	NO RUNOFF
10/5/2000	0.10	0.15	219,825	25,027	589,215	NO RUNOFF
10/6/2000	0.00	0.00	0	0	589,215	NO RUNOFF
10/7/2000	0.00	0.00	0	0	589,215	NO RUNOFF
10/8/2000	0.00	0.00	0	0	589,215	NO RUNOFF
10/9/2000	0.06	0.09	131,895	15,016	589,215	NO RUNOFF
10/10/2000	0.00	0.00	0	0	589,215	NO RUNOFF
10/11/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
10/12/2000	0.09	0.13	197,842	22,524	589,215	NO RUNOFF

Date	Reference Rainfall (Stn 838.1)	Adjusted Rainfall for Basin 4	Volume of Rainfall on 56.6 Acre Development (gallon)	Estimated Runoff with 8.5% Impermeable Surface (gallon)	On-Development Retention Storage Volume (10-Year Design Storm) (gallon)	Net Runoff to Kawa Stream from Development
10/13/2000	0.00	0.00	0	0	589,215	NO RUNOFF
10/14/2000	0.23	0.33	505,597	57,562	589,215	NO RUNOFF
10/15/2000	0.00	0.00	0	0	589,215	NO RUNOFF
10/16/2000	0.04	0.06	87,930	10,011	589,215	NO RUNOFF
10/17/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
10/18/2000	0.01	0.01	21,982	2,503	589,215	NO RUNOFF
10/19/2000	0.30	0.44	659,475	75,081	589,215	NO RUNOFF
10/20/2000	0.02	0.03	43,965	5,005	589,215	NO RUNOFF
10/21/2000	0.00	0.00	0	0	589,215	NO RUNOFF
10/22/2000	0.00	0.00	0	0	589,215	NO RUNOFF
10/23/2000	0.00	0.00	0	0	589,215	NO RUNOFF
10/24/2000	0.09	0.13	197,842	22,524	589,215	NO RUNOFF
10/25/2000	0.09	0.13	197,842	22,524	589,215	NO RUNOFF
10/26/2000	0.07	0.10	153,877	17,519	589,215	NO RUNOFF
10/27/2000	0.00	0.00	0	0	589,215	NO RUNOFF
10/28/2000	0.00	0.00	0	0	589,215	NO RUNOFF
10/29/2000	0.38	0.55	835,335	95,103	589,215	NO RUNOFF
10/30/2000	1.33	1.94	2,923,672	332,860	589,215	NO RUNOFF
10/31/2000	0.09	0.13	197,842	22,524	589,215	NO RUNOFF